Bank ownership and cost efficiency in Russia, revisited

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Abstract

This paper adds to the literature on banking in transition with regard to the comparative efficiency of different bank groups. We use bank-level quarterly data for Russia over the period of 2005-2013 and modify the method of computation of comparative bank efficiency. The contribution is three-fold: (1) We show that revaluations of foreign currency and securities are material because their effects are unevenly distributed among Russian banks, and we control for them in the process of stochastic frontier analysis (SFA) of cost efficiency; (2) we build more coherent bank clusters by splitting the category of state-controlled banks into two subgroups and applying stricter criteria of foreign strategic control; and (3) using the generalized method of moments (GMM), we estimate a set of distance functions measuring the observed differences in both banks' and bank clusters' SFA scores, where such distance functions depend on the heterogeneity in either risk preference or asset structure of the banks. It addresses the causes of the bank efficiency rankings change. Our results suggest that: (1) the elimination of revaluations of foreign currency and securities produces efficiency scores that are higher and less volatile across the board; (2) the spreads between different types of banks in terms of efficiency shrink; (3) on average, the group of foreign banks appears to be the least efficient among market participants; (4) on average, the core state banks are nearly as efficient as domestic private banks; but (5) based on our estimated distance functions we argue that foreign banks are able to be more cost efficient than others when they increase loans-to-assets ratios above the sample median level. Conversely, when the loans-to-assets ratio falls below the sample median level, it ensures the superiority of the core state banks in terms of efficiency. Some of these results are consistent with previous research; others challenge the conventional wisdom with regard to the general level of Russian bank efficiency and especially that of foreign banks. We conclude that, to prevent the distorting effect of currency and securities revaluations, a refined definition of bank revenue is proper in comparative bank efficiency computations for countries with substantial volatility in financial markets.

Key words: banks; comparative efficiency; SFA; state-controlled banks; Russia

JEL codes: G21, P23, P34, P52

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1. Introduction

Bank efficiency becomes a relevant issue as the Russian economy slows down. Despite comfortably wide interest margins and high returns on equity, Russian banks yet face the challenge of expanding credit at sustainable lending rates in order to make credit more affordable to the non-financial sector of the economy. Efficiency computations might suggest the potential scope, if any, for the reduction of bank operational and non-operational expenses.

Our key research question relates to the comparative cost-efficiency of different types of Russian banks. We wish to find out which of them leads in terms of efficiency and how much room for cost cutting each of the bank groups potentially has.

Several authors have already approached the subject of comparative bank efficiency in transition, shaping the main stream of empirical findings. Bonin, Hasan and Wachtel (2005a) found foreign-owned banks to be more cost-efficient than other banks in eleven transition countries in 1996-2000. Those banks also provide better service, in particular if they have a strategic foreign owner. However, government-owned banks are not appreciably less efficient than domestic private banks. On a narrower sample of the largest banks in six transition countries (Bulgaria, Croatia, Czech Republic, Hungary, Poland and Romania) the computations support the hypothesis that foreign-owned banks are the most, and government-owned banks the least, efficient (Bonin et al., 2005b).

An examination of the cost efficiency of 289 banks in 15 East European countries suggests that a higher share of foreign-owned banks in total assets leads to lower costs, although the association between a country's progress in banking reform and cost efficiency is non-linear: initial cost reductions are succeeded by rising costs at more advanced stages. Private banks are more efficient than state-owned banks, but there are differences among private banks. Privatized banks with majority foreign ownership are the most efficient and those with domestic ownership are the least (Fries, Taci, 2005).

Data envelopment analysis (DEA) of bank-level efficiency in a wide range of transition countries suggests that foreign ownership with controlling power and enterprise restructuring enhance commercial bank efficiency (Grigorian, Manole, 2006).

An estimation of the margins and marginal costs of banks in transition countries shows that in the first sub-period (1995–98), privatized banks earned higher margins than other banks, while foreign start-ups had lower marginal costs. In the third sub-period (2002–2004), foreign banks remained low marginal cost service providers, while privatized domestic banks had the widest margins. Initially privatized banks had the largest mark-ups. However, by the third sub-period, differences among private banks diminish. State banks persistently under-perform *vis-à-*

vis private banks in controlling costs and attracting demand. Overall, foreign bank entry promoted lower costs (Fries et al., 2006).

Russia remains a special case among transition countries in various senses. Unlike in Central Europe, the share of foreign banks in total bank assets did not exceed 20%. The spontaneous privatization that crushed the system of state-owned specialized banks (Schoors, 2003) failed to create efficient private ownership, neither domestic nor foreign. Public banks became extinct in Central and Eastern Europe, but in Russia they survived the financial crisis of 1998 and kept increasing their market share ever since, to reach nearly 60% (Vernikov, 2014).

Given the high relevance of state banks in Russia, the research question remains pertinent whether these banks lead or lag in terms of efficiency in comparison to other types of institutions. The specific features of the Russian economy may have influenced the unconventional results of some of the empirical studies with regard to bank comparative efficiency. Karas, Schoors and Weill note that while foreign banks are found to be more efficient than domestic private banks, these latter are, unexpectedly, not more efficient than domestic public banks (Karas et al., 2010). State-controlled banks might actually be the market leaders in terms of operational efficiency expressed through the cost-to-income ratio (Mamonov, 2013).

In this paper, we shed new light on the issue of comparative bank efficiency in Russia by using alternative techniques in the computation, namely:

(1) *Control for the effect of revaluation of foreign currency and securities*. Previous empirical research on banking in transition employs data that reflect gross bank revenues/costs. Group efficiency ranks may have been influenced by the effect of the revaluations (hereinafter *Revals***)** of foreign currency and securities because Russia, just like some other transition and emerging countries, has long remained a dollarized and volatile economy. We argue that *Revals* bear little relation to the essence of operating cost efficiency. To check our hypothesis, we assess the substantiality of revaluations in the profit and loss accounts of Russian banks and then perform alternative calculations *with* and *without* revaluations.

(2) *A modified grouping of the Russian banks ownership-wise*. The conventional breakdown of the sample into state-owned, foreign-owned and domestic private banks needs to be amended in the particular context of Russia with its broad public sector. State-controlled institutions make a heterogeneous group that displays excessive intra-group variance. In order to estimate comparative bank efficiently more accurately, we split it into two sub-new groups, namely the core state-controlled banks and the rest of them. Furthermore, we stick to a modified principle of selection of the foreign-controlled banks. Placing substance over form, we focus on the Russian banks under the control of strategic foreign investors, i.e. the subsidiaries of foreign banks.

(3) We introduce what we believe is an *addition to the regression analysis*, by distinguishing different bank-specific factors that explain the rankings of each bank group at each point of observation. In particular, we specify a set of empirical equations in which we show how average rankings between different groups of banks can vary depending on changes in either banks' risk preferences or assets compositions.

The rest of the paper is organized as follows. Section 2 offers empirical evidence of the polluting effect of currency and securities revaluations on Russian bank revenues and costs. In Section 3 we describe our data, methodology and empirical strategy. Section 4 contains the estimation results and their discussion. Section 5 reports the robustness checks. Section 6 concludes.

2. The revaluations of foreign currencies and securities and their impact on bank profit-and-loss accounts

Quite a large share of Russian banks' operations is denominated in foreign currency, mostly US dollars and Euros. That share rose from 29.8% of assets and 29.5% of liabilities before the 2008 financial crisis to 35.2% and 31.2%, respectively, two years later (**Table 1**). The mismatch between those figures reflects the large and positive net foreign currency position of the Russian banking sector. After the crisis subsided, the share of foreign currency items in bank balance sheets gradually declined to 22.1% of all assets and 21.2% of liabilities at the end of 2013 but remains economically significant. 2014 and onward data are likely to demonstrate a new upward trend.

The financial crisis of 2008 brought about a flight to quality in the shape of a restructuring of Russian bank balance sheets in favor of foreign currency. The Ruble depreciated cumulatively by 28% against the US Dollar and by 21% against the Euro, thus generating *Revals* of foreign currency-denominated items on bank balance sheets. During 2008-2009, the ratio of positive *Revals* to total assets of the banking system increased sharply from 11.7% to 68.4%, while the ratio of negative *Revals* rose identically from 11.8% to 68.5%. That compares to the ratios of interest income to total assets of just 9.3% or interest expenses to total assets of 5.1% in 2009 (**Table 1**). By the end of the sample period (2013 Q4), the ratios of positive and negative *Revals* to assets declined to 26.8% and 26.7%, respectively, remaining at double the pre-crisis level.

Table 1

The breakdown of profits and losses of the Russian banking system (in % of total assets)

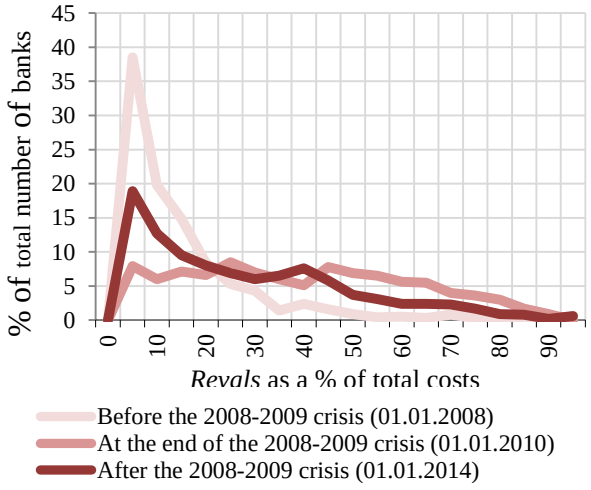
	The 2008-2009 crisis			
	before	during	after	
	2007Q4	2009Q4	2011Q4	2013Q4
Total income	*40.7*	*105.4*	*65.7*	*53.9*
Interest income	6.9	9.3	6.7	7.7
Income from operations with securities	2.7	2.7	1.4	2.5
Positive securities revaluation	1.0	0.3	0.4	0.1
Income from operations in foreign currency	15.0	76.9	43.3	30.9
Income from positive revaluation of assets and negative revaluation of liabilities both denominated in foreign currency	11.7	68.4	37.5	26.8
Fee and commission income	1.8	1.6	1.4	1.4
Income from decreasing of loan loss provisions (+LLP)	10.7	12.2	9.6	8.4
Other income	3.6	2.8	3.5	2.9
Total costs	*38.4*	*104.9*	*64.1*	*52.5*
Interest expenses	3.2	5.1	3.1	3.8
Expenses due to operations with securities	2.1	2.1	1.3	2.4
Negative securities revaluation	0.4	0.2	0.5	0.1
Expenses due to operations in foreign currency	14.8	76.7	43.1	30.8
Expenses due to negative revaluation of assets and positive revaluation of liabilities both denominated in foreign currency	11.8	68.5	37.5	26.7
Fee & commission expenses	0.2	0.2	0.2	0.3
Expenses due to increasing of loan loss provisions (-LLP)	11.5	15.4	9.8	9.5
Personnel expenses	1.9	1.5	1.6	1.5
Other expenses	4.8	4.0	5.0	4.3
Profit (after LLP and taxation)	*2.3*	*0.4*	*1.7*	*1.4*
Net interest income	3.4	3.7	3.0	3.4
Net income from operations with securities	0.9	1.2	0.7	0.6
Net securities revaluation	0.7	0.5	0.0	0.0
Net income from operations in foreign currency	0.2	0.2	0.2	0.2
Net foreign currency revaluation	–0.1	–0.1	0.1	0.1
Net fee & commission income	1.7	1.4	1.2	1.1
Net income from decreasing of loan loss provisions	–0.8	–3.3	–0.3	–1.1
Personnel expenses (with "-" sign)	–1.9	–1.5	–1.6	–1.5
Net other income	–1.2	–1.2	–1.6	–1.4
Net foreign currency position	*0.3*	*4.0*	*2.9*	*0.9*
Assets in foreign currency	29.8	35.2	30.3	22.1
Liabilities in foreign currency	29.5	31.2	27.4	21.2

Source: own calculations based on the CBR database on banks' balance sheets and profit-and-loss statements

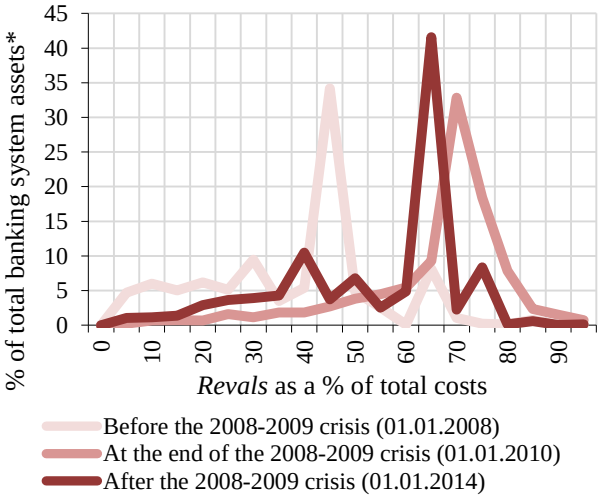
Positive *Revals* and negative *Revals* are by far the largest item of total income and total costs of the Russian banks, respectively. However, the net effect of *Revals* is very small at between -0.1% and 0.1% of total assets, as compared to the net interest income of over 3.0% of to-

tal assets.

Revals would not matter if they were uniformly distributed among banks in the sample, i.e. if all, or the majority of, banks displayed the same share of *Revals* in their total costs at each point of time. In that case, *Revals* would not affect the results of estimation in terms of bank ranking by cost efficiency. However, this is not the case with Russian banks. The distribution of *Revals*' share in costs is not uniform both in terms of number of banks (**Fig. 1.a**) and their shares in total banking system assets before, during and after the 2008 crisis (**Fig. 1.b**) ranges from almost 0% to 95%. **Fig. 2.a** additionally illustrates how the *Revals* evolved over time in different percentiles of banks' distribution.



