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Bank cost efficiency in Kazakhstan and Russia

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Abstract

The Kazakhstan banking system is increasingly viewed as more advanced than the Russian system. Kazakhstan adopted the International Accounting System (IAS) in 2003 and the Basel II norms in 2005, while Russia has yet to fully adopt either IAS or Basel II. In this paper, bank data for 2002-2006 are used to estimate models of bank cost efficiency. In contrast to most previous papers, no significance difference is found for the average cost efficiency scores of banks for the two countries during 2002-2006. How banks are ranked for efficiency depends upon the chosen model (input and output sets). An interesting insight is the finding that most banks in both countries are below optimal size.

Keywords: Cost efficiency, banks, stochastic frontier approach
JEL Classification: D21, G21, F30

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Bank cost efficiency in Kazakhstan and Russia

Tiivistelmä

Tässä tutkimuksessa vertaillaan Kazakstanin ja Venäjän pankkijärjestelmän kustannustehokkuutta. Kazakstanin pankkijärjestelmää on usein pidetty kehittyneempänä kuin Venäjän järjestelmää. Kazakstan otti käyttöön kansainvälisen tilinpäätösstandardin (International Accounting System, IAS) vuonna 2003 ja Basel II -säännöt vuonna 2005, kun taas Venäjä ei ole vielä ottanut täysin käyttöön kumpaakaan. Tässä tutkimuksessa käytetään vuosien 2002–2006 aineistoa pankkien kustannustehokkuuden mallintamiseksi. Vastoin aiempia tutkimustuloksia tässä tutkimuksessa ei löydetä merkittäviä eroja näiden kahden maan pankkien keskimääräisessä kustannustehokkuudessa vuosina 2002–2006. Pankkien välinen sijoitus kustannustehokkuusvertailussa riippuu malliin valitusta panos- ja tuotosjoukosta. Mielenkiintoinen tutkimustulos on, että suurin osa kummankin maan pankeista on optimaalista kokoaan pienempiä.

Avainsanat: kustannustehokkuus, pankit, stokastinen eturintamametodologia

1 Introduction

After the Soviet Union collapsed, the New Independent States inherited pieces of the Soviet banking system. While the new banking systems had identical initial conditions, their subsequent development has depended on country-specific factors such as legislation, state policy, country size, etc. Only the banking systems in the three largest former-Soviet states (the Russian Federation, the Republic of Ukraine, and the Republic of Kazakhstan) possess enough banks to perform meaningful econometric analysis. Further, the data limitations in the case of Ukraine compel us to limit our scope of analysis exclusively to the Kazakh and Russian banking systems. Kazakhstan's banking system somewhat defies common expectations as it is institutionally more advanced than the Russian system.

Kazakhstan adopted the International Accounting System (IAS) in 2003 and the Basel II capital adequacy accord in 2005. In contrast, only a few banks in Russia today even publish IAS-compliant balance sheets. Moreover, the Central Bank of Russia (CBR) has caved to pressure from Russian banks on several occasions by postponing the transition of banks to IAS. The current date for IAS implementation is 2010, but further delays are not out of the question.

Despite the vast literature on bank efficiency, only a few papers consider the efficiency of Russian banks, and, to the best of our knowledge, only a single paper (Fries and Taci, 2005), discusses the efficiency of banks in Kazakhstan.

Our paper contributes to the existing literature on two issues.

First, we compare the efficiency of Kazakhstan and Russian banks during 2002-2006, a period of relatively stable economic development in both countries. In contrast to Fries and Taci (2005), who found banks to be more efficient in Kazakhstan than in Russia, we find no significant difference in bank efficiency between the two countries.

Second, we compare bank rankings according to efficiency estimates derived from different models (input and output sets) and different specifications of error distribution in the cost function. Most papers consider just one model specification and make conclusions on bank efficiency based on the chosen model, leaving open the issue of how robust those conclusions are to the model specification. We use two models and three error specifications for each model, and conclude that bank efficiency ratings crucially depend on the model (i.e. the chosen set of outputs and factors) and do not significantly depend on error specification.

Finally, most banks in Kazakhstan and Russia appear to be below their optimal size.

2 Literature review

Koopmans (1951) introduced the concept of technical efficiency, i.e. a firm is technically efficient when it is not possible to generate more output with the same inputs. It is assumed that the inability of a firm to produce the maximum possible volume of output can be explained by inefficient management.

Farrell (1957) suggests a non-parametric approach to measure technical efficiency by a linear programming method designated as data envelopment analysis (DEA). Though widely used, DEA suffers numerous shortcomings such as sensitivity to random deviations, outliers, and data errors. It also requires large datasets.

Aigner et al. (1977), and Meeusen and Broeck (1977) propose a parametric approach to measure technical efficiency: stochastic frontier analysis (SFA).

Both methods are intensively used in the analysis of the efficiency of banks and financial institutions. In the review by Berger and Humphrey (1997), approximately half of 130 studies used a parametric approach. Berger and Mester (1997) discuss various SFA models and come to the conclusion that the models (in terms of cost efficiency and profit efficiency) give approximately the same estimates of technical efficiency of US banks using data for 1990-1995.

Bauer et al. (1998) compares variants of different approaches (DEA, SFA, as well as the distribution free approach, DFA, and the thick frontier approach, TFA) to measure the efficiency of US banks over the period 1977-1988. They conclude that, given the same set of four inputs and four outputs, parametric and nonparametric methods are not mutually consistent.

Most papers dealing with the technical efficiency of banks study just one country. Among the first papers comparing the technical efficiency of banks in different countries was the study of Maudos et al. (2002), who consider the cost efficiency and profit efficiency of banks in ten leading EU countries during 1993-1996. The sample included 3,328 observations of 832 banks. The authors conclude that the estimated cost efficiency is lower than the estimated profit efficiency and that the correlation between the two estimates is low. Mid-sized banks and banks with a high ratio of loans to assets are found to be most efficient. Market concentration positively correlates with profit efficiency and negatively with cost efficiency.

