

Прикладная эконометрика, 2018, т. 49, с. 91–114.

Applied Econometrics, 2018, v. 49, pp. 91–114.

V. Belousova, A. Karminsky, I. Kozyr¹

The macroeconomic and institutional determinants of the profit efficiency frontier for Russian banks

This paper investigates how institutional and macroeconomic factors influence the profit efficiency frontier of Russian banks. We demonstrate that the macroeconomic environment is crucial for constructing the profit frontier. The cargo transportation index, exchange rate, and intermediation ratio have a positive relationship with this efficiency frontier while the share of loan loss provision in the loan portfolio is negatively associated with it. In addition, we find that such institutional determinants as a bank's location, branch network diversity, and ownership type matter for constructing this frontier.

Keywords: bank; profit efficiency frontier; macroeconomic factors; institutional factors; Russia.

JEL classification: G21; L16; L25; P34.

1. Introduction

Bank efficiency tends to promote the economic growth of countries, including those that have a bank-based financial sector (Hasan et al., 2009; Koetter, Wedow, 2010). Therefore, scholars have analyzed the efficiency of banking sectors in general and the efficiency scores of individual banks in particular. Several different techniques are used to assess the efficiency scores and Stochastic Frontier Analysis (SFA), which is one of the most popular approaches (Berger, Humphrey, 1997; Lensink et al., 2008).

There are two sets of factors that explain the efficiency scores of banks: bank characteristics such as size, asset structure, ownership types (Berger et al., 1993; Bonin et al., 2005a; Karas et al., 2010) and macroeconomic (including industry-specific) indicators (Dietsch, Lozano-Vivas, 2000; Lozano-Vivas, Pastor, 2010). Our paper sheds some light on the key determinants of the profit efficiency frontier for Russian banks from both macroeconomic and institutional perspectives. This combination of factors is of interest for examination given that the macroeconomic indicators are frequently used as both control variables (Dietrich, Wanzenried, 2014) and key variables (Lozano-Vivas, Pastor, 2010) in the papers that are devoted to developed countries (for Russia, such studies are scarce (Belousova, Kozyr, 2016; Kumbhakar, Peresetsky, 2013). In addition, over the last decade, scholars have received con-

¹ Belousova Veronika — National Research University Higher School of Economics, Moscow; vbelousova@hse.ru.
Karminsky Alexander — National Research University Higher School of Economics, Moscow; akarminsky@hse.ru.
Kozyr Ilya — Fraud Investigations and Dispute Services, EY Russia, Moscow; ilya-2@mail.ru.

troversial evidence when exploring the efficiency of banks with different types of ownership. For example, Fries and Taci (2005) found that state-owned banks were the least efficient, Karas et al. (2010) demonstrated that state-owned banks were as efficient as private ones while foreign banks were the most efficient financial institutions. Mamonov and Vernikov (2017) concluded that state-owned banks were more efficient than others and foreign banks were the least efficient.

Moreover, we also add value in providing evidence on the revenue side of banking efficiency in Russia as previous studies focus on cost efficiency (Karas et al., 2010; Mamonov, Vernikov, 2017). Our results are important as being cost efficient means having the lowest costs; however, higher costs might be covered by higher revenues, this leads a cost inefficient bank being profit efficient.

Finally, we also take into account the location of bank's headquarters and include the structure of a bank's branch network in our model and find that the location of the headquarters and the number of branches play a prominent role in determining the profit efficiency frontier. For the Russian banking sector, previous scholars focus only on the location of banks' headquarters (Styrin, 2005; Golovan, 2006; Fungáčová, Solanko, 2009) but actually we observe a huge difference between two banks with the headquarters in Moscow when the former has no branches and the latter has more than 10 branches.

Taking these gaps into account, we explore the profit efficiency frontier of Russian banks taking into consideration both macroeconomic and institutional factors. As macroeconomic factors, we use the cargo transportation index (which describes economic activity), the exchange rate (illustrates the volatility of the Russian ruble), the intermediation ratio (shows the roles of the financial intermediary performed by banking sector) and the share of loan loss provision in the loan portfolio (characterizes credit risk in the banking system). Furthermore, we compare different groups of Russian banks in terms of sensitivity to changes in these factors.

The paper is structured as follows. Section 2 presents the literature review on measuring banking efficiency. The empirical model and data are described in Section 3 and 4, respectively. The baseline empirical results and the determinants of the efficiency frontier by bank's location and branch network diversity are discussed in Section 5. A robustness check is presented in Section 6. In Section 7, we draw our conclusions.

2. Literature review

Many scholars have addressed the issue of measuring banking efficiency. By studying US banks, A. Berger, D. Humphrey, and L. Mester have contributed a great deal to this field of research (Berger, Humphrey, 1991; Berger et al., 1993, 1997; Berger, Mester, 1997). As a rule, the balance sheet and profit and loss statement are generally employed for both banking efficiency (Berger et al., 1993, 1997) and banking profitability (Goddard et al. 2004; Athanasoglou et al., 2008). Earlier, the profitability and efficiency of banks fully depended on bank-specific determinants which the CAMELS methodology (capital adequacy, asset quality, management, earnings, liquidity and sensitivity to risk) proposes. However, recently, many authors used these factors as control variables and focused on other institutional factors such as a bank's ownership structure and location or incorporated the characteristics of the macroeconomic conditions in which banks operate.

2.1. Institutional factors

Institutional variables are often measured by the types of bank ownership and the location of banks. Many researchers analyzed whether state-owned banks were better in terms of key performance indicators than others. La Porta et al. (2002) showed that the state ownership of banks was associated with slower subsequent financial development and lower per capita income and productivity. Moreover, the majority of cross-country studies found that state-owned banks were less efficient in developing countries (Bonin et al., 2005a, b). The researchers concluded that privatization led to the rapid development of banking sectors in European countries.

Fries and Taci (2005), Grigorian and Manole (2006) included Russian banks in their samples and also concluded that state-owned banks were the least efficient ones. They believed that state-owned banks had fewer capabilities in attracting demand for their services and they set significantly lower net interest margins in comparison with other banks (Drakos, 2003). Moreover, namely the «political» approach argued that state-owned banks brought a lot of policy-motivated loans and subsidies to supporters approved by the state (La Porta et al., 2002)

The evidence from Russia showed mixed results. Karas et al. (2010) demonstrated that state-owned banks were at least as efficient as private banks; Mamonov and Vernikov (2017) concluded that these banks were even more efficient than others mainly due to the government support they received. For example, the state created banks known as «national champions» (Vernikov, 2013), which had a significant market.

A large number of studies on banking efficiency aimed to compare foreign-owned banks and domestic ones. Both the separate analysis of developing European countries (Jemric, Vujcic, 2002; Weill, 2003; Havrylchyk, 2006) and cross-country studies (Fries, Taci, 2005) provided empirical evidence that allowed researchers to support the hypothesis for superior efficiency scores attributed to foreign-owned banks. This hypothesis was also confirmed for the Russian banking sector (Styrin, 2005; Karas et al., 2010). Many researchers believed that advanced technology, superior management and access to cheaper funding from parent banks were critical competitive advantages for these banks (Styrin, 2005; Karas et al., 2010). In contrast, Lensink et al. (2008) concluded that for a large number of countries foreign-owned banks were not the most efficient. Berger et al. (2000) called this result the «home field advantage hypothesis» when foreign banks faced country-specific differences. Mamonov and Vernikov (2017) supported this result for foreign-owned banks in Russia.

Furthermore, Berger and DeYoung (1997) analyzed efficiency by considering where banks were located and found that dummies for different states were statistically significant but not in all cases. A number of subsequent researchers focused on the interconnection between banking efficiency and the location of banks (Bos, Kool, 2006; Sun et al., 2013). The importance of regional specific factors was confirmed for Russian banks (Styrin, 2005; Golovan, 2006; Fungáčová, Solanko, 2009). Researchers compared Moscow banks with other regional banks or Moscow banks with Saint-Petersburg banks and with other banks and found that Moscow banks were less efficient than regional ones because they faced higher competition and had to spend more money on advertising and marketing (Styrin, 2005). However, some researchers (Golovan, 2006; Fungáčová, Solanko, 2009) found opposite results and showed that Moscow banks are more efficient and more stable than others.