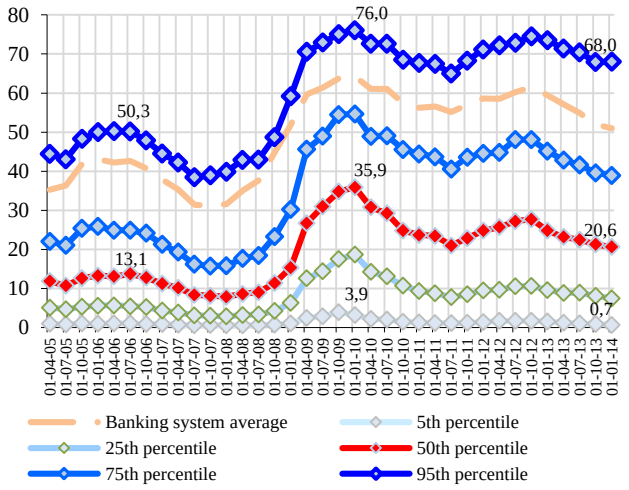
(a) Distribution by the number of banks



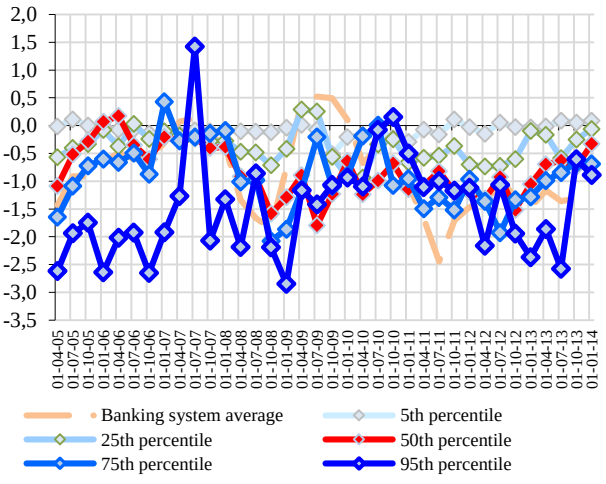
(b) Distribution by the share in total assets of the banking system

Notes: * The peaks correspond to Sberbank that holds about 30% of total banking system assets.

Fig. 1. Frequency distribution of banks according to the materiality of negative revaluations of foreign currency and securities (*Revals*)



(a) Negative *Revals* as percentage of total costs



(b) Net *Revals* (positive *Revals* minus negative *Revals*) as percentage of total income

Fig. 2. Revaluations of foreign currency and securities (*Revals*) in total costs and revenues in different percentiles of the bank distribution

We observe a sharp increase of *Reveals* during the crisis of 2008-2009 in almost every percentile of the distribution; after the crisis, the *Reveals* remain rather high. At the same time, just a small minority of banks gains economically significant profits from net *Reveals* (**Fig. 2.b**).

3. Data and methodology

3.1. Data

To feature bank-specific factors, we obtain disaggregated bank-level data from Russian bank balance sheets and profit-and-loss (P&L) statements disclosed through the Central Bank of Russia web site[3]. We use the monthly bank balance sheets (official reporting form No. 101) from March 2004 through December 2013 and the quarterly P&L statements (reporting form No. 102) from 2004 Q1 through 2013 Q4. We combine these two forms into a quarterly panel dataset using MS SQL Server. While the Form 101 provides stock data, the Form 102 is organized as flow data that builds up cumulatively from one quarter to another within each year. We rearrange these data as moving sums for four consecutive quarters, so we lose observations within 2004 and start our resulting sample period from 2005 Q1. This allows us to interpret factor input prices used in the cost frontier estimations (Section 3.3) as annual rather than quarterly, which is more useful when comparing with interest rates provided by the Central Bank of Russia in its Banking Supervision Reports (CBR, 2014).[4]

The initial sample includes all Russian banks that disclose financial accounts data, i.e. up to 1248 financial institutions within 2005 Q1 - 2013 Q4 representing 95% of total Russian banking system assets, on average. It results in a maximum of 36422 bank-quarter observations in pooled sample. Disaggregating these pooled data into quarter level, we have statistics on 803 banks as a minimum in 2005 Q4 and 1015 banks as a maximum in 2009 Q4. The gap between these two quarterly numbers and the number of banks in the pooled data shows that the sample is quite unstable, i.e. we have many newly created banks along with many banks that leave the market during the sample period.

Quarterly based macroeconomic variables were collected from the Federal State Statistics Service web site (www.gks.ru) for the same period and include real GDP growth rates (per four moving quarters), real households income growth rate (per 4 moving quarters), and non-financial firms' profit-to-debt ratio. In addition, we use daily data on the Ruble exchange rate to a bi-currency basket (USD 0.55 and EUR 0.45) from analytical agency Finam (www.finam.ru).

[3] http://www.cbr.ru/credit/forms.asp Data from the same source are used in many studies on Russian banks, e.g.: (Chernykh, Cole, 2011; Anzoátegui et al., 2012; Karas et al., 2013).
[4] http://www.cbr.ru/eng/publ/?PrtId=nadzor

3.2. Bank groups

Using the data described above, this paper breaks down the sample of Russian banks into four categories: core state-controlled banks[5], other state-controlled banks, foreign bank subsidiaries, and all other Russian banks.

Many papers on comparative banking in transition divide the sample into three groups: state-owned banks, domestic private banks and foreign banks. Alternative bank classifications based on the type of ownership have emerged to address a particular research question related to comparative bank efficiency. Bonin et al. (2005a) consider four bank categories, namely, those with majority government ownership, majority domestic private ownership, strategic foreign ownership, and other foreign majority ownership, in the attempt to capture the effect of a particular type of foreign ownership. Fries and Taci (2005) distinguish between privatized banks with majority foreign ownership from those with domestic ownership. Grigorian and Manole (2006) introduce a dummy for foreign ownership (1 if more than 30% owned, 0 otherwise) without specifying within domestically owned banks. Havrylchyk and Jurzyk (2011) distinguish newly established ("greenfield") foreign banks from those who took over existing entities in the host country, in order to assess the importance of the market entry mode by foreign banks.

In countries with a vast public sector, its breakdown into sub-categories may be appropriate. China's "Big Four" dominant state banks are analyzed separately from the other state-controlled banks (Berger, Hasan, Zhou, 2009). Russia, like China, features a substantial public sector of the banking industry consisting of up to 51 banks[6], depending on the point of observation, who jointly possess about 48-60% of all assets. We regard a bank as a state-controlled bank if it is majority-owned by a public entity. In the Russian case, a public entity may vary from the federal government to industrial companies and banks whose equity stems from public funds (Vernikov, 2012). State-controlled banks constitute a heterogeneous group with a broad intra-group variance in size, scope, business model, and governance. While the three largest ones often act as government agents and pursue a combination of financial and non-financial objectives (Vernikov, 2014), many of the smaller state-controlled banks, and particularly the indirectly-

[5] We prefer the term 'state-controlled banks' over 'state-owned banks' because from a legal viewpoint one party cannot own a joint-stock company but only shares thereof. Importantly, few public banks worldwide remain 100%-owned by the government; many of them have sold sizeable stakes to outside investors including foreign ones. Thus, the term 'state-owned bank' appears to lack accuracy, despite its broad usage in the academic literature.

[6] We use various sources to classify bank owners as state, namely the websites of the banks in question, CBR, Bankscope, Banker's Almanac, etc. Like Bertay, Demirgüç-Kunt and Huizinga (2015), we only include in the sample banks that we can identify to be owned by public entity (-ies) with a 50% or higher ownership share. Moreover, we identify the presence of public institutions among the shareholders of the bank shareholders by screening the information disclosure of bank parent entities. We put substance over the form where appropriate.

owned ones, display market behavior similar to that of domestic private institutions and are excused from on-lending public funds to government-supported projects.

Therefore, like Berger et al. (2009), we think that specific industry structure warrants for the introduction of additional sub-categories of state-controlled banks. For the purposes of this paper, we split that group into the core state-controlled banks, or *State-1*, and other state-controlled banks, or *State-2*. This breakdown enhances homogeneity within each of the sub-groups and enables us gauging more accurately the variance of our efficiency indicators. *State-1* comprises the three "national champions" (Sberbank, VTB and Rosselkhozbank) that control between 35% and 43% of the total banking assets in Russia. *State-2* consists of between 28 and 46 banks, depending on the quarter, that jointly own a market share of 19% (**Annex 1**).

The group of foreign banks represented by the variable *Foreign* counts with between 27 and 48 entities possessing 8-12% of total banking system assets (**Annex 1**). We focus on the fully owned foreign bank subsidiaries and the institutions predominantly owned by foreign banks such as *Rosbank* (*Société Générale*). In order to set a coherent and consistent category of banks with more pronounced performance characteristics, we remove the following bank types:

(1) banks whose nominal shareholders are foreign but the final beneficiary(-ies) are Russian;
(2) banks controlled by foreign private individuals, institutional investors other than banks, and international institutions;
(3) banks controlled by industrial loan corporations, primarily the offspring of the foreign automotive companies (BMW, VW, Daimler, Toyota, PSA Peugeot Citroën, etc.) whose main business is the financing of car sales in the Russian market rather than commercial banking as such; and
(4) banks controlled by foreign investment companies ("investment banks") that mainly conduct financial market operations and do not pursue classical commercial bank business models.

We assume that the characteristics among banks controlled by foreign strategic investors shall be more coherent than within a heterogeneous group that includes diverse bank types. Comparing the performance of foreign bank subsidiaries with that of state-controlled banks and private banks should therefore yield more meaningful results than those emerging from the previous studies of aggregated bank categories.

The remaining group of banks privately owned by Russian residents (*Private*) covers between 745 and 920 banks whose market share varies within the range from 31% to 42% of all assets (**Annex 1**).

Each quarter the composition of each group is revised to reflect possible migrations.

3.3. Empirical strategy

Our empirical strategy includes three steps:

(1) the specification of the empirical cost function;

(2) the aggregation of bank-level cost efficiency scores into group-level characteristics;

(3) the estimation of bank-level sources of efficiency heterogeneity.

Step 1.

We use stochastic frontier technique to compute time-specific rankings in bank cost efficiency. We specify the empirical cost function on the bank level within production approach taking into account prices of inputs, quantities of outputs and the equity netputs to control for banks differences in risk preferences (Turk Ariss, 2010; Fiordelisi, Marques-Ibanes and Molyneux, 2011). We prefer production approach over intermediation approach for two main reasons: (a) to avoid possible bias of efficiency estimates due to incomplete assets and liabilities coverage in the intermediation approach (Fortin, Leclerc, 2007); and (b) to account for the fact that loans are funded not only by deposits but also by other sources such as inter-bank deposits, foreign liabilities, loans from central bank, debt securities issued by banks, etc. When specifying the cost function we take into account possible non-linear and non-neutral features of technical progress in the banking industry (Berger and DeYoung, 1997; Maudos and Fernández de Guevara, 2007; Schaeck and Cihák, 2010; Turk Ariss, 2010; Fiordelisi et al., 2011).

Our key distinction from previous research is the treatment of *Revals*. We analyze the potentially distortive role of *Revals* in bank performance analysis by specifying two alternative empirical cost functions: (a) total costs minus interest expenses as a dependent variable; (b) the same as (a) minus *Revals*. We deduct interest expenses from total costs on the assumption that interest expenses reflect bank market power rather than its efficiency. Similarly, we believe that *Revals* reflect the action of an exogenous factor, namely the exchange rate of the national currency, and therefore bear little relation, if any, to the essence of bank cost efficiency that presumably should be within the management control. In a similar fashion, the revaluation of securities, despite being economically meaningful, is in a sense alien to the operating efficiency concept. *Revals* may substantially fluctuate depending on national currency exchange rate dynamics, especially in a dollarized commodity economy like Russia's. The distorting potential of this item increases during periods of financial turmoil (**Fig. 2.a**). We think that by dropping the *Revals* from the total costs we can get closer to the essence of operating costs and perform efficiency estimates more accurately.

Our two alternatives for empirical cost function take the following (translog) form:

$$\ln OC_{it}^{(alt)} = \beta_0 + \sum_{j=1}^{3}\beta_j \cdot \ln Y_{j,it} + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3}\beta_{kl} \cdot \ln Y_{k,it} \cdot \ln Y_{l,it} + \sum_{m=1}^{3}\gamma_m \cdot \ln P_{m,it} + \frac{1}{2}\sum_{r=1}^{3}\sum_{q=1}^{3}\gamma_{rq} \cdot \ln P_{r,it} \cdot \ln P_{q,it} + \quad (1)$$

$$+ \sum_{s=1}^{3}\sum_{u=1}^{3}\delta_{su} \cdot \ln Y_{s,it} \cdot \ln P_{u,it} + \sum_{j=1}^{3}\varphi_j \cdot \ln Y_{j,it} \cdot T + \sum_{m=1}^{3}\psi_m \cdot \ln P_{p,it} \cdot T + \alpha_1 \cdot T + \alpha_2 \cdot T^2 + \mu_1 \cdot \ln EQ_{it} +$$

$$+ \mu_2 \cdot (\ln EQ_{it})^2 + \sum_{j=1}^{3}\rho_j \cdot \ln Y_{j,it} \cdot \ln EQ_{it} + \sum_{m=1}^{3}\xi_m \cdot \ln P_{m,it} \cdot \ln EQ_{it} + \eta \cdot T \cdot \ln EQ_{it} + v_{it} + u_{it}$$

where alt stands for two alternative compositions of cost so that $alt = 1$ for operating costs with *Revals* kept, while $alt = 2$ when *Revals* are dropped from the operating costs. Next, for bank i at time t $OC_{it}^{(alt)}$ are operating costs with *Revals* ($alt = 1$) and without *Revals* ($alt = 2$). $Y_{j,it}$ is a j-th output: loans to households and nonfinancial firms ($j = 1$), retail and corporate deposits (without government and inter-bank accounts, $j = 2$), fee and commission income as a proxy for noninterest-based output ($j = 3$). $P_{m,it}$ is an m-th factor input price: average funding rate as a price of funds ($m = 1$), personnel expenses to total assets ratio as a price for labor ($m = 2$) and other non-interest and non-personnel expenses to total assets ratio as a proxy for the price of physical capital ($m = 3$). EQ_{it} is equity capital as a netput factor reflecting differences in managers' risk preferences. T is the time trend. $v_{it} + u_{it}$ is a composite error term where $v_{it} \sim N(0, \sigma_v^2)$ is a random error that follows symmetric normal distribution (by assumption). $u_{it} \sim N^+(u, \sigma_u^2)$ captures cost inefficiency and is set to follow (positive) half-normal[7] distribution. In estimating empirical cost function we impose, standardly, linear homogeneity conditions on factor input prices as well as symmetry conditions.

