BOFIT Discussion Papers
22 • 2015

Mikhail Mamonov and Andrei Vernikov

Bank ownership and cost efficiency in Russia, revisited

Bank of Finland, BOFIT
Institute for Economies in Transition

BOFIT Discussion Papers
Editor-in-Chief Laura Solanko

BOFIT Discussion Papers 22/2015
27.7.2015

Mikhail Mamonov and Andrei Vernikov: Bank ownership and cost efficiency in Russia, revisited

ISBN 978-952-323-052-1
ISSN 1456-5889 (online)

Suomen Pankki
Helsinki 2015

Contents

Mikhail Mamonov and Andrei Vernikov

Bank ownership and cost efficiency in Russia, revisited

Abstract

This paper considers the comparative efficiency of public, private, and foreign banks in Russia, a transition economy with several unusual features. We perform stochastic frontier analysis (SFA) of Russian bank-level quarterly data over the period 2005–2013. The method of computation of comparative cost efficiency is amended to control for the effect of revaluation of foreign currency items in bank balance sheets. Public banks are split into core and other state-controlled banks. Employing the generalized method of moments, we estimate a set of distance functions that measure the observed differences in SFA scores of banks and bank clusters (heterogeneity in risk preference and asset structure) to explain changes in bank efficiency rankings. Our results for comparative Russian bank efficiency show higher efficiency scores, less volatility, and narrower spreads between the scores of different bank types than in previous studies. Foreign banks appear to be the least cost-efficient market participants, while core state banks on average are nearly as efficient as private domestic banks. We suggest that foreign banks gain cost-efficiency when they increase their loans-to-assets ratios above the sample median level. Core state banks, conversely, lead in terms of cost efficiency when their loans-to-assets ratio falls below the sample median level. The presented approach is potentially applicable to analysis of bank efficiency in other dollarized emerging markets.

Key words: banks; comparative efficiency; SFA; state-controlled banks; Russia.
JEL codes: G21, P23, P34, P52.

Mikhail Mamonov, Center for Macroeconomic Analysis and Short-Term Forecasting (CMASF); Institute of Economic Forecasting, Russian Academy of Sciences; and National Research University Higher School of Economics, Laboratory for Analysis and Forecast of Economic Processes, Center for Fundamental Studies, Moscow, Russia. Corresponding author, email: mmamonov@forecast.ru.

Andrei Vernikov, National Research University Higher School of Economics; and Institute of Economics, Russian Academy of Sciences, Moscow, Russia. Email: avernikov@hse.ru.

Mikhail Mamonov acknowledges financial support received under the Basic Research Program at the National Research University Higher School of Economics in 2015.

Acknowledgements
The authors are grateful for the comments and suggestions from Laura Solanko, Vladimir Sokolov, Zuzana Fungáčová, Israel Marques, and other participants of the BOFIT research seminar at the Bank of Finland (April 2015). Any errors or omissions are ours, and the views expressed here do not necessarily reflect those of the Bank of Finland, Center for Macroeconomic Analysis and Short-term Forecasting or Higher School of Economics.

1 Introduction

With the Russian economy's slowdown and tightened prudential regulation on the part of the Central Bank of Russia (CBR), bank efficiency has become a concern for policymakers. Russian banks have had to find ways to optimize their cost structures, even if their scope to do so may be quite limited. Bank cost efficiency in Russia depends on multiple factors such as ownership type (public or private), risk preference, and asset composition.

In their influential paper, La Porta, López-de-Silanes, and Shleifer (2002) argue that government ownership of banks leads to inefficiency and hinders financial development. Some of the subsequent empirical papers nuance or qualify the claim (e.g. Andrianova, Demetriades, and Shortland, 2012; Körner and Schnabel, 2011).

Several empirical works shape the subject of comparative bank efficiency in transition countries. Bonin, Hasan, and Wachtel (2005a) find foreign-owned banks to be more cost efficient and provide better service than other banks in eleven transition economies during the period 1996–2000. However, government-owned banks are not found to be appreciably less efficient than private domestic banks. The same authors, examining a narrower sample of the largest banks in six transition countries (Bulgaria, Croatia, Czech Republic, Hungary, Poland, and Romania), find support their hypothesis that foreign-owned banks are more efficient than government-owned banks (Bonin et al., 2005b).

Fries and Taci (2005) examine the cost efficiency of 289 banks in 15 Eastern European countries. They suggest that a higher share of foreign-owned banks in total banking sector assets leads to lower costs, although the association between a country's progress in banking reforms and cost efficiency is non-linear, i.e. higher costs at later stages offset initial cost reductions. They note that private banks as a rule are more efficient than state-owned banks, but add that there are differences among private banks. Among private banks, majority-foreign-owned banks were most efficient and banks with domestic owners least efficient.

Grigorian and Manole (2006), employing Data Envelopment Analysis (DEA) to examine bank-level efficiency across a wide range of transition countries, observe that foreign ownership with controlling power and enterprise restructuring enhances commercial bank efficiency.

Fries et al. (2006) estimate the margins and marginal costs of banks in transition countries. They show that privatized banks in 1995–1998 earned higher margins than other banks, while foreign start-ups had lower marginal costs. In 2002–2004, foreign banks still

were the lowest marginal cost service providers, while private domestic banks had the widest margins and initially privatized banks had the largest mark-ups. By the third sub-period in their study, differences among private banks diminished. State banks persistently under-performed relative to private banks in controlling costs and attracting demand. Overall, foreign bank entry is seen to promote lower costs in the sector.

The technical efficiency of Russian banks has been researched by Caner and Kontorovich (2004), Golovan (2006), Golovan, Karminsky and Peresetsky (2008), Belousova (2009), Peresetsky (2010), Karas, Schoors and Weill (2010) and Mamonov (2013). Karas et al. (2010) make the somewhat surprising observation that, while foreign banks are found to be more efficient than private domestic banks, the latter appear to be not more efficient than public banks. Indeed, state-controlled banks may actually be the market leaders in terms of operational efficiency expressed through the cost-to-income ratio (Mamonov, 2013).

Russia stands out as a special case among transition countries. Foreign banks hold no more than 10% of total banking sector assets. Public banks, which have largely gone extinct in Central and Eastern Europe, have increased their market share in Russia to nearly 60% (Vernikov, 2014). Efficient private ownership has yet to emerge in Russia, despite the fact that spontaneous privatization crushed the system of state-owned specialized banks two decades ago (Schoors, 2003).

Our motivation for revisiting the interplay between bank ownership and cost efficiency in Russia is a widely overlooked practice – the revaluation of foreign currency items in Russian banks balance sheets (hereafter "*revals*"). Russia's economy, like numerous other transition and emerging economies, remains volatile and dollarized. Previous research on banking in transition countries focus on data concerning gross bank incomes or costs, and overlook the possibility of a *revals* effect that may influence group efficiency ranks, especially during periods of financial turmoil. This is quite understandable. *Revals* constitute a non-core item that bears no obvious relation to operating cost efficiency. Nevertheless, we argue that dropping *revals* in Russia's case improves the accuracy of efficiency estimates.

Our research question relates to the comparative efficiency of Russian banks after controlling for the distorting effect of *revals*. To demonstrate the existence of such a distorting effect, we compare the efficiency estimations when *revals* are kept or dropped from operating costs. Beyond determining which bank group leads in efficiency and who has the

most room for improvement, we are interested in the mechanism driving intra-group heterogeneity of bank efficiency rankings.[1] Specifically, we ask whether a given bank's asset composition and risk preference affect its efficiency rankings. This approach departs from previous research that relies on a dummy-variables approach in averaging efficiency rankings of various banks groups over a sample period. We also check the pre-crisis findings of Karas et al. (2010) regarding public bank efficiency, which is highly relevant in the Russian case, and examine how public bank efficiency rankings evolved over the 2005–2013 period. This long period is sufficient to not only incorporate the 2008–2009 financial crisis but also assure that pre- and post-crisis dynamics are observable.

This work departs from earlier studies on comparative bank efficiency in emerging markets in several respects:

- We demonstrate the materiality of *revals* in the financial results of Russian banks and the uneven distribution of *revals* among banks.
- We control for the effect of *revals* in a stochastic frontier analysis (SFA) of comparative cost efficiency of different bank groups in Russia (*revals* kept and dropped).
- In grouping of Russian banks by ownership, we differentiate between core state banks and other state-controlled banks and focus on foreign bank subsidiaries of all banks controlled by foreign entities.
- We distinguish bank-specific factors that explain the rankings of each bank at each point of observation in our regression analysis.
- We specify a set of empirical equations to show how average rankings between different banks vary depending on changes in bank risk preference and asset composition.

This paper also contributes to the comparative bank efficiency literature in two ways.

First, we obtain qualitatively different results for comparative bank efficiency when *revals* are dropped. Bank efficiency scores rise and become less volatile across the board, while spreads narrow between different types of Russian banks. Efficiency ranks of bank groups differ from those presented in earlier studies, i.e. the group of foreign banks appears as the least efficient type of market participant, while core state banks are nearly as efficient on average as private domestic banks.

Second, we provide an empirical explanation for variation in average rankings of bank groups based on risk preference and asset composition. Foreign banks can achieve

[1] The closely related question of what drives changes in bank efficiency rankings over time is left for future research.

greater cost efficiency than other banks when they increase their loans-to-assets ratios above the sample median level. Conversely, core state banks gain cost efficiency when their loans-to-assets ratio falls below the sample median level.

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 Revaluations of foreign currencies and securities and their impact on bank profit-and-loss statements

A large share of Russian banking operations is denominated in foreign currencies, mostly US dollars and euros. That share rose from 29.8% of assets and 29.5% of liabilities on the eve of the 2008 financial crisis to 35.2% and 31.2%, respectively, two years later (Table 1). The mismatch between the 2010 asset and liability percentages reflects the large, positive net foreign currency position of Russia's banking sector. Although the share of foreign currency items in balance sheets then gradually declined to 22.1% of all assets and 21.2% of liabilities by the end of 2013, the share for both assets and liabilities remained economically significant. The data for 2014 and 2015 are likely to show an upward trend.

The financial crisis of 2008 brought about a flight to quality in the form of a restructuring of Russian bank balance sheets in favor of foreign currencies. For the 2008–2009 crisis period, the ruble's overall depreciation amounted to 28% against the US dollar and 21% against the euro. This generated substantial *revals* of foreign currency-denominated items on bank balance sheets. The ratio of positive *revals* to total assets of the banking sector during 2008–2009 increased from 11.7% to 68.4%, while the ratio of negative *revals* rose almost identically from 11.8% to 68.5%. That compares to the 2009Q4 ratios of interest income to total assets of just 9.3% and interest expenses to total assets of 5.1% (Table 1). By the end of our sample period (2013Q4), the ratios of positive and negative *revals* to assets had declined to 26.8% and 26.7%, respectively, about double their pre-crisis levels.

Positive and negative *revals* are by far the largest items in the total income and total costs statements of Russian banks. However, the net effect of *revals* is small (between -0.1%

and 0.1% of total assets). Indeed, *revals* would hardly matter if they were uniformly distributed across banks in the sample (i.e. if all or most banks displayed the same share of r*evals* in their total costs at each point in time). In such case, *revals* would not affect the results of estimation in terms of bank ranking by cost efficiency. This is not the case, however. The distribution of the *revals* share in costs is uneven both in terms of number of banks and total banking sector assets (Fig. 1a). Their shares of total banking sector assets before, during, and after the 2008 crisis range from near 0% to 95% (Fig. 1b). Fig. 2a illustrates how r*evals* as a percentage of total bank costs evolve over time at various percentiles of bank's distribution.