2.2. Macroeconomic factors

Before bringing the Maastricht Treaty into force and repealing the Glass–Steagall act, only a few banks operated abroad due to the restrictive legislative banking framework (Berg et al., 1993, 2000). Then, the liberalization of banking regulations created favorable conditions for the rapid growth and development of banks and the international activity of banks increased rapidly and banking markets became more competitive than ever. However, banks also faced such difficulties as unfamiliar foreign markets and specific macroeconomic conditions. In these circumstances, external macroeconomic factors played a crucial role as the determinants of banking efficiency.

Dietsch and Lozano-Vivas (2000) first prepared a classification of macroeconomic variables in detail. They categorized macroeconomic variables into three groups. The first described the main macroeconomic conditions under which banks operated. This group included such indicators as population density, per capita income, and the density of demand. The second group of factors analyzed the structure and regulation of the banking industry. This group had such variables as the degree of concentration, average capital ratio, and intermediation ratio (loans to deposits ratio). Finally, the third group focused on the accessibility of banking services for customers and measured this as the number of branches per km².

Later, researchers added some new indicators to each group of macroeconomic variables. For example, such parameters as inflation and the exchange rate were intensively used for emerging markets. For the case of Russia, high inflation was associated with higher profitability (Mamonov, 2011), and the depreciation of the national currency increased banking efficiency (Cancer, Kontorovich, 2004). In addition, Chaffai et al. (2001) added the number of branches per inhabitant in the second group as a proxy for competition. Lozano-Vivas et al. (2002) introduced the amount of deposits per branch in the third group: The higher this indicator was, the lower costs and higher profitability of the banking sector might be.

Moreover, Dietsch and Lozano-Vivas (2000) provided the deepest empirical study that analyzed how adding the macroeconomic factors affects the efficiency frontier and efficiency scores. The scholars assumed that including macroeconomic factors in the efficiency frontier could both increase the efficiency scores and cut the excessive differences between countries. The authors used a two-step approach. The first step analyzed a common efficiency frontier without environmental factors. The results indicated a high inefficiency score and an extremely large gap between these scores across countries. The second step allowed the authors to add a set of environmental factors in the efficiency frontier. The results supported the main hypothesis and showed that macroeconomic factors played an important role in banking efficiency studies and had to be included in the efficiency frontier.

Moreover, a number of subsequent studies focused on the interconnection between macroeconomic factors and banking efficiency (Chaffai et al., 2001; Casu, Molyneux, 2003; Lozano-Vivas et al., 2001, 2002; Albertazzi, Gambacorta, 2009; Lozano-Vivas, Pastor 2010) and indicated how crucial getting accurate and unbiased efficiency scores was. Furthermore, in recent years a lot of research studies have integrated macroeconomic factors in empirical studies as a set of control variables (Athanasoglou et al., 2008; Kosmidou, Zopounidis, 2008; Bonin, Louie, 2015). These factors were significant and had a positive impact on banking efficiency and profitability.

In addition, several studies focused on macroeconomic factors in terms of Russian banking efficiency and included these factors in the efficiency frontiers. They include both comparative

studies (Caner, Kontorovich, 2004; Fries, Taci, 2005; Yildirim, Philippatos, 2007) and studies devoted to Russian banks only (Pavlyuk, 2006; Mamonov, 2011; Mamonov, Vernikov, 2017). Overall, these studies highlighted the positive influence of macroeconomic factors on the efficiency scores of Russian banks. The cross-country studies used different macroeconomic indicators such as inflation, exchange rate, GDP per capita, the density of demand, and intermediation ratio. When authors analyzed Russian banks only, they included aggregate deposits and loans, inflation, M2 money aggregator, average salary, and average income per capita.

Other scholars focused mostly on the link between macroeconomic factors and banking profitability which was usually measured by ROA and ROE (Athanasoglou et al., 2008; Trujillo-Ponce, 2013; Dietrich, Wanzenried, 2014). They used a variety of macroeconomic factors such as inflation, concentration indicators, the term structure of the interest rate, inflation, GDP or growth rate, stock-market capitalization and volatility, and the ratio of banking lending to GDP. The authors also showed that external factors were an important determinant of banking profitability in Europe and Asia.

Researchers also explored external macroeconomic factors which referred to the profitability of Russian banks (Mamonov, 2011; Belousova, Kozyr, 2016) and their costs (Kumbhakar, Peresetsky, 2013). Mamonov (2011) found a positive influence of such indicators as GDP growth, inflation and the real exchange rate, and the negative influence of Herfindahl–Hirschman index and corporate tax ratio on banking profitability in the pre-crisis and crisis periods. Belousova and Kozyr (2016), by using a set of 12 macroeconomic indicators based on the classification of macroeconomic indicators proposed by Dietsch and Lozano-Vivas (2000), concluded that the exchange rate, GDP per branch and per capita, banks per 100,000 inhabitants, intermediation ratio, and the density of branches positively affected banking profitability in Russia while the density of the population, deposit per branch, inflation, and nominal salary and production index negatively affected this.

3. Methodology

We apply the SFA methodology that was first presented by Aigner et al. (1977) and Meeusen, Van der Broeck (1977) and then became one of the most widespread techniques (Appendix 1). The main idea of SFA is that the difference between optimal and total profit (or costs) might be explained by both inefficiency term u and by random disturbance v . The term u refers to a managerial inefficiency and the random disturbance v reflects a measurement error. Therefore, a stochastic inefficiency term u is actually the distance between the best practice and current results of a financial institution. Both the inefficiency term and random errors are assumed to be orthogonal to inputs, outputs, and control variables. The random term v is identically distributed with zero mean and σ_v^2 variance. In contrast, the inefficiency term is distributed as follows:

$$u_{i,t} = \exp\{-\eta(t - T_i)\} u_i. \quad (1)$$

We use the profit function which is presented below. $\Pi_{i,t}$ (total profit for the i -th bank in period t) is given by equation (2) where $Y_{i,t}$ is the number of outputs (loans and securities), $P_{i,t}$ are the prices of inputs (price of deposits, price of fixed assets and price of labor), $Z_{i,t}$ are the types

of control variables (credit risk, liquidity risk, and capital adequacy), $IF_{i,t}$ are the institutional factors and MF_i are the macroeconomic factors:

$$\Pi_{i,t} = f(Y_{i,t}, P_{i,t}, Z_{i,t}, IF_{i,t}, MF_i) + v_{i,t} - u_{i,t}. \quad (2)$$

We apply a translog specification for the profit function, which includes squared and interaction terms of inputs and outputs and uses the standard symmetry and homogeneity assumptions. We normalize inputs, outputs, and profitability by the price of labor to achieve linear homogeneity of a model and to reject heteroskedasticity. We proceed with the data in this way by following the suggestions of Berger and Mester (1997).

Therefore, the profit efficiency frontier is specified as follows:

$$\begin{aligned} \ln(\Pi_{i,t}/w_{3it} + \theta) = & \alpha_0 + \alpha_1 \ln(y_{1it}/w_{3it}) + \alpha_2 \ln(y_{2it}/w_{3it}) + \alpha_3 \ln(w_{1it}/w_{3it}) + \alpha_4 \ln(w_{2it}/w_{3it}) + \\ & + \frac{1}{2} \sum_{n=1}^2 \sum_{m=1}^2 \alpha_5 \ln(y_{nit}/w_{3it}) \ln(y_{mit}/w_{3it}) + \frac{1}{2} \sum_{n=1}^2 \sum_{m=1}^2 \alpha_6 \ln(w_{nit}/w_{3it}) \ln(w_{mit}/w_{3it}) + \\ & + \frac{1}{2} \sum_{n=1}^2 \sum_{m=1}^2 \alpha_7 \ln(y_{nit}/w_{3it}) \ln(w_{mit}/w_{3it}) + \alpha_8 \ln z_{nit} + (\eta_1, \dots, \eta_4) MF_i + (\mu_1, \dots, \mu_4) IF_i + v_{i,t} - u_{i,t}; \end{aligned} \quad (3)$$

where $\Pi_{ni,t}$ = profitability indicators (ROA or ROE); $\theta = |\min(\Pi_{i,t}/w_{3it})| + 1$ for rejecting the negative value of profitability according to Berger and Mester (1997); y_1 = loans normalized by equity; y_2 = securities normalized by equity; w_1 = price of deposits; w_2 = price of fixed assets; w_3 = price of labor; z_n = credit risk, liquidity risk, and capital adequacy; MF_i = vector of macroeconomic factors in logarithm; IF_i = vector of institutional factors; i = bank number; t = period number; v_i = error term; u_i = inefficiency term.