Having estimated two alternative sets of parameters of cost function, we compute two versions of cost efficiency scores for bank i at time t:

$$SFA_{it}^{(alt)} = \exp\{-\hat{u}_{it}^{(alt)}\} \quad (2)$$

where $\hat{u}_{it}^{(alt)}$ is an estimate of inefficiency term with *Revals* ($alt = 1$) and without *Revals* ($alt = 2$).[8]

[7] We also tested (positive) truncated form for the distribution of inefficiency term within Battese and Coelli (1995) model. Our key results remain qualitatively unchanged.

[8] We use Stata 11 software to implement our estimation procedures. The basic specification of cost function (1) is estimated using *frontier* routine, which allows calculating bank-level time-specific SFA scores (2) though it does not account for panel fixed effects. SFA scores obtained under the frontier routine have one general advantage: they imply no particular intertemporal functional form as, for example, linear time-decay model of (Battese and Coelli, 1992) realized in the *xtfrontier* Stata routine. Anyway, we additionally use *sfpanel* routine introduced recently by Belotti et al. (2013) to account for panel fixed effects in our frontier estimations and verify our basic results. More details are provided in Robustness checks (see Section 5). Here, we just notice that we do not use the *sfpanel* routine

Step 2.

The bank-level cost efficiency scores obtained at the previous step are aggregated into group-level scores. We break the entire sample into four groups (State-1, State-2, Foreign and Private), as explained in the Section 3.2. The purpose is to compare the performance of Russian banks with regard to their ownership status. We aggregate individual (bank-level) SFA scores for both alternatives, i.e. with *Reveals* kept and dropped, in order to arrive at group-level characteristics that would reflect the same two alternatives. We take a simple arithmetic average and a weighted average (with the weights equal to bank share in total banking system assets). We regard the arithmetic average as the basic approach because it provides equal weights to all banks within particular group irrespectively to their scale and thus better reflects average movements. We complete this step by comparing group-level SFA scores for groups of banks as period averages and in dynamics.

Step 3.

Finally, we proceed with the heterogeneity analysis in order to explain the observable differences in cost efficiency levels, e.g. SFA scores from Eq.(2), both within particular group of banks (the core- and the rest of state-controlled banks and foreign-controlled banks) and between them. The motivation is that some banks from one group can be more cost efficient than banks in another group even if on the group level the average ranking is different. It is important to find out why and when some banks from a less efficient group can be more efficient than banks with similar characteristics from a more efficient group. We use the loans-to-assets ratio to catch differences in funds allocation between interest-generating and noninterest-based activities, and the equity-to-assets ratio to manage the variation in risk tolerance. We specify the following set of empirical equations in a static panel framework:

$$SFA_{it}^{(alt)} = \alpha_{h,i} + \sum_{j=1}^{3} \beta_{hj} GROUP_j + \sum_{j=1}^{3} \gamma_{hj} GROUP_j X_{h,it} + \gamma_h X_{h,it} + \tag{3}$$

$$+ \sum_{k=1}^{K} \delta_{hk} BSF_{k,it} + \sum_{m=1}^{M} \varphi_{hm} MACRO_m + \varepsilon_{h,it}$$

where for bank i at time t $SFA_{it}^{(alt)}$ is cost efficiency score from Eq.(2) computed with *Reveals*

to perform our basic estimations of cost frontier for the following reason. We are interested not only in ranking government-owned and foreign-owned banks by inefficiency term as in Karas et al. (2010) but also in a deeper analysis of possible heterogeneity sources of such rankings. We found that *sfpanel* based on non-linear iterative procedures (such as BFGS) produces highly sensitive to initial values estimates of interaction terms (dummy for bank group multiplied by bank-specific candidate in heterogeneity factors) included as explanatory variables in mean inefficiency term equation (within, for example, the model of Battese and Coelli (1995) or the True fixed effects model of Greene (2005) that are both realized in the *sfpanel* routine). We decided to use more flexible frontier routine to generate SFA scores at the first step to be able to estimate their heterogeneity sources at the further steps using GMM (see Step 3 below in this Section)

($alt=1$) and without *Reveals* ($alt=2$). $X_{h,it}$ is h-th potential candidate for efficiency heterogeneity factors. We consider more general bank-specific characteristics for $X_{h,it}$: equity-to-assets ratios ($h=1$) and loans-to-assets ratios ($h=2$) that are assumedly responsible for bank-level heterogeneity of SFA scores within particular $GROUP_j$ as well as between all three groups considered: the core state-controlled banks ($j=1$), the rest of the state-controlled banks ($j=2$) and foreign-controlled banks ($j=3$), while private domestic banks are treated as the reference group. $BSF_{k,it}$ is k-th bank-specific factor that may affect cost efficiency: size, share of retail loans in total loans, loans dynamics, loans-to-deposits ratio, and market power (price mark-up as measured by efficiency and the funding-adjusted Lerner index, a modification proposed by Koetter et al. (2012)). $MACRO_m$ is m-th macroeconomic factor to control for business-cycle, Ruble volatility and borrowers' creditworthiness.

As a basic estimator of Eq.(3), we exploit 2-step GMM to address possible endogeneity and heteroscedasticity concerns.

Our main hypotheses regarding chosen heterogeneity factors $X_{h,it}$ are as follows.

First, larger equity relative to assets provides potential for maintaining and expanding commercial loans that are among the three outputs included into our cost function. The higher equity-to-assets ratio a bank has, the greater its outputs could be with the same volume of costs. Thus, it implies higher SFA scores. So, if j-th banks group ($GROUP_j$) is on average less efficient compared to the reference group (privately-owned banks), then we would expect that increasing such banks equity-to-assets ratios would reduce their distance to the reference group and, probably, overcome it. This is in line with Berger and Mester (1997) who claim that more prudent banks could be those with higher efficiency levels. On the other hand, holding more capital could be costly as it implies lower lending activities in the current period (Koetter, Poghosyan, 2009; Williams, 2012). We wish to investigate which of these competing effects are predominant in the Russian banking system and for each $GROUP_j$.

Second, intensifying lending activities may facilitate economy of scale effects so that increasing loans-to-assets ratio may positively affect cost efficiency (SFA score) (Solis, Maudos, 2008; Williams, 2012). Similarly to the previous case, j-th banks group ($GROUP_j$) could shorten the distance between them and the reference group by increasing the loans-to-assets ratio. At the same time, increasing loans requires more costs for borrowers screening which could lower cost efficiency (Williams, 2012). As in the previous case, we are to define empirically the prevailing effect in the Russian banking system.

To deal with outliers, we employ common filtering procedures to our panel dataset. First, we exclude the data below the 1st and above the 99th percentiles of the initial sample. That applies to data on relative indicators including factor input prices in Eq.(1) and all bank-specific variables in Eq.(3) with the exception of bank size in order not to drop largest banks such as Sberbank or VTB. Further, we drop the observations with loans-to-assets ratio smaller than 10% in order to focus on banks providing credit to the economy and to eliminate entities that do not function as genuine banks (Schoors, 2000; Karas, Schoors, 2010). After these filtering procedures we have an unbalanced panel data on 1038-1196 entities, and the number of observations ranges from 17401-20319 in Eq.(3) to 29082-29146 in Eq.(1) estimations.

4. Estimation results and discussion

In this section, we present and discuss our empirical results obtained from cost frontier estimations (Section 4.1), the aggregation of bank-level SFA scores into group-level (Section 4.2) and the analysis of bank-level and group-level heterogeneity of estimated SFA scores (Section 4.3).

4.1. Bank-level cost efficiency

Descriptive statistics of variables included in the empirical cost functions appear in **Annex 2**, and the estimation results of the cost functions are in **Annex 3**. In **Table 2,** we present SFA scores calculated for three distinct percentiles of the distribution — 25th, 50th, and 75th — and then averaged within the whole sample period (2005Q1 – 2013Q4). These values allow us to reveal the scope of differences between less efficient (p25) and more efficient (p75) banks in both alternatives of SFA score computation, i.e. with *Revals* kept and dropped. We also complement the analysis by the SFA scores averaged within two sub-periods: before and after the crisis of 2008-2009, to account for possible changes occurred during the crisis.

Table 2

Bank-level operating cost efficiency (SFA scores, production approach) for different percentiles of bank distribution and within various time periods

	Whole period (2005Q1– 2013Q4)			Before the crisis of 2008-2009 (2005Q1– 2008Q2)			After the crisis of 2008-2009 (2010Q1– 2013Q4)		
	p25	p50	p75	p25	p50	p75	p25	p50	p75
(A) *Revals** kept									
All banks	50.9	68.3	82.0	59.3	72.8	83.3	46.9	66.0	81.8
(B) *Revals* dropped									
All banks	74.3	83.9	90.5	73.7	83.6	90.6	74.6	84.1	90.3
Difference between (B) and (A)									
All banks	23.4	15.6	8.5	14.4	10.8	7.3	27.6	18.1	8.5

Notes: * revaluations of foreign currency and securities

Irrespectively of the phase of the business cycle, the average SFA scores calculated without *Revals* ($alt = 2$) are greater than the scores with *Revals* kept ($alt = 1$) – 83.9% and 68.3%, respectively, in the 50th percentile for the whole period. When we keep *Revals*, the average SFA score deteriorates from 72.8% before the crisis to 66.0% after it, which is hard to interpret. By contrast, if *Revals* are dropped, the average SFA score grows slightly from 83.6% before the crisis to 84.1% after the crisis. On the one hand, these are technical results: when we exclude one element, such as negative *Revals*, from total costs and leave the same factor input prices, outputs and netputs, the resulting cost efficiency level must be higher. On the other hand, the magnitude of this effect matters. If the resulting SFA score increase is small, then the necessity of dropping *Revals* is doubtful. However, such an increase turns out to be economically significant ranging from 8.5 to 27.6 percentage points (**Table 2**), despite the downward trend as we move from lower to higher percentiles of the SFA distribution.

We also present the distributions of SFA scores in both alternatives as 2005 Q1 - 2013 Q4 averages (**Fig.3**). If we keep *Revals*, the peaks in the distribution range from 74 to 89% covering 30% of all bank-quarter observations, and the distribution is uniform. If we drop *Revals*, the majority of Russian banks are located within approximately 78-95% range of the SFA score. The peak of the distribution is reached at SFA scores between 90 and 95% covering about 22% of all bank-quarter observations, and the distribution is quite skewed to the right.

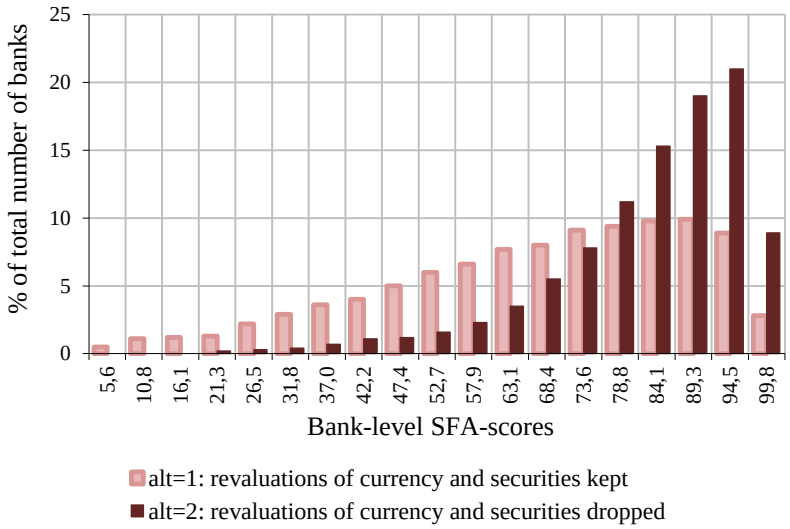


Fig. 3. Frequency distribution of banks' SFA scores as average of 2005Q1-2013Q4 (production approach)

Our estimated SFA scores (with *Revals* kept) are lower than those produced by some other authors. Turk Ariss (2010) estimates Russian banks SFA score to be 83% on average. Kumbhakar and Peresetsky (2013) arrive at an estimated average SFA score of 81% when comparing cost efficiency of Russian banks to that of banks in Kazakhstan. The period and the scope might explain these differences. Turk Ariss builds a panel of 821 banks from 60 different coun-

tries including Russia; Kumbhakar and Peresetsky consider only Russian 78 banks, which is nearly one-tenth of the size of our sample. The period of observations of Turk Ariss is 1999-2005, and that of Kumbhakar and Peresetsky is 2002-2006, of which only two years (2005 and 2006) overlap with our sample period (from 2005 through 2013). We use quarterly data, whereas Kumbhakar and Peresetsky use annual data. Given that Russia is an emerging economy and the Russian banks were not very advanced yet at the mid-2000s, SFA scores above 80% appear to be on the high side because they imply limited room for improvement in cost efficiency.[9] Our estimated average SFA level of 68% (with *Revals* kept, for comparability sake) might therefore look more credible.