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

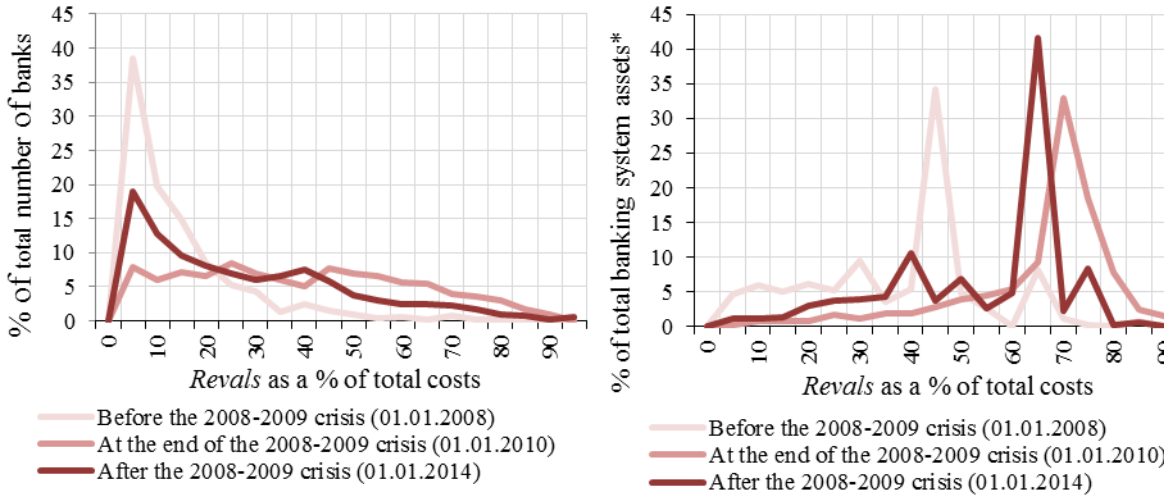
While the currency composition of bank assets is a management choice and an operative decision, *revals* bear little relation to bank cost efficiency (something presumably in management's control). Rather, *revals* reflect the action of an exogenous factor, the exchange rate of the national currency. Currency r*evals* may substantially fluctuate depending on national currency exchange rate dynamics, especially in a dollarized commodity economy like Russia's. Similarly, the revaluation of securities, while economically meaningful, is alien to the concept of operating efficiency. The distorting potential of r*evals* increases during periods of financial turmoil (Fig. 2a).

Table 1 Breakdown of profits and losses of Russian banking sector (ratio of total assets in %)

	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 cur-	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	11.8	68.5	37.5	26.7
Fee & commission expenses	0.2	0.2	0.2	0.3
Expenses from raising 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 CBR database of bank balance sheets and profit-and-loss statements

Figure 1 Frequency distribution of banks by revals materiality

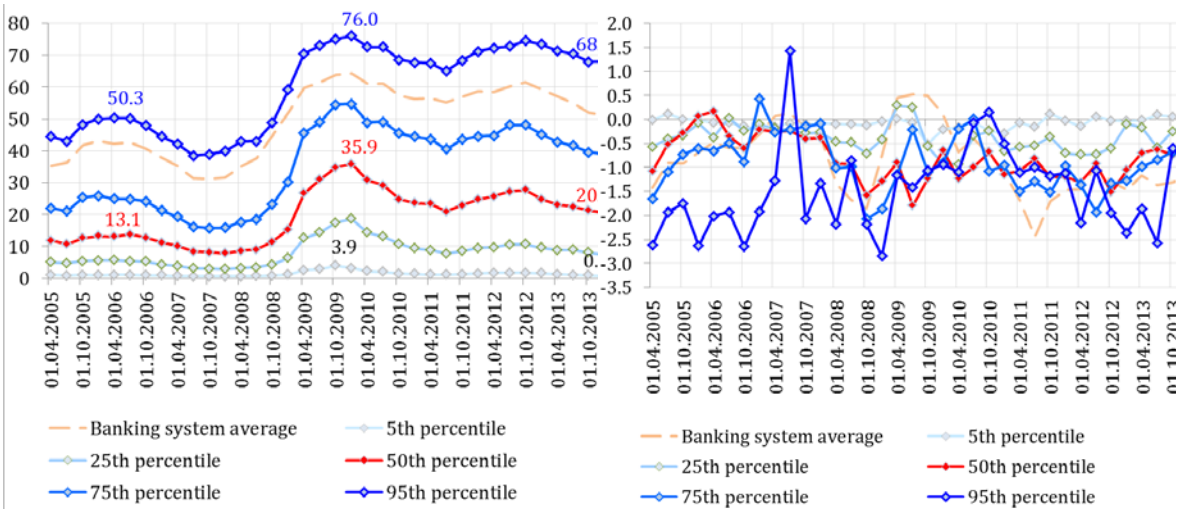


(a) Distribution by number of banks

(b) Distribution by share of total banking sector assets

Notes: * The peaks correspond to Sberbank holding about 30% of total banking sector assets.

Figure 2 Share of *revals* in total costs and income for different percentiles of bank distribution



(a) Negative revals as percentage of total costs

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

To sum up, *revals* are economically significant and not uniformly distributed among Russian banks. Our working hypothesis is that dropping *revals* from total costs will more accurately reflect actual operating costs and yield better efficiency estimates.

3 Data and methodology

This section provides a dataset description and explains our methodology of comparative efficiency analysis. The methodology calls for:

- Estimation of the cost frontier;
- Computation of bank-level time-varying cost efficiency scores with SFA;
- Regressing scores on the set of ownership dummies and their interactions with risk preference and asset composition measures, controlling for other bank-specific and macroeconomic variables; and
- Calculation of the distance function values extracted from the previous step to tease out bank-specific differences between banks in various ownership groups.

3.1 Data

For bank-specific factors, we obtain disaggregated bank-level data from Russian bank balance sheets and profit-and-loss (P&L) statements available to the public via the CBR's website.[2] In addition to monthly bank balance sheets (official reporting form No. 101) from March 2004 through December 2013, we use quarterly P&L statements (reporting form No. 102) from 2004Q1 through 2013Q4. We combine these two data sources into a quarterly panel dataset using MS SQL Server. While the Form 101 provides stock data, Form 102 is organized as flow data that build up cumulatively from one quarter to another within each year. As we rearrange these data as moving sums for four consecutive quarters, we lose observations within 2004 and start our resulting sample period from 2005Q1. This allows us to interpret factor input prices used in the cost frontier estimations (Section 3.3) on an annual, rather than quarterly, basis. Annual factor input prices are more tractable when comparing them to interest rates provided in the CBR's Banking Supervision Reports (CBR, 2015).[3]

The initial sample includes all Russian banks that disclose their financial accounts data. This amounts to a sample with up to 1,248 financial institutions during the period 2005Q1–2013Q4, and represents on average about 95% of total Russian banking sector assets. This yields 36,422 bank-quarter observations for the pooled sample. Disaggregating the pooled data to quarter level gives us a low point in bank numbers (803 in 2005Q4) and a

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

high point (1,015 banks in 2009Q4). The gap between these two quarterly numbers and the number of banks in the pooled data shows that the sample is quite unstable. New banks are created and old banks leave the market throughout the sample period.

Quarterly macroeconomic variables were collected from the Federal State Statistics Service website (www.gks.ru) for the observation period. Of interest are real GDP growth rates (per four moving quarters), real household income growth rate (per four moving quarters), and profit-to-debt ratios of non-financial firms. We also use daily data on the ruble exchange rate relative to its dual currency basket (fixed at 0.55 US dollar and 0.45 euro) as posted by the financial analytics firm Finam (www.finam.ru).

3.2 Bank groups

Using the data described above, this paper breaks down the sample of Russian banks into four categories:

- Core state-controlled banks4
- Other state-controlled banks
- Foreign bank subsidiaries
- All other Russian banks

Many papers on comparative banking in transition only distinguish among state-owned banks, private domestic banks, and foreign banks. However, alternative bank classifications based on the type of ownership have emerged to address research questions related to comparative bank efficiency. Bonin et al. (2005a), for example, in their attempt to capture the effect of a particular type of foreign ownership, consider four bank ownership categories: majority government ownership, majority private domestic ownership, strategic foreign ownership, and other foreign majority 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 further specifying domestically owned banks. To assess the

[4] We prefer the term "state-controlled" banks to "state-owned" banks. From a legal standpoint, one party cannot *own* a joint-stock company, only its shares. More importantly, 100%-government-owned public banks are a rarity these days. In most countries, sizeable stakes in state banks have been sold to outside investors, including foreign investors. Thus, the term "state-owned bank" no longer reflects reality, despite its broad persistence in the academic literature.

importance of the market entry mode for foreign banks, Havrylchyk and Jurzyk (2011) distinguish newly established ("greenfield") foreign banks from banks that take over existing entities in the host country.

Moreover, in countries with a vast public sector, breaking down state-controlled banks into sub-categories may be appropriate. China's "Big Four" state banks, for example, are analyzed separately from the other state-controlled banks (Berger, Hasan, Zhou, 2009). Russia similarly features large-scale public sector participation in the banking industry. Depending on the point chosen in our observation period, the number of state-controlled banks climbs as high as 51 banks,[5] with joint control ranging from 48% to 60% of total banking sector assets.

We consider a bank to be state-controlled bank if it is majority-owned by a public entity. The Russian notion of "public entity" is quite loose. It can mean an agency of federal government, an industrial company, or a bank with equity stemming 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 Russia's three largest state banks often act as government agents and pursue a combination of financial and non-financial objectives (Vernikov, 2014), many of the smaller state-controlled banks, particularly indirectly-owned banks, display market behavior similar to private domestic institutions. They are typically excused from on-lending of public funds to government-supported projects.

In other words, Russia's state banks are too numerous, their business models too diverse, and their market share too large (up to 60%) to be treated as a single group. This specific industry structure warrants for the introduction of additional sub-categories of state-controlled banks for the sake of a more accurate estimation of comparative efficiency. We introduce the group of core state-controlled banks (*State-1)* and other state-controlled banks (*State-2*), thus enhancing homogeneity within each of the groups. *State-1* comprises the three "national champions" (Sberbank, VTB, and Rosselkhozbank), which together control between 35% and 43% of total banking sector assets in Russia. *State-2* consists of the 28 to 46

[5] We use various sources to classify bank owners as state such as the websites of the banks in question, the CBR, Bankscope, and Banker's Almanac. Similar to Bertay, Demirgüç-Kunt, and Huizinga (2015), our sample only includes banks where we can determine that a 50 % or larger stake is held by a public entity(-ies). We identify the presence of public institutions among the shareholders of the bank shareholders by screening the information disclosure of bank parent entities.

banks (depending on the quarter) that jointly own a market share of 19% (Table A1 in Appendix).

The group of foreign-controlled banks (*Foreign*), 27 to 48 entities that control 8–12% of total banking sector assets. We focus on the fully owned foreign bank subsidiaries and the institutions predominantly owned by foreign banks such as *Rosbank* (*Société Générale*). Emphasizing substance over form, we exclude the following types of banks:

- Banks with nominal foreign shareholders, but Russian end beneficiaries;
- Banks controlled by foreign private individuals, non-bank institutional investors, international institutions, or national development agencies;
- Banks controlled by industrial loan corporations, primarily the offspring of the foreign automotive companies (e.g. BMW, VW, Daimler, Toyota, and PSA Peugeot Citroën) that mainly exist to finance car sales in the Russian market and do not engage in commercial banking otherwise; and
- 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 performance characteristics of banks controlled by foreign strategic investors should be more coherent than within a heterogeneous group that includes diverse bank types. Our expectation is that comparison of the performance foreign bank subsidiaries to that of state-controlled banks and private banks will yield different results than those of previous studies on aggregated bank categories.

The remaining group of banks privately owned by Russian residents (*Private*) covers some 745 to 920 banks with a market share ranging from 31% to 42% of banking sector assets.