For specifying banking inputs and outputs, we use the intermediation approach (Sealey, Lindley, 1977) when any bank is assessed as a financial intermediary. This approach is highly recommended to study banks as a separate financial institution by taking into account interest expenses (Berger, Humphrey, 1997). According to this study, we define three prices for inputs: price of deposits (interest paid on deposits to total deposits), price of fixed assets (operating expenses to fixed assets) and price of labor (personnel expenses to total assets); and two outputs: loans (loans to the economy and interbank loans) and securities (the government, corporate and foreign securities). We specify the translog profit function, which is widely applied to both banks and financial institutions in developed countries (Berger et al., 1997) and in Russia (Karas et al., 2010; Mamonov, Vernikov, 2017). This specification was also used to analyze whether macroeconomic factors influenced banking efficiency (Chaffai et al., 2001).

Moreover, we control for features of the banking industry and consider four standard determinants of banking activity. Credit risk is measured as the ratio of loan loss provision to total loans. This indicator refers to the quality of bank's loan portfolio, and higher credit risk means higher potential losses (Staikouras et al., 2008). Capital adequacy risk is represented by the ratio of equity to assets. On the one hand, the excessive equity buffer can lead to inefficient assets structure and decrease profitability, but on the other hand, higher capital adequacy provides higher stability for a bank especially in the crisis period (Berger, Mester, 1997). Liquidity risk

is evaluated by the ratio of liquid assets to total assets. Evidence on the chronic liquidity deficit in the Russian banking sector suggests that this factor might be crucial (Mamonov, Solntsev, 2012). As a proxy for size, we use a bank's net assets and the squared term in order to capture the possible non-linear relationship of this indicator with the efficiency of banks. Medium-sized banks in Russia tended to have more market power (Fungáčová, Weill, 2013), and we expect that they are more profitable. In addition, economies of scale are expected to be observed for the largest banks.

We analyzed a set of macroeconomic indicators and finally choose four uncorrelated ones for our baseline models.

- **Exchange rate:** this indicator describes the volatility of the Russian ruble. The increase of the exchange rate means the depreciation of the national currency, which tends to increase foreign investments, the amount of loans denominated in foreign currency, and banking activity on foreign markets (Caner, Kontorovich, 2004). Mamonov also showed the positive interconnection between exchange rate and the profitability of Russian banks (Mamonov, 2011). In fact, the depreciation of national currency brings additional profit to banks because it increases net profit from the revaluation of accounts in foreign currency. For example, the profit of Russian banks increased by 52 bln rubles due to the net profit from the revaluation of accounts denominated in foreign currency but because of the appreciation of Russian ruble, the net profit from the revaluation of accounts denominated in foreign currency become negative and decreased by 41 bln rubbles in the first six months of 2016 (Gazeta.ru, 2016).

- **Intermediation ratio:** this variable is defined as the ratio of total loans to total deposits. This demonstrates the ability of banking sector to operate as a financial intermediary which accumulates mainly deposits and converts these funds into loans to obtain higher yield. Lending is the most important banking activity, so the higher this intermediation ratio, the higher efficiency is expected (Dietsch, Lozano-Vivas, 2000).

- **The index for cargo transportation tariffs:** this variable represents the change in tariffs for cargo transportation, which is based on a variety of criteria: the type and size of shipment, speed of delivery, distance of transported area of transportation and others, excluding changes in the structure of transported goods. This index is calculated by weighting the individual transportation indexes (railway, pipeline, sea, inland waterway, road, air) on revenue for every type of transportation. Bakshi et al. (2011) as well as Karminsky and Polozov (2016) found a positive link between shipping transportations index and economic growth.

- **The quality of the loan portfolio for the banking sector:** this indicator is measured by the ratio of loan loss provision to loan portfolio. This indicator is closely related to banking profitability and efficiency because a high indicator of credit risks reduces the profitability of banking sector as a whole and the profitability of a single bank (Solntsev et al., 2011).

Moreover, we use two additional macroeconomic factors to further check the robustness of our results. According to the literature, these indicators tend to influence banking profitability and efficiency in the same way that some macroeconomic factors from our baseline model do. Therefore, we replace one indicator with another and check the sign for this indicator in particular and for all other macroeconomic and institutional indicators in general. Our results seem to be robust if the sign and significance of these coefficients remain constant. The macroeconomic factors, which we use for robustness check, are:

- **Banks per 100000 inhabitants:** this indicator usually describes both the level of competition for the banking market and accessibility of banking services (Chaffai et al., 2001). In the Russian

case, a positive effect of this indicator on profitability was observed because banks were forced to develop and introduce new technologies and services to attract new clients and keep them loyal (Belousova, Kozyr, 2016).

- The quality of loan portfolio for the banking sector which is measured by the ratio of overdue loans to the loan portfolio. This indicator is expected to have the same influence on the dependent variable as the ratio of loan loss provision to loan portfolio (Peresetsky, Karminsky, 2011).

As institutional determinants of banking profitability, we use:

- A dummy for state ownership: we believe that state-owned banks are at least as profitable as other banks (Karas et al., 2010) or even the most efficient (Mamonov, Vernikov, 2017) due to strong government support especially in the crisis periods.

- A dummy for foreign ownership: on the one hand, foreign-owned banks are able to use their competitive advantage (new technology, the support from parent companies, etc.) and be more efficient than other banks (Karas et al., 2010). However, on the other hand, some foreign-owned banks tried to use the «cherry-picking» strategy and during a crisis could not compete with other banks, so they were less profitable than other banks (Mamonov, Vernikov, 2017).

- Multiregional banks are represented by the dummy for banks from Moscow and Saint-Petersburg with more than 10 branches. Fungáčová and Solanko (2009) found that these banks were more stable. We expect that banks from Moscow and Saint-Petersburg with more than 10 branches have a more diversified structure of assets and face a less competitive environment due to their multiregionality. Moreover, these banks are the most popular, so they are able to attract investments at a lower cost, which allows them to be more profitable than others.

- Centrally located banks: the dummy for banks from Moscow and Saint-Petersburg with less than 10 branches illustrates this type of banks. We believe that these banks face a very competitive environment in the cities and have to spend more on marketing and the salaries of highly qualified employees than small local banks and are not able to compete with multiregional banks, so they tend to be less profitable (Styrin, 2005).

Table 1 provides the descriptive statistics of the variables, which we focus on, as well as the expected sign of their effect on the profit efficiency frontier.

Table 1. The descriptive statistics of institutional and macroeconomic variables and the expected impact on the profit efficiency frontier

Variables	Mean	Standard deviation	Expected effect
State-owned banks	0.087	0.282	+
Foreign-owned banks	0.100	0.300	?
Multiregional banks	0.138	0.345	+
Centrally located banks	0.544	0.498	–
Exchange rate	32.00	8.92	+
Intermediation ratio	1.45	0.14	+
Cargo transportation index	103.19	6.12	+
Loan loss provision ratio	0.09	0.325	–
Banks per 100000 inhabitants	0.702	0.069	+
Overdue loans ratio	0.033	0.012	–

4. Data

We gather banking data from the Mobile Information Agency (*Banking and Finance* database) and official statistical data available on the website of the Bank of Russia. This allowed us to construct a representative dataset (91.32% of total assets²) for the 240 largest Russian banks (see Appendix 2 for the descriptive statistics of bank-specific indicators). The information about the types of ownership is used from another study (Karas, Vernikov, 2016). This study identifies state-owned banks as banks in which the state, Central Bank of Russia, state-controlled companies, or municipalities hold a majority stake. Foreign-owned banks are defined as banks in which foreign investors hold the majority of shares. To receive data on the location of banks' headquarters and branch networks, the website of Bank of Russia served as a source of information. Finally, we created an unbalanced panel with nearly 9000 bank-quarter observations that cover the period from the beginning of 2004 to the third quarter of 2015. This period covers both relatively stable times and three crises (liquidity crisis in 2004, the financial crisis in 2008–2010 and the geopolitical crisis starting from the second half of 2014). This dataset was combined with the quarterly macroeconomic information collected from the website of Federal State Statistics Service and the Bank of Russia. There are 47 quarters in our sample, so we have 47 observations for each macroeconomic variable and there are an equal number of observations for the all banks in the same period.