4.2. Group-level cost efficiency

We proceed with the comparative analysis of cost efficiency levels of the four groups of banks for the whole sample period first and then in dynamics.

Estimation results for the group-level operating cost efficiency are SFA scores averaged across all banks constituting a particular group (**Table 3**). In Panel 1 and Panel 2 of this table, we put the descriptive statistics of SFA scores computed with and without *Revals*, respectively.

Table 3
Group-level operating cost efficiency (SFA scores, production approach) as averages of 2005Q1-2013Q4

Bank group	SFA score		Standard deviation	Min	Max	Obs.	No. of banks
	%	rank					
*Panel 1: With Revals**							
All groups	64.5		21.7	0.4	99.4	29113	1139
State-1	50.8	3	25.9	12.0	97.8	108	3
State-2	67.1	1	21.9	4.3	98.5	1204	61
Foreign	29.2	4	21.9	1.0	98.4	1177	49
Private	66.1	2	20.2	0.4	99.4	26624	1065
Panel 2: Without Revals							
All groups	80.1		14.1	2.1	99.8	29113	1139
State-1	75.5	3	18.6	34.9	98.0	108	3
State-2	78.2	2	15.2	20.8	98.7	1204	61
Foreign	60.3	4	19.9	6.9	97.9	1177	49
Private	81.1	1	13.1	2.1	99.8	26624	1065

Notes: * negative revaluations of foreign currency and securities

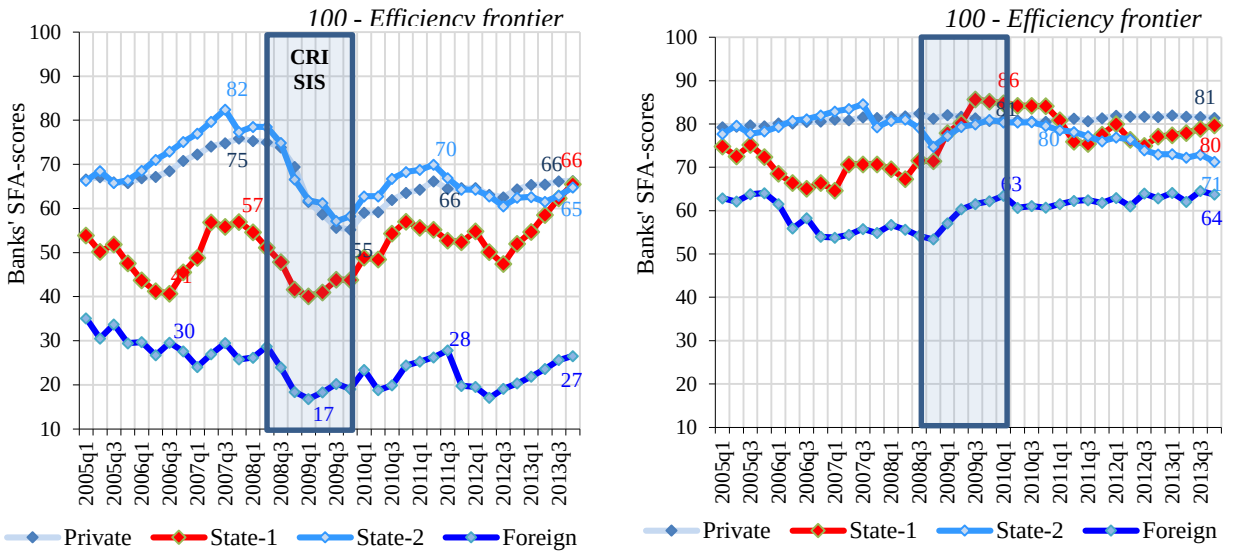
Revals substantially affect the levels of cost efficiency of all four groups and their rankings, so it matters whether *Revals* are kept or dropped. Average SFA scores rise substantially from Panel 1 to Panel 2 for each particular group. Again, as in previous section, we observe that these SFA scores become less volatile when Revals are dropped. Next, the data in Panel 1 indicate that when *Revals* are kept, the highest SFA score (67.1%) belongs to non-core state-

[9] Schaeck and Cihák (2010) estimate average EU banking system SFA score to be 88% for 1995-2005.

controlled banks (State-2) followed by domestic privately owned banks (66.1%), core state-controlled banks (50.8%) and foreign subsidiary banks (29.2%). Dropping the *Revals* upsets that ranking (Panel 2): the leading position goes to domestic private banks (81.1%), followed by non-core state banks (78.2%), core state banks (75.5%) and foreign banks (60.3%). SFA scores of State-1, State-2 and private banks become closer. Foreign banks benefit the most from the procedure of dropping the *Revals*: although they remain at the bottom of the ranking, their average SFA score more than doubles.

The empirical result for foreign banks as the least efficient group of Russian market participants goes contrary to the mainstream of literature on banking in transition (Bonin et al., 2005a; 2005b; Fries, Taci, 2006; Grigorian, Manole, 2006; Fries et al., 2006; Karas et al., 2010). This result requires some interpretation. As shown in Lensink et al. (2008), substantial institutional differences between home and host countries — i.e. developed and transition ones in our case — can lead to higher negative, not positive, effect of foreign ownership on banking efficiency. Why could that be the case for Russia? At the initial period of penetration into the Russian market, the foreign banks may have kept excessive capital adequacy and a relatively small loan portfolio, which impeded exploiting full economies of scale and therefore depressed SFA efficiency scores. Another yet explanation of lesser cost efficiency of foreign banks in Russia may be related to the transfer pricing between subsidiary banks in Russia and their parent banks in the home country: foreign banks are not interested to show excessive profits (and thus pay higher taxes) in the host country. It can cause a "Quiet life" syndrome (Berger, Hannan, 1998), especially for large banks like Raiffeisenbank, UniCredit and Citibank.

The 2008 financial crisis may have produced structural changes, so we test it by performing the comparisons in dynamics and break down the observation period into different subperiods: pre-crisis, crisis and post-crisis, in two versions, with *Revals* kept and dropped (**Fig. 4**).



(a) With the revaluations of foreign currency and securities

(b) Without the revaluations of foreign currency and securities

Fig. 4. SFA scores for different bank groups (arithmetic averages within each group; ranging from 0 for the least efficient to 100 for the most efficient)

The immediate finding is that after dropping the *Revals* we observe the spreads between different groups of banks in terms of efficiency shrink. It is consistent with the hypothesis that all players within a banking system are exposed potentially to the best available technology, so the formal status of banks (state-controlled or private) does not explain the deviation from the best practice[10]. The inclusion of *Revals* in the bank financial results has blurred this effect hitherto.

Our second finding is that the ranking of bank groups is not constant over the period of observations, and the elimination of *Revals* affects the rankings, albeit in a different fashion than in **Table 3**. More specifically, if we keep *Revals***,** then State-2 is the most efficient group most of the time (**Fig. 4.a**). Without *Revals*, however, the leadership of any particular group in terms of cost efficiency is only temporary. Before the 2008 crisis, State-2 and private banks were co-leading with SFA scores around 80% (**Fig. 4.b**). During the crisis (2008 Q4 – 2010 Q1), the SFA score of State-1 jumped to 86% and ensured the lead for this group. This phenomenon may be due to the anti-crisis policies of the Russian government and the flight to quality combined with aggressive marketing by the core state banks. In the post-crisis period, the core state-controlled banks were more efficient than the other state-controlled banks and nearly as efficient as domestic private banks. During this period, the State-1 group had lost up to 9 percentage points of the SFA score (to 75% in the mid-2011) and gradually yielded the top rank to the domestic private banks. These could be a consequence of increasing wages that were lowered by the core state-

[10] Likewise, Altunbas, Evans and Molyneux (2001) compare different groups of banks within the German banking system and find small spreads in efficiency levels between government- and privately owned banks.

controlled banks during the crisis as compared to the wages offered in privately-owned banks[11]. But, having reached the floor of 75%, the SFA score of the State-1 group has turned to increase again and achieved 80% at the end of the sample period which is qualitatively the same level that the privately-owned banks have at the same period (81%). The State-2 group, as contrast to the State-1 banks, could not break the decreasing trend of cost efficiency so that to the end of the sample period their SFA score was approximately 9 percentage points less than that of State-1 banks.

Thirdly, **Fig. 4.a** suggests that during financial turmoil the efficiency of banks declines as compared opposed to normal circumstances. **Fig. 4.b**, conversely, shows that bank efficiency grows during the period of the crisis, which is in line with the concept that an economic crisis can discipline economic agents by forcing them to eliminate unnecessary costs accumulated in previous periods. We would not be able to capture this important effect had we kept the *Revals*.

4.3. The determinants of within- and between-group heterogeneity of cost efficiency

In this section, we present and discuss our empirical results related to the observable heterogeneity of cost efficiency within and across the four groups of banks. Rather than discussing average differences in cost efficiency levels between the four groups, we instead identify the conditions under which a bank from a less efficient group could be more efficient than a bank from the leading group. With that goal in mind, we regress bank-level SFA scores on a set of dummies for banks groups and their respective cross-products with some broad bank-level characteristics. Descriptive statistics appear in **Annex 4**. We apply GMM as a basic estimator in those regressions. We present our core estimation results in **Table 4**. We describe here only the effects that have been revealed for the group dummies and their interactions with respective heterogeneity factors (equity-to-assets or loans-to-assets ratio), while the full set of estimation results concerning other bank-specific and macroeconomic controls is provided in **Annex 5**.

[11] Banks are not required to disclose the number of employees, so we can compare banks only in terms of the personnel expenses to total assets ratio. In the State-1 group the ratio was 1.4% before the crisis, 1.2% during and 1.3% after the crisis. Respective values for private banks were 3.3%, 3.9%, and 3.3%. The rise of the indicator for private banks during the crisis is the result of sharp decrease of total assets and much lesser reduction of staff costs. Nevertheless, the wide gap between these two groups of banks is a feature of the Russian banking industry and reflects the dominance of state-controlled banks. In order to stay competitive with them, privately-owned banks are forced to overpay the staff.

Table 4

GMM estimation results: The determinants of within- and between-group heterogeneity of cost efficiency (2005Q1-2013Q4; dependent variable: bank-level SFA score with and without *Revals*)

Revals kept	Yes			No		
	M1.1	M1.2	M1.3	M2.1	M2.2	M2.3
Dummy variables for bank ownership status						
State-1	2.780	–1.584	–4.390	2.704*	–5.365**	15.123***
	(2.649)	(4.639)	(6.869)	(1.406)	(2.648)	(4.984)
State-2	8.559***	7.387***	7.055**	1.672***	1.895***	5.643***
	(0.525)	(1.120)	(2.765)	(0.241)	(0.572)	(1.223)
Foreign-owned	–16.222***	–7.939***	–28.756***	–0.021	–4.456***	–20.925***
	(0.996)	(1.704)	(3.165)	(0.693)	(1.159)	(1.892)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.661***	0.676***	0.638***	0.426***	0.417***	0.419***
	(0.018)	(0.018)	(0.018)	(0.011)	(0.011)	(0.011)
ETA × State-1		0.386			0.569***	
		(0.254)			(0.166)	
ETA × State-2		0.090			–0.021	
		(0.063)			(0.035)	
ETA × Foreign-owned		–0.453***			0.241***	
		(0.083)			(0.059)	
Loans-to-assets ratio (LTA)	0.607***	0.606***	0.589***	0.439***	0.439***	0.428***
	(0.012)	(0.013)	(0.012)	(0.008)	(0.008)	(0.008)
LTA × State-1			0.107			–0.244***
			(0.139)			(0.085)
LTA × State-2			0.023			–0.074***
			(0.048)			(0.022)
LTA × Foreign-owned			0.215***			0.371***
			(0.061)			(0.037)
No. of obs.	19546	19546	20319	19573	19573	20319
(banks)	(967)	(967)	(978)	(967)	(967)	(978)
Centered R^2	0.337	0.369	0.352	0.557	0.559	0.549
No. of endog. vars., excl. instr.	6, 12	9, 15	9, 15	6, 12	9, 15	9, 15
P-val for Hansen J-stat	0.558	0.569	0.719	0.143	0.221	0.167
P-val for Kleibergen-Paap LM	0.000	0.000	0.000	0.000	0.000	0.000

Notes: In this table, we present our core estimation results. Full estimation results are located in **Annex 5**.

Revals are negative revaluations of foreign currency and securities.

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are provided in parentheses under the coefficients.

Each of the two sections of the **Table 4** relates to a differently calculated dependent variable while the set of regressors remains identical. Models M.1.1, M.1.2 and M.1.3 were run with *Revals* kept, as other authors do, and in the models M.2.1, M.2.2 and M.2.3 we remove *Revals*. Each of the two sections reflects three regression results. In the models M1.1 and M2.1 we simply regress SFA scores on the four groups dummies without interacting them with other bank-specific factors, controlling for other bank-level and macroeconomic variables. This preliminary step provides a bridge from the comparative analysis of average efficiency levels of the four groups of banks (Section 4.2) to the following heterogeneity analysis. Regression models M1.2 and M2.2 describe how SFA scores are distributed among banks depending on their respective equity-to-assets ratios measuring banks risk tolerances. Regression models M1.3 and M2.3 outline the role of loans-to-assets ratios as a measure of assets composition in identifying the efficiency heterogeneity.