The following papers present an analysis of banks in developing countries.

Weill (2003) analyzes banks in the Czech Republic and Poland. Foreign-owned banks are found to be more efficient than domestic-owned banks.

Fries and Taci (2005) looks at the technical efficiency of banks in 15 East European transition countries (including Russia and Kazakhstan) during 1994-2001. Private banks are more efficient than public banks. Kazakh banks are found to be more efficient than Russian banks.

Bonin et al. (2005a) deal with banks in eleven European transition countries during 1996-2000. They find that government-owned banks are not appreciably less efficient than domestic private banks. Foreign-owned banks are determined to be more cost-efficient and provide better service than other banks.

Bonin et al. (2005b) study the impacts of bank privatization in transition countries. They take the largest banks in six relatively advanced countries (Bulgaria, the Czech Republic, Croatia, Hungary, Poland, and Romania) and find that foreign-owned banks are most efficient and government-owned banks least efficient. Furthermore, early-privatized banks are more efficient than later-privatized banks (a result not explained by a selection effect).

Carvallo and Kasman (2005) estimate a common cost frontier with country-specific environmental variables for a panel of 481 banks from 16 Latin American countries. Their results suggest a wide range of inefficiency levels across countries. Underperforming banks tend to be small, undercapitalized, and more prone to engage in risky financial policies.

The authors of two papers (Staikouras et al. 2008; Mamatzaki et al. 2008) use data for six countries in southeastern Europe (Bosnia-Herzegovina, Bulgaria, Croatia, FYR of Macedonia, Romania, and Serbia-Montenegro) during 1998-2003, as well as ten new European Union member states over the same period. Like Carvallo and Kasman (2005), they find inefficiency varies significantly among countries. Foreign banks outperform both state-owned and domestic private-owned banks in terms of profit efficiency, while the results are less clear in the case of cost efficiency.

Lensink et al. (2008) use stochastic frontier analysis for a sample of 2,095 commercial banks in 105 countries during 1998-2003. Unlike most studies, they find that foreign ownership negatively affects bank efficiency. The authors use, as we do here, the SFA specification suggested by Battese and Coelli (1995). As in most of the papers mentioned above, they also use the BankScope[1] database and give the standard caveats about its data imperfections (see e.g. Bonin et al., 2005b). Among the more notable BankScope database drawbacks are its inclusion of non-bank financial institutions, repeated use of several banks in the data, and failure to compensate for the different accounting systems used by banks in different countries – all problems that are particularly acute in transition economies.

[1] Bureau van Dijk Electronic Publishing, *www.bvdep.com/en/bankscope.html*

A handful of papers tackle the technical efficiency of Russian banks. In addition to Fries and Taci (2005), this problem is discussed in the following.

Caner and Kontorovich (2004), the pioneers in estimating the technical efficiency of Russian banks, use data for 1999-2003. They conclude that the efficiency of Russian banks is significantly lower than the efficiency of European banks.

Styrin (2005), analyzing data for the period 1999-2002, finds an increase in the average efficiency of Russian banks. He includes the ratio of past due loans to total loans as a proxy for the riskiness of bank financial policies. The focus of the paper is to determine the factors that influence efficiency. He finds that different methods produce different results, but a negative correlation between efficiency and ratio of past due loans to total loans is common to all methods.

Balash and Pavlyuk (2005) use data for 2000-2003 for 160 Russian banks. Applying a profit-efficiency SFA approach, they conclude that Moscow banks are less efficient than regional banks and that large banks are most efficient.

Golovan (2006) determines the factors that are important for the efficiency of Russian banks in issuing loans and attracting deposits. He finds that the average bank efficiency increased over 2003-2005. The most efficient lenders are Moscow banks and banks with a high capitalization. A high ratio of past due loans is negatively related to efficiency. The larger the bank, the greater its efficiency. As we might expect, this relation is weaker for large banks, since large banks diversify their activities and their efficiency in issuing loans may be lower than that of specialized mid-sized banks.

Golovan et al. (2008) include factor prices and variables related to the quality and riskiness of the assets in their model. Analyzing Russian bank data for 2002-2005, they find Moscow banks are the most efficient. Moreover, the efficiency of foreign-owned banks does not differ significantly from the efficiency of domestic-owned banks. A U-shaped influence of bank size is noted. Initially, as size increases, efficiency decreases (as a result of diversification of bank activities). Once a size threshold is passed, efficiency begins to rise. The explanation offered is that the largest banks use their size to gain an advantage in competing for funds and minimizing costs.

Karas et al. (2008) use data on Russian banks for the period 2002–2006 to determine whether private banks are more efficient than state-owned banks. They conclude there is no direct evidence that the privatization of a bank in Russia increases its efficiency. Also they find that foreign banks are more efficient than domestic banks. They suggest the efficiency of the Russian banking system could be boosted by having the Central Bank of Russia (CBR) advance banking regulations, increasing competition among banks, and allowing foreign banks greater access to the Russian banking sector.

3 Kazakhstan and Russia banking systems

The banking systems of Kazakhstan and Russia have much in common. Both started at the same time and both are considered to be the most developed of the post-Soviet countries.

They also differ sharply in some respects. It is generally held that banking regulation in Kazakhstan is the most advanced among the post-Soviet countries. According to the rating agency Expert RA,[2] Kazakh banks as of 2007 were ahead of Russian banks in terms of technology, practice of risk management, quality of banking regulation and appropriateness of size given the size of the economy. Indicators of the economy and banking systems of the two countries are presented in Table 1.