5. Empirical results

5.1. Baseline results

In this section, we estimate our model with and without macroeconomic factors because it helps us compare the influence of macroeconomic and institutional factors on the profit efficiency frontier (more details in Table 2).

We observed that the dummy for multiregional banks is significant and positive. Multiregional banks in our interpretation are banks from Moscow and Saint-Petersburg and they are usually large, highly capitalized, and have many branches. As a result, these banks might have cheaper funding and attract more clients. Moreover, this strategy helps banks operate on less competitive regional markets and have diverse financial risks. Fungáčová and Solanko (2009) demonstrated that Moscow banks were the most stable and found a positive link between banks' size and their stability.

In contrast, another important finding is that the coefficients related to centrally located banks have a negative sign for both models. This implies that banks with a weak branch network from Moscow and Saint-Petersburg face with serve competition on local markets and have to spend more funds on advertising campaigns, the development of new products, and bringing in new clients (Styrin, 2005). At the same time, centrally located banks are less popular than multiregional banks and even less popular than regional ones (the number of banks on average is significantly lower in the regions), so they have to attract low-quality borrowers (high-quality borrowers operate with multiregional banks) and more expensive funds due to tough competition.

² Those observations which have the ratio of equity to assets being above 100% or below 2%, or the ratio of loans to assets being below 5% are excluded from the sample.

Table 2. Results for baseline model

Variables	ROA based	ROA with macro	ROE based	ROE with macro
Loans	0.240*** (0.0702)	0.285*** (0.0677)	0.225*** (0.0760)	0.232*** (0.0730)
Securities	-0.0116 (0.0404)	0.0719* (0.0405)	-0.0277 (0.0437)	0.0614 (0.0437)
Assets	-0.226* (0.130)	-0.225* (0.125)	-0.200 (0.140)	-0.351*** (0.135)
Squared term of assets	0.00650* (0.0038)	0.00525 (0.00366)	0.00508 (0.0041)	0.00797** (0.00394)
State-owned	0.0701 (0.072)	0.118* (0.0689)	0.0886 (0.077)	0.116 (0.0742)
Foreign-owned	-0.165** (0.069)	-0.154** (0.0660)	-0.128* (0.074)	-0.108 (0.0712)
Multiregional	0.160** (0.067)	0.243*** (0.0657)	0.214*** (0.073)	0.294*** (0.0708)
Centrally located	-0.0751* (0.042)	-0.0884** (0.0408)	-0.0887* (0.046)	-0.103** (0.0440)
Exchange rate		2.084*** (0.0961)		2.052*** (0.104)
Intermediation ratio		1.866*** (0.214)		4.343*** (0.230)
Cargo index		4.421*** (0.299)		4.357*** (0.322)
Loan loss provision ratio		-0.683*** (0.0668)		-0.510*** (0.0720)
Constant	6.292*** (1.113)	-23.23*** (1.856)	8.043*** (1.204)	-20.24*** (1.999)
Log likelihood	-17474.3	-17130	-18188.1	-17799
Observations	8985	8985	8985	8985
Number of banks	240	240	240	240

Notes. ***, **, * represent significance at the level of 1, 5 and 10%, respectively. Figures in parentheses are standard errors.

Next, we find that a bank's ownership type significantly affects the profit efficiency frontier. Our research demonstrates that foreign ownership has a negative effect (excluding the model with ROE and macroeconomic factors). Foreign-owned banks tried to follow the «cherry-picking» strategy especially in the period before the 2008 crisis when profitability on the Russian market was significantly higher than profitability in developed countries, so good number of foreign banks entered the Russian market, however, the crisis of 2008–2010 disrupted their plans. Moreover, some foreign-owned banks, which had left the Russian market, declared that they could not compete with state-owned banks after this crisis. The dynamics of foreign-owned banks' share in assets supported this hypothesis because in 2016 the share of foreign banks fell to 10-year minimum (Vedomosti, 2016). Therefore, the foreign-owned banks, which did not consider Russia as their «second home market», left the Russian market (Bonin, Louie, 2015). This finding corroborates the ideas of Mamonov and Vernikov (2017) who analyzed the link between the cost efficiency of and the type of ownership for Russian banks.

Another result shows that state ownership is not significant for the baseline specification but makes sense when we add macroeconomic factors for model with ROA. Government support (in 2008, state-owned banks received more than 75% of overall support (Vernikov, 2013); in 2015, this figure was 60% (RBC, 2015)), implicit guarantees, deposit insurance, and other advantages (such as unsecured loans from the Bank of Russia) are possible reasons. In addition, deposit insurance increased moral hazard risk for private banks, while public ones became more profitable and efficient than previously (Karas et al., 2010).

There is a positive impact of the cargo transportation index on the efficiency frontier. This result might be explained by the fact that cargo transportation is associated with economic growth (Bakshi et al., 2011) because the price of goods increases when this index rises and vice versa.

The exchange rate has a positive sign in our models. This result may be driven by the revaluation of foreign currency when banks have a gap between assets and liabilities denominated in foreign currency (Mamonov, Vernikov, 2017). Moreover, during all periods, banks have income from operations with foreign currency. The depreciation of the national currency increases the number of both foreign investors and local businessmen operating on the banking market (Caner, Kontorovich, 2004). Additional empirical support for this hypothesis was found by Belousova and Kozyr (2016) where the exchange rate was one of the key indicators explaining banking profitability in Russia (for the period from 2008 to 2014).

Another interesting result is that the intermediation ratio has a positive impact on the efficiency frontier. This indicator describes the overall efficiency of the banking industry and demand for loans and deposits (Dietsch, Lozano-Vivas, 2000). The higher efficiency of the whole industry and higher demand for key banking products increase banking profitability. Dietsch, Lozano-Vivas (2000) and Belousova, Kozyr (2016) found comparable results.

It is interesting to note that the share of loan loss provision in the loan portfolio has a negative impact on the efficiency frontier. If this ratio is high, this means the low quality of the loan portfolio for all banks in the banking sector, so there might be problems on the banking market because borrowers are unable to pay on time. The decrease in the quality of loans means that the financial results of borrowers have become worse (Solntsev et al., 2011).

Moreover, we find that securities have a significant positive impact on ROA when the macroeconomic factors are taken into account. The Russian financial market is a market with an extremely high volatility (the maximum closing price of Russian market volatility index was 66.2 and the average monthly value was 33.9 (MOEX, 2017)), so securities trading can bring both profit and losses to banks. Furthermore, to revalue trading securities was an important part of the profit and loss statement for Russian banks primarily during the crisis. Russian banks increased the share of government bonds in their assets portfolio during unstable periods, but this decision brought relatively small margins and simply represented a short-run investment. During the crisis period (especially in year 2009), the share of securities in the assets portfolio nearly doubled (from 8.6% to 15%), and 44% of these securities were securities from the government and Bank of Russia (ExpertRA, 2011). When we add macroeconomic factors, we indirectly consider such environmental fluctuations. Although the securities became significant, they are still less important in comparison with loans. Investments in securities are not significant for models with ROE as a dependent variable because the amount of equity remains relatively stable regardless of the share of securities in total assets.

Finally, we determined that that bank's size has a negative impact on the efficiency frontier, but there is a nonlinear impact solely for the model with ROA as a dependent variable and with-

out macroeconomic factors. Bank's optimal size is 34.97 billion rubles, so medium-sized banks according to our sample are relatively more profitable. However, when we include macroeconomic factors, the optimal size became 22.02 billion rubles (for the model with ROE), but a bank's size has a negative impact upon the frontier constructed for ROA as a dependent variable. The proxy for size is not significant for the model with ROE and without macroeconomic factors.

