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TECHNICAL EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY IN THE KAZAKH BANKING INDUSTRY

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This paper investigates the technical efficiency and productivity of Kazakh commercial banks over the period 2000–2013. Non-parametric approaches, namely the Data Envelopment Analysis and the Malmquist index are employed to calculate technical efficiency and productivity. In addition, a second-stage regression is also estimated to identify the determinants of efficiency. The results indicate that banks in Kazakhstan operate below their optimum levels, with larger banks being more efficient than smaller ones. The results also indicate the presence of economies of scale for banks of all sizes. The efficiency of banks is found to be significantly and positively related to profitability, capitalisation, bank size, and liquidity. The results further indicate that Kazakh banks seem to have experienced a significant productivity growth over the sample period.

Keywords: Kazakh banks, technical efficiency, Malmquist total factor productivity index, DEA

JEL classification indices: D24, G21

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1. INTRODUCTION

After the collapse of the communist system and after declaring its independence in 1991, Kazakhstan initiated the process of the sound reformation of its political and socioeconomic systems from a planned economic system to a market-oriented one. In this framework, the financial system of the country, represented mostly by the banking sector, has gone through the process of fundamental restructuring. Before the initiation of economic reforms, the banking system of Kazakhstan was represented by three banks.[1] The first Western-type banking law, the Banks and Banking Activity Act, was passed in December 1990.[2] This Act permitted the establishment of private banks, created a central banking authority, defined the status of commercial banks, and established limits on the types of transactions that banks can conduct. However, despite the Act's important contribution to Kazakhstan's banking system, it rapidly proved inadequate and was replaced with two separate statutes in 1993, the National Bank Act and the Banks Act (Kibatullin 1995).

In 1991, the banking system consisted of the National Bank of Kazakhstan (NBK), which had previously been a branch of the Soviet Gosbank, the five specialised state-owned banks and 72 commercial banks that had been licensed over the period 1988–1991 (Akimov – Dollery 2007). Immediately after its independence, Kazakhstan adopted a very liberal policy, which was represented by low capital adequacy requirements, flexible licensing policies, inadequate prudential regulation, and the absence of a legal framework. Consequently, by the end of 1993, the number of banks tripled and reached 184. However, most of newly-established banks were poorly capitalised and managed, and were created to serve the financial needs of their parent enterprises. Following the introduction of the tenge, Kazakhstan's national currency, in November 1993, the NBK has become fully independent to carry out the country's monetary policy and to regulate banking operations (Bhatti 2013). The Banks Act of 1993 started the legislative reforms: the existing licensing regulations were tightened, the minimum legal capital requirement was increased, and strict actions were taken against poorly capitalised, non-viable banks. Hence, many banks were liquidated and the number of banks decreased significantly. Three important developments were also observed over the period 1995–1999: (1) the adoption of guidelines for the prudential supervision of the Bank of International Settlement (BIS), (2) the huge amount of bank non-performing loans inherited from the Soviet Union was transferred to newly-created debt resolution institutions, and (3) the establishment of the Deposit Insurance Fund.

[1] These are Gosbank (State Bank), Stroibank (Construction Bank), and Vneshtorgbank (Foreign Trade Bank).

[2] It should be noted that Kazakhstan did not declare its independence from the USSR until December 16, 1991.

By the end of 1999, the initial phase of the banking sector restructuring programme was performed successfully and the regulatory and prudential environment was largely in place. Relevant amendments were made to the legislation on bank supervision in 2001, which greatly contributed to improving the quality of the supervision of large banks and the development of fair competition in the banking sector. In 2003, the Agency for Regulation and Supervision of Financial Markets and Financial Organisations was established, followed by the adoption of the International Accounting Standards (IAS) and the Basel II Capital Adequacy Accord in 2005.

The main objective of this paper is to investigate the impact of the regulatory and institutional developments on the efficiency and productivity of Kazakhstani commercial banks over the period 2000–2013. An analysis of the efficiency and productivity of the banking sector in this new economic and regulatory environment is particularly important since most of the regulatory and institutional changes occurred before this period. The paper also aims to identify possible determinants of technical efficiency. Particular focus is set on examining the impact of the global financial crisis on the performance of the banking sector.