Table 1 Indicators of the banking sector and economies of Kazakhstan and Russia as of January 1, 2007

	Russia[3]	Kazakhstan[4]
GDP (US$ billion)	1011	73.7
GDP per capita (US$)	7082	4644
Number of banks	1189	33
Assets (US$ billion)	533.4	67.2
Equity (US$ billion)	64.29	8.85
Assets / GDP, %	52.8%	91.1%
Equity / GDP, %	6.4%	12.0%
Loans / GDP, %	30.2%	61.5%
Deposits / GDP, %	31.4%	48.4%
Fixed assets (US$ billion)	15.57	0.704
Equity / Assets, %	12.1%	13.2%
Loans / Deposits	0.960	1.27
Average assets (US$ billion)	0.45	2.04
Assets / Fixed assets	34.3	95.4
Banks' assets per capita (US$ billion)	3.74	4.23

[2] *www.raexpert.ru/researches/banks/retail/part1/*.
[3] Central Bank of the Russian Federation, *www.cbr.ru*.
[4] Agency of the Republic of Kazakhstan on regulation and supervision of financial markets and financial organizations (FSA, АФН), *www.afn.kz*.

As of January 1, 2007, the Russian banking system consisted of 1,189 banks, a significant share of which consisted of small banks. The average Russian bank was significantly smaller than the average Kazakh bank (see Table 1).

The structure of the Kazakhstan banking sector is similar to the structure of the banking sector in Russia. The National Bank of the Republic of Kazakhstan (the analog to CBR), is responsible for money liquidity and regulates the activity of the commercial banks. As of January 1, 2007, the Kazakhstan banking system consisted of 33 second-tier banks. Note that 59% of the total assets of the banking system belonged to Kazakhstan's Big Three: Kazkommertsbank, Bank TuranAlem (BTA Bank), and Halyk Savings Bank of Kazakhstan.

At the end of 2006, the relative size of the Kazakhstan banking system (in terms of total assets to GDP or total equity to GDP) was almost twice that of the Russian banking system. The relative volume of issued loans was significantly higher (61.5% in Kazakhstan versus 30.2% in Russia), while the relative volume of deposits did not differ significantly (48.4% versus 31.4%). This points to differences in the structure of fund sources.

The Kazakhstan banking system continued to boom in 2006. Total assets, equity and fixed capital increased by 97%, 100%, and 66%, respectively. This was significantly higher than the indicators for the Russian banking system (44%, 36%, and 9%, respectively).

4 Data

For a correct comparative analysis of the two banking systems it is highly desirable – and somewhat problematic − to use bank data for the two countries in the same accounting system. Kazakh banks have published balance sheets in accordance with IAS since 2003. Many, but not all, Russian banks voluntarily published dual versions of their balance sheets; one compiled under the Russian Accounting System (RAS) as required by CBR, and IAS. Databases on RAS balance sheets are available from e.g. Interfax or Mobile information agencies, but to the best of our knowledge no accessible database on IAS balance sheets of Russian banks currently exists. In this paper, we use data on audited IAS balance sheets of Kazakhstan and Russia banks from Moody's. The obvious advantage is that these data comply with a single set of rules. The disadvantage is that the number of Russian banks is limited to banks with a Moody's rating. This means that we must deal with a non-representative sample biased toward large banks interested in having a rating to gain access to the international financial market.

Our sample thus covers the period 2002–2006, representing 78 Russian banks (382 observations) and 16 Kazakh banks (78 observations).

The mean sample values of selected indicators for Russian and Kazakhstan banks at the end of 2006 are presented in Table 2. Note that the total assets from the sample contain 77.8% of the assets of the entire Russian banking system and 97% of the total assets of the Kazakhstan banking system.[5]

Table 2 Average values of indicators over the samples of Kazakhstan and Russian banks as of January 1, 2007

Indicator (US$ million)	Russia	Kazakhstan
Assets	5,324.0	4,310.7
Equity	612.1	445.2
Deposits	3,904.6	2,454.6
Loans	3,411.2	2,756.4
Borrowings	617.1	1,179.9
Interest income	419.7	302.0
Interest expenses	177.8	165.1
Personnel expenses	98.0	31.1
Operational expenses	233.7	68.4
Net profit	120.8	70.1
Fixed assets	168.6	43.8
Fixed expenditures	135.7	37.3

Comparing Tables 1 and 2, we see the average size of the Russian bank in the sample is larger than the average size of the Kazakh bank in the sample (and vice versa for the banking systems as a whole). This indicates a significant non-homogeneity of banks and a bias of the sample toward large banks. Particularly significant is the difference in personnel expenses and fixed assets (much larger for Russian banks). Kazakh banks have more than double the borrowings of Russian banks; this is the difference in the sources of funding noted above.

The average values of some indicators of banks' efficiency over the sample for the end of 2006 are presented in Table 3. For each country, the average of ratios and the ratio of averages of the indicator is presented (e.g. average value of equity to assets ratios and ratio of average equity to average assets).[6] Due to the non-homogeneity of the banks in the samples, these values are different. The differences in these values indicate the shapes of the distributions of the indicators over the

[5] As calculated by AFN data. This does not correspond to Tables 1 and 2, because Table 2 presents data on consolidated balance sheets of Kazakh banks, while Table 1 presents data from the AFN site, which is derived from unconsolidated balance sheets. The main differences stem from the reporting of Kazkommertsbank and Bank TuranAlem. Expert RA data differ from AFN data for the same reason.
[6] Equal to the ratio of total equity to total assets, as calculated for the sample.

sample. For example, the ROA profitability of large Russian banks is higher than the ROA of small Russian banks. The reverse is true for Kazakhstan.