We revise the composition of each group for each quarter to reflect possible migrations.

3.3 Empirical strategy

The literature on banking efficiency provides two alternatives for the estimating the cost (profit) frontier and its determinants. The *two-step approach* separates frontier evaluation from the estimation of inefficiency covariates. The *one-step approach* determines and estimates both frontier and inefficiency covariates simultaneously.[6] Wang and Schmidt (2002)

[6] See the recent overview of Belotti et al. (2013), who discuss and implement various models with both one-step and two-step approaches using Stata software.

show that the two-step approach can lead to biased estimates due to the fact that the inefficiency term is normally treated as a one-side (positive) disturbance in the first step and as a two-side disturbance in the second step. Recognizing this drawback, several authors opt for the one-step approach (e.g. Bonin et al., 2005; Karas et al., 2010). Unfortunately, the one-step approach is limited when a broader set of covariates is taken into account (e.g. in addition to dummies on bank groups, bank-specific characteristics such as market power). Bank-level estimates of market power are usually based on the estimates of marginal costs (Lerner index or Boone indicator) obtained after the frontier is evaluated. Hence, one cannot estimate the effect of market power on efficiency using the one-step approach.

Given the large body of literature on the market power-efficiency nexus that claim market power is a major factor in determining efficiency (e.g. Maudos and Fernández de Guevara, 2007; Solís and Maudos, 2008; Turk Ariss, 2010), we are reluctant to omit market power estimates from the list of bank-specific controls in our comparative efficiency analysis. Moreover, the "market power" strand of the literature adopts the two-step approach, as do some papers dealing with comparative efficiency. For example, the above mentioned study on Chinese banks by Berger et al. (2009) embraces the two-step approach, even if does not employ market power estimates in the second step. Thus, we use the two-step approach, leaving the one-step alternative as our robustness check.

(1) Specification of the empirical cost function

We use stochastic frontier technique to compute time-specific rankings in bank cost efficiency. The empirical cost function at bank level is specified within the *production approach*, taking into account prices of inputs, quantities of outputs, and equity netputs to control for differences in bank risk preference (Turk Ariss, 2010; Fiordelisi, Marques-Ibanes, and Molyneux, 2011). We prefer the production approach over the *intermediation approach*, because (a) it avoids possible bias of efficiency estimates due to incomplete assets and liabilities coverage in the intermediation approach (Fortin, Leclerc, 2007); and (b), it lets us account for the fact that loans are funded not only by deposits but also other sources such as inter-bank deposits, foreign liabilities, loans from the central bank, and debt securities issued by banks. 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; Turk Ariss, 2010; Fiordelisi et al., 2011).

The key distinction here from previous research is our 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*. Following Berger and DeYoung (1997), Maudos and Fernández de Guevara (2007) and Solis and Maudos (2008), we deduct interest expenses from total costs on the assumption that interest expenses reflect bank market power rather than its efficiency. Our two alternatives for empirical cost function take the following (translog) form:

$$\ln OC_{it}^{(alt)} = \beta_0 + \sum_{j=1}^{3}\beta_j \cdot \ln Y_{j,it} + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3}\beta_{kl} \cdot \ln Y_{k,it} \cdot \ln Y_{l,it} + \sum_{m=1}^{3}\gamma_m \cdot \ln P_{m,it} + \frac{1}{2}\sum_{r=1}^{3}\sum_{q=1}^{3}\gamma_{rq} \cdot \ln P_{r,it} \cdot \ln P_{q,it} + \quad (1)$$
$$+ \sum_{s=1}^{3}\sum_{u=1}^{3}\delta_{su} \cdot \ln Y_{s,it} \cdot \ln P_{u,it} + \sum_{j=1}^{3}\varphi_j \cdot \ln Y_{j,it} \cdot T + \sum_{m=1}^{3}\psi_m \cdot \ln P_{p,it} \cdot T + \alpha_1 \cdot T + \alpha_2 \cdot T^2 + \mu_1 \cdot \ln EQ_{it} +$$
$$+ \mu_2 \cdot (\ln EQ_{it})^2 + \sum_{j=1}^{3}\rho_j \cdot \ln Y_{j,it} \cdot \ln EQ_{it} + \sum_{m=1}^{3}\xi_m \cdot \ln P_{m,it} \cdot \ln EQ_{it} + \eta \cdot T \cdot \ln EQ_{it} + v_{it} + u_{it} \quad ,$$

where alt stands for two alternative compositions of cost so that $alt = 1$ for operating costs with *revals* kept, while $alt = 2$ when r*evals* are dropped from the operating costs. 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 not including government and inter-bank accounts ($j = 2$), and 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 ($m = 1$), the ratio of personnel expenses to total assets as a price for labor ($m = 2$), and the ratio of other non-interest and non-personnel expenses to total assets 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 preference. 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 distribution.[7] In estimating empirical cost function, we standardly impose linear homogeneity conditions on factor input prices, as well as symmetry conditions.

We estimate Eq.(1) over the 40 quarters of 2005–2013. This fairly long observation period breaks into three sub-periods, i.e. the periods before, during, and after the 2008–2009 financial crisis. Although some changes in the underlying cost function may have occurred due to the destructive nature of crisis, we do not separate the estimations for these three sub-periods in our basic version for two reasons. First, the 2008–2009 crisis was expeditiously tackled by the Russian government, which granted 1.08 trillion rubles (3% of GDP in 2009) in subordinated loans or secondary public offerings (SPOs) to support systemically important banks, as well as developed flexible instruments for liquidity support. As argued in Solntsev, Pestova and Mamonov (2010), these measures softened the impacts of the banking crisis in Russia, eliminating its most destructive effects. Second, the more flexible translog form of cost frontier implies time- and bank-specific relationships between costs and key explanatory variables. Hence, the influence of the crisis may have already been accounted for.[8]

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

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

where $\hat{u}_{it}^{(alt)}$ is an estimate of inefficiency term with *revals* kept ($alt = 1$) and with r*evals* dropped ($alt = 2$).

(2) Aggregation of bank-level cost efficiency scores into group-level characteristics

The bank-level cost efficiency scores obtained at the previous step are aggregated into group-level scores. As explained in the Section 3.2, we break the sample into four groups (State-1, State-2, Foreign, and Private) to compare the performance of Russian banks with regard to ownership status. We aggregate individual (bank-level) SFA scores for both alternatives (*re-*

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

[8] As a robustness check we re-estimated our cost function on the post-crisis sub-period and found no qualitative changes of our baseline results.

vals kept and dropped) to arrive at group-level characteristics that reflect the two alternatives. We take a simple arithmetic average and a weighted average equal to bank share in total banking sector assets. We regard the arithmetic average as the basic approach. It provides equal weights to all banks within a particular group irrespective of 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.

(3) Estimation of bank-level sources of efficiency heterogeneity

Finally, we proceed with a heterogeneity analysis to explain the observable differences in cost efficiency levels, e.g. SFA scores from Eq.(2), both within a particular group of banks (core state-controlled banks, other state-controlled banks, and foreign-controlled banks) and among them. The motivation is that efficiency ranking may depend on bank-specific factors. Thus, some banks in one group may be more cost efficient than banks in another group, even if the average ranking is different at the group level. Where this is the case, it becomes important to find out why and when some banks in a less efficient group are more efficient than banks with similar characteristics in a more efficient group. For bank-specific factors, 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. Following Solís and Maudos (2008), Maudos and Fernández de Guevara (2007) and Turk Ariss (2010), we specify the following set of empirical equations under a static panel framework:[9]

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

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

where for bank i at time t $SFA_{it}^{(alt)}$ is cost efficiency score from Eq.(2) computed with *revals* ($alt = 1$) and without *revals* ($alt = 2$). $X_{h,it}$ is h-th potential candidate for efficiency het-

[9] Possible persistence in the behavior of operating costs under the dynamic panel framework calls for exploration outside the scope of this paper or the mentioned studies.

erogeneity 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 assumed to be responsible for bank-level heterogeneity of SFA scores within a particular $GROUP_j$, as well as among the three groups considered: core state-controlled banks ($j=1$), other state-controlled banks ($j=2$), and foreign-controlled banks ($j=3$). Private domestic banks are treated as the reference group. $BSF_{k,it}$ is a 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. For market power the price mark-up is measured by the Lerner index adjusted for the cost inefficiencies of both bank as described in Koetter et al. (2012), while bank funding rates are determined as in Solís and Maudos (2008). $MACRO_m$ is an m-th macroeconomic factor to control for business-cycle, ruble volatility, and borrower creditworthiness.

As a basic estimator of Eq.(3), we exploit a 2-step GMM to address possible endogeneity and heteroscedasticity concerns. As instruments, we use the two first lags of all endogenous (bank-level) variables.

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* (one of the three outputs included in our cost function). The higher a bank's equity-to-assets ratio, the greater its outputs can be with the same volume of costs. This implies higher SFA scores. Thus, if j-th banks group ($GROUP_j$) is on average less efficient compared to the reference group (privately-owned banks), we would expect that increasing the equity-to-assets ratios of such banks narrows (and likely closes) the distance to the reference group. This is in line with Berger and Mester (1997), who claim that prudent banks are likely to have higher efficiency levels. On the other hand, holding more capital may be costly if it implies lower lending activities in the current period (Koetter and Poghosyan, 2009; Williams, 2012).

To investigate which of these competing effects predominate in the Russian banking setting and for each $GROUP_j$, we include equity capital at both steps (cost frontier and efficiency equation). Thus, we do not treat a bank as inefficient for being risk-averse, but still acknowledge that risk aversion may come with additional costs and/or benefits under Berger and Mester's prudent-efficient hypothesis.

Second, *intensifying lending activities may facilitate economy-of-scale effects*, i.e. a higher loans-to-assets ratio may positively affect cost efficiency (SFA score) (Solís and Maudos, 2008; Williams, 2012). Similarly to the previous case, j-th banks group ($GROUP_j$) could shorten the distance between themselves and the reference group by increasing its loans-to-assets ratio. At the same time, increased lending could increase borrower-screening costs and thereby lower cost efficiency (Williams, 2012). As in the previous case, we define empirically the prevailing effect in the Russian banking system.

On the basis of Eq.(3), we determine the distances between each $GROUP_j$ and the referent group in terms of SFA scores. We refer to that as distance functions and apply them to answering the question how a group's efficiency ranking may depend on bank-specific factors $X_{h,it}$. These functions can be represented as follows:

$$\Delta SFA_{j,it}^{(alt)} = \beta_{hj} + \gamma_{hj} X_{h,it} \qquad (4)$$

For each bank i from $GROUP_j$, $\Delta SFA_{j,it}^{(alt)} < 0$ ($\Delta SFA_{j,it}^{(alt)} > 0$) implies that this bank is less (more) cost efficient compared to the average privately owned bank.

Earlier research typically only analyzes the time-invariant first component on the right-hand side of Eq.(4), i.e. β_{hj} (Bonin et al., 2005; Karas et al., 2010).

Before estimating Eq.(1)-Eq.(4), we apply common filtering procedures to our panel dataset to deal with outliers. 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 so as to not drop the largest banks such as Sberbank or VTB. Further, we drop the observations with loans-to-assets ratio smaller than 10% to focus on banks providing credit to the economy and eliminate entities that do not function as genuine banks (Schoors, 2000; Karas and Schoors, 2010). After these filtering procedures, we have an unbalanced panel data for 1,038–1,196 entities, and the number of observations ranges from 17,401–20,319 in Eq.(3) to 29,082–29,146 in Eq.(1).

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 to group level (Section 4.2), and the analysis of bank-level and group-level heterogeneity of estimated SFA scores, tracing the changes in efficiency ranking of different groups of banks (Section 4.3).