5.2. Results by bank's location and branch network diversity

We expect that the efficiency frontier differs by ownership type even taking into account macroeconomic and institutional factors. This might occur as banks with a different type of ownership in Russia also have different strategies and varying appetites for risk. Banks may also respond differently to an increase in credit risk created by moral hazard (Fungáčová, Poghosyan, 2011).

However, researches usually analyze a full sample of banks, which includes large and small banks, banks that operate in different regions, banks with different branch networks. In this section, we intend to analyze how ownership type affects the efficiency frontier of Russian banks for different groups of banks respectively. These groups are multiregional banks (banks from Moscow and Saint-Petersburg with more than 10 branches); centrally located banks (banks from Moscow and Saint-Petersburg with fewer than 10 branches); regional banks (banks are based in other regions of Russia). Moreover, we explore how banks from each group are sensitive to macroeconomic factors. This allowed us to reveal potential challenges in which banks might be more stable and less sensitive to the macroeconomic environment (Table 3).

Our results indicate that state ownership is a substantial institutional determinant of the efficiency frontier for the centrally located banks. All centrally located banks tend to compete with multiregional banks, which tend to be more well-known, spend more funds on advertising, choose the best clients, or have other competitive advantages. In these circumstances, loyal clients and the durability of funds might become a crucial element for centrally located banks that have higher risks, such as moral hazard, than others (Karas et al., 2010). State-owned centrally located banks mostly operate with state-owned or state-connected companies, which are more loyal in the long term. Moreover, in a competitive environment, implicit guarantees from the government might play an important role and increase the bank's profit.

In addition, we find that foreign ownership has a negative effect on the centrally located subgroup of banks (for model with ROA). Some of these banks entered the Russian market just before the 2008–2010 crisis and they did not invest enough in this market or took too many risks associated with rapid growth, then they were forced to curtail the size of their businesses. On the one hand, these banks cannot compete with multiregional state-owned banks, furthermore, these banks could not develop specific projects with relatively low competition (for example, microfinancing) as private centrally located banks do. Moreover, these banks have a low market share and their parent banks do not consider Russia a «second home market», so they tend to reduce operations during a crisis and some parent banks are even able to solve their problems in other countries by using the funds of Russian banks. Bonin and Louie (2015) demonstrated this for European countries.

We find that the dummy for state ownership has no effect on the efficiency frontier of multiregional banks while Karas et al. (2010) showed that state-owned banks in Russia were no

Table 3. Results for regional and branch sub-groups of banks

Variables	ROA			ROE		
	Multiregional banks	Centrally located banks	Regional banks	Multiregional banks	Centrally located banks	Regional banks
Securities	0.216 (0.244)	0.117** (0.0486)	0.0692 (0.0792)	0.210 (0.262)	0.131** (0.0525)	0.0294 (0.0847)
State-owned	0.203 (0.176)	0.172* (0.0986)	0.00578 (0.124)	0.234 (0.190)	0.177* (0.107)	−0.000553 (0.133)
Foreign-owned	−0.0718 (0.172)	−0.142* (0.0758)	−0.564 (0.450)	−0.00700 (0.185)	−0.0944 (0.0820)	−0.677 (0.481)
Exchange rate	2.092*** (0.316)	2.100*** (0.125)	2.206*** (0.176)	1.895*** (0.340)	2.096*** (0.136)	2.216*** (0.189)
Intermediation ratio	1.643*** (0.569)	1.876*** (0.294)	2.312*** (0.391)	4.014*** (0.612)	4.374*** (0.317)	4.777*** (0.419)
Cargo index	4.710*** (0.795)	4.155*** (0.407)	4.474*** (0.530)	4.365*** (0.855)	4.157*** (0.440)	4.353*** (0.568)
Loan loss provision ratio	−0.517*** (0.200)	−0.735*** (0.0894)	−0.553*** (0.126)	−0.306 (0.215)	−0.570*** (0.0966)	−0.353*** (0.134)
Constant	−22.03*** (5.311)	−23.23*** (2.624)	−23.48*** (4.081)	−18.75*** (5.714)	−20.40*** (2.836)	−21.58*** (4.366)
Log likelihood	−2391	−9281	−5434	−2482	−9661	−5627
Observations	1246	4883	2856	1246	4883	2856
Number of banks	39	147	73	39	147	73

Notes. ***, **, * represent significance at 1, 5 and 10%, respectively. Figures in parentheses are standard errors.

less efficient than private banks. Despite the fact that state-owned multiregional banks include the «national champions» who have a lion's share of the market, other multiregional banks are large and famous enough, they also are able to attract long-term deposits at relatively low cost, and are able to choose the best clients and spend a great amount of money on advertisement. Moreover, private multiregional banks are also able to spend a lot of funds on innovation and development projects which increase profitability in the medium- and long-term. In addition, the majority of multiregional banks are systemically significant banks, so the government supports them by providing implicit guarantees to them. Therefore, in comparison with other multiregional banks alone, the advantages of state-owned banks are not enough, and this dummy has no effect on the efficiency frontier.

It is interesting to note that foreign ownership does not affect the efficiency frontier for the multiregional sub-groups of banks. Foreign-owned banks are well-known and operate most of the time on the Russian market, so they have a relatively stable source of funding and client base. As Bonin and Louie (2015) demonstrated, the largest foreign-owned banks did not «cut and run» during the 2008–2010 crisis in the emerging economies of Europe because these countries were a «second home market» for these banks. It seems that the foreign-owned multiregional banks have the relatively same behavior as private multiregional banks. These banks have a strategy that is particularly the same as the strategies of private banks because the foreign-owned multiregional banks do not follow the «cherry-picking» strategy but operate like strategic investors.

The profit efficiency frontier for the sub-group of regional banks does not depend on the ownership type. This result may be explained by the fact that regional banks usually compete not with one another but with multiregional banks, thus they do not have a variety of business strategies to be profitable. Traditionally, regional banks understand the situation in their own regions better than multiregional banks do. Moreover, regional banks have close connections with some regional companies and the regional elite, and these connections more depend on personal relationships but not on bank's type of ownership (Styrin, 2005). State-owned regional banks actually do not receive serious government support and implicit guarantees, further, they do not play an important role for regional state-owned banks because large multiregional banks have stronger guarantees. Foreign-owned regional banks are quite rare, and if a foreign bank has a headquarters that is not located in Moscow or Saint-Petersburg, this bank operates as a standard regional bank.

We find that investments in securities are significant for centrally located banks only. Banks with a high share of securities in the assets portfolio do not develop their branch network and are located in key, financially developed cities, such as Moscow or Saint-Petersburg.

All macroeconomic factors (excluding the share of loan loss provision in the loan portfolio for multiregional banks) become significant and they are in line with our baseline model. Then, we checked the sensitivity of each sub-group of banks to macroeconomic factors. This certainly is not a direct measure of financial stability (like the z-score, for example), but it helps us analyze the efficiency frontier of which sub-group of banks more depends on macroeconomic factors.

We find that multiregional banks are the most sensitive to the cargo transportation index. This index is a proxy of economic activity, so the profitability of multiregional banks is closely related to business cycles. In contrast, centrally located banks are less sensitive to the cargo index due to a high competition in regions that located close to the center.

Multiregional banks are the least sensitive to the intermediation ratio because their reputation allows these banks to attract credit-worthy clients at a lower cost in comparison with other banks. In contrast, this indicator is very important for regional and centrally located banks that compete with multiregional banks and for which a higher intermediation ratio is attributed with an increase in lending, which brings banks additional profit.

As for the exchange rate, multiregional banks are the least sensitive to the volatility of the national currency while regional banks are the most sensitive. Thus, the multiregional banks control exchange risk better and have a more balanced structure of assets and liabilities denominated in foreign currencies. Moreover, regional companies with earnings in foreign currencies are usually the clients of these regional banks (if this company is located in the same region as the bank), so these banks are more sensitive to the exchange rate. Multiregional banks also have a lot of clients with earnings in foreign currencies, but there are usually large companies that have the structure of assets and liabilities denominated in foreign currencies. In addition, fee incomes are also sensitive to the exchange rate (Belousova, Kozyr, 2016) which is higher for regional and centrally located banks than for multiregional banks.