There are numerous studies that estimated the performance of the banking sectors in the developed countries and major developing countries. Our contribution to the related literature is twofold: first, this paper uses unique data from a major transition country's banking system. The data are particularly well suited for the paper's objectives since it includes detailed information about balance sheets and income statements. Haselmann – Wachtel (2007) argue that banks behave differently under different institutional settings. Hence, the implications of previous studies on developed and major developing countries' banking systems may not apply to the transition countries' banking systems. This is because banks in transition countries mostly operated in more repressed financial environments and have witnessed significant regulatory and structural changes in the last two decades. The regulatory efforts in transition countries are also quantitatively and qualitatively different from those in other countries. Overall, the banking systems in transition countries have unique and different characteristics, warranting a proper and separate investigation. Second, investigating the performance of Kazakh banks will shed light on the dynamics and characteristics of a major transition and under-researched market. Very few studies have investigated the performance of banks on this market and even these are mostly cross-country studies.[3] The present paper differs significantly from previous studies with re-

[3] These are Grigorian – Manole (2002), Fries – Taci (2005), Peresetsky (2010), and Kumbhakar – Peresetsky (2013). To our knowledge, Bhatti (2013) is the only paper that investigates the efficiency of banks in Kazakhstan in a single country setting.

spect to its scope and time period, and produces both technical efficiency and productivity scores for all commercial banks operating in the market. It also investigates the impact of the global financial crisis of 2007 on the banking sector and evaluates the recovery measures undertaken by the authorities. Finally, the paper also identifies the sources of technical efficiency.

The paper is organised as follows: Section 2 provides a brief review of the related literature. In Section 3, we discuss the methodology. The data and empirical results are reported in Section 4. The paper's concluding remarks are provided in Section 5.

2. LITERATURE REVIEW

Following economic and political changes of 1989, an abundance of research has been devoted to developments in the financial sector in the countries of Central and Eastern Europe (CEE) and the Former Soviet Union (FSU), more widely known as transition countries. The literature on transitional banking issues in CEE economies is abundant compared to the FSU.[4]

Nazin (2010) investigated the efficiency of Russian banks during the crisis period and the exposure of different categories of banks to external shocks. He found that foreign banks perform better than domestic banks and that the difference between the banking groups is further exacerbated by the crisis. Mertens – Urga (2001) examined the banks in Ukraine and concluded that small banks operate more efficiently in terms of cost, but less efficiently in terms of profit. Moreover, larger banks show significant diseconomies of scale, while smaller ones show significant scale economies.

Given the excessive interest in emerging market economies during the last decade and the problems experienced by Kazakhstan's financial system after the global financial crisis in recent years, surprisingly little academic research has

[4] Early studies on the banking systems in CEE countries focused on loan performance, recapitalisation, and market entry for foreign banks (McKinnon 1991; Buch 1997). The role of the privatisation of state-owned banks and its impact on banking sector performance and efficiency in 11 CEE countries was examined by Bonin et al. (2005). Kraft – Tirtiroglu (1998) highlighted the increased efficiency of newly privatised banks in Croatia, while Hasan – Marton (2003) concluded that privatisation and the entry of foreign banks were the most significant factors in strengthening the banking system in Hungary. Foreign banks were found to be more efficient than domestic ones in the Czech Republic and Poland (Weil 2003; Kasman 2005; Kasman – Yildirim 2006; Havranek – Irsova 2013). Drakos (2003) assessed the effect of reforms in transition banking and stated that the overall transition process has been effective.

been undertaken on the costs and efficiency analysis of Kazakh banks. In most cases, the country was included in the sample of FSU economies.

The first authors to include Kazakhstan in their sample were Grigorian – Manole (2002). They examined the performance of commercial banks in 17 transition countries over the period 1995–1998. They inferred the positive effect of progress in institutional reform and foreign ownership over bank cost efficiency. Kazakhstan exhibited the highest efficiency scores in the subgroup of the Commonwealth of Independent States (CIS) during the time period under study. This may be related to the fact that right after declaring independence in 1991, the new government took serious steps in restructuring the country's financial system by initiating privatisation and new legislations. These findings were supported by Fries – Taci (2005), who examined the cost efficiency of 289 banks in 15 post-communist countries during the period 1994–2001, using the stochastic frontier approach. They found banks in Kazakhstan to be more efficient than in Russia during the time period under study. However, the results were at variance with the findings of Peresetsky (2010) and Kumbhakar – Peresetsky (2013), who found no significant difference in the average cost efficiency scores of banks in the two countries. The differences could be attributed to the different time periods chosen by the two studies, since the banking systems of both Kazakhstan and Russia evolved after 2001. Djalilov – Piesse (2011) examined the progress of the transition to a market economy for banks in Central Asian countries and found that improvement in TFP was driven mostly by technical progress. Meanwhile, the low levels of technical efficiency were a barrier to growth in the sector. The authors proposed removing barriers to foreign entry and attracting foreign investors as being the best option for improving competition and ensuring economic growth. More recent research, which focused on the performance of banks in Kazakhstan, was carried out by Bhatti (2013). He examined the technical efficiency of 20 Kazakhstani banks during the period 2007–2011 and concluded that the Kazakh banking sector can be characterised as technically more efficient. Bhatti (2013) also pointed out that foreign banks perform relatively better than domestic banks, which is consistent with previous research.