4.1 Bank-level cost efficiency

Descriptive statistics of variables included in the empirical cost functions appear in Table A2 (Appendix), and the estimation results of the cost functions are given in Table A3 (Appendix). Table 2 presents SFA scores calculated for three distinct percentiles of the distribution (25^{th}, 50^{th}, and 75^{th}) averaged within the whole sample period (2005Q1–2013Q4). These values reveal the scope of differences between less efficient (p25) and more efficient (p75) banks in both versions of our SFA score computation (*revals* kept and dropped). We also complement the analysis with the SFA scores averaged within the sub-periods before and after the crisis of 2008–2009 to account for possible changes that may have occurred during the crisis.

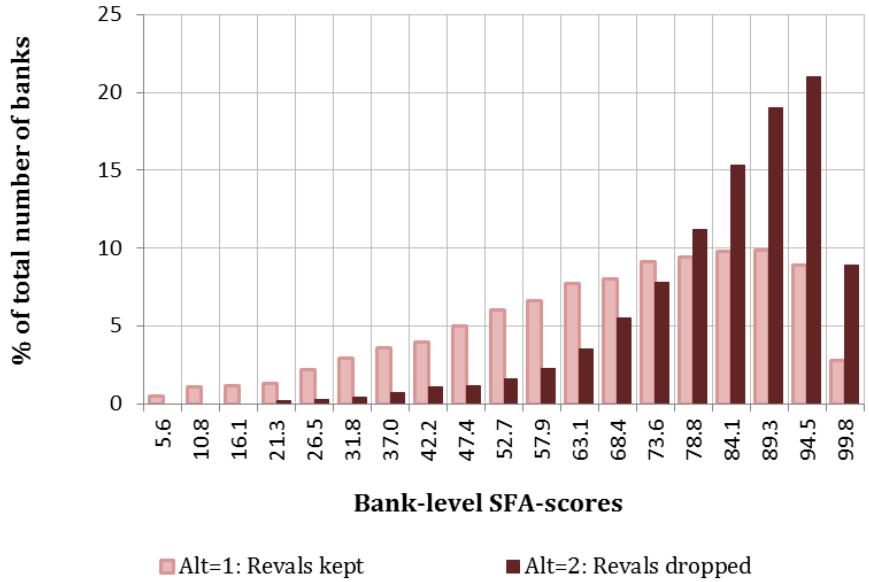
Irrespective of the business cycle phase, the average SFA scores calculated with *revals* dropped ($alt = 2$) are greater than scores with *revals* kept ($alt = 1$), 83.9% and 68.3%, respectively, in the 50^{th} percentile for the whole period. Keeping *revals*, the average SFA score deteriorates from 72.8% pre-crisis to 66.0% post-crisis, a result that defies intuition. When r*evals* are dropped, the average SFA score grows slightly from 83.6% pre-crisis to 84.1% post-crisis, a much more expected result. Obviously, these are technical results. Excluding one element such as negative *revals* from total costs and leaving the same factor input prices, outputs, and netputs, boosts the resulting cost efficiency level. On the other hand, our interest here is *the magnitude of this effect*. If the resulting SFA score increase is negligible, the need to drop *revals* is dubious. Dropping r*evals* is justified, however, if the increase turns out to be economically significant. Table 2 shows an effect ranging from 8.5 to 27.6 percentage points (Table 2), with a downward trend as we move from the low to high percentiles of SFA distribution.

Table 2 Bank-level operating cost efficiency (SFA scores, production approach) for select percentiles of bank distribution in whole, pre-crisis, and post-crisis periods

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

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

Figure 3 Frequency distribution of banks' SFA scores as average of 2005Q1–2013Q4 (production approach)



Our estimated SFA scores (*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% in comparing cost efficiency of banks in Russia and Kazakhstan. The period and the scope might explain these differences. Turk Ariss builds a panel of 821 banks from 60 different countries, including Russia. Kumbhakar and Peresetsky consider only 78 Russian banks, a sample less than a tenth the size of our sample. Moreover, the observation periods differ, i.e. Turk Ariss (1999–2005) and Kumbhakar and Peresetsky (2002–2006), so the only overlap years are 2005 and 2006 in our sample period (2005–2013). We further use quarterly data, whereas Kumbhakar and Peresetsky use annual data. Given that Russia is an emerging economy and the Russian banks were still rather primitive in the mid-2000s, SFA scores above 80% appear on the high side as they imply quite limited room for improvement in cost efficiency.[10] Our estimated average SFA level of 68% with *revals* kept looks much more credible.

4.2 Group-level cost efficiency

We proceed with the comparative analysis of cost efficiency levels of the four groups of banks, first for the entire sample period 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 panels 1 and 2, we put the descriptive statistics of SFA scores computed with *revals* kept and dropped, respectively.

Dropping or keeping *revals* substantially affect the levels of cost efficiency of all four groups and their rankings. Average SFA scores rise substantially from Panel 1 to Panel 2 for each particular group. We observe, as in the previous section, that SFA scores become less volatile with *revals* dropped. The data in Panel 1 indicate that the highest SFA score (67.1%) with *revals* kept belongs to non-core state-controlled banks (State-2), followed by privately owned domestic banks (66.1%), core state-controlled banks (50.8%), and foreign subsidiary banks (29.2%). Dropping *revals* changes the rankings (Panel 2). The leading position goes to private domestic banks (81.1%), followed by non-core state banks (78.2%), core state banks (75.5%), and foreign banks (60.3%). The SFA scores narrow for State-1,

[10] Schaeck and Cihák (2014) estimate an average EU banking system SFA score of 88% for 1995–2005.

State-2, and private banks. Foreign banks benefit the most from dropping *revals*. Although they remain at the bottom in the rankings, their average SFA score more than doubles.

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: *Revals* kept							
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: *Revals* dropped							
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

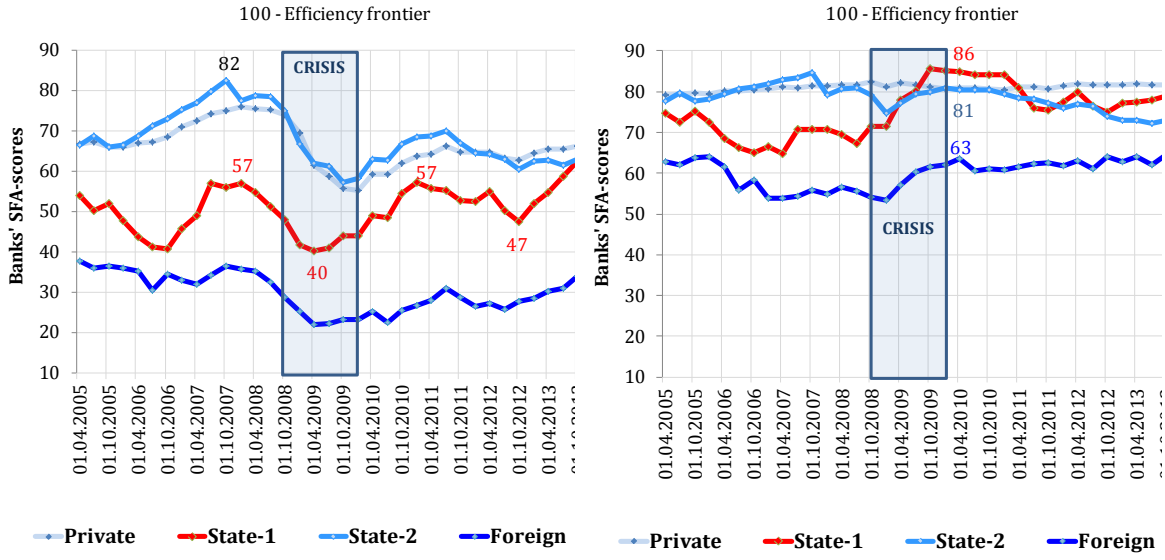
Our empirical result that foreign banks are the least efficient group of Russian market participants deserves some interpretation as it runs contrary to the mainstream literature on banking in transition (Bonin et al., 2005a; 2005b; Fries and Taci, 2006; Grigorian and Manole, 2006; Fries et al., 2006; Karas et al., 2010). As shown theoretically by Mian (2006) and empirically by Lensink, Meesters, and Naaborg (2008), substantial institutional differences between home and host countries (developed and transition economies here) can lead to a negative effect of foreign ownership on banking efficiency, resulting from additional costs borne by foreign banks as compared to domestic banks. We see two potential explanations of this reduced cost efficiency of foreign banks in Russia: (a) excessive capital adequacy with a relatively small loan portfolio of foreign banks at the initial period of penetration into the Russian market, impeding the exploitation of economies of scale; and (b) risk aversion of foreign banks in a volatile Russian market with poor protections of property rights. The validity of these explanations, however, must remain a topic of future research.

Additionally, the 2008 financial crisis may well have produced structural changes, so we test for such changes with comparisons in dynamics and breaking the observation

period (with *revals* kept and dropped) into sub-periods: pre-crisis, crisis, and post-crisis (Fig. 4).

After dropping *revals*, it is clear that the spreads narrow between different groups of banks in terms of efficiency. This observation is consistent with the hypothesis that all players within a banking system are exposed potentially to the best available technology, so the status of banks (state-controlled or private) does not preclude them from adopting best practices.[11] Keeping *revals* in the bank financial results, on the other hand, blurs this effect.

Figure 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)



(a) With *revals* kept (b) With *revals* dropped

Our second finding is that the ranking of bank groups is not constant over the period of observation. Here, elimination of *revals* affects the rankings, but in a different fashion than in Table 3. Specifically, if we keep *revals*, then State-2 is the most efficient group most of the time (Fig. 4a). Without *revals*, however, leadership of any particular group in terms of cost efficiency is only temporary. Before the 2008 crisis, State-2 and private banks were co-leaders with SFA scores of around 80% (Fig. 4b). During the crisis (2008Q4–2010Q1), the SFA score of State-1 jumped to 86%, securing the lead for this group. This could be due to the anti-crisis policies of the Russian government and a flight to quality, combined with

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

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 private domestic banks. During this period, the State-1 group SFA scores declined by up to 9 percentage points (75% in the mid-2011) and gradually yielded the top tier in the rankings to private domestic banks. The shift may reflect wage give-backs; wages were lowered at core state-controlled banks during the crisis.[12] Having reached the floor of 75%, the SFA score of the State-1 group then increases, returning to 80% at the end of the sample period. This is qualitatively the same level as privately owned banks in this period (81%). The State-2 group, in contrast 1, fails to break out of its declining trend in cost efficiency. At the end of the sample period, their SFA score is approximately 9 percentage points below that of State-1 banks.

Finally, 4a suggests that, unlike in normal conditions, the efficiency of banks declines during financial turmoil. 4b, conversely, shows that bank efficiency rises during a crisis period, which comports with the view that economic crises discipline economic agents by forcing them to eliminate unnecessary costs accumulated in previous periods. We do not capture this important effect keeping *revals*.

4.3 Distance functions: How does group ranking depend on bank-specific factors?

Descriptive statistics and pairwise correlations of variables employed in the regression analysis appear in Table A4 and Table A5 in the Appendix. In this section, we present the estimation results on the distance functions of Eq.(4) obtained using 2-step GMM. The underlying coefficients from Eq.(3) are presented in Table A6 in the Appendix.

[12] Banks are not required to disclose how many people they employ, so we can compare banks only in terms of the ratio of personnel expenses to total assets. In the State-1 group, this ratio was 1.4% pre-crisis, 1.2% during the crisis, and 1.3% post-crisis. The respective values for private banks were 3.3%, 3.9%, and 3.3%. The rise of the indicator for private banks during the crisis indicates a much sharper decrease in total assets compared to staffing cuts. 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. To stay competitive, privately owned banks must pay their staff more than their counterparts at state-controlled banks.