The ratio of deposits to assets is higher for Russian banks and the ratio of borrowings to assets is lower for Russian banks than for Kazakhstan banks. Other indicators calculated by the sample do not differ significantly.

Table 3 Average values of relative indicators of banks in the sample at the end of 2006

2006	Russia		Kazakhstan	
Indicator	Average of ratios	Ratio of averages	Average of ratios	Ratio of averages
Equity / Assets, %	13.6	11.5	18.7	10.3
Return on assets, ROA, %	1.7	2.3	2.5	1.6
Return on equity, ROE, %	14.1	19.7	16.5	15.7
Costs to assets, %	7.9	7.7	6.2	5.4
Deposits to assets, %	72.2	73.3	53.6	56.9
Loans to assets, %	62.4	64.1	63.0	63.9
Borrowings to assets, %	10.2	11.6	21.0	27.4

5 Cost-efficiency models

We use the following definition of (in)efficiency as formulated by Berger and Mester (1997).

Cost efficiency shows how close a bank's expenditures are to the best examples given the same output and environment. Assuming a multiplicative form of inefficiency, the cost function can be written as

$$\ln C = f(w, y, z, q) + u + v\,. \tag{1}$$

Here, C represents expenditures (costs); w factor prices; y output; z fixed factors (resources, output); q environment variables that might influence output, v a random error, and u inefficiency. It is assumed that $Ev = 0$, and that $u \geq 0$.

Currently, the most common choice for the functional form of the cost function (1) is the translog specification (2)

$$\ln C_{it} = \beta_0 + \sum_{m=1}^{K} \beta_m \ln x_{it}^{(m)} + \sum_{m=1}^{K} \gamma_m (\ln x_{it}^{(m)})^2 + \sum_{1 \leq m < n \leq K,} \delta_{mn} \ln x_{it}^{(m)} \ln x_{it}^{(m)} + \alpha' d_{it} + u_{it} + v_{it}\,. \tag{2}$$

Here, $(x^{(1)}, x^{(2)}, ..., x^{(K)})$ is vector (w, y, z, q) of the arguments of the function *f* from (1), d_{it} represent external environment variables, *i* the bank's number (ID), and *t* time (year) of the observation.

We consider the following three specifications of the distribution of the error v_{it} and inefficiency component u_{it}:

(1) $v_{it} \sim N(0, \sigma_v^2)$, $u_{it} \sim N^+(0, \sigma_u^2)$ (normal and half-normal distributions);

(2) $v_{it} \sim N(0, \sigma_v^2)$, and the inefficiency component has a truncated normal distribution $u_{it} \sim N^+(m_{it}, \sigma_u^2)$, where $m_{it} = \sum_l \mu_l g_{it}^{(l)}$ and $g = (g^{(1)}, ..., g^{(L)})$ is a vector of factors that have an impact on m_{it}[7];

(3) $v_{it} \sim N(0, \sigma_{v,it}^2)$, $u_{it} \sim N^+(0, \sigma_{u,it}^2)$, where $\ln \sigma_{v,it}^2 = a' z_{it}^{(v)}$, $\ln \sigma_{u,it}^2 = a' z_{it}^{(u)}$ is a linear function of bank and external variables.

In all specifications it is assumed that all u_{it} and v_{js} are uncorrelated. Consider two models, i.e. different specifications of the cost functions (1) and (2):

The first model includes a single output (loans) and the prices of three factors: labor, fixed capital, and funds. We use the ratio of personnel expenses to total assets as a proxy for the price of labor. This is a common choice in the absence of data on the quantity of personnel (see e.g. Carvallo and Kasman, 2005). We use the ratio of differences between operational expenses and personnel expenses to fixed assets as a proxy for the price of fixed capital. The price of funds is calculated by dividing total interest expenses by total deposits

The second model includes three outputs (loans, deposits, borrowings) and the prices of two factors (labor, fixed capital). For both models the full translog specification (2) is used.

The first model compares banks with the same volume of loans and same prices, so that banks may optimize their costs by varying the volumes of their deposits and borrowings. The second model compares banks with equal volumes of loans, deposits, and borrowings. Thus, the second model leaves less room to optimize expenditures. It is likely that the average efficiency estimates given by the first model will be lower than under the second model as many banks cannot vary deposits and borrowing volumes due to institutional restrictions.

For both models, we use the three specifications of the error distributions and the inefficiency component mentioned above. STATA was used for the estimating. Usually, the estimate of

[7] This specification was originally suggested by Battese and Coelli (1995).

the value $ce = \exp\ -E(u \mid u+v)$ was used as a measure of bank efficiency in specification (1), which has values from the interval [0, 1]; the closer *ce* is to 1, the more efficient the bank. An exact formula for the calculation of efficiency can be found, e.g. in Kumbhakar and Lovell (2000).

In the specification of the error terms in (2), vector *g* contains four components: the intercept, the dummy variable for Kazakhstan, a proxy for capital sufficiency (the ratio of equity to assets) and its square for the first model, and equity and assets for the second model. In the specification of the error terms in (3), the vector $z^{(u)}$ consists of two components: the intercept and the dummy variable for Kazakhstan, and vector $z^{(v)}$ consists of three components: the intercept, the log of equity, and the square of the log of equity.

Full control for the external country and time-specific factors was used in all specifications: vector d_{it} contains ten components, i.e. ten year-country dummies for the two countries and the five years of observations (2002-2006).

In all six models (both model types and three specifications of the error term for each type), inefficiency is found to be statistically significant.