Finally, centrally located banks are the most sensitive to the ratio of loan loss provision to the loan portfolio while multiregional banks are the least sensitive. Centrally located banks might not be able to attract the creditworthy clients because of high competition; as a result, they have to lend money to riskier borrowers who have a higher probability of default than others. Therefore, the quality of the loan portfolio of centrally located banks is lower, and these banks become more sensitive to the ratio of loan loss provision to the loan portfolio.

5.3. Results by bank's ownership type

Here, we analyze how the location of a bank's headquarters and branch network influence the efficiency frontier of banks with different ownership types. Moreover, we check whether the results for state-, foreign- and privately owned banks in particular are robust to macroeconomic indicators (Table 4).

Table 4. Results for location and branch sub-groups of banks

Variables	ROA			ROE		
	State-owned banks	Foreign-owned banks	Privately owned banks	State-owned banks	Foreign-owned banks	Privately owned banks
Securities	0.190 (0.214)	0.257** (0.124)	0.0827* (0.0441)	0.0625 (0.239)	0.245* (0.137)	0.0745 (0.0472)
Multiregional	0.365 (0.252)	0.373 (0.452)	0.246*** (0.0727)	0.524* (0.281)	0.707 (0.498)	0.291*** (0.0778)
Centrally located	0.114 (0.163)	0.228 (0.427)	-0.118*** (0.0433)	0.177 (0.182)	0.465 (0.470)	-0.134*** (0.0464)
Exchange rate	1.776*** (0.303)	2.182*** (0.270)	2.199*** (0.110)	1.753*** (0.338)	2.234*** (0.297)	2.155*** (0.118)
Intermediation	2.141*** (0.767)	3.860*** (0.698)	1.744*** (0.236)	4.613*** (0.856)	6.205*** (0.768)	4.220*** (0.253)
Cargo index	4.620*** (1.003)	3.152*** (0.914)	4.512*** (0.332)	4.928*** (1.120)	3.537*** (1.006)	4.345*** (0.356)
Loan loss provision ratio	-0.813*** (0.255)	-0.244 (0.217)	-0.696*** (0.0744)	-0.585** (0.285)	-0.124 (0.239)	-0.523*** (0.0797)
Constant	-15.30** (7.047)	-30.44*** (6.853)	-25.72*** (2.226)	-14.48* (7.869)	-31.49*** (7.549)	-22.35*** (2.384)
Log likelihood	-1493	-1648	-13940	-1580	-1735	-14440
Observations	790	895	7300	790	895	7300
Number of banks	28	36	202	28	36	202

Notes. ***, **, * represent significance at 1, 5 and 10%, respectively. Figures in parentheses are standard errors.

We find that the efficiency frontier of private banks particularly depends on the location of a bank's headquarters and branch network. The dummy for multiregional banks has a positive sign for the sub-group of private banks. These banks are the largest ones. The strong branch network helps these banks to diversify risks and receive other competitive advantages. Moreover, as we mentioned earlier, these banks are able to compete even with «national champions» and can choose credit-worthy clients and attract cheaper funds. In contrast, centrally located private banks are the least profitable. For these banks, it is really hard to compete with multiregional banks as mentioned previously. Regional banks face a lower rate of competition, they are more profitable than centrally located banks, but still less profitable than multiregional banks with a strong branch network.

There is no significant difference in the efficiency frontier for different sub-groups of foreign- owned and state-owned banks. We find that during all periods, multiregional foreign- and

state-owned banks are as profitable as both centrally located and regional foreign-owned banks, so the strong branch network brings them no advantages.

Investments in securities are not significant for state-owned banks alone. Even during the crises, these banks did not significantly change the structure of their assets portfolio and continued their lending activity. At the same time, there is a positive effect of securities on profitability for foreign- and private-owned banks, which have changed the structure of assets during the crises.

We find that macroeconomic factors are significant and important determinants of the efficiency frontier for each sub-group. The cargo transportation index has the most significant influence on state-owned banks because these banks during the crisis period supported lending activity, so they might be sensitive to these factors.

Foreign-owned banks are the most sensitive to the intermediation ratio because the majority of these banks entered the Russian market in the period before the 2008–2010 crisis, when there was economic growth and a credit boom. Therefore, foreign-owned banks are very sensitive to the efficiency of the Russian banking sector.

State-owned banks are the least sensitive to the exchange rate because they operate with a lower exchange rate risk and they are less sensitive to the exchange rate fluctuations. State-owned banks have a small gap between assets and liabilities denominated in foreign currencies. In contrast, foreign-owned banks are more sensitive to the exchange rate fluctuations because these banks are able to attract funds from their parent companies or operate with foreign companies. Private banks are sensitive to the exchange rate as well because they are usually riskier and have a less balanced structure of assets and liabilities denominated in foreign currencies.

The ratio of loan loss provision to the loan portfolio has a negative effect on the state-owned and privately owned sub-groups of banks. However, this ratio is not significant when analyzing the foreign-owned banks. This particular result should be explored in further studies.

6. Robustness check

In this section, we present the series of robustness checks for our baseline specification. First, we use an alternative indicator describing the quality of the loan portfolio measured by the ratio of overdue loans to the loan portfolio for the banking sector as a whole. Our main results remain the results of the baseline model. State ownership (for ROA) and multiregionality have a positive influence on the efficiency frontier and foreign ownership (for ROA) and those with a central location have a negative one. All macroeconomic factors are significant and have the expected impact on the efficiency frontier (Table 5).

Moreover, we replace the intermediation ratio with the indicator measured as the number of banks per 100,000 inhabitants, which is able to describe both the accessibility of banking services and the structure of banking industry (Chaffai et al., 2001). These coefficients and their significance in general correspond with our key results. Multiregionality has a positive sign while foreign ownership (for ROA), and a central location negatively affects the efficiency frontier of Russian banks (Table 6).

Table 5. Robustness check for the share of overdue loans in the loan portfolio for the banking sector

Variables	ROA	ROE
Loans	0.281*** (0.0680)	0.229*** (0.0731)
Securities	0.0660* (0.0404)	0.0571 (0.0506)
Assets	-0.317** (0.125)	-0.420*** (0.134)
Squared term of assets	0.00744** (0.00366)	0.00962** (0.00394)
State-owned	0.124* (0.0691)	0.121 (0.0744)
Foreign-owned	-0.154** (0.0663)	-0.108 (0.0713)
Multiregional	0.283*** (0.0656)	0.325*** (0.0707)
Centrally located	-0.0845** (0.0409)	-0.0998** (0.0440)
Exchange rate	2.033*** (0.0985)	2.012*** (0.106)
Intermediation ratio	1.388*** (0.234)	3.990*** (0.251)
Cargo index	4.437*** (0.301)	4.367*** (0.324)
Overdue loans ratio	-0.422*** (0.0580)	-0.313*** (0.0624)
Constant	-21.69*** (1.868)	-19.05*** (2.010)
Log likelihood	-17156	-17811
Observations	8985	8985
Number of banks	240	240

Notes. ***, **, * represent significance at 1, 5 and 10%, respectively.
Figures in parentheses are standard errors.

7. Conclusion

This study is devoted to determining the effect of key macroeconomic and institutional determinants on the profit efficiency frontier applied to Russian banks during the period of 2004–2015. As institutional factors, we explore the type of bank's ownership, the diversity of banks' branch network, and location of bank headquarters. We examined such macroeconomic factors as cargo index, exchange rate, intermediation ratio, and the ratio of loan loss provision to the loan portfolio.