The referent group in all regressions presented is domestic privately owned banks. For each of the three remaining groups there are three possible outcomes regarding the sign of the coefficient before respective dummy variable – significantly negative, insignificant, or significantly positive. It means that respective group is less cost-efficient, has the same efficiency level, or is more cost efficient as compared to the referent group. The same three possible outcomes apply to the sign of the coefficient before the cross product of respective group dummy and equity-to-assets/loans-to-assets ratios. Combining them together we get 3*3=9 possible outcomes for each of the three non-referent groups. But the most valuable outcomes, as we suppose, could be the combinations of either a "–" sign before a dummy and a "+" sign before a cross-product or inversely a "+" sign before a dummy and a "–" sign before a cross-product as it would imply the *convergence* of efficiency between a non-referent and the referent group. In addition, it could be an equally important outcome if both signs were either positive or negative as it can reflect the *divergence* of efficiency levels between the groups.

More specifically, a "–" coefficient before a group dummy and a "+" coefficient before a cross-term of this group dummy and equity-to-assets ratio would suggest that an increase in equity-to-assets ratio(s) of some bank(s) from this particular group can narrow the efficiency gap between that bank(s) and the referent group. That would mean that decreased risk tolerance as measured by increased equity-to-assets ratio could drive a reduction of efficiency heterogeneity between the groups[12]. On the contrary, if the estimated coefficient before the cross-product turns out to be negative, it would imply that a higher equity-to-assets ratio increases the observable heterogeneity between the groups[13]. The same applies to the assets composition as proxied by loans-to-assets ratio.

(1) *Homogenous relations*

As follows from Models 1.1 and 2.1 (**Table 4**), when controlling for other micro- and macroeconomic fundamentals, in both respective cases the average efficiency score of the core state banks turns out to be insignificantly different from that of the referent group, i.e. private banks. This finding means that even quite large observed differences in the average efficiency scores outlined in the previous section (SFA score at 50% for State-1 vs 65% for Private when *Revals* are kept, and 75% vs 81% otherwise) can disappear when we take into account internal specifics of these groups' risk preferences, assets compositions, market powers and other bank-level characteristics unrelated to costs. The core state banks possess greater market power than

[12] We observe the same reduction in heterogeneity in case of a "+" coefficient before a group dummy and a "–" coefficient before a cross-product of the dummy and equity-to-assets ratio.

[13] Analogously, if both coefficients before the dummy and the cross-product are negative, it implies growing heterogeneity caused by an increase in equity-to-assets ratio.

private banks (Anzoátegui et al., 2012) and are in fact no less cost efficient than private banks in spite of the formally lower efficiency score.

As opposed to the core state banks (State-1), the other state-controlled banks (State-2) seem to be more cost efficient on average as compared to the referent group of private banks and hence the State-1 too. In case *Revals* are kept, the estimated coefficient is 8.6 while in the opposite case the same coefficient is only 1.7, both are significant at 1% level. On the one hand, it reflects one of our previous results concerning the shrinking effect that elimination of *Revals* has on the spread of efficiency scores of different groups (Section 4.2). On the other hand, the fact that State-2 banks can be more cost efficient as compared to the State-1 banks might reflect a lesser degree of political interference into bank decision making. Unlike in the case of State-1 banks, the government would not force the State-2 banks to finance government-approved projects.

Up to this point, estimation results were only quantitatively, not qualitatively, affected by the treatment of *Revals*. The following example illustrates the materiality of *Revals* in examining observable differences in cost efficiency scores between groups of banks. For Foreign banks, with *Revals* kept we observe a negative, statistically significant and quite large coefficient (-16.2) implying an extraordinarily inefficient performance of foreign banks in Russia, as discussed in Section 4.2. But this conclusion is challenged when we remove *Revals*: the respective coefficient become close to zero. It might be driven by a higher dependence of foreign banks on cross-border operations, mostly with parent banks in home countries, resulting in that the share of negative *Revals* in total expenses is 58% for the Foreign banks (average during the sample period) against only 23% for other banks.

(2) Heterogeneous relations based on differences in risk preferences

We now analyze the estimation results from Models M1.2 and M2.2 with differences in banks' risk preferences as a source of efficiency heterogeneity. From **Table 4** we see whether the convergence/divergence of SFA scores exists for banks from different groups, before moving to **Table 5** that shows how the differences in efficiency scores between particular group and the referent group are distributed by our chosen proxy for risk preference (equity-to-assets ratio). In terms of Eq.(3), such differences, or *distance functions*, can be represented as $\beta_{1j} + \gamma_{1j} X_{1,it}$, where 1 refers to bank-level equity-to-assets ratio (ETA) and j stands for a group of banks (State-1, State-2 or Foreign). We have calculated all possible values of such distance functions, but we present and describe them partially, i.e. for the 10th, 25th, 50th, 75th and 90th percentiles of ETA distribution, without any loss of generality.

Table 5

GMM post-estimation results: Heterogeneity in risk preferences as a major factor determining the distances between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: With Revals (Model M1.2)					
State-1	1.807	2.331	3.153	4.343*	6.592**
State-2	7.993***	8.176***	8.417***	9.018***	10.115***
Foreign	–11.670***	–12.967***	–14.981***	–19.120***	–26.742***
Panel 2: Without Revals (Model M2.2)					
State-1	–0.370	0.403	1.614	3.368**	6.679***
State-2	1.753***	1.711***	1.654***	1.514***	1.258***
Foreign	–2.471***	–1.781**	–0.709	1.493*	5.548***
Panel 3: Percentiles of equity-to-assets distributions within particular group of banks					
State-1	8.8	10.1	12.3	15.3	21.2
State-2	6.7	8.8	11.5	18.1	30.3
Foreign	8.2	11.1	15.6	24.7	41.5
Private	8.2	11.0	16.5	27.1	44.3

Notes: domestic privately owned banks are the referent group. Risk preferences are proxied by banks' equity-to-assets ratios.
Revals are negative foreign currency and securities revaluations.
***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided for space reason.

For State-1 banks, we have a function of estimated coefficients: $-1.5+0.4\times\mathrm{ETA}$, in case *Revals* are kept (M1.2), and qualitatively the same function: $-5.4+0.6\times\mathrm{ETA}$, otherwise (M2.2). Although both coefficients in the first function are insignificant, their linear combination, i.e. the distance, can still be significant for some values of ETA, so we keep this function in mind but prefer the second one where both coefficients are significant. Equating these simple expressions to zero and solving respective linear equations, we get thresholds dividing positive and negative values of the distance functions. For the first equation, this threshold is only 4.1%, which is below the 1st percentile of the ETA distribution in the whole sample. 9.4% is the estimated threshold for the second equation and it lies in the 16th percentile of the ETA distribution. Consequently, if a bank from the State-1 group has a very small value of ETA (e.g., 6.9% that corresponds to the 5th percentile of ETA distribution) and decides to decrease its risk preferences to our estimated threshold (9.4%), we will observe convergence of cost efficiency levels between this bank and the referent group. Further increasing of the ETA ratio by this bank above the threshold will gradually produce the opposite effect, i.e. the divergence of efficiency levels.

If *Revals* are kept (Panel 1 of **Table 5**), there is no statistical difference between State-1 and the referent group up to, approximately, the 75th percentile of ETA distribution of State-1 banks. In other words, about 75% of all observations on core state banks reveal no statistical difference between them and private banks, but such differences emerge and grow after the 75th percentile. A State-1 bank with ETA ratio of 15.3% (corresponds to the 75th percentile, see Panel

3 of **Table 5**) is 4.3 percentage points more cost efficient than average bank in the referent group that has SFA score of 66% (**Table 3**). Moreover, a State-1 bank with ETA ratio in the 90th percentile (21.2%) is 6.6 percentage points more cost efficient than an average bank from the referent group.

If we remove *Reveals*, the estimation results remain qualitatively and quantitatively similar but statistically more significant (Panel 2 of **Table 5**). A State-1 bank with ETA ratio greater than 15.3% is at least 3.4 percentage points more cost efficient than the average level of the referent group.

Estimation results show that State-2 banks with ETA ratios between 6.7% and 30.3% (10th-90th percentiles range of the respective distribution, Panel 3) have SFA scores of 7.9 to 10.1 percentage points higher than in the referent group if we keep *Reveals* (Panel 1) but only of 1.7 to 1.3 percentage points higher if we drop *Reveals* (Panel 2). In both cases, all presented values of respective distance functions are mainly determined by the average difference between the State-2 and the referent group rather than by the difference in the dynamics of equity-to-assets ratios. This follows from the statistically significant coefficients before the State-2 dummy variable that are 7.4 in the first case and only 1.9 in the second case, and statistically insignificant coefficients before the ETA and State-2 interaction term.

Finally, for the Foreign banks we have very different results depending on whether we keep *Reveals* or not. In case *Reveals* are kept, our estimates indicate a strong divergence of efficiency levels between Foreign and the referent group: they never converge as the estimated distance function takes the form of $-7.9-0.5\times \mathrm{ETA}$ that has no positive threshold in terms of ETA. Within the considered range of ETA ratios (8.2%-41.5% corresponding to 10th-90th percentiles of respective distribution) Foreign banks have *Reveals*-unadjusted SFA scores 11.7-26.7 percentage points lower than the average level of the referent group. After we remove *Reveals*, the substantial deviation disappears, as in case of homogeneous relationships. Moreover, the Foreign banks' distance function transforms to $-4.5+0.2\times \mathrm{ETA}$ and now has a threshold equal to 18.5% corresponding to the 57th percentile of ETA distribution in the whole sample. According to this function, we can observe convergence with the referent group in case a foreign bank gradually increases or decreases its ETA ratio towards this estimated threshold. Conversely, the divergence expands when, for example, this bank keeps increasing its ETA ratio after reaching the threshold. A Foreign bank with a very small ETA ratio of 8.2% or less (below 10th percentile) is at least 2.5 percentage points less cost efficient than the referent group. A foreign bank with a median ETA ratio (15.6%, 50th percentile) has no statistical difference from the referent group in terms of cost efficiency. A foreign bank with very large ETA ratio (41.5% and more, above the 90th percentile)

is at least 5.5 percentage points more cost efficient than the average rival from the referent group.

To sum up these findings, these are the outcomes from our regression analysis:

(1) If *Revals* are kept, one can claim that, regardless of their risk preferences, the core state banks are less cost efficient than other banks. In case of high capital adequacy (15.3% of their assets or more) the core state banks can outperform private banks but they still underperform the other state-controlled banks. However, if we remove *Revals*, then core state banks are able to be the most cost efficient players in the system leaving provided that they increase their capitalization from the median level of 12.3 to at least 15.3%;

(2) Foreign banks, as core state-controlled banks, can be more cost efficient than private banks if they have higher capitalization. But we can verify that only with *Revals* dropped. To achieve that effect, foreign banks need much greater increase in equity-to-assets ratio as compared to the state banks, i.e. from the median level of 15.6% to 24.7%. An ETA of 24.7% implies strong risk aversion and might be an unrealistic condition.

Results for the State-1 and foreign banks follow the prudent-efficient hypothesis of Berger and Mester (1997).

(3) *Heterogeneous relations based on differences in asset composition*

We now analyze how the asset composition can affect the distance between a group of banks and the referent group (domestic privately owned banks). As in previous case, in line with Eq.(3), such distance can be represented as functions $\beta_{2j}+\gamma_{2j}X_{2,it}$, where 2 refers to bank-level loans-to-assets (LTA) ratio and j stands for a group of banks.

For the core state banks, our estimated coefficients for the distance function are insignificant in case we keep *Revals* (**Table 4**, Model M1.3). Moreover, any value of this function is insignificant too (see Panel 1 of **Table 6**). Conversely, when we do exclude *Revals*, such function takes the form of $15.1-0.2\times\text{LTA}$ with both significant coefficients (see **Table 4**). This function has a threshold equal to 62.0%, which lies in the 65th percentiles of the whole sample LTA distribution. Having computed the values of this function for different percentiles of the State-1 banks' LTA distribution (Panel 2 of **Table 6**), we suggest that State-1 banks can be more cost efficient in case they replace loans by other types of assets. If the LTA ratio drops from its median value of 61.1% to 43.7% (25th percentile), the SFA score of a State-1 bank becomes 4.4 percentage points higher than the average level of the referent group (81.1% as indicated in **Table 3**).

Table 6

GMM post-estimation results: Heterogeneity in assets composition as the determinant of the distance between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: With Revals (Model M1.3)					
State-1	–0.453	0.286	2.141	2.702	3.224
State-2	7.568***	7.975***	8.262***	8.488***	8.695***
Foreign	–27.380***	–23.573***	–18.699***	–15.599***	–13.536***
Panel 2: Without Revals (Model M2.3)					
State-1	6.140***	4.454**	0.223	–1.058	–2.247
State-2	4.006***	2.708***	1.793***	1.072***	0.410
Foreign	–18.552***	–11.989***	–3.586***	1.758**	5.316***
Panel 3: Percentiles of loans-to-assets distributions within particular group of banks					
State-1	36.8	43.7	61.1	66.3	71.2
State-2	22.0	39.4	51.7	61.4	70.3
Foreign	6.4	24.1	46.7	61.1	70.7
Private	23.3	39.4	54.8	66.7	75.8

Notes: domestic privately-owned banks are the referent group. Assets compositions are proxied by banks' commercial loans-to-assets ratios. *Revals* are negative foreign currency and securities revaluations.

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided in order to safe space.

For State-2 banks, we have no significant heterogeneous effect in case *Revals* are kept, but the homogeneous effect, i.e. the coefficient before the State-2 dummy (Model M1.3, **Table 4**), is estimated to be significant (7.1). These banks have SFA scores that exceed the average level of the referent group by approximately 7.6-8.7 percentage points, which is significant. If we exclude *Revals*, the difference becomes lesser: SFA score exceeds that of the referent group by 4.0 percentage points for a bank in the 10th percentile, by 2.7 percentage points in the 25th percentile, and by 1.8 percentage points in the 50th percentile (Panel 2 of **Table 6**). The distance function for the State-2 banks is estimated as $5.6-0.1\times\mathrm{LTA}$ with both significant coefficients and the threshold equal to 76.3% of LTA (91th percentile of the LTA distribution).