3. METHODOLOGY

The basic idea of efficiency analysis is to make a comparison among a group of banking firms or branches in order to evaluate how the resources (inputs) are used to produce goods or services (outputs). Following a number of studies on bank performance in developing and transition countries, this paper uses the mathematical programming technique called data envelopment analysis (DEA), which

was first developed by Charnes et al. (1978) and later improved by Banker et al. (1984), in measuring bank performance. In contrast to parametric approaches, the DEA approach does not need the specification of a functional form for the frontier (inputs-outputs relation) and a distributional form for the inefficiency and error terms. Hence, DEA assumes that there are no random fluctuations in production and that all deviation from the estimated frontier represents inefficiency.[5] Moreover, DEA is relatively less data demanding. That is, it works well with a small sample size. Although most Kazakh banks are covered in the sample, the relatively small size of the number of banks in the sample justifies the use of DEA in the study.

DEA models can take two different orientations. The first one, called input orientation, aims at reducing the input amounts by as much as possible while keeping at least the present output level. Hence, the output level remains unchanged and input levels are reduced proportionately until the frontier is reached. The second one, referred to as output orientation, holds the input bundle unchanged and expands the output level until the frontier is reached. In practice, whether the input- or output-oriented measure is more appropriate would depend on whether input conservation is more important than output augmentation (Daraio – Simar 2007).

The input-oriented specification of the DEA method in comparison to the output-oriented one allows the identification of the sources of input waste in the banking sector and the drawing of some policy conclusions. This "input-saving" approach aims at reducing the input amounts by as much as possible while keeping at least the present output levels. This is a framework generally adopted when the decision-maker can control the inputs, but has no control over the outputs (Daraio – Simar 2007). The choice of input orientation is based on the assumption that during periods of regulatory changes and the introduction of competition, which Kazakh banks faced after the implementation of structural reforms, they strategically focused on cutting costs. Considering the inadequate development of financial markets compared to developed economies, enhanced by low confidence among the population to alternative banking instruments except deposits, could impose obstacles for banks to target the output levels.[6]

[5] Irsova – Havranek (2013) show that the choice of methodology affects the reported estimates of efficiency in a systematic way. In general, the parametric approach yields higher scores than the non-parametric approaches as expected. Using a meta-regression analysis of 32 studies on frontier efficiency measurement in banking, they also showed that the differences between the scores estimated using parametric and non-parametric approaches arise when the Fourier flexible functional form is used since this functional form yields lower scores.

[6] The existing literature has traditionally focused on the estimation of input- or cost-based efficiency, assuming the bank management has more control over costs rather than over outputs (Casu et al. 2004).

To compute technical efficiency for bank *i* under the input-oriented assumption, the following linear programming model is used for each bank in the sample:

$$\min_{\theta,\lambda} \theta_i. \tag{1}$$

Subject to

$$\theta_i X_{ki} \geq \sum_j \lambda_j X_{kj} \qquad k = 1, 2, ...K,$$
$$Y_{mi} \leq \sum_j \lambda_j Y_{mj} \qquad m = 1, 2, ...M,$$
$$\lambda_j \geq 0 \qquad j = 1, 2, ...N,$$