Columns I–III in Table A6 provide the estimation results with *revals* kept, and columns IV–VI the results with *revals* dropped. Estimated equations within each pair of columns I and IV, II and V, and III and VI have the same explanatory variables. The only difference is whether we keep or drop *revals* from the dependent variable (i.e. SFA score).

In the first pair of models (I and IV), we simply regress SFA scores on the group dummies without interacting them with other bank-specific factors as in previous studies. In the second pair of models (II and V), we include all dummies and their interaction terms with the bank-level equity-to-assets ratios in order to measure bank risk tolerances. In the third pair of models (III and VI), we include all dummies and their interaction terms with the bank-level loans-to-assets ratios as a measure of asset composition.

From a technical viewpoint, all six presented models satisfy the 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 obtain quite large values for the centered R^2: 34–37% in models with *revals* kept and 55–56% with *revals* dropped. Hence, dropping *revals* improves the goodness-of-fit. Most of estimated coefficients correspond to their respective pairwise correlations.

We next interpret the estimation results obtained from the models IV–VI with our proposed procedure of dropping *revals*, and analyze how these results change with respect to kept *revals* in models I–III.

(1) Homogenous relations: previous research findings revisited

We start with the first pair of models, Model I and Model IV in Table A6, representing the average ranking of our four bank groups over the sample period.

The core state banks (State-1) are found to be slightly more cost efficient than the private banks as the estimated coefficient before respective dummy is positive and marginally significant (see column IV). The estimated difference between the two groups is only 2.7 p.p. in terms of SFA scores. Keeping *revals* leads to about the same estimated difference, albeit insignificant (see column I). In any case, the results support the findings of Karas et

al. (2010) and suggest that core state banks are no less cost efficient than private banks in Russia.[13]

The other state-controlled banks (State-2) seem to be more cost efficient than the private banks (see column IV). The estimated difference of 1.7 p.p. in terms of SFA scores is very significant, but quite small (even smaller than the difference between State-1 and private banks discussed above). If we keep *revals* (column I), the estimated coefficient is much higher (8.6 p.p.), and in isolation could lead us to the incorrect conclusion that State-2 banks outperform all three other groups.[14]

Foreign banks on average display no differences with private banks in terms of cost efficiency, i.e. the estimated coefficient is negative, but insignificant (column IV). Keeping *revals* (column I) leads to the qualitatively opposite conclusion here; the estimated coefficient is 16.2 and highly significant, implying extraordinarily inefficient performance of foreign banks in Russia (see Section 4.2 discussion). These findings contradict those of Karas et al. (2010), who stress that foreign banks outperformed all the other groups in Russia prior to the 2008–2009 crisis.[15]

(2) Heterogeneous relations based on differences in risk preference

We now consider our second pair of models, Model II and Model V, in Table A6. The interpretation of respective coefficients provides little information on the ranking of banks, so we move to analyzing the underlying distance functions (Eq.4). For each bank group separately, we generate the distribution of values obtained from respective distance functions, depending on the equity-to-assets ratios (ETA) of banks, and then extract the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentiles from these distributions for further analysis. The results are laid out in Table 4 (panels 1–3).

[13] These findings imply that even 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 preference, asset composition, market powers, and other bank-level characteristics unrelated to costs. The core state banks possess greater market power than private banks (Anzoátegui et al., 2012), and are, in fact, no less cost-efficient than private banks despite formally lower efficiency scores.

[14] The obtained estimates, 8.6 and 1.7 p.p., reflect 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)

[15] Our findings may stem from the higher dependence of foreign banks on cross-border operations (mostly with their parent banks in their home countries), resulting in a period-average share of negative *revals* in total expenses of 58% (compared to just 23% for other groups).

The core state banks (State-1) mainly show ETA ratios ranging from 8.8% (p10) to 21.2% (p90) over the sample period (see Panel 3 of Table 4). Up to the 15.3% (p75) in this range, we see no statistical difference between State-1 and private banks in terms of cost efficiency (Panel 2). Differences emerge and increase above p75; State-1 outperforms all the other three groups. Specifically, a State-1 bank with an ETA ratio of 15.3% (21.2%) is 4.3 p.p. (6.7 p.p.) more cost efficient than the average private bank with an estimated SFA score of 81% (Table 3). Keeping *revals* again leads to the conclusion that State-1 banks are more cost efficient than private and foreign banks when they possess ETA ratios above p75, and that they are less cost efficient than State-2 banks (see Panel 1 of Table 4).

Foreign banks appear to be the least cost-efficient group only in case they operate with ETA ratios below the p50; that is, a foreign bank with ETA ratio of 8.2% (11.1%), which corresponds to p10 (p25), is 2.5 p.p. (1.8 p.p.) less cost efficient than the average private bank. Decreasing leverage by increasing ETA ratio above p50 allows foreign banks to outperform private banks and, above p75, even State-2 banks. For example, a foreign bank with an ETA ratio of 41.5% (p90) is 5.5 p.p. more cost efficient than the average private bank (although it makes little sense to maintain a sky-high ETA ratio 3.5 times above the banking sector average, and thereby substantially restrain profitability). If we keep *revals*, the distance goes from 5.5 to –26.7 p.p., clearly demonstrating the materiality of *revals* for this group of banks.

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

(3) Heterogeneous relations based on differences in asset composition

Lastly, we consider our third model pair, Model III and Model VI, from Table A6. As in previous case, we analyze separately for each bank group the extractions from the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentiles of the distributions of values calculated from their respective distance functions, each of which depends on the bank's loans-to-assets ratios (LTA). The results are presented below in Table 4 (panels 4–6).

Table 4 GMM post-estimation results: Distances between groups of banks in terms of cost efficiency (p.p. of SFA scores) determined on basis of observable heterogeneity in risk preference or asset composition, averages for 2005Q1–2013Q4

Percentile [a]	p10	p25	p50	p75	p90
Distances as a function of risk preference (equity-to-assets ratios, ETA)					
Panel 1: *Revals* kept (on the basis of model II from Table A6)					
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: *Revals* dropped (on the basis of model V from Table A6)					
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 ETA 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
Distances as a function of asset composition (loans-to-assets ratios, LTA)					
Panel 4: *Revals* kept (on the basis of model III from Table A6)					
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 5: *Revals* dropped (on the basis of model VI from Table A6)					
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 6: Percentiles of LTA 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: ***, ** and * – an estimate is significant at the 1%, 5% and 10%, respectively. Robust standard errors are not provided for reasons of space.

[a] The number of bank-quarter observations employed to calculate the values of the distance functions are 108 for State-1 banks, 1,204 for State-2 banks, and 1,177 for the Foreign banks. The referent group (Private banks) accounts for 26,624 observations.

We can infer from Panel 6 of Table 4 that State-1 banks operate with one of the largest LTA ratios in the Russian banking system, while foreign banks are less specialized in allocating loans to the economy than all the other groups. Within the p10–p90 distributions, the State-1 bank LTA ratios range from 36.8% to 71.2%, while foreign bank LTA ratios are only 6.4% in p10 and 70.7% in p90. Here, our estimations on efficiency distance functions yield an

important result: *State-1 banks become the most cost-efficient group when they lend less to the economy*, while *foreign banks tend to be the most cost-efficient group when they lend more to the economy* (Panel 5).[16] In p10, the SFA score of a State-1 bank is 6.1 p.p. higher than that of an average private bank, and the SFA score of a foreign bank is 18.6 p.p. lower than the average private bank. In p90, the opposite is true. Importantly, these results are garbled when r*evals* are kept (Panel 4).

Another notable result comes from the comparison of State-1 and State-2 banks. As our estimations show, State-2 banks are more cost efficient than State-1 banks in the p50–p75 range of LTA ratios. This could reflect a lesser degree of political interference in bank decision-making. Unlike the case of State-1 banks, the government does compel State-2 banks to lend to government-approved projects. With *revals* kept (Panel 4), we could claim that State-2 banks are *always* (not just within the p50–p75 range of LTS distribution) more cost efficient than State-1 banks.

5 Robustness check

We re-estimate Eq.(1)–Eq.(4) either by replacing the production approach by the intermediation approach or applying a Tobit, rather than GMM, estimator. We also include additional outputs in our translog cost function, Eq.(1), and drop all but one macroeconomic control, GDP growth rate, from Eq.(4) to address possible multicollinearity concerns.

First, staying within the production approach, we re-estimate Eq.(3) using Tobit analysis rather to account for the censored nature of SFA scores, i.e. their lower and upper bounds that are, by construction, 0 and 100, respectively.[17] The results of this exercise are

[16] We suppose that the growing efficiency of foreign subsidiary banks as they lend more is quite logical. 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.

[17] For that purpose, we employ the *ivtobit* routine in Stata with the two-step option that actually performs the minimum chi-squared estimator proposed in Newey (1987).

presented in Table A7 in the Appendix. Comparing these results to our GMM estimation results in Table A6, we observe no qualitative differences as the coefficients change only slightly. Consequently, no qualitative changes occur with the efficiency distance functions measured either by risk preference or asset composition. This can further be verified by comparing Table A8 in the Appendix with Table 4. We therefore continue to assert that core state banks can be the most cost-efficient group when they gradually replace loans with other types of assets, and that foreign subsidiary banks can outperform the other three groups when they lend more to the economy.

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 average funding rate as an explanatory variable.[18] The results are reported in Table A3. We find that the majority of the coefficients remain qualitatively the same. The few exceptions concern three interaction terms (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 the much lower values of the likelihood function.

Third, we re-calculate SFA scores under the intermediation approach and aggregate them into group-averages (Table A9 in the Appendix). Comparing these with our results under the production approach (Table 3), we conclude that foreign banks on average remain the least cost-efficient group, regardless of whether *revals* are kept or dropped. The core state banks hold the first position rather than third position after State-2 and private banks as estimated under the production approach. Average SFA scores for all three groups exhibit unstable patterns in dynamics, and lead to several reshufflings of the rankings. This could be caused by the dramatic drop in goodness-of-fit observed within the intermediation approach.

Fourth, we again re-estimate Eq.(3) replacing the production-approach SFA scores with SFA scores from the intermediation approach. Here, we only employ GMM as no qualitative changes are revealed when we use the Tobit technique. Estimation results are reported in Table A10 in the Appendix. The newly estimated coefficients that are qualitatively different from respective baseline results from Table A6 are bolded for convenience. About half

[18] It may be reasonable to suggest that operating costs are indirectly affected by the price of deposits through the adverse selection problem, i.e. when the price of deposits rises, banks tend to increase the price of their loans. The latter usually decreases the incentive of borrowers with good creditworthiness to take new loans, so banks may soften their lending standards to find new borrowers. While this may lead to lower screening costs for the bank over the short run, the long-term problem may be higher costs caused by non-performing loans.

of the coefficients before the variables of interest display changes in either significance or sign. We do not analyze each change, but trace its impact on our basic findings. Panels 1–3 of Table A11 in the Appendix reports the values of efficiency distance functions measured in terms of risk preference. Panels 4–6 of Table A11 gives distance functions based on asset composition. Comparing Table A11 with Table 4, we observe that the core state banks are still the most efficient group when they maintain higher capital adequacy or decrease their loans-to-assets ratio below the sample median. What we no longer observe is that foreign banks can be more cost efficient than the other groups when the rely more on equity capital than on attracted funds.[19] We interpret this finding with great caution; it is not robust to the change in approach to estimating the cost function. Otherwise, our conclusion that foreign banks can increase their cost efficiency (and even outperform other groups) when they lend more to the economy remains unchanged.

Fifth, we address possible multicollinearity concerns raised by the fact that pairwise correlations between different macroeconomic controls (GDP and households income growth rates, profit-to-debt ratio of firms, and ruble volatility) are quite high, ranging from –0.59 to 0.68 (Table A5). We drop all but GDP growth rate from Eq.(3) and re-estimate Eq.(4) within both the intermediation and production approaches, and employing both the 2-Step GMM and IV Tobit estimators. Our baseline results do not exhibit significant qualitative changes.