For Foreign banks we obtained similar distance functions in both cases: $-28.8+0.2\times\mathrm{LTA}$ if we keep *Revals* and $-20.9+0.4\times\mathrm{LTA}$ if we exclude them. The threshold is calculated to be 144%, which lies above the 100th percentile of respective distribution and thus is unfeasible, in the first case and 56.4% (the 54th percentile of the LTA distribution) in the second case. Thus, if we not exclude *Revals* we would conclude that Foreign banks are less cost efficient in most times and can only move towards the efficiency level of the referent group (by increasing their LTA ratios), but never reach it. On the contrary, if we turn to the second case (*Revals* exclusion), we observe more realistic, and more interesting, results. A foreign bank in the 25th percentile, though remains less efficient as compared to the referent group, but not so dramatical-

ly as in the previous case: its SFA score is twice closer to the referent group, i.e. less on only 12.0 rather than 23.6 percentage points. Moreover, a foreign bank in the 75th percentile, unexpectedly, become more cost efficient as compared to banks with the same percentile of LTA from all the other groups. Specifically, its SFA score is about 1.8 percentage points higher than that in the referent group and the State-1 group and 0.7 (1.8-1.1) percentage points more comparing to the other state-controlled banks. Moreover, a foreign banks with LTA ratios above the 90th percentile (70.7%) are at least 5.3 percentage points more cost efficient than all the other three groups.

As a preliminary finding, we suggest that:

(1) The other state-controlled banks (State-2 group) outperform the other three groups *on average* but are not always the most cost efficient, i.e. their efficiency rankings depend on how much the banks from other groups lend. The core state banks (State-1) are more cost efficient than the State-2 banks when they decrease their loans-to-assets ratios below the median level. Thus, in the post-crisis period the State-1 banks tend to be the most cost efficient as they diversify assets from loans to other asset classes relying less on interest income and more on income from operations with securities, fees and commissions, etc. We can only grasp this important effect if we remove *Revals* from our cost efficiency estimations.

(2) Foreign banks become more cost efficient than others when they increase loans-to-assets ratios above the sample median level, rather than decrease it below the median level as in case of the State-1 banks. Again, we would not observe that if we had kept *Revals*.

Our interpretation of these empirical findings is as follows. The growing efficiency of foreign subsidiary banks as they develop lending operations is quite logical. The effect of the economy of scale makes sense, especially if we examine traditional commercial banks geared towards lending and other core banking business. Our finding proves that the subsidiaries of foreign commercial banks, as opposed to other types of foreign-controlled banking entities, are 'normal' commercial banks pursuing healthy business models. What is unusual is the decreasing efficiency of core state banks in dynamics. We do not interpret it as a depressing effect of loans on bank efficiency. We might be actually looking at banks pursuing different business models. For instance, an expansion of retail/consumer/mortgage lending might require additional costs reflecting investments in technology and infrastructure, at least for a certain period. On the other hand, for systemically important state banks a surge in policy lending might constrain the growth of profitability. Another possible explanation would be that in the case of large state banks, a lesser share of commercial loans in assets corresponds to a larger, than average, share of financial instruments and other asset classes typical of investment banking that bring higher returns. That puts those banks at an advantage before others in terms of efficiency. Finally, state banks

can be prone to corruption in the lending process in the form of kick-backs and/or related lending to a greater degree than peer banks.

From a technical viewpoint, all presented models satisfy necessary requirements. The sets of instruments employed at the first stage of regressions are valid according to the Hansen test as none of P-values are below the 10% threshold. These sets of instruments are exogenous as predicted by the Kleibergen-Paap LM statistics in respective regressions (P-values are below the 1% level). We obtained quite large estimated values for the centered R^2, namely 34%-37% in the models with *Revals* kept and 55-56% otherwise. The removal of *Revals* improves the goodness-of-fit.

5. Robustness check

We check the robustness of our findings at each step of the methodology. Generally, we re-estimate Eq.(1)-Eq.(3) by either replacing the production approach by the intermediation approach or by applying Tobit instead of GMM estimators.

First, staying within the production approach, we re-estimate Eq.(3) using Tobit estimation technique rather than the GMM procedure to account for the censored nature of SFA scores, i.e. their lower and upper bounds that are, by construction, 0 and 100, respectively. For that purpose, we employ the *ivtobit* routine in Stata with the two-step option that actually performs the minimum chi-squared estimator (Newey, 1987). The results of this exercise are presented in **Annex 6**. Comparing them with respective GMM estimation results from **Table 4**, we observe no qualitative differences between them as the coefficients change only slightly. Consequently, no qualitative changes occur with the efficiency distance functions measured using either risk preferences or assets composition. That can be verified by comparing **Annex 7** with **Table 5** and **Annex 8** with **Table 6**, respectively. As a result, we still claim that the core state banks can be the most cost efficient group in case they gradually replace loans by other types of assets and that the foreign subsidiary banks can outperform the other state-controlled and private banks (but not the core state banks) if they rely more on equity capital.

Second, we re-estimate the translog cost function under the intermediation approach by dropping deposits and fees variables from the list of regressors, but keeping the average funding rate as an explanatory variable[14]. Results are reported in **Annex 3**. We find that the majority of

[14] It might be reasonable to suggest that the operating costs can be indirectly affected by the price of deposits through the adverse selection problem. In other words, when the price of deposits rises banks are tending to increase the price of loans. The latter usually decreases the stimulus of borrowers with good creditworthiness to take new loans so that banks are forced to soften their lending standards to find new borrowers. It might well lead to decrease in their screening costs in the short run; but in the longer term it might require to make additional costs in order to stop growing bad debts.

the coefficients remains qualitatively the same with few exceptions concerning three interaction terms, i.e. price of physical capital and time trend, equity capital and each of the first two input prices. Expectedly, the goodness-of-fit decreases dramatically as can be seen from much lower values of likelihood function.

Next, we re-calculate SFA scores under the intermediation approach and aggregate them into group-averages (Annex 9). Comparing these with what we have achieved under the production approach (**Table 3**), we conclude that, on average, Foreign banks remain to be the least cost efficient group regardless of whether *Revals* are kept or dropped. The core state banks hold the 1st position rather than the 3rd position after State-2 and Private as previously estimated under the production approach. Average SFA scores for all three groups exhibit unstable patterns in dynamics causing several reshufflings of the ranking. It might be the case that the intermediation and production approaches capture different aspects of such unstable patterns.

Finally, we again re-estimate Eq.(3) replacing the SFA scores from production approach by SFA scores from intermediation approach. Here we employ only GMM procedure because no changes are revealed when we use Tobit technique. Estimation results are in **Annex 10** where the newly estimated coefficients that are qualitatively different from respective baseline results in **Table 4** are bolded for the sake of convenience. About one-half of these coefficients before the variables of interest display changes in either significance or sign. We do not analyze every such change but trace its impact on our basic findings. For that purpose, in **Annex 11** we report the values of efficiency distance functions measured in terms of risk preferences, and in **Annex 12** such distance functions are measured based on assets composition. Comparing **Annex 11** with **Table 5** and **Annex 12** with **Table 6**, we observe that the core state banks can still be the most efficient group in case they maintain higher capital adequacy or decrease the loans-to-assets ratio below median in the sample. What we do not observe anymore is that Foreign banks can be more cost efficient than State-2 and Private banks in the case of relying more on equity capital than on attracted funds. This is caused by the change of signs of the coefficients before the interaction terms in respective distance function, i.e. within the intermediation approach the distance function for Foreign banks is positively - and not negatively as in the case of production approach - determined by equity-to-assets ratio. This makes us interpret the finding with caution as it not robust to the change in approach to estimating cost function. But, on the other hand, the production approach prevails over the intermediation approach (Fortin and Leclerc, 2007), so we still argue that holding more equity capital relative to assets that an average bank holds enables a foreign bank to outperform all but the core state-controlled banks in terms of cost efficiency.

6. Conclusion

In this paper, we introduce three amendments into the SFA computation of comparative bank efficiency in Russia. *Firstly*, we show that the effects of revaluation of foreign currency and securities are unevenly distributed among banks, so they do matter for bank efficiency rankings. We control for that distorting effects and perform alternative calculations with and without re-valuations. *Secondly*, we analyze the performance of the core state-controlled banks separately from that of the rest of the state-controlled banks. *Thirdly*, within the group of foreign banks we focus on those controlled by strategic foreign investors, i.e. the subsidiaries of foreign banks, and not just any foreign investors.

Our empirical results shed new light on the issue of comparative bank efficiency in Russia. A refined definition of bank revenue that controls for the effect of currency and securities revaluation suggests that:

(1) efficiency scores become higher and less volatile across the board;

(2) the spreads between different types of banks in terms of efficiency shrink;

(3) during financial turmoil the efficiency of banks grows as compared to normal circumstances;

(4) foreign-controlled banks appear to be the least efficient market participants, on average;

(5) the core state-controlled banks are more efficient than other state-controlled banks and nearly as efficient as domestic private banks which is true starting from the crisis of 2008-2009;

(6) based on our estimated distance functions we argue that foreign-controlled banks are able to be more cost efficient than others when they increase loans-to-assets ratios above the sample median level. Conversely, when the loans-to-assets ratio falls below the sample median level, it ensures the superiority of the core state-controlled banks in terms of cost efficiency.

Some of the results are consistent with previous research (Karas et al., 2010). Others challenge the conventional wisdom with regard to the general level of Russian bank efficiency, the performance of foreign-controlled banks (Bonin et al., 2005a; Fries, Taci, 2005; Grigorian, Manole, 2006) and bank behavior during crises. The most striking finding is the inferior efficiency performance of banks controlled by strategic foreign investors. This result might be attributable to transfer pricing, but in any event it requires further research.

Another important finding is that large state-controlled banks are not necessarily poor performers ‘by definition’.

Our empirical findings might have research and policy implications. From a research perspective, this paper offers evidence that bank rankings in terms of efficiency might be upset unless the effects of revaluation of foreign currency and securities are neutralized. Hopefully, subsequent estimations of comparative performance and efficiency estimations will use refined bank

revenue data.

From the policy perspective, our empirical results might invite regulators to adjust the industrial policy with regard to banks. Both the prejudice against state banks and the bias in favor of foreign banks should give way to a more balanced industrial policy aimed at a better performance of all national banks. However, there might be less room for the improvement of cost efficiency than is widely believed.

Last but not least, we think that our approach is potentially applicable to other dollarized emerging markets. Checking this remains a research task for the future.

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Annex 1

The breakdown of the sample of banks (Number of banks and group's share in total assets of the sample in respective quarter)

Period	Core state-controlled banks (*State-1*)		Other state-controlled banks (*State-2*)		Domestic privately-owned banks (*Private*)		Foreign subsidiary banks (*Foreign*)		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
4Q2005	3	36.8	28	11.7	745	41.7	27	9.8	803	100.0
4Q2006	3	35.0	30	12.7	865	42.5	27	9.8	925	100.0
4Q2007	3	36.7	33	12.0	891	39.9	34	11.4	961	100.0
4Q2008	3	38.3	45	17.7	871	32.1	37	11.9	956	100.0
4Q2009	3	39.8	46	18.5	920	31.3	46	10.4	1015	100.0
4Q2010	3	39.4	41	17.4	908	33.1	48	10.1	1000	100.0
4Q2011	3	40.8	37	17.5	880	32.0	45	9.7	965	100.0
4Q2012	3	41.5	36	17.0	857	32.4	43	9.1	939	100.0
4Q2013	3	42.6	36	17.7	820	31.7	42	8.0	901	100.0

Annex 2

Descriptive statistics of variables in the cost function (2005 Q1 – 2013 Q4)

	Unit	Symbol	Mean	St.Dev	Min	Max	Obs	Banks
Dependent Variables								
Total costs minus interest expenses minus *Revals**	RUB bn	$OC_{it}^{(1)}$	7.7	69.8	0.0	2904.0	30784	1196
Total costs minus interest expenses	RUB bn	$OC_{it}^{(2)}$	19.2	207.2	0.0	8885.6	30753	1196
Explanatory Variables								
Loans to households and nonfinancial firms	RUB bn	$Y_{1,it}$	18.2	206.7	0.0	10015.4	30045	1159
Retail and corporate accounts and deposits	RUB bn	$Y_{2,it}$	16.6	205.1	0.0	10374.8	30635	1191
Fee and commission income	RUB bn	$Y_{3,it}$	0.5	5.0	0.0	220.6	30635	1189
Average funding rate	%	$P_{1,it}$	4.9	2.8	0.0	50.1	29365	1152
Price for personnel expense	%	$P_{2,it}$	4.1	3.3	0.1	49.5	30784	1196
Price of physical capital	%	$P_{3,it}$	23.7	22.4	0.2	180.0	30784	1196
Equity capital	RUB bn	EQ_{it}	3.8	40.8	0.0	1954.2	30745	1196

Notes: * *Revals* are negative foreign currency and securities revaluations.