Our main findings can be summarized as follows. First, we find that macroeconomic factors have a significant impact on the profit efficiency frontier in Russia. In addition, the cargo index,

Table 6. Robustness check for the number of banks per 100,000 inhabitants

Variables	ROA	ROE
Loans	0.330*** (0.0669)	0.313*** (0.0721)
Securities	0.0991** (0.0388)	0.0876** (0.0418)
Assets	-0.0292 (0.123)	0.0507 (0.132)
Squared term of assets	0.00112 (0.00360)	-0.000963 (0.00388)
State-owned	0.0620 (0.0682)	0.0362 (0.0734)
Foreign-owned	-0.194*** (0.0653)	-0.175** (0.0703)
Multiregional	0.113* (0.0652)	0.0820 (0.0702)
Centrally located	-0.0828** (0.0403)	-0.0919** (0.0434)
Exchange rate	4.126*** (0.162)	4.940*** (0.174)
Banks per 100000 inhabitants	6.212*** (0.362)	9.404*** (0.390)
Cargo index	4.090*** (0.296)	4.050*** (0.319)
Loan loss provision ratio	-0.553*** (0.0666)	-0.362*** (0.0717)
Constant	-27.56*** (1.842)	-27.55*** (1.984)
Log likelihood	-17023	-17691
Observations	8985	8985
Number of banks	240	240

Notes. ***, **, * represent significance at 1, 5 and 10%, respectively.
Figures in parentheses are standard errors.

exchange rate, and intermediation ratio have a positive effect while the share of loan loss provision in the loan portfolio has a negative one. All these results are in line with previous empirical evidence on developed and emerging markets, and on Russia in particular (Solntsev et al., 2011; Mamonov, Vernikov, 2017). This means that the Russian banking sector still develops in accordance with other emerging markets in terms of the relationship between the macroeconomic environment and efficiency frontier.

Second, we analyzed whether the profit efficiency frontier of each sub-group of banks based upon the type of ownership, the diversity of the bank's branch network and location of bank headquarters is sensitive to a country's macroeconomic factors. However, we did not identify any sub-groups of banks that are the most or the least sensitive to these factors. However,

we confirmed that state-owned banks are the most profitable banks and foreign-owned banks are the least profitable. These results correspond to those mentioned in (Mamonov, Vernikov, 2017) although they estimated the cost efficiency of Russian banks.

Third, we modified the standard regional classification of Russian banks and took into account not just the location of their main office, but also the branch network diversity. This allowed us to categorize banks into three groups (multiregional banks, centrally located banks, and regional banks). For these groups, we concluded that the multiregionality of banks has a positive impact on the profit efficiency frontier while a central location has a negative one. Moreover, we analyzed the profit efficiency frontier of Russian banks for each sub-group of banks and found that state ownership has a positive effect for the centrally located sub-group; a central location and foreign ownership have a negative effect for the respective sub-group. Furthermore, the multiregionality positively affects the efficiency frontier both in the state-owned and private sub-groups, and the centrally located banks are the least efficient among the private sub-groups. These results tend to show that privately owned and centrally located banks are the least homogenous sub-groups. Finally, we checked the robustness of our results and indicated that they remain robust when grouping banks differently and adding new macroeconomic factors.

Acknowledgements. The research project leading to these results has received funding from the Ministry of Education and Science of the Russian Federation in 2017–2018 (project ID: RFMEFI57217X0007).

References

- Aigner D., Lovell C. K., Schmidt P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics*, 6 (1), 21–37.
- Albertazzi U., Gambacorta L. (2009). Bank profitability and the business cycle. *Journal of Financial Stability*, 5 (4), 393–409.
- Athanasoglou P. P., Brissimis S. N., Delis M. D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money*, 18 (2), 121–136.
- Bakshi G., Panayotov G., Skoulakis G. (2011). The Baltic dry index as a predictor of global stock returns, commodity returns, and global economic activity. *SSRN Research paper*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1747345.
- Belousova V., Kozyr I. (2016). How do macroeconomic indicators influence banking profitability in Russia. *Journal of the New Economic Association*, 30 (2), 72–103 (in Russian).
- Berg S. A., Forsund F. R., Hjalmarsson L., Suominen M. (1993). Banking efficiency in the Nordic countries. *Journal of Banking and Finance*, 17 (2), 371–388.
- Berger A. N., DeYoung R., Genay H., Udell G. F. (2000). Globalisation of financial institutions: Evidence from cross-border banking performance. *Brookings-Wharton Papers on Financial Services*, 1, 23–120.
- Berger A. N., DeYoung R. (1997). Problem loans and cost efficiency in commercial banks. *Journal of Banking and Finance*, 21 (6), 849–870.
- Berger A. N., Humphrey D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research*, 98 (2), 175–212.

- Berger A. N., Mester L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking and Finance*, 21 (7), 895–947.
- Berger A. N., Leusner J. H., Mingo J. J. (1997). The efficiency of bank branches. *Journal of Monetary Economics*, 40 (1), 141–162.
- Berger A. N., Hunter W. C., Timme S. G. (1993). The efficiency of financial institutions: A review and preview of research past, present and future. *Journal of Banking and Finance*, 17 (2), 221–249.
- Berger A., Humphrey D. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics*, 28 (1), 117–148.
- Bonin J. P., Louie D. (2015). Did foreign banks «cut and run» or stay committed to emerging Europe during the crises? *Working papers by Bank of Finland Institute for Economics in Transition. Series DP BOFIT Discussion Papers No. 31/2015*.
- Bonin J. P., Hasan I., Wachtel P. (2005a). Bank performance, efficiency and ownership in transition countries. *Journal of Banking and Finance*, 29 (1), 31–53.
- Bonin J. P., Hasan I., Wachtel P. (2005b). Privatization matters: Bank efficiency in transition countries. *Journal of Banking and Finance*, 29 (8), 2155–2178.
- Bos J. W. B., Kool C. J. M. (2006). Bank efficiency: The role of bank strategy and local market conditions. *Journal of Banking and Finance*, 30 (7), 1953–1974.
- Caner S., Kontorovich V. (2004). Efficiency of the banking sector in the Russian Federation with international comparison. *HSE Economic Journal*, 8 (3), 357–375.
- Casu B., Molyneux P. (2003). A comparative study of efficiency in European banking. *Applied Economics*, 35 (17), 1865–1876.
- Chaffai M. E., Dietsch M., Lozano-Vivas A. (2001). Technological and environmental differences in the European banking industries. *Journal of Financial Services Research*, 19 (2–3), 147–162.
- Dietrich A., Wanzenried G. (2014). The determinants of commercial banking profitability in low-, middle-, and high-income countries. *The Quarterly Review of Economics and Finance*, 54 (3), 337–354.
- Dietsch M., Lozano-Vivas A. (2000). How the environment determines banking efficiency: comparison between French and Spanish industries. *Journal of Banking and Finance*, 24 (6), 985–1004.
- Drakos K. (2003). Assessing the success of reform in transition banking 10 years later: An interest margins analysis. *Journal of Policy Modeling*, 25 (3), 309–317.
- ExpertRA. (2011). Development of Russian banking system in years 2005–2010. <http://www.raexpert.ru/docbank/7b1/525/0ae/3eec263a575f4d3f4807de4.pdf> (in Russian).
- Fries S., Taci A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking and Finance*, 29 (1), 55–81.
- Fungáčová Z., Poghosyan T. (2011). Determinants of bank interest margins in Russia: Does bank ownership matter? *Economic Systems*, 35 (4), 481–495.
- Fungáčová Z., Solanko L. (2009). Risk-taking by Russian banks: Do location, ownership and size matter? *HSE Economic Journal*, 13 (1), 101–129.
- Fungáčová Z., Weill L. (2013). Does competition influence bank failures? Evidence from Russia. *Economics of Transition*, 21 (2), 301–322.
- Gazeta.ru. (2016). Banks are also crying. <https://www.gazeta.ru/business/2016/08/01/9733805.shtml> (in Russian).
- Goddard J., Molyneux P., Wilson J. O. (2004). The profitability of European banks: A cross-sectional and dynamic panel analysis. *The Manchester School*, 72 (3), 363–381.

Golovan S. (2006). Factors influencing the efficiency of the Russian banks performance. *Applied Econometrics*, 2, 3–17 (in Russian).

Grigorian D. A., Manole V. (2006). Determinants of commercial bank performance in transition: An application of data envelopment analysis. *Comparative Economic Studies*, 48 (3), 497–522.

Hasan I., Koetter M., Wedow M. (2009). Regional growth and finance in Europe: Is there a quality effect of bank efficiency? *Journal of Banking and Finance*, 33 (8), 1413–1422.

Havrylchyk O. (2006). Efficiency of the Polish banking industry: Foreign versus domestic banks. *Journal of Banking and Finance*, 30 (7), 1975–1996.

Jemric I., Vujcic B. (2002). Efficiency of banks in Croatia: A DEA approach. *Comparative Economic Studies*, 44 (2–3), 169–193.