Sixth, we re-configure our translog cost function by adding more outputs or replacing operating costs with total costs (only with *revals* dropped). We include securities, both private and government, as the fourth output into Eq.(1), given that this class of asset may be important for banks less geared to lending to the economy. As shown in Panel 6 of Table 4, this is the case of foreign banks in Russia. Next, we include foreign assets (loans to and securities of non-residents) into Eq.(1) as the fifth output to account for the fact that Russian banks rely on this class of asset more than loans to residents in periods of ruble instability. We finish the exercise by replacing operating costs by total costs within the basic specification of Eq.(1), i.e. with only three outputs. Estimation results for each of the three cases are presented in Figure A1 in the Appendix. Comparing the latter with Figure 4b in Section 4, we infer that our baseline results remain unchanged, although we observe that including

[19] This is caused by the change of signs of the coefficients before the interaction terms in respective distance function. Under the intermediation approach, the distance function for foreign banks is determined positively (and not negatively as in the production approach) by equity-to-assets ratios.

more outputs decreases the distances between foreign banks and the other three groups of banks. In any case, this finding lends support to the theoretical predictions of Mian (2006) and empirical results of Lensink et al. (2008) regarding the lower efficiency of foreign banks relative to domestic financial institutions.

Finally, we omit the Lerner index from the list of inefficiency covariates and re-estimate Eq.(1) and Eq.(3) simultaneously, i.e. within the one-step approach, taking into account bank-level fixed-effects and replacing (positive) half-normal distribution of the inefficiency term by the (positive) truncated-normal alternative. For this purpose, and similar to Karas et al. (2010), we employ the model of Battese and Coelli (1995). Our basic results on comparative efficiency appear robust to this methodological change.

6 Conclusions

This paper introduced three amendments to SFA computation of comparative bank efficiency in Russia.

First, we showed that the effects of the revaluations of all foreign currency items on Russian banks balance sheets (*revals*) are unevenly distributed among banks and thus matter for bank efficiency rankings. We demonstrate this distorting effect through alternative calculations with *revals* kept and dropped.

Second, we analyzed the performance of core state-controlled banks separate from other state-controlled banks.

Third, within the group of foreign banks, we focused on those controlled by strategic foreign investors (i.e. subsidiaries of foreign banks).

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:

- Efficiency scores become higher and less volatile across the board.
- Spreads shrink between different types of banks in terms of efficiency.
- Bank efficiency improves during financial turmoil relative to normal circumstances.
- Foreign-controlled banks on average appear to be the least efficient market participants.

- Russia's core state-controlled banks are more efficient than other state-controlled banks, and nearly as efficient as private domestic banks during and after the 2008–2009 financial crisis.
- Based on our estimated distance functions, we argue that foreign-controlled banks can become more cost efficient than others when they increase their loans-to-assets ratios above the sample median level. Conversely, when their loans-to-assets ratio falls below the sample median level, core state-controlled banks are superior in cost efficiency.

Some of our 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 may be attributable to institutional differences between Russia and the home countries of some foreign banks present in Russia (Mian, 2006; Lensink et al., 2008), as well as the inability of foreign banks to take advantage of economies of scale. This issue requires further research. Another important finding is that *Russia's large state-controlled banks are not necessarily poor performers*.

These empirical findings might have research and policy implications. From a research perspective, this paper offers evidence that bank rankings in terms of efficiency may be misleading 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 may motivate regulators to adjust industrial policy with regard to banks. The prejudice against state banks in favor of foreign banks should give way to a more balanced industrial policy aimed at a better performance of all national banks. On the other hand, even with this more enlightened approach, there may be less room for improvements in cost efficiency than widely believed.

In any case, we believe this approach show here is applicable to other dollarized emerging markets and offers valuable avenues research yet to be traveled.

References

Altunbas Y., Evans L., Molyneux P. (2001). Bank ownership and efficiency. *Journal of Money, Credit and Banking* 33(4): 926–954.

Andrianova S., Demetriades P., Shortland A. (2012). Government ownership of banks, institutions and economic growth. *Economica* 79(315): 449–469.

Battese G., Coelli T. (1995). A model for technical inefficiency effects in a stochastic frontier production for panel data. *Empirical Economics* 20(2): 325–332.

Belotti F., Daidone S., Ilardi G., Atella V. (2013). Stochastic frontier analysis using Stata. *STATA Journal* 13(4): 719–758.

Belousova V. (2009). Effektivnost izderzhek odnorodnykh rossiyskikh kommercheskikh bankov: obzor problemy i noviye rezultaty [Cost efficiency of similar Russian commercial banks: A survey and new evidence], *Economic Journal of the Higher School of Economics* 13(4): 489–519. [in Russian]

Berger A., DeYoung R. (1997). Problem loans and cost efficiency in commercial banks. *Journal of Banking and Finance* 21(6): 849–870.

Berger A., Mester L. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking and Finance* 21(7): 895–947.

Berger A., Hasan I., Zhou Mingming (2009). Bank ownership and efficiency in China: What will happen in the world's largest nation? *Journal of Banking and Finance* 33(1): 113–130.

Bertay A., Demirgüç-Kunt A., Huizinga H. (2015). Bank ownership and credit over the business cycle: Is lending by state banks less procyclical? *Journal of Banking and Finance* 50: 326–339.

Bonin J., Hasan I., Wachtel P. (2005a). Bank performance, efficiency and ownership in transition countries. *Journal of Banking and Finance* 29(1): 31–53.

Bonin J., Hasan I., Wachtel P. (2005b). Privatization matters: Bank efficiency in transition countries. *Journal of Banking and Finance* 29(8–9): 2155–2178.

Caner S., Kontorovich V. (2004). Efficiency of the banking sector in the Russian Federation with international comparison, *Economic Journal of the Higher School of Economics* 8(3): 357–375.

CBR (2015). *Banking Supervision Report in 2014*. Moscow: Central Bank of Russia. [in Russian].

Chernykh L., Cole R. (2011). Does deposit insurance improve financial intermediation? Evidence from the Russian experiment. *Journal of Banking and Finance* 35(2): 388–402.

Claessens S., van Horen N. (2012). Being a foreigner among domestic banks: Asset or liability? *Journal of Banking and Finance* 36(5): 1276–1290.

Fiordelisi F., Marques-Ibanez D., Molyneux P. (2011). Efficiency and risk in European banking. *Journal of Banking and Finance* 35(5): 1315–1326.

Fortin M., Leclerc A. (2007). Should we abandon the intermediation approach for analyzing banking performance? GREDI Working Paper 07–01, Université de Sherbrooke.

Fries S., Taci A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking and Finance* 29(1): 55–81.

Fries S., Neven D., Seabright P., Taci A. (2006). Market entry, privatisation and bank performance in transition. *Economics of Transition* 14(3): 579–610.

Golovan S. (2006). Faktory, vliyayuschie na effektivnost rossiyskikh bankov [Factors influencing the efficiency of Russian bank performance], *Applied Econometrics* 2(2): 3–17. [in Russian].

Golovan S., Karminsky A., Peresetsky A. (2008). Cost efficiency of Russian banks. Models with risk factors, *Ekonomika i matematicheskiye metody* 44(4): 28–38.[in Russian].

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

Havrylchyk O., Jurzyk E. (2011). Inherited or earned? Performance of foreign banks in Central and Eastern Europe. *Journal of Banking and Finance* 35(5): 1291–1302.

Jiang C., Yao S., Feng G. (2013). Bank ownership, privatization, and performance: Evidence from a transition country, *Journal of Banking and Finance* 37(9): 3364–3372.

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

Karas A., Schoors K. (2010). A guide to Russian bank data. SSRN Working Paper Series No. 1658468.

Karas A., Pyle W., Schoors K. (2012). Deposit insurance, banking crises, and market discipline: Evidence from a natural experiment on deposit flows and rates. *Journal of Money, Credit and Banking* 45(1): 179–200.

Körner T., Schnabel I. (2011). Public ownership of banks and economic growth: The impact of country heterogeneity. *Economics of Transition* 19(3): 407–441.

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

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

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

Mamonov M. (2013). Gosbanki vs chastny bankovsky sector: kto effektivneye? [State banks vs the private banking sector: Who is more efficient?], *Bankovskoye delo* 5: 23–30. [in Russian]

Maudos J., Fernández de Guevara J. (2007). The cost of market power in banking: Social welfare loss vs. cost inefficiency. *Journal of Banking and Finance* 31(7): 2103–2125.

Mian A. (2006). Distance constraints: The limits of foreign lending in poor countries. *Journal of Finance* 61(3): 1465–1505.

Newey W. (1987). Efficient estimation of limited dependent variable models with endogenous explanatory variables. *Journal of Econometrics* 36(3): 231–250.

Peresetsky A. (2010). Bank cost efficiency in Kazakhstan and Russia. BOFIT Discussion Papers 1/2010, Bank of Finland Institute for Economies in Transition.

Schaeck K., *Cihák* M. (2014). Competition, efficiency, and stability in banking. *Financial Management* 43(1): 215–241.

Schoors K. (2000). A note on building a database on Russian banks: Fieldwork against the odds. *Post-Communist Economies* 12(2): 241–249.

Schoors K. (2003). The fate of Russia's former state banks: Chronicle of a restructuring postponed and a crisis foretold. *Europe-Asia Studies* 55(1): 75–100.

Solís L., Maudos J. (2008). The social costs of bank market power: Evidence from Mexico. *Journal of Comparative Economics* 36(3): 467–488.

Solntsev O., Pestova A., Mamonov M. (2010). Stress test: Will Russian banks need new government support? *Problems of Economic Transition* 54(8): 68–94.

Turk Ariss R. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking and Finance* 34(4): 765–775.

Vernikov A. (2012). Impact of state-controlled banks on the Russian banking sector. *Eurasian Geography and Economics* 53(2): 250–266.

Vernikov A. (2014). 'National champions' in Russia's banking services market. *Problems of Economic Transition* 57(4): 3–25.

Wang H., Schmidt P. (2002). One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels. *Journal of Productivity Analysis* 18(2): 289–296.

Appendix

Table A1 Breakdown of sample banks

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

* Group share of total assets of the sample for the respective quarter

Table A2 Descriptive statistics of variables in the cost function (2005Q1–2013Q4)

	Unit	Symbol	Mean	Std 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								
Retail and corporate loans	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

Table A3 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

Approach		Production (basic)		Intermediation	
Reavals kept		Yes	No	Yes	No
Explanatory variables, in logs	Symbol	I	II	III	IV
Std. dev. of inefficiency term, rest of error		0.730, 0.061	0.334, 0.049	0.873, 0.208	0.536, 0.177

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

Table A4 Descriptive statistics of variables in cost efficiency equations (2005Q1–2013Q4), %

	Mean	Std 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
Funding- and efficiency adjusted Lerner index of market power**	17.0	37.3	–96.8	94.9	22316	1033
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	

Notes:
* All values reported in this table were obtained through applying filtering procedures as described in Section 3.3.
** Negative values of the Lerner index for some banks in our sample may reflect either a cross-subsidy strategy to gain higher market share (Solís and Maudos, 2008) or the greater inefficiencies of small banks, i.e. players who cannot dictate prices for their loans and suffer from negative margins. Notably, as shown by Solís and Maudos (2008), the Lerner index averaged across all banks operating within the market for loans in the Mexican banking system achieved huge negative values, including –0.41 in 2003! The cross-subsiding strategy implies covering such negative margins in one market with positive margins in others. For example, in 2003, the Lerner index for deposits market in Mexico was about +0.48. We assume similar patterns are observable within the Russian banking market.