Time invariant efficiency. The six models described above assume the possibility that inefficiency varies with time. De Young (1997) argues that for a four-to-six-year period it is reasonable to suppose that the inefficiency is time invariant. We also consider estimates for time-invariant efficiency, which we estimate in several ways. First, we use averaged efficiency estimates derived from the six models given above. Second, we estimate a random effect panel data model (3). which is similar to the model (2) except that the inefficiency *u* is time invariant:

$$\ln C_{it} = \beta_0 + \sum_{m=1}^{K} \beta_m \ln x_{it}^{(m)} + \sum_{m=1}^{K} \gamma_m (\ln x_{it}^{(m)})^2 + \sum_{1 \le m < n \le K,} \delta_{mn} \ln x_{it}^{(m)} \ln x_{it}^{(m)} + \alpha' d_{it} + u_i + v_{it}\,. \qquad (3)$$

The distribution of u_i is assumed to be truncated normal, $N^{+}(m, \sigma_u^2)$. The formula $ce = \exp\ -E(u \mid u+v)$ is used to estimate the efficiency given the estimate $\hat{\varepsilon}$ of $\varepsilon = u + v$.

Third, we use a distribution free approach, DFA. We estimate the random effect panel data model (3) and take $\hat{u}_i = \frac{1}{T}\sum_{t=1}^{T} \hat{\varepsilon}_{it}$ as estimator for u_i. Cost efficiency is calculated by

$$ce_i^{(df)} = \exp(-(u_i - \min(u_i))) \qquad (4)$$

In this approach at least one bank achieves an efficiency score of 1.

We include time dummies and their cross terms with the country dummy in the cost functions in both (2) and (4). This implies that we suppose that the cost function in the two countries could differ by a factor that varies with time and country. In this way we achieve full control for differences in the macroeconomic environments in the two countries. This is necessary, since, as pointed out by Berger (2007), banks that operate in different nations often face highly disparate prudential supervisory and regulatory conditions, labor laws, market conditions (such as competition for inputs or outputs), and levels of financial market evolution. All these factors may affect a bank's cost performance, resulting in the possibility that it is measured as being a certain distance from the common frontier for reasons totally unrelated to its competence in minimizing costs. A comprehensive discussion of the common production frontier problem can be found in Berger (2007).[8]

All other coefficients β_m, γ_m, δ_{mn} are assumed to be constant over time and the same for both countries. This assumption seems not overly restrictive: the two countries have strong economic ties; the largest Russian banks (e.g. Sberbank, VTB) have branches in Kazakhstan, and the largest Kazakhstan bank, BTA, has branches in Moscow.

6 Results

Average values of efficiency estimates over countries and years are presented in Table 5 and Figure 3 in the Appendix. These were calculated in accordance with the first model for three specifications of the error term (*ce1, ce2, ce3*), and in accordance with the second model (*ce4, ce5, ce6*).

The estimate *ce2* is quite different from the other estimates. This could be a technical difficulty of estimation: finding the extreme of a function of several variables is an algorithmically complex problem. Moreover, it is difficult to find the same set of factors $g = (g^{(1)},...,g^{(L)})$ for the second specification of errors for both models due to problems with the convergence of the algorithm. Thus, we use the equity to assets ratio, its square, and the Kazakhstan dummy variable as the set of $g = (g^{(1)},...,g^{(L)})$ factors in the second specification for the first model (*ce2* estimate), and logs of equity and assets, and the Kazakhstan dummy variable in the second specification for the second model (*ce5* estimate).

Tests show that mean bank efficiency in all models does not differ statistically for the two countries. This result differs from the conclusion of Fries and Taci (2005), who find Kazakh banks more efficient than Russian banks based on data for the period 1994-2001.

[8] Also see Berger and Humphrey (1997) and Weill (2003).

This difference in conclusions can be explained in several ways:

1) Different periods of observations (1994-2001 and 2002-2006).
2) The 1994-2001 period includes the financial crisis of 1998, which is an outlier in the data and in a regression results are often driven by an outlier.
3) Different models are used. Fries and Taci (2005) use a model with two outputs (deposits and loans) and one price (the ratio of operation expenditures to total assets). This model does not take into account borrowings of Kazakh banks, which were especially high the last few years, and so this model may not be adequate to estimate the situation for the period 2002-2006.
4) Potentially, as Fries and Taci (2005) report, the effect of a higher efficiency of Kazakh banks disappears if country-level variables are included in the regression. Remember that the inclusion of country-level variables in the regression allow us to take into account possible differences in the cost function for the two countries due to differing bank environments (taxes, interest rates, legislation). In our model specifications (2) and (3) we have full control of country-specific external factors, including time dummies and cross terms of time dummies with the Kazakhstan dummy.

The first explanation is supported by Styrin (2005) and Golovan (2006), who find an increasing efficiency of Russian banks during the periods 1999-2002 and 2003-2005.

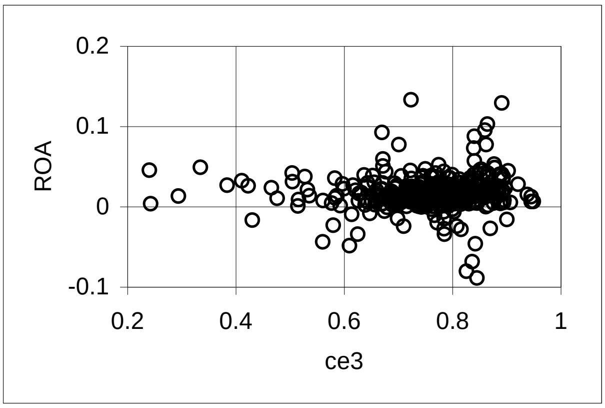
Regardless of the surprisingly low *ce2* estimates for Kazakh banks, the rankings of the bank-year observations by estimated efficiency for different specifications of the first and the second model are quite close to each other, especially in a one-country framework. Spearman rank-order correlations are presented in Table 6 in the Appendix. The correlation for one model type and one country are all above 0.82 (0.91, if the *ce2* estimate is dropped).