Karas A., Vernikov A. (2016). Russian bank database: Birth and death, location, mergers, deposit insurance participation, state and foreign ownership. *Utrecht School of Economics Discussion Paper Series No. 16–04*.

Karas A., Schoors K., Weill L. (2010). Are private banks more efficient than public banks? *Economics of Transition*, 18 (1), 209–244.

Karminsky A., Polozov A. (2016). *Handbook of ratings: Approaches to ratings in the economy, sports, and society*. Springer International Publishing, Switzerland.

Kosmidou K., Zopounidis C. (2008). Measurement of bank performance in Greece. *South-Eastern Europe Journal of Economics*, 1 (1), 79–95.

Koetter M., Wedow M. (2010). Finance and growth in a bank-based economy: Is it quantity or quality that matters? *Journal of International Money and Finance*, 29, 1529–1545.

Kumbhakar S., Peresetsky A. (2013). Cost efficiency of Kazakhstan and Russian banks: Results from competing panel data models. *Macroeconomics and Finance in Emerging Market Economies*, 6 (1), 88–113.

La Porta R., Lopez de Silanes F., Shleifer A. (2002). Government ownership of banks. *Journal of Finance*, 57 (1), 265–301.

Lensink R., Meesters A., Naaborg I. (2008). Bank efficiency and foreign ownership: Do good institutions matter? *Journal of Banking and Finance*, 32 (5), 834–844.

Lozano-Vivas A., Pastor J. T. (2010). Do performance and environmental conditions act as barriers for cross-border banking in Europe? *Omega*, 38 (5), 275–282.

Lozano-Vivas A., Pastor J. T., Hasan I. (2001). European Bank Performance Beyond Country Borders: What Really Matters? *European Finance Review*, 5 (1–2), 141–165.

Lozano-Vivas A., Pastor J. T., Pastor J. M. (2002). An efficiency comparison of European banking systems operating under different environmental conditions. *Journal of Productivity Analysis*, 18 (1), 59–77.

Mamonov M., Vernikov A. (2017). Bank ownership and cost efficiency: New empirical evidence from Russia. *Economic Systems*, 41 (2), 305–319.

Mamonov M., Solntsev O. (2012). Liquidity of Russian banking sector: Is there light at the end of the tunnel visible? *Bankovskoe delo*, 1, 6–13 (in Russian).

Mamonov M. (2011). The impact of the crisis on the profitability of the Russian banking sector. *Bankovskoe delo*, 12, 15–26 (in Russian).

MOEX (2017). Russian volatility index. <http://www.moex.com/ru/index/RVI/archive/#/from=2013-12-01&till=2017-06-01&sort=TRADEDATE&order=asc> (in Russian).

Pavlyuk D. (2006). Efficiency model of Russian banks. *Applied Econometrics*, 3, 3–8 (in Russian).

Peresetsky A., Karminsky A. (2011). Models for Moody's bank ratings. *Frontiers in Finance and Economics*, 1, 8 (1), 88–110.

RBC (2015). The government divided the 830 billion rubles between the 27 banks. <http://www.rbc.ru/finances/23/01/2015/54c28a769a79479a09ce9ea0> (in Russian).

Sealey C. W., Lindley J. T. (1977). Inputs, outputs, and a theory of production and cost at depository financial institutions. *Journal of Finance*, 32 (4), 1251–1266.

Solntsev O., Mamonov M., Pestova A., Magomedova Z. (2011). Experience in developing early warning system for financial crises and the forecast of Russian banking sector dynamic in 2012. *Journal of the New Economic Association*, 12 (4), 41–76 (in Russian).

Staikouras C., Mamatzakis E., Koutsomanoli-Filippaki A. (2008). Cost efficiency of the banking industry in the South Eastern European region. *Journal of International Financial Markets, Institutions and Money*, 18 (5), 483–497.

Styrin K. (2005). What explains differences in efficiency across russian banks? M.: EERC.

Sun J., Harimaya K., Yamori N. (2013). Regional economic development, strategic investors, and efficiency of Chinese city commercial banks. *Journal of Banking and Finance*, 37 (5), 1602–1611.

Trujillo-Ponce A. (2013). What determines the profitability of banks? Evidence from Spain. *Accounting and Finance*, 53 (2), 561–586.

Vedomosti. (2016). The proportion of foreigners in the capital of Russian banks fell to 10-year minimum. <https://www.vedomosti.ru/finance/articles/2016/08/22/653881-dolya-inostrantsev-kapitale-rossiiskih-bankov-upala-10-letnego-minimuma> (in Russian).

Vernikov A. (2013). National champions and the competitive structure of the Russian banking market. *Voprosy Ekonomiki*, 3, 94–108 (in Russian).

Weill L. (2003). Banking efficiency in transition economies. *Economics of Transition*, 11 (3), 569–592.

Yildirim H. S., Philippatos G. C. (2007). Efficiency of banks: Recent evidence from the transition economies of Europe, 1993–2000. *European Journal of Finance*, 13 (2), 123–143.

Received 22.06.2017; accepted 12.02.2018.

Appendix 1. The list of methods used to study banking efficiency and profitability

Study	Methodology
Albertazzi, Gambacorta, 2009	Generalized method of moments (GMM)
Athanasoglou et al., 2008	Stochastic frontier method (SFA)
Belousova, Kozyr, 2016	Panel data models (pooled Ordinary least squares (OLS), fixed effects and random effects) and SFA
Berg et al., 1993	Data envelopment analysis (DEA)
Berger et al., 1997	Fourier-flexible distribution-free frontier approach
Berger et al., 2000	DFA
Berger, DeYoung, 1997	Granger-causality model
Berger, Humphrey, 1991	«Thick frontier» approach (TFA)
Berger, Mester, 1997	Distribution free approach (DFA) and SFA
Bonin et al., 2005a	SFA
Bonin et al., 2005b	SFA
Bonin, Louie, 2015	Pooled ordinary least squares with country fixed effects and clustered robust standard errors
Bos, Kool, 2006	SFA
Caner, Kontorovich, 2004	SFA
Casu, Molyneux, 2003	DEA
Chaffai et al., 2001	SFA
Dietrich, Wanzenried, 2014	GMM
Dietsch, Lozano-Vivas, 2000	DFA
Drakos, 2003	Generalized least squares (GLS)
Fries, Taci, 2005	SFA
Fungáčová, Solanko, 2009	Z-score
Goddard et al., 2004	OLS and GMM
Golovan, 2006	SFA
Grigorian, Manole, 2006	DEA
Havrylchyk, 2006	DEA
Jemric, Vujcic, 2002	DEA
Karas et al., 2010	SFA and DEA
Lensink et al., 2008	SFA
Lozano-Vivas et al., 2001	DEA
Lozano-Vivas et al., 2002	DEA
Lozano-Vivas, Pastor, 2010	DEA
Kumbhakar, Peresetsky, 2013	SFA
Mamonov, 2011	OLS
Mamonov, Vernikov, 2017	SFA
Pavlyuk, 2006	SFA
Styrin, 2005	DEA and SFA
Sun et al., 2013	SFA
Trujillo-Ponce, 2013	GMM
Weill, 2003	SFA

Appendix 2. The descriptive statistics for bank-specific indicators

Variable	Definition	Unit	Mean	Standard deviation
Profit	Return on assets	RUB thous.	$5.4 \cdot 10^5$	$5.4 \cdot 10^6$
Loans	Loan portfolio including household and corporate loans, interbank loans	RUB thous.	$9.5 \cdot 10^7$	$6.26 \cdot 10^8$
Securities	Investment in government, non-government, and foreign securities	RUB thous.	$1.72 \cdot 10^7$	$9.57 \cdot 10^7$
Price of labor	Personnel expenses to bank assets ratio		0.053	0.382
Price of deposits	Interest expenses (paid out to depositors) to deposits ratio		0.399	8.33
Price of fixed assets	Operating expenses to fixed assets ratio		3269.55	105239.1
Equity	The natural logarithm of equity	RUB thous.	$1.75 \cdot 10^7$	$1.07 \cdot 10^8$
Quality of loan portfolio	Loan loss provision to total loans		0.09	0.325