Table A5 Pairwise correlations of variables in cost efficiency equations (2005Q1-2013Q4)

	1	2	3	4	5	6	7	8	9	10	11	12
1. SFA with *Revals* kept	1.00											
2. SFA with *Revals* dropped	0.66	1.00										
3. Equity-to-assets ratio (ETA)	0.18	0.19	1.00									
4. Loans-to-assets ratio (LTA)	0.26	0.32	–0.05	1.00								
5. Loans-to-deposits ratio	–0.19	–0.33	0.32	0.39	1.00							
6. Share of retail loans in total loans	0.11	0.07	0.02	–0.01	–0.04	1.00						
7. Bank size (in terms of assets)	–0.01	0.01	–0.06	0.02	0.02	–0.02	1.00					
8. Lerner index of market power	0.18	0.25	0.26	0.06	–0.08	0.22	–0.12	1.00				
9. 3-month ruble volatility	–0.11	0.02	0.05	0.00	0.01	0.01	0.00	–0.06	1.00			
10. GDP (y-o-y)	0.19	0.00	–0.07	0.02	–0.01	0.00	0.00	0.07	–0.56	1.00		
11. Real households income (y-o-y)	0.08	–0.03	–0.03	0.04	0.03	–0.02	0.00	0.06	–0.49	0.51	1.00	
12. Firms' profit-to-debt ratio	0.12	–0.01	–0.04	0.03	0.01	–0.01	0.00	0.07	–0.59	0.59	0.68	1.00

Table A6 GMM estimation results: Determinants of within- and between-group heterogeneity of cost efficiency, 2005Q1–2013Q4 (dependent variable is bank-level SFA score, *Revals* kept or dropped)

Revals kept	Yes			No		
	I	II	III	IV	V	VI
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)
Funding- and efficiency-adjusted Lerner index of market power [a]	–0.007 (0.006)	–0.007 (0.006)	–0.003 (0.006)	0.012*** (0.003)	0.012*** (0.003)	0.013*** (0.003)
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. variables, excl. instr.	6, 12	9, 15	9, 15	6, 12	9, 15	9, 15
P-value for Hansen J-stat	0.558	0.566	0.719	0.143	0.221	0.167
P-value 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% level, respectively. Robust standard errors are provided in parentheses under the coefficients.
Privately owned domestic banks are the referent group. SFA scores are defined within production approach.
[a] Cumulative effect of four quarters (0, –1, –2, and –3).

Table A7 Tobit estimation results: Determinants of within- and between-group heterogeneity of cost efficiency, 2005Q1–2013Q4 (dependent variable is bank-level SFA score, Revals kept or dropped)

Revals kept	Yes			No		
	I	II	III	IV	V	VI
Dummy variables for bank ownership status						
State-1	2.387 (2.781)	–1.553 (6.269)	–4.621 (9.904)	2.308* (1.285)	–6.132** (2.891)	13.856*** (4.620)
State-2	8.583*** (0.608)	7.239*** (1.328)	7.028** (2.995)	1.692*** (0.281)	1.718*** (0.613)	5.739*** (1.397)
Foreign	–16.336*** (0.785)	–8.034*** (1.374)	–28.534*** (2.738)	–0.206 (0.363)	–4.598*** (0.634)	–20.728*** (1.278)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.659*** (0.016)	0.672*** (0.016)	0.636*** (0.016)	0.422*** (0.007)	0.413*** (0.007)	0.416*** (0.007)
ETA × State-1		0.353 (0.433)			0.621*** (0.200)	
ETA × State-2		0.101 (0.082)			–0.006 (0.038)	
ETA × Foreign		–0.455*** (0.063)			0.238*** (0.029)	
Loans-to-assets ratio (LTA)	0.605*** (0.010)	0.605*** (0.010)	0.589*** (0.010)	0.438*** (0.005)	0.437*** (0.005)	0.428*** (0.004)
LTA × State-1			0.105 (0.180)			–0.226*** (0.084)
LTA × State-2			0.024 (0.054)			–0.075*** (0.025)
LTA × Foreign			0.211*** (0.051)			0.368*** (0.024)
Loans-to-deposits ratio	–0.113*** (0.003)	–0.113*** (0.003)	–0.106*** (0.003)	–0.105*** (0.001)	–0.104*** (0.001)	–0.101*** (0.001)
Share of retail loans in total loans	0.077*** (0.006)	0.075*** (0.006)	0.074*** (0.006)	0.009*** (0.003)	0.011*** (0.003)	0.008*** (0.003)
Bank size	0.224 (0.178)	0.173 (0.178)	0.242 (0.185)	0.498*** (0.082)	0.519*** (0.082)	0.543*** (0.087)
Funding- and efficiency adjusted Lerner index of market power [a]	–0.006 (0.006)	–0.006 (0.006)	–0.002 (0.005)	0.013*** (0.003)	0.013*** (0.003)	0.014*** (0.003)
Macroeconomic factors						
3-month ruble volatility	–1.066*** (0.346)	–1.080*** (0.345)	–0.904*** (0.334)	0.203 (0.160)	0.203 (0.159)	0.185 (0.156)
GDP (annual growth rate)	0.873*** (0.031)	0.873*** (0.031)	0.848*** (0.030)	0.054*** (0.014)	0.053*** (0.014)	0.052*** (0.014)
Real households income (annual growth rate)	–0.202*** (0.037)	–0.205*** (0.036)	–0.183*** (0.036)	–0.064*** (0.017)	–0.063*** (0.017)	–0.053*** (0.017)
Firms' profit-to-debt ratio	0.200** (0.099)	0.205** (0.098)	0.159 (0.101)	0.019 (0.046)	0.019 (0.045)	–0.003 (0.047)
Intercept	28.334*** (0.725)	28.225*** (0.725)	29.310*** (0.747)	61.349*** (0.335)	61.443*** (0.395)	61.654*** (0.349)
No. of observations	19546	19546	20319	19573	19573	20319
(No. of 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 exogeneity	0.000	0.000	0.000	0.001	0.000	0.000

Notes: ***, ** and * – an estimate is significant at the 1%, 5% and 10% level, respectively. Robust standard errors are provided in parentheses under the coefficients.
Privately owned domestic banks are the referent group. SFA scores are defined within production approach.
[a] Cumulative effect of four quarters (0, –1, –2, and –3).

Table A8 Tobit post-estimation results: Distances between groups of banks in terms of cost efficiency (p.p. of SFA scores) determined on the basis of observable heterogeneity in risk preference or asset composition, averages for 2005Q1–2013Q4

Percentile	p10	p25	p50	p75	p90
Distances as a function of risk preference (equity-to-assets ratios, ETA)					
Panel 1: *Revals* kept (on the basis of model II from Table A7)					
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: *Revals* dropped (on the basis of model V from Table A7)					
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 ETA 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
Distances as a function of asset composition (loans-to-assets ratios, LTA)					
Panel 4: *Revals* kept (on the basis of model III from Table A7)					
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 5: *Revals* dropped (on the basis of model VI from Table A7)					
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 6: Percentiles of LTA 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: ***, ** and * – an estimate is significant at the 1%, 5% and 10% level, respectively. Robust standard errors are not provided for reasons of space.
Privately owned domestic banks are the referent group. SFA scores are defined within production approach.

Table A9 Group-level operating cost efficiency (SFA scores, intermediation approach) as averages of 2005Q1–2013Q4

Bank group	SFA score		Standard deviation	Min	Max	Obs.	No. of banks
	%	Rank					
Panel 1: *Revals* kept							
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: *Revals* dropped							
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

Table A10 Intermediation approach instead of production approach. GMM estimation results: The determinants of within- and between-group heterogeneity of cost efficiency, 2005Q1–2013Q4. Dependent variable is bank-level SFA score with Revals kept or dropped.

Revals kept	Yes			No		
	I	II	III	IV	V	VI
Dummy variables for bank ownership status						
State-1	2.519	–8.751	26.178	7.366***	**0.478**	28.066***
	(3.887)	(8.757)	(20.685)	(1.013)	**(2.062)**	(4.218)
State-2	7.976***	9.013***	**2.742**	1.842***	1.766***	**–2.704*** **
	(1.239)	(3.466)	**(4.479)**	(0.194)	(0.441)	**(0.945)**
Foreign	–	**–2.096**	–	**3.389*** **	**5.130*** **	–3.334***
	14.703***	**(2.902)**	18.175***	**(0.253)**	**(0.465)**	(0.960)
Bank-specific factors						
Equity-to-assets ratio (ETA)	0.742***	0.767***	0.741***	0.581***	0.584***	0.582***
	(0.068)	(0.052)	(0.067)	(0.008)	(0.007)	(0.008)
ETA × State-1		0.948*			0.544***	
		(0.519)			(0.160)	
ETA × State-2		–0.058			0.007	
		(0.158)			(0.024)	
ETA × Foreign		–			**–0.097*** **	
		0.695***			**(0.026)**	
Loans-to-assets ratio (LTA)	0.970***	0.970***	0.965***	0.739***	0.738***	0.734***
	(0.037)	(0.038)	(0.037)	(0.004)	(0.004)	(0.004)
LTA × State-1			–0.442			–0.383***
			(0.425)			(0.077)
LTA × State-2			0.096			**0.083*** **
			(0.072)			**(0.017)**
LTA × Foreign			**0.062**			0.122***
			(0.059)			(0.018)
Loans-to-deposits ratio	–0.022*	–0.021*	–0.022**	–0.006***	–0.006***	–0.007***
	(0.012)	(0.012)	(0.012)	(0.001)	(0.001)	(0.001)
Share of retail loans in total loans	0.050	0.045	0.049	–0.008***	–0.009***	–0.009***
	(0.032)	(0.034)	(0.031)	(0.003)	(0.002)	(0.003)
Bank size	0.421	0.333	0.508	0.389***	0.370***	0.452***
	(0.278)	(0.253)	(0.342)	(0.095)	(0.091)	(0.086)
Funding- and efficiency adjusted Lerner index of market power [a]	–0.017	–0.013	–0.016	–0.009***	–0.009***	0.010***
	(0.034)	(0.036)	(0.034)	(0.003)	(0.003)	(0.003)
Macroeconomic factors						
3-month ruble volatility	–0.697	–0.671	–0.708	–0.295***	–0.301***	–0.321***
	(0.900)	(0.929)	(0.873)	(0.114)	(0.113)	(0.111)
GDP (annual growth rate)	0.617***	0.618***	0.615***	–0.023**	–0.024**	–0.026***
	(0.056)	(0.058)	(0.055)	(0.009)	(0.009)	(0.009)
Real households income (annual growth rate)	–0.058	–0.056	–0.057	–0.012	–0.014	–0.012
	(0.120)	(0.124)	(0.116)	(0.013)	(0.013)	(0.013)
Firms' profit-to-debt ratio	–0.405	–0.425	–0.402	–0.105**	–0.102**	–0.096**
	(0.463)	(0.481)	(0.451)	(0.044)	(0.043)	(0.042)
Intercept	–8.266***	–	–7.980***	19.867***	19.845***	20.193***
	(1.027)	8.504***	(1.022)	(0.241)	(0.241)	(0.241)
No. of obs.	17057	17057	17057	17084	17084	17084
(banks)	(890)	(890)	(890)	(890)	(890)	(890)
Centered R^2	0.333	0.303	0.339	0.901	0.902	0.904
No. of endog. vars., excl. instr.	6, 9	9, 12	9, 12	6, 9	9, 12	9, 12
P-val for Hansen J-stat	0.744	0.811	0.744	0.941	0.937	0.898
P-val for Kleibergen-Paap LM stat	0.000	0.000	0.000	0.018	0.016	0.019

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

Domestic privately-owned banks are the referent group. Coefficients on the group dummies and their interactions with ETA or LTA that are qualitatively different from respective baseline results in Table A6 are **bolded**.