However, rankings by the two model types differ significantly. This is hardly surprising as the models themselves differ significantly. The first model considers cost efficiency by comparing banks with the same volume of loans and factor prices (including deposit prices). The second model considers cost efficiency by comparing banks with the same volume of loans, deposits, and borrowings.

This difference in models also explains the differences in changes in the average efficiency over time (see Table 5 and Figure 3 in the Appendix). For example, if we consider the first specification for both models, we conclude that the average bank efficiency of Kazakh banks decreases with time according to the first model (*ce1*), but this effect is not observed in the second model (*ce4*). This difference in the conclusions can be explained by the fact that the second model takes into account the difference in the sources of funding in the two countries.

ROA and ROE. What is the relation of the two standard performance measures, ROA (return on assets) and ROE (return on equity), to the banks' cost efficiency? One can hardly expect a high correlation between these indicators and cost efficiency, because they estimate bank performance from different points of view. A bank with a high ROA does not necessarily have a high value of cost efficiency as it is possible that another bank with the same volume of outputs (deposits, loans, etc.) has lower expenditures. Spearman rank-order correlations of ROA and ROE indicators with estimates of cost efficiency are presented in Table 7 in the Appendix for the total sample and separately for each country. The correlation between cost efficiency and ROA is positive (the sole exception is model 2, which, as noted above, most likely was not estimated correctly), larger than the correlation between cost efficiency and ROE (close to zero), but, as expects, very low (0.06 to 0.18 for Russia and -0.06 to 0.29 for Kazakhstan). These results are consistent with the findings reported by Bauer et al. (1998), who found correlations between ROA and efficiency measures generated by different techniques in the range 0.00-0.023; see also Weill (2004), who finds correlations in the range 0.06-0.30. Figure 1 presents the joint distribution of ROA and *ce3* over the whole sample.

Figure 1 Joint distribution *ce3* —ROA



Economies of scale. The models we use here to estimate cost efficiency could just as well be used for estimating economies of scale. For example, if all outputs grow by 1%, but total costs grow by less than 1%, then increasing the size of the bank leads to lower costs per unit of output. Following Carvallo and Kasman (2005), we calculate the following measure of the scale economies for each bank in the sample:

$$scale = \sum \frac{\partial \ln C}{\partial \ln y_i}$$

Here, y_i are outputs. If *scale* < 1, then banks operate below the optimal scale levels and can reduce costs by increasing output. Let *scale1* to *scale6* be the measures of the scale economies calculated for each of our six models. Table 4 presents the average values over five years of observation of these measures separately for Russian and Kazakh banks. The first and third quartiles of the estimated distributions of efficiency are also presented. Since most efficiency scores are below 1, most banks would benefit from getting bigger. This conclusion is supported by Figure 4 in the Appendix, which presents histograms of the measures *scale3* and *scale6* for the sample of Russian banks.

Table 4 Average values of the measures of the scale economies

	Russia			Kazakhstan		
Measure	Average	1st Quartile	3rd Quartile	Average	1st Quartile	3rd Quartile
scale1	0.929	0.894	0.973	0.961	0.903	1.007
scale2	0.905	0.860	0.954	0.914	0.849	0.982
scale3	0.933	0.895	0.977	0.966	0.904	1.010
scale4	0.923	0.886	0.960	0.963	0.920	0.991
scale5	0.946	0.923	0.970	0.969	0.943	0.983
scale6	0.901	0.857	0.939	0.989	0.903	1.011

Figure 2 presents the evolution of the average values of the estimated measure of scale economies *scale1* for the samples of banks from the two countries. For both countries this measure increases over time. Therefore, in both countries the banking systems were moving in the direction of minimizing relative costs. The measures *scale2*-*scale6* lead to the same conclusion, so the choice of model is not important here.

Figure 2 Evolution of the measure of scale economies for Kazakhstan and Russia

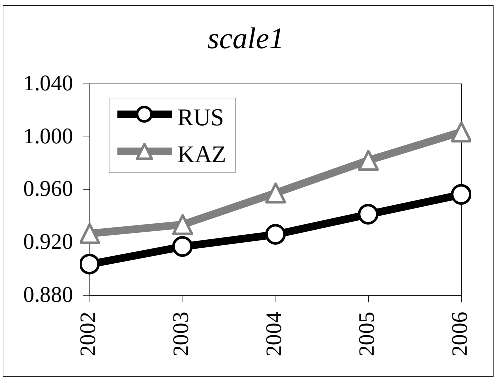


Figure 5 in the Appendix presents scatter plots of the scale economies measure versus size of the bank. The possible effect of the scale economies decreases with the size of the bank. The outlier in the plot for *scale3* corresponds to the Development Bank of Kazakhstan, which was established in 2001 by decree of the Government of the Republic of Kazakhstan and is not entirely a commercial bank. The main purpose of the bank is to increase the efficiency of government investments, develop industrial infrastructure, and assist in attracting domestic and foreign investment into the national economy.

Time-invariant efficiency. Let *ce1m–ce6m* be the cost efficiency scores *ce1–ce6* averaged over time. Panel data cost frontier models with time invariant inefficiency produce efficiency scores *ce01* for model 1 and *ce02* for model 2. Estimating panel data random effect linear regressions, we use formula (4) to calculate DFA estimates of efficiency, and *dfce1* and *dfce2* for the first and second model, respectively. We have five estimates of time invariant efficiency for model 1 *(dfce1, ce01, ce1m, ce2m, ce3m)* and five estimates for model 2 *(dfce2, ce02, ce4m, ce5m, ce6m).* Spearman rank-order correlations of these ten efficiency estimates are presented in Table 8 in the Appendix. From the table, it is apparent that the ranking of efficiency estimates for the first and second models are quite similar: Spearman correlations are in excess of 0.77 for model 1 and in excess of 0.81 for model 2. If we exclude the (possibly not correctly estimated) averages *ce2m* and *ce5m*, the correlations exceed 0.80 and 0.87, respectively. A distribution-free approach gives results similar to these estimates, based on different error distribution assumptions.