Annex 3

Empirical cost functions under stochastic frontier analysis: estimation results (2005Q1-2013Q4)

Approach		Production (basic)		Intermediation	
Revals kept		Yes	No	Yes	No
Explanatory variables, in logs	Symbol	I	II	III	IV
Loans to households and nonfinancial firms (*LNS*)	$\ln Y_{1,it}$	0.136*** (0.012)	0.247*** (0.007)	0.506*** (0.007)	0.606*** (0.008)
Retail and corporate accounts and deposits (*DEP*)	$\ln Y_{2,it}$	0.378*** (0.011)	0.303*** (0.006)		
Fee and commission income (*FEE*)	$\ln Y_{3,it}$	0.049*** (0.009)	0.079*** (0.005)		
Average funding rate (*AFR*)	$\ln P_{1,it}$	0.003 (0.009)	–0.039*** (0.005)	0.025** (0.012)	–0.067*** (0.008)
Price for personnel expense (*PPE*)	$\ln P_{2,it}$	0.369*** (0.011)	0.388*** (0.006)	0.339*** (0.016)	0.385*** (0.011)
Price of physical capital (*PPC*)	$\ln P_{3,it}$	0.628*** (0.010)	0.651*** (0.006)	0.637*** (0.014)	0.682*** (0.010)
LNS²	$(\ln Y_{1,it})^2$	0.019*** (0.008)	0.018*** (0.000)	0.076*** (0.001)	0.068*** (0.001)
LNS×DEP	$\ln Y_{1,it} \ln Y_{2,it}$	–0.011*** (0.002)	–0.012*** (0.001)		
LNS×FEE	$\ln Y_{1,it} \ln Y_{3,it}$	–0.006*** (0.001)	0.006*** (0.001)		
DEP²	$(\ln Y_{2,it})^2$	0.074*** (0.001)	0.071*** (0.001)		
DEP×FEE	$\ln Y_{2,it} \ln Y_{3,it}$	–0.008*** (0.001)	–0.013*** (0.001)		
FEE²	$(\ln Y_{3,it})^2$	0.007*** (0.001)	0.011*** (0.001)		
AFR²	$(\ln P_{1,it})^2$	–0.010*** (0.001)	–0.006*** (0.001)	–0.023*** (0.002)	–0.019*** (0.001)
AFR×PPE	$\ln P_{1,it} \ln P_{2,it}$	0.014*** (0.003)	0.011*** (0.002)	0.053*** (0.004)	0.045*** (0.003)
AFR×PCE	$\ln P_{1,it} \ln P_{3,it}$	0.006*** (0.002)	0.000 (0.001)	–0.0075** (0.0032)	–0.0070** (0.0022)
PPE²	$(\ln P_{2,it})^2$	0.051*** (0.002)	0.053*** (0.001)	0.0070** (0.0031)	0.021*** (0.002)
PPE×PCE	$\ln P_{2,it} \ln P_{3,it}$	–0.116*** (0.003)	–0.117*** (0.002)	–0.067*** (0.004)	–0.087*** (0.003)
PCE²	$(\ln P_{3,it})^2$	0.055*** (0.001)	0.058*** (0.001)	0.037*** (0.002)	0.046*** (0.002)
LNS×AFR	$\ln Y_{1,it} \ln P_{1,it}$	0.000 (0.002)	0.011*** (0.001)	0.059*** (0.003)	0.057*** (0.002)
LNS×PPE	$\ln Y_{1,it} \ln P_{2,it}$	0.002 (0.002)	–0.004** (0.002)	–0.077** (0.003)	–0.057** (0.002)
LNS×PCE	$\ln Y_{1,it} \ln P_{3,it}$	–0.002 (0.002)	–0.007*** (0.002)	–0.017*** (0.003)	–0.000 (0.002)
DEP×AFR	$\ln Y_{2,it} \ln P_{1,it}$	0.008*** (0.002)	–0.001 (0.001)		
DEP×PPE	$\ln Y_{2,it} \ln P_{2,it}$	–0.017*** (0.003)	–0.012*** (0.002)		
DEP×PCE	$\ln Y_{2,it} \ln P_{3,it}$	0.008*** (0.002)	0.014*** (0.001)		

Approach		Production (basic)		Intermediation	
Revals kept		Yes	No	Yes	No
Explanatory variables, in logs	Symbol	I	II	III	IV
FEE×*AFR*	$\ln Y_{3,it} \ln P_{1,it}$	–0.006*** (0.002)	–0.006*** (0.001)		
FEE×*PPE*	$\ln Y_{3,it} \ln P_{2,it}$	0.000 (0.002)	0.003*** (0.001)		
FEE×*PCE*	$\ln Y_{3,it} \ln P_{3,it}$	0.006*** (0.002)	0.002** (0.001)		
Trend	T	0.0038*** (0.0012)	–0.0007 (0.0006)	0.016*** (0.002)	0.0054*** (0.0012)
Trend^2	T^2	–0.0001*** (0.0000)	0.0000* (0.0000)	–0.0002*** (0.0000)	–0.0000 (0.0002)
Trend×*AFR*	$T \ln P_{1,it}$	–0.0009*** (0.0002)	0.0007*** (0.0001)	–0.000 (0.000)	0.0019*** (0.0002)
Trend×*PPE*	$T \ln P_{2,it}$	0.0002 (0.0002)	–0.0010*** (0.0001)	0.001 (0.000)	–0.0013*** (0.0003)
Trend×*PCE*	$T \ln P_{3,it}$	0.0008*** (0.0002)	0.0004*** (0.0001)	–0.000 (0.000)	–0.0006*** (0.0002)
Trend×*LNS*	$T \ln Y_{1,it}$	–0.001*** (0.000)	–0.0024*** (0.0002)	–0.000 (0.000)	–0.0029*** (0.0002)
Trend×*DEP*	$T \ln Y_{2,it}$	0.0010*** (0.0003)	0.0006*** (0.0001)		
Trend×*FEE*	$T \ln Y_{3,it}$	–0.0005*** (0.0002)	–0.0000 (0.0001)		
Equity capital (EQ)	$\ln EQ_{it}$	0.542*** (0.012)	0.413*** (0.006)	0.571*** (0.016)	0.388*** (0.011)
EQ^2	$(\ln EQ_{it})^2$	0.094*** (0.002)	0.086*** (0.001)	0.105*** (0.003)	0.081*** (0.002)
EQ×*AFR*	$\ln EQ_{it} \ln P_{1,it}$	0.021*** (0.002)	0.006*** (0.001)	–0.009** (0.004)	–0.030*** (0.003)
EQ×*PPE*	$\ln EQ_{it} \ln P_{2,it}$	–0.005* (0.003)	–0.006*** (0.002)	0.028*** (0.004)	0.018*** (0.003)
EQ×*PCE*	$\ln EQ_{it} \ln P_{3,it}$	–0.015*** (0.003)	0.000 (0.002)	–0.019*** (0.004)	0.012*** (0.003)
EQ×*LNS*	$\ln EQ_{it} \ln Y_{1,it}$	–0.007** (0.003)	–0.005*** (0.002)	0.002*** (0.000)	–0.152*** (0.002)
EQ×*DEP*	$\ln EQ_{it} \ln Y_{2,it}$	–0.166*** (0.002)	–0.158*** (0.001)		
EQ×*FEE*	$\ln EQ_{it} \ln Y_{3,it}$	0.006*** (0.002)	0.005*** (0.002)		
EQ×*Trend*	$\ln EQ_{it} T$	0.0023*** (0.0003)	0.0025*** (0.0001)	0.0022*** (0.0004)	0.0035*** (0.0003)
Intercept		–3.036*** (0.029)	–3.073*** (0.016)	–3.258*** (0.031)	–3.401*** (0.022)
Obs.		29082	29082	29146	29146
Log *L*		–13683.328	7620.759	–22793.544	–10954.861
Convergence achieved		yes	yes	yes	yes
St.dev of the inefficiency term, the rest of the error		0.730, 0.061	0.334, 0.049	0.873, 0.208	0.536, 0.177

Notes: *Revals* are negative foreign currency and securities revaluations.

Annex 4

Descriptive statistics of variables in cost efficiency equations (2005Q1-2013Q4), %

	Mean	St.Dev	Min	Max	Obs	Banks
Bank-specific factors						
Equity-to-assets ratio	18.6	12.0	1.9	79.8	22629	1038
Loans-to-assets ratio	55.1	16.7	10.0	96.0	22629	1038
Loans-to-deposits ratio	107.3	83.0	10.5	996.0	22629	1038
Share of retail loans in total loans	31.8	23.5	0.0	100.0	22629	1038
Bank size (in terms of assets)	0.1	1.1	0.0	31.6	22629	1038
Lerner index of market power	11.2	36.6	-99.9	94.9	23180	1040
Macroeconomic controls						
3-month Ruble volatility	0.6	0.5	0.1	2.2	36	
GDP (annual growth rate)	3.4	4.9	-11.2	8.6	36	
Real households income (annual growth rate)	6.1	4.9	-4.9	15.4	36	
Firms' profit-to-debt ratio	4.7	2.1	-1.7	10.4	36	

Annex 5

GMM estimation results: The drivers of within- and between-group heterogeneity of cost efficiency (2005Q1-2013Q4; dependent variable: bank-level SFA score with and without *Revals*)

Revals kept	Yes			No		
	M1.1	M1.2	M1.3	M2.1	M2.2	M2.3
Dummy variables for bank ownership status						
State-1	2.780 (2.649)	–1.584 (4.639)	–4.390 (6.869)	2.704* (1.406)	–5.365** (2.648)	15.123*** (4.984)
State-2	8.559*** (0.525)	7.387*** (1.120)	7.055** (2.765)	1.672*** (0.241)	1.895*** (0.572)	5.643*** (1.223)
Foreign	–16.222*** (0.996)	–7.939*** (1.704)	–28.756*** (3.165)	–0.021 (0.693)	–4.456*** (1.159)	–20.925*** (1.892)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.661*** (0.018)	0.676*** (0.018)	0.638*** (0.018)	0.426*** (0.011)	0.417*** (0.011)	0.419*** (0.011)
ETA × State-1		0.386 (0.254)			0.569*** (0.166)	
ETA × State-2		0.090 (0.063)			–0.021 (0.035)	
ETA × Foreign		–0.453*** (0.083)			0.241*** (0.059)	
Loans-to-assets ratio (LTA)	0.607*** (0.012)	0.606*** (0.013)	0.589*** (0.012)	0.439*** (0.008)	0.439*** (0.008)	0.428*** (0.008)
LTA × State-1			0.107 (0.139)			–0.244*** (0.085)
LTA × State-2			0.023 (0.048)			–0.074*** (0.022)
LTA × Foreign			0.215*** (0.061)			0.371*** (0.037)
Loans-to-deposits ratio	–0.114*** (0.005)	–0.115*** (0.005)	–0.107*** (0.005)	–0.106*** (0.003)	–0.106*** (0.004)	–0.101*** (0.004)
Share of retail loans in total loans	0.077*** (0.006)	0.076*** (0.006)	0.074*** (0.006)	0.009*** (0.003)	0.011*** (0.003)	0.009*** (0.003)
Bank size	0.206 (0.167)	0.157 (0.171)	0.229 (0.178)	0.483*** (0.064)	0.513*** (0.063)	0.533*** (0.066)
Lerner index of market power						
lag = 0 quarters	0.081 (0.128)	0.073 (0.125)	0.179 (0.131)	0.089 (0.264)	0.089 (0.064)	0.087 (0.067)
lag = 1 quarters	–0.153 (0.156)	–0.141 (0.152)	–0.264* (0.159)	–0.103 (0.079)	–0.104 (0.077)	–0.100 (0.082)
lag = 2 quarters	0.039 (0.036)	0.036 (0.033)	0.042 (0.034)	0.007 (0.017)	0.008 (0.017)	0.002 (0.018)
lag = 3 quarters	0.026* (0.013)	0.025* (0.013)	0.041*** (0.015)	0.019*** (0.007)	0.019*** (0.007)	0.023*** (0.007)
Macroeconomic factors						
3-Month Ruble volatility	–1.068*** (0.361)	–1.090*** (0.360)	–0.915*** (0.351)	0.202 (0.160)	0.205 (0.159)	0.177 (0.158)
GDP (annual growth rate)	0.873*** (0.034)	0.874*** (0.034)	0.848*** (0.033)	0.053*** (0.015)	0.053*** (0.014)	0.050*** (0.014)
Real households income (annual growth rate)	–0.203*** (0.036)	–0.204*** (0.036)	–0.184*** (0.036)	–0.066*** (0.017)	–0.066*** (0.017)	–0.059*** (0.017)
Firms' profit-to-debt ratio	0.204** (0.096)	0.207** (0.095)	0.167* (0.100)	0.028 (0.046)	0.029 (0.046)	0.018 (0.049)
Intercept	28.297*** (0.763)	28.196*** (0.761)	29.276*** (0.780)	61.283*** (0.396)	61.361*** (0.395)	61.552*** (0.412)
No. of obs. (banks)	19546 (967)	19546 (967)	20319 (978)	19573 (967)	19573 (967)	20319 (978)
Centered R^2	0.337	0.369	0.352	0.557	0.559	0.549
No. of endog. vars., excl. instr.	6, 12	9, 15	9, 15	6, 12	9, 15	9, 15
P-val for Hansen J-stat	0.558	0.569	0.719	0.143	0.221	0.167
P-val for Kleibergen-Paap LM	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are provided in parentheses under the coefficients. *Revals* are negative foreign currency and securities revaluations.