[a] Cumulative effect of four quarters (0, –1, –2, and –3).

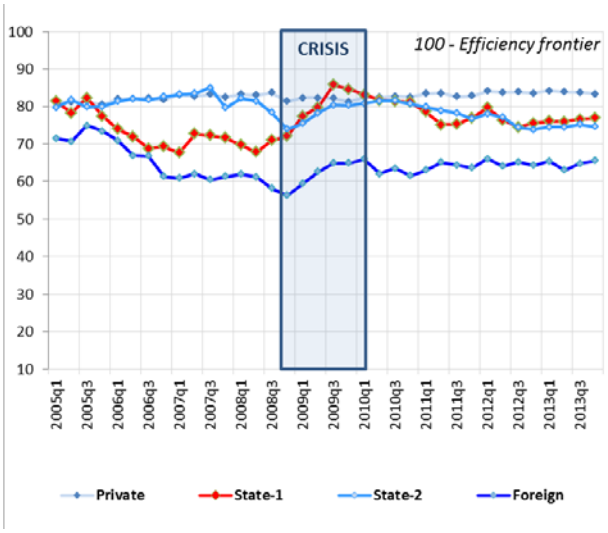
Table A11 GMM post-estimation results under the intermediation approach: Distances between groups of banks in terms of cost efficiency (p.p. of SFA scores) determined on the basis of observable heterogeneity in risk preference or asset composition, averages of 2005Q1-2013Q4.

Percentile	p10	p25	p50	p75	p90
Distances as a function of risk preference (equity-to-assets ratios, ETA)					
Panel 1: *Revals* kept (on the basis of model II from Table A10 in Appendix)					
State-1	–0.424	0.863	2.883	5.807*	11.326**
State-2	8.620***	8.501***	8.344***	7.955***	**7.244*** **
Foreign	–7.828***	–9.821***	–12.916***	–19.276***	–30.987***
Panel 2: *Revals* dropped (on the basis of model V from Table A10 in Appendix)					
State-1	**5.251*** **	**5.989*** **	**7.146*** **	8.822***	11.985***
State-2	1.810***	1.823***	1.841***	1.885***	1.965***
Foreign	**4.330*** **	**4.051*** **	**3.619*** **	**2.731*** **	1.096
Panel 3: Percentiles of ETA 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
Distances as a function of asset composition (loans-to-assets ratios, LTA)					
Panel 1: *Revals* kept (on the basis of model III from Table A10 in Appendix)					
State-1	**9.915***	**6.862***	–0.798	–3.116	–5.270
State-2	**4.844***	**6.510*** **	7.686***	8.611***	9.461***
Foreign	–17.775***	–16.671***	–15.256***	–14.357***	–13.758***
Panel 2: *Revals* dropped (on the basis of model VI from Table A10 in Appendix)					
State-1	13.956***	11.307***	**4.661*** **	**2.649***	0.781
State-2	**–0.879**	**0.568***	**1.588*** **	**2.392*** **	**3.130*** **
Foreign	–2.551***	–0.386	2.387***	4.150***	5.324***
Panel 3: Percentiles of LTA 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

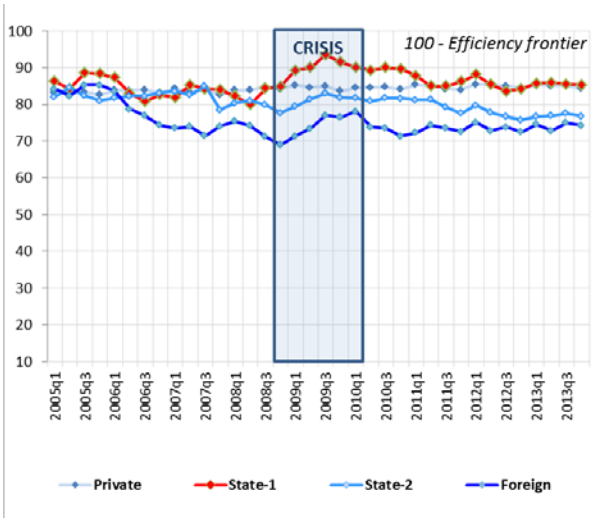
Notes: ***, ** and * – an estimate is significant at the 1%, 5% and 10% level, respectively. Robust standard errors are not provided for reasons of space.
Privately owned domestic banks are the referent group.
Coefficients that are qualitatively different from respective baseline results in Table A6 are **bolded**. SFA scores are defined within intermediation approach.

Figure A1 SFA scores for different bank groups (arithmetic averages within each group; *revals* dropped).

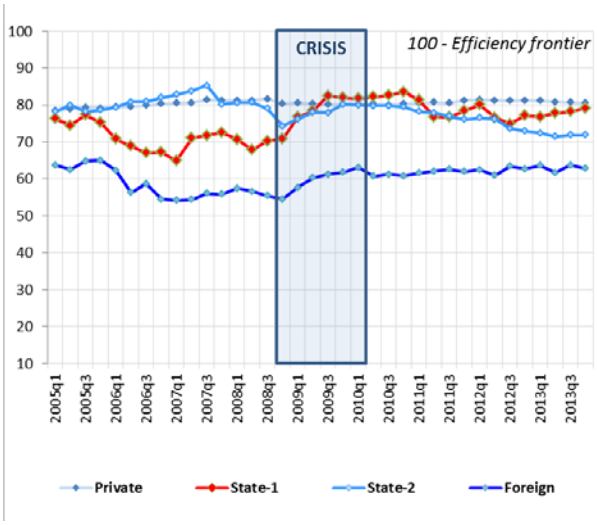
1 Securities included as fourth output into translog cost function.



2 Foreign assets included as fifth output into translog cost function.



3 Operating costs replaced by total costs in three-output version of translog cost function.



BOFIT Discussion Papers

A series devoted to academic studies by BOFIT economists and guest researchers. The focus is on works relevant for economic policy and economic developments in transition / emerging economies.

2014
- No 1 Vikas Kakkar and Isabel Yan: Determinants of real exchange rates: An empirical investigation
- No 2 Iftekhar Hasan, Krzysztof Jackowicz, Oskar Kowalewski and Łukasz Kozłowski: Politically connected firms in Poland and their access to bank financing
- No 3 Carsten A. Holz and Aaron Mehrotra: Wage and price dynamics in a large emerging economy: The case of China
- No 4 Zuzana Fungáčová, Anna Kochanova and Laurent Weill: Does money buy credit? Firm-level evidence on bribery and bank debt
- No 5 Jitka Poměnková, Jarko Fidrmuc and Iikka Korhonen: China and the World economy: Wavelet spectrum analysis of business cycles
- No 6 Christopher A. Hartwell: The impact of institutional volatility on financial volatility in transition economies: a GARCH family approach
- No 7 Christian Dreger, Tongsan Wang and Yanqun Zhang: Understanding Chinese consumption: The impact of hukou
- No 8 John Bonin, Iftekhar Hasan and Paul Wachtel: Banking in transition countries
- No 9 Chun-Yu Ho: Switching cost and deposit demand in China
- No 10 Zuzana Fungáčová and Laurent Weill: Understanding financial inclusion in China
- No 11 Anna Krupkina, Elena Deryugina and Alexey Ponomarenko: Estimating sustainable output growth in emerging market economies
- No 12 Qing He, Chang Xue and Chenqi Zhu: Financial Development and patterns of industrial specialization: Regional evidence from China
- No 13 Carsten A. Holz: Wage determination in China during the reform period
- No 14 Thorsten Beck, Hans Degryse, Ralph De Haas and Neeltje van Horen: When arm's length is too far. Relationship banking over the business cycle
- No 15 Boris Blagov and Michael Funke: The credibility of Hong Kong's currency board system: Looking through the prism of MS-VAR models with time-varying transition probabilities
- No 16 Philip Molyneux, Hong Liu and Chunxia Jiang: Bank capital, adjustment and ownership: Evidence from China
- No 17 Yin-Wong Cheung and Dagfinn Rime: The offshore renminbi exchange rate: Microstructure and links to the onshore market
- No 18 Marko Melolinna: What is the role of Emerging Asia in global oil prices?
- No 19 Yiwei Fang, Iftekhar Hasan and Lingxiang Li: Banking reform, risk-taking, and earnings quality – Evidence from transition countries
- No 20 Yanrui Wu: Local government debt and economic growth in China
- No 21 Christophe J. Godlewski, Rima Turk-Ariss and Laurent Weill: Do the type of sukuk and choice of shari'a scholar matter?
- No 22 Elena Deryugina and Alexey Ponomarenko: A large Bayesian vector autoregression model for Russia
- No 23 Yin-Wong Cheung, Menzie D. Chinn and Xingwang Qian: The structural behavior of China-US trade flows
- No 24 Claudio Cozza, Roberta Rabellotti and Marco Sanfilippo: The impact of outward FDI on the performance of Chinese multinationals

2015
- No 1 Qing He, Liping Lu and Steven Ongena: Who gains from credit granted between firms? Evidence from inter-corporate loan announcements Made in China
- No 2 Ke Pang and Pierre L. Siklos: Macroeconomic consequences of the real-financial nexus: Imbalances and spillovers between China and the U.S.
- No 3 V.V. Mironov, A.V. Petronevich: Discovering the signs of Dutch disease in Russia
- No 4 Joshua Aizenman: The internationalization of the RMB, capital market openness, and financial reforms in China
- No 5 Yu-Fu Chen, Michael Funke and Kunyu Tao: Financial market reform – A new driver for China's economic growth?
- No 6 Jarko Fidrmuc and Iikka Korhonen: Meta-analysis of Chinese business cycle correlation
- No 7 Jarko Fidrmuc, Zuzana Fungáčová and Laurent Weill: Does bank liquidity creation contribute to economic growth? Evidence from Russia
- No 8 Elena Deryugina, Olga Kovalenko, Irina Pantina and Alexey Ponomarenko: Disentangling loan demand and supply shocks in Russia
- No 9 Michael Funke, Petar Mihaylovski and Haibin Zhu: Monetary policy transmission in China: A DSGE model with parallel shadow banking and interest rate control
- No 10 Riikka Nuutilainen: Contemporary monetary policy in China: A move towards price-based policy?
- No 11 Iftekhar Hasan, Nada Kobeissi, Haizhi Wang and Mingming Zhou: Banking structure, marketization and small business development: Regional evidence from China
- No 12 Linlin Niu, Xiu Xua and Ying Chen: An adaptive approach to forecasting three key macroeconomic variables for transitional China
- No 13 Heiner Mikosch and Stefan Neuwirth: Real-time forecasting with a MIDAS VAR
- No 14 Alexander Libman and Björn Vollan: Anti-Western conspiracy thinking and expectations of collusion: Evidence from Russia and China
- No 15 Mikhail Stolbov: Causality between credit depth and economic growth: Evidence from 24 OECD countries
- No 16 Kefei You: What drives China's outward FDI? A regional analysis
- No 17 José R. Sánchez-Fung: Estimating the impact of monetary policy on inequality in China
- No 18 Christian Hattendorff: Economic concentration and finance: Evidence from Russian regions
- No 19 Alexey Porshakov, Elena Deryugina, Alexey Ponomarenko and Andrey Sinyakov: Nowcasting and short-term forecasting of Russian GDP with a dynamic factor model
- No 20 Qing He, Iikka Korhonen, Junjie Guo and Fangge Liu: The geographic distribution of international currencies and RMB internationalization
- No 21 Haining Wang, Zhiming Cheng and Russell Smyth: Does consuming more make you happier? Evidence from Chinese panel data
- No 22 Mikhail Mamonov and Andrei Vernikov: Bank ownership and cost efficiency in Russia, revisited

ISSN 1456-4564 (print) // ISSN 1456-5889 (online)