Spearman correlations for efficiency estimates for the different models are much lower: 0.18-0.60 (0.38-0.60, excluding *ce2m* and *ce5m*).

At least in this case, we must conclude that the efficiency ranking depends crucially on the chosen model (inputs, outputs) and very little on assumptions concerning the distribution of errors.

7 Conclusions

In this paper, we considered the robustness of various specifications of cost-efficiency models using data for Kazakh and Russian banks over the period 2002-2006.

We find that the ranking of the banks according to the estimated cost efficiency largely depends upon the model specification (the chosen set of outputs and factors). The specification of the distribution of the error term has a much smaller impact on the ranking.

As expected, the model with three outputs (our second model) produces higher values of cost efficiency on average than the model with a single output.

In contrast to Fries and Taci (2005), we do not find a statistically significant difference in the cost efficiency of banks in Kazakhstan and Russia. It could be that this difference became insignificant as the two banking systems evolved after 2001. An alternative explanation is that the specification of the cost function used by Fries and Taci (2005) does not distinguish between deposits and borrowings.

Most banks in both countries are still below their optimal size. However, both banking systems are moving toward optimization of relative costs.

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Appendix

Table 5 Average values of bank technical efficiency

	Russia						Kazakhstan					
Year	*ce1*	*ce2*	*ce3*	*ce4*	*ce5*	*ce6*	*ce1*	*ce2*	*ce3*	*ce4*	*ce5*	*ce6*
2002	0.751	0.787	0.756	0.817	0.851	0.837	0.760	0.361	0.788	0.801	0.793	0.742
2003	0.753	0.763	0.759	0.816	0.863	0.837	0.745	0.391	0.771	0.798	0.807	0.737
2004	0.751	0.755	0.756	0.814	0.859	0.836	0.735	0.432	0.768	0.801	0.798	0.736
2005	0.752	0.753	0.758	0.817	0.867	0.838	0.725	0.428	0.764	0.807	0.832	0.743
2006	0.753	0.757	0.758	0.812	0.865	0.834	0.735	0.408	0.771	0.800	0.840	0.727

Table 6 Spearman rank-order correlations of technical efficiency estimates

All	*ce*1	*ce*2	*ce*3	*ce*4	*ce*5	*ce*6
*ce*1	1					
*ce*2	*0.792*	*1*				
*ce*3	0.988	*0.736*	1			
*ce*4	0.576	*0.386*	0.577	1		
*ce*5	*0.478*	*0.301*	*0.460*	*0.940*	*1*	
*ce*6	0.574	*0.513*	0.539	0.941	*0.918*	1
Russia	*ce*1	*ce*2	*ce*3	*ce*4	*ce*5	*ce*6
*ce*1	1					
*ce*2	*0.913*	*1*				
*ce*3	0.996	*0.913*	1			
*ce*4	0.568	*0.471*	0.570	1		
*ce*5	*0.462*	*0.320*	*0.453*	*0.947*	*1*	
*ce*6	0.567	*0.476*	0.571	0.994	*0.937*	1
Kazakhstan	*ce*1	*ce*2	*ce*3	*ce*4	*ce*5	*ce*6
*ce*1	1					
*ce*2	*0.827*	*1*				
*ce*3	0.996	*0.818*	1			
*ce*4	0.617	*0.499*	0.632	1		
*ce*5	*0.503*	*0.306*	*0.527*	*0.920*	*1*	
*ce*6	0.604	*0.488*	0.615	0.993	*0.926*	1

Table 7 Spearman rank-order correlations of technical efficiency estimates with ROA and ROE

All	ce1	ce2	ce3	ce4	ce5	ce6
ROA	0.117	–0.003	0.130	0.154	0.133	0.087
ROE	0.018	–0.193	0.038	0.167	0.235	0.073
Russia						
ROA	0.128	0.063	0.118	0.160	0.183	0.154
ROE	0.059	–0.061	0.049	0.212	0.320	0.197
Kazakhstan						
ROA	0.192	0.288	0.197	0.205	0.056	0.178
ROE	–0.026	–0.061	0.002	0.050	0.052	0.022