Annex 6

Tobit estimation results: The determinants of within- and between-group heterogeneity of cost efficiency (2005Q1-2013Q4; dep. variable: bank-level SFA score with and without *Revals*)

Revals kept	Yes			No		
	M3.1	M3.2	M3.3	M4.1	M4.2	M4.3
Dummy variables for bank ownership status						
State-1	2.387	–1.553	–4.621	2.308*	–6.132**	13.856***
	(2.781)	(6.269)	(9.904)	(1.285)	(2.891)	(4.620)
State-2	8.583***	7.239***	7.028**	1.692***	1.718***	5.739***
	(0.608)	(1.328)	(2.995)	(0.281)	(0.613)	(1.397)
Foreign	–16.336***	–8.034***	–28.534***	–0.206	–4.598***	–20.728***
	(0.785)	(1.374)	(2.738)	(0.363)	(0.634)	(1.278)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.659***	0.672***	0.636***	0.422***	0.413***	0.416***
	(0.016)	(0.016)	(0.016)	(0.007)	(0.007)	(0.007)
ETA × State-1		0.353			0.621***	
		(0.433)			(0.200)	
ETA × State-2		0.101			–0.006	
		(0.082)			(0.038)	
ETA × Foreign		–0.455***			0.238***	
		(0.063)			(0.029)	
Loans-to-assets ratio (LTA)	0.605***	0.605***	0.589***	0.438***	0.437***	0.428***
	(0.010)	(0.010)	(0.010)	(0.005)	(0.005)	(0.004)
LTA × State-1			0.105			–0.226***
			(0.180)			(0.084)
LTA × State-2			0.024			–0.075***
			(0.054)			(0.025)
LTA × Foreign			0.211***			0.368***
			(0.051)			(0.024)
Loans-to-deposits ratio	–0.113***	–0.113***	–0.106***	–0.105***	–0.104***	–0.101***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Share of retail loans in total loans	0.077***	0.075***	0.074***	0.009***	0.011***	0.008***
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
Bank size	0.224	0.173	0.242	0.498***	0.519***	0.543***
	(0.178)	(0.178)	(0.185)	(0.082)	(0.082)	(0.087)
Lerner index of market power						
lag = 0 quarters	0.094	0.090	0.200	0.111*	0.104*	0.130**
	(0.133)	(0.131)	(0.130)	(0.264)	(0.060)	(0.061)
lag = 1 quarters	–0.167	–0.161	–0.289*	–0.130*	–0.122*	–0.153**
	(0.161)	(0.159)	(0.159)	(0.079)	(0.074)	(0.074)
lag = 2 quarters	0.041	0.039	0.046	0.012	0.011	0.012
	(0.034)	(0.033)	(0.033)	(0.016)	(0.015)	(0.015)
lag = 3 quarters	0.026***	0.026***	0.041***	0.020***	0.020***	0.024***
	(0.010)	(0.010)	(0.010)	(0.005)	(0.004)	(0.005)
Macroeconomic factors						
3-Month Ruble volatility	–1.066***	–1.080***	–0.904***	0.203	0.203	0.185
	(0.346)	(0.345)	(0.334)	(0.160)	(0.159)	(0.156)
GDP (annual growth rate)	0.873***	0.873***	0.848***	0.054***	0.053***	0.052***
	(0.031)	(0.031)	(0.030)	(0.014)	(0.014)	(0.014)
Real households income (annual growth rate)	–0.202***	–0.205***	–0.183***	–0.064***	–0.063***	–0.053***
	(0.037)	(0.036)	(0.036)	(0.017)	(0.017)	(0.017)
Firms' profit-to-debt ratio	0.200**	0.205**	0.159	0.019	0.019	–0.003
	(0.099)	(0.098)	(0.101)	(0.046)	(0.045)	(0.047)
Intercept	28.334***	28.225***	29.310***	61.349***	61.443***	61.654***
	(0.725)	(0.725)	(0.747)	(0.335)	(0.395)	(0.349)
No. of obs.	19546	19546	20319	19573	19573	20319
(banks)	(967)	(967)	(978)	(967)	(967)	(978)
No. of endog. vars., excl. instr.	6, 12	9, 15	9, 15	6, 12	9, 15	9, 15
P-val for Wald test of exogenei-	0.000	0.000	0.000	0.001	0.000	0.000

Notes: ***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are provided in parentheses under the coefficients. *Revals* are negative foreign currency and securities revaluations.

Annex 7

Tobit post-estimation results: Heterogeneity in risk preferences as a major factor determining the distances between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: With Revaluations (Model M3.2)					
State-1	1.548	2.028	2.780	3.869	5.924
State-2	7.921***	8.128***	8.400***	9.078***	10.314***
Foreign	–11.785***	–13.090***	–15.116***	–19.278***	–26.942***
Panel 2: Without Revaluations (Model M4.2)					
State-1	–0.678	0.165	1.488	3.403**	7.018***
State-2	1.677***	1.665***	1.648***	1.608***	1.534**
Foreign	–2.635***	–1.952**	–0.892**	1.286**	5.297***
Panel 3: Percentiles of equity-to-assets distributions within particular group of banks					
State-1	8.8	10.1	12.3	15.3	21.2
State-2	6.7	8.8	11.5	18.1	30.3
Foreign	8.2	11.1	15.6	24.7	41.5
Private	8.2	11.0	16.5	27.1	44.3

Notes: domestic privately-owned banks are chosen to be the referent group. Risk preferences are proxied by banks' equity-to-assets ratios.

SFA scores are defined within production approach

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided in order to safe space.

Annex 8

Tobit post-estimation results: Heterogeneity in assets compositions as a major factor determining the distances between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: With Revaluations (Model M3.3)					
State-1	–0.739	–0.010	1.818	2.371	2.885
State-2	7.563***	7.987***	8.286***	8.522***	8.738***
Foreign	–27.188***	–23.466***	–18.699***	–15.668***	–13.650***
Panel 2: Without Revaluations (Model M4.3)					
State-1	5.517***	3.951***	0.023	–1.166	–2.270
State-2	4.079***	2.764***	1.836***	1.106***	0.435
Foreign	–18.378***	–11.881***	–3.561***	1.729***	5.252***
Panel 3: Percentiles of loans-to-assets distributions within particular group of banks					
State-1	36.8	43.7	61.1	66.3	71.2
State-2	22.0	39.4	51.7	61.4	70.3
Foreign	6.4	24.1	46.7	61.1	70.7
Private	23.3	39.4	54.8	66.7	75.8

Notes: domestic privately-owned banks are chosen to be the referent group. Assets compositions are proxied by banks' commercial loans-to-assets ratios.

SFA scores are defined within production approach

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided in order to safe space.

Annex 9

Group-level operating cost efficiency (SFA scores, intermediation approach) as averages of 2005 Q1 – 2013 Q4

Bank group	SFA score		Standard deviation	Min	Max	Obs.	No. of banks
	%	rank					
*Panel 1: With Revals**							
All groups	55.5		21.0	0.2	97.3	29146	1142
State-1	58.7	1	16.6	25.3	86.4	108	3
State-2	57.5	2	20.3	8.4	95.8	1204	61
Foreign	33.0	4	21.4	1.0	97.3	1179	49
Private	56.3	3	20.5	0.2	96.3	26655	1068
Panel 2: Without Revals							
All groups	67.8		16.4	1.5	97.3	29177	1142
State-1	78.2	1	6.7	60.2	89.4	108	3
State-2	65.4	3	16.2	10.6	97.3	1204	61
Foreign	63.4	4	19.4	8.4	97.3	1179	49
Private	68.1	2	16.2	1.5	97.0	26686	1068

Notes: * negative revaluations of foreign currency and securities

Annex 10: Intermediation approach instead of production one

GMM estimation results: The determinants of within- and between-group heterogeneity of cost efficiency (2005 Q1 – 2013 Q4; dep. variable: bank-level SFA score with and without *Revals*)

Revals kept	Yes			No		
	M5.1	M5.2	M5.3	M6.1	M6.2	M6.3
Dummy variables for bank ownership status						
State-1	**3.758***	–3.209	**8.792****	**7.083*****	**0.559**	24.706***
	(2.149)	(3.783)	**(4.431)**	**(0.990)**	**(1.938)**	(4.069)
State-2	7.093***	6.407***	**0.170**	1.874***	1.557***	**–12.580*****
	(0.404)	(0.761)	**(1.543)**	(0.183)	(0.384)	**(2.525)**
Foreign	–14.809***	–3.962***	–13.218***	**3.219*****	**5.118*****	–12.251***
	(0.858)	(1.406)	(3.084)	**(0.248)**	**(0.431)**	(2.988)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.796***	0.821***	0.844***	0.587***	0.591***	0.522***
	(0.013)	(0.013)	(0.013)	(0.006)	(0.006)	(0.023)
ETA × State-1		**0.641*****			0.495***	
		(0.202)			(0.151)	
ETA × State-2		0.053			0.021	
		(0.040)			(0.021)	
ETA × Foreign		–0.582***			**–0.102*****	
		(0.070)			**(0.022)**	
Loans-to-assets ratio (LTA)	0.936***	0.934***	0.913***	0.738***	0.737***	0.525***
	(0.009)	(0.008)	(0.008)	(0.003)	(0.003)	(0.054)
LTA × State-1			–0.070			–0.410***
			(0.091)			(0.065)
LTA × State-2			**0.124*****			**0.259*****
			(0.028)			**(0.045)**
LTA × Foreign			**–0.036**			0.229***
			(0.059)			(0.041)
Loans-to-deposits ratio	–0.028***	–0.029***	–0.030***	–0.006***	–0.006***	0.014***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.006)
Share of retail loans in total loans	0.073***	0.071***	0.080***	–0.008***	–0.008***	–0.010***
	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Bank size	0.256**	0.167	–0.029	0.418***	0.424***	0.583***
	(0.103)	(0.103)	(0.140)	(0.093)	(0.088)	(0.101)
Lerner index of market power						
lag = 0 quarters	0.210*	0.150	–0.255***	0.127***	0.104**	0.084**
	(0.108)	(0.100)	(0.068)	(0.046)	(0.044)	(0.038)
lag = 1 quarters	–0.332**	–0.255**	0.216***	–0.166***	–0.137**	–0.097**
	(0.134)	(0.124)	(0.073)	(0.057)	(0.055)	(0.041)
lag = 2 quarters	0.075**	0.058**	–0.020*	0.035***	0.029**	0.009
	(0.031)	(0.029)	(0.012)	(0.012)	(0.012)	(0.006)
lag = 3 quarters	0.006	0.005	–0.001	–0.004	–0.005*	0.001
	(0.014)	(0.012)	(0.008)	(0.003)	(0.003)	(0.003)
Macroeconomic factors						
3-Month Ruble volatility	–1.220***	–1.269***	–1.916***	–0.299***	–0.318***	0.010
	(0.273)	(0.269)	(0.295)	(0.094)	(0.092)	(0.154)
GDP (annual growth rate)	0.568***	0.567***	0.546***	–0.018**	–0.019**	–0.008
	(0.026)	(0.026)	(0.026)	(0.009)	(0.008)	(0.011)
Real households income (annual growth rate)	–0.136***	–0.143***	–0.169***	–0.011	–0.013	–0.008
	(0.029)	(0.029)	(0.025)	(0.010)	(0.010)	(0.012)
Firms' profit-to-debt ratio	–0.071	–0.046	–0.067	–0.126***	–0.116***	–0.055*
	(0.081)	(0.078)	(0.062)	(0.031)	(0.030)	(0.029)
Intercept	–8.024***	–8.250***	–7.667***	19.891***	19.851***	30.164***
	(0.580)	(0.564)	(0.588)	(0.240)	(0.238)	(2.699)
No. of obs.	17401	17401	18532	17644	17644	17858
(banks)	(889)	(889)	(915)	(898)	(898)	(902)
Centered R^2	0.628	0.640	0.645	0.557	0.902	0.861
No. of endog. vars., excl. instr.	6, 17	9, 18	9, 19	6, 14	9, 17	9, 25
P-val for Hansen J-stat	0.207	0.099	0.153	0.036	0.012	0.093
P-val for Kleibergen-Paap LM stat	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are provided in parentheses under the coefficients. *Revals* are negative revaluations of foreign currency and securities. oefficients that are qualitatively different from respective baseline results in **Table 4** are bolded.

Annex 11

GMM post-estimation results: Heterogeneity in risk preferences as a major factor determining the distances between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: With Revaluations (Model M5.2)					
State-1	2.419	3.289	4.654**	6.630***	10.361***
State-2	6.762***	6.869***	7.012***	7.364***	**8.008*** **
Foreign	–8.756***	–10.423***	–13.011***	–18.330***	–28.125***
Panel 2: Without Revaluations (Model M6.2)					
State-1	**4.900*** **	**5.571*** **	**6.624*** **	8.149***	11.027***
State-2	1.702***	1.746***	1.803***	1.946***	2.208***
Foreign	**4.277*** **	**3.985*** **	**3.531*** **	**2.598*** **	0.880
Panel 3: Percentiles of equity-to-assets distributions within particular group of banks					
State-1	8.8	10.1	12.3	15.3	21.2
State-2	6.7	8.8	11.5	18.1	30.3
Foreign	8.2	11.1	15.6	24.7	41.5
Private	8.2	11.0	16.5	27.1	44.3

Notes: domestic privately-owned banks are chosen to be the referent group. Risk preferences are proxied by banks' equity-to-assets ratios. Coefficients that are qualitatively different from respective baseline results in **Table 5** are bolded. SFA scores are defined within intermediation approach

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided in order to safe space.

Annex 12

GMM post-estimation results: Heterogeneity in assets compositions as a major factor determining the distances between groups of banks in terms of cost efficiency levels (SFA scores)

Percentile	p10	p25	p50	p75	p90
Panel 1: Revaluations not excluded (Model M5.3)					
State-1	**6.227*** **	**5.745*** **	4.537*	4.171	3.832
State-2	**2.902*** **	**5.067*** **	6.594***	7.797***	8.901***
Foreign	–13.449***	–14.090***	–14.911***	–15.433***	–15.781***
Panel 2: Revaluations excluded (Model M6.3)					
State-1	9.618***	6.786***	–0.321	–2.472	–4.470**
State-2	–6.891***	–2.382***	0.798***	3.303***	5.601***
Foreign	–10.789***	–6.747***	–1.571	**1.721** **	**3.912*** **
Panel 3: Percentiles of loans-to-assets distributions within particular group of banks					
State-1	36.8	43.7	61.1	66.3	71.2
State-2	22.0	39.4	51.7	61.4	70.3
Foreign	6.4	24.1	46.7	61.1	70.7
Private	23.3	39.4	54.8	66.7	75.8

Notes: domestic privately-owned banks are chosen to be the referent group. Assets compositions are proxied by banks' commercial loans-to-assets ratios. Coefficients that are qualitatively different from respective baseline results in **Table 6** are bolded. SFA scores are defined within intermediation approach

***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided in order to safe space.