Figure 3 Average values of bank technical efficiency

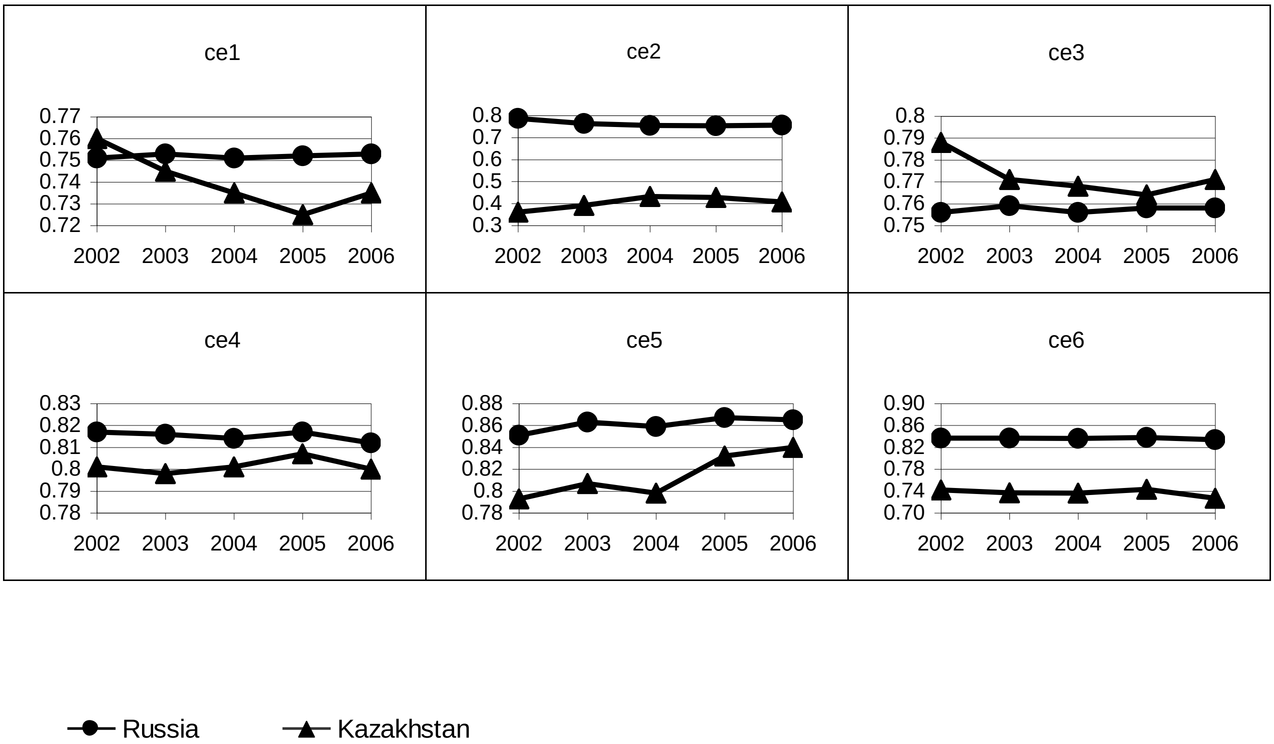


Figure 4 Histograms of the scale economies measures *scale3* and *scale6* for the sample of Russian banks

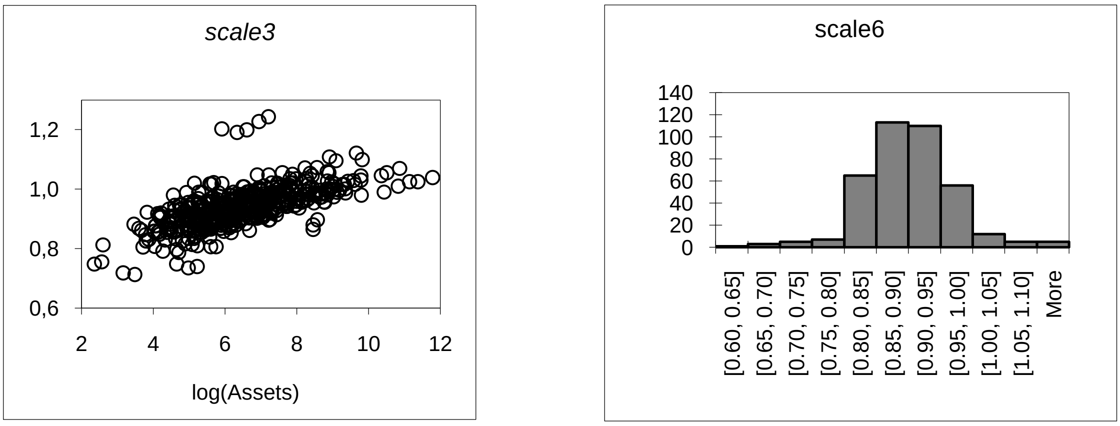
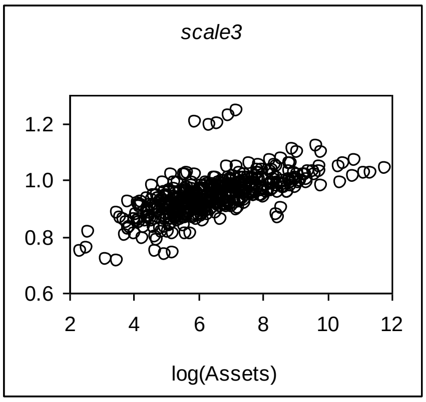


Figure 5 Measures of scale economies against size of bank



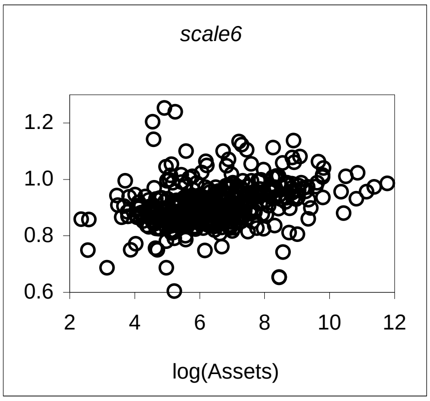


Table 8 Spearman rank-order correlations of cost efficiency time-invariant estimates

	dfce1	*ce01*	*ce1m*	*ce2m*	*ce3m*	*dfce2*	*ce02*	*ce4m*	*ce5m*	*ce6m*
dfce1	1									
ce01	0.991	1								
ce1m	0.879	0.822	1							
ce2m	*0.841*	*0.817*	*0.845*	1						
ce3m	0.856	0.800	0.981	0.777	1					
dfce2	0.524	0.485	0.605	0.440	0.602	1				
ce02	0.535	0.497	0.605	0.445	0.602	0.999	1			
ce4m	0.436	0.382	0.600	0.411	0.595	0.945	0.935	1		
ce5m	*0.251*	*0.182*	*0.487*	*0.307*	*0.457*	*0.823*	*0.810*	*0.930*	*1*	
ce6m	0.484	0.439	0.608	0.558	0.546	0.876	0.868	0.921	*0.888*	1

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