where X and Y represent the vector of inputs and outputs, respectively, and define the weight of each unit within the reference or peer group to which any particular observation is compared in order to determine the distance to the efficient frontier. Hence, the solution, θ_i^*, is the measure of the technical efficiency of bank *i*. Bank *i* is technically efficient if $\theta_i^* = 1$, and it is technically inefficient if $\theta_i^* \leq 1$. Three different technologies could be assumed by imposing additional restrictions to the above problem. The constant returns to scale (CRS) technology does not require further restriction on λ. In the case of variable returns to scale (VRS) and non-increasing returns to scale (NIRS) technologies, the restrictions are $\sum_j \lambda_j = 1$ and $\sum_j \lambda_j \leq 1$, respectively. It is also possible to compute scale efficiency for bank *i* by comparing the three technical efficiency measures, i.e., CRS, VRS, and NIRS. Technical efficiency can be decomposed into pure technical efficiency (PTE) and scale efficiency by recalculating the problem with an additional constraint, where $\sum_j \lambda_j = 1$. Hence, the solution, $\theta_{i,VRS}^*$, is the measure of pure technical efficiency for bank *i*. The same procedure is employed for NIRS. The scale efficiency for bank *i* is the ratio:

$$SE_i = \frac{\theta_{i,CRS}^*}{\theta_{i,VRS}^*} = \frac{TE}{PTE}, \tag{2}$$

where *TE* denotes technical efficiency. The scale efficiency measure for bank *i* provides information about the excessive use of inputs associated with operating at a non-optimal level of output. If technical efficiency and pure technical efficiency are equal, then $SE_i = 1$ and the bank is operating at constant returns to scale, which is economically and socially optimal. If $SE_i < 1$, the bank is scale-inefficient.

The Malmquist index approach is used to measure total factor productivity (TFP) change in banking firms operating in Kazakhstan's banking sector. The Malmquist TFP index has been the most commonly used measure of productivity change in the related literature. The advantages of the Malmquist index are that it does not make assumptions about the optimising behaviour of the producers and it allows for inefficiency (Fare et al. 1994). Moreover, it does not rely on

econometric estimation, but instead uses a non-parametric approach similar to that used by DEA. The technical derivation of the Malmquist index is provided in the *Appendix.*

4. DATA AND EMPIRICAL RESULTS

4.1. Data

The data for the empirical analysis were taken from the balance sheets and income statements published in the yearly audited consolidated financial statements of banks. The financial reports were obtained from the official websites of the banks and the Kazakhstan Stock Exchange (KASE). The sample consisted of 30 second-tier commercial banks operating in Kazakhstan. These are selected out of 38 banks and account for about 96% of total bank assets in the country.[7] The House Construction Savings Bank of Kazakhstan and Eximbank were not included in the sample due to their specific functions.[8] Other banks are excluded from the sample due to a limited access to their financial data or due to being newly established. As a result of the absence of financial reports for particular years of some banks, the data for the analysis can be classified as unbalanced panel data. The sample covers the period from 2000 to 2013. The early 2000s indicate the period of competitive banking sector formation. The second part of this period enables the investigation of the impact of the global financial crisis.

Input – output determination

As for the determination of inputs and outputs of a commercial bank, there is a disagreement in the literature over which bank services to define as outputs and inputs. The three most commonly applied methods include the asset approach, the user-cost approach, and the value-added approach. In the current research,

[7] This figure is based on 2013 data from the banking sector performance reports published by the NBK (www.nationalbank.kz).

[8] The former bank aims to improve the housing conditions of middle and below middle class groups by collecting deposits and then issuing mortgage loans. 100% of its shares are owned by the government and it is the only state-owned bank in the country. The latter bank was established as a government agency to finance state investment policies and promote export-import relations. Although the bank was privatised later and started providing general banking services, it was not included in the sample because it served as an investment bank for most of the time period covered by the study.

the asset approach is applied, in which banks are considered only as financial intermediaries between liability holders and those who receive bank funds. Banks combine deposits together with purchased funds to produce financial services and products. Accordingly, loans and other assets are considered to be bank outputs, while deposits and other liabilities are inputs to the intermediation process. It is assumed that a bank, being a competitive and efficient institution, would minimise its costs. Hence, banks operating in Kazakhstan utilise two inputs in their "production process" to produce two outputs.

The outputs include interest income (y_1) and other operating income (y_2). Interest income expresses remuneration for issued loans to non-bank entities and loans to other banks, lease-financing receivables, and interest and dividend income on securities. Operating income or non-interest income comprises net commission income, gains and losses from trading securities, and foreign exchange transactions. These outputs represent the banks' revenues and major business activities. The inputs are formed of the interest expenses (x_1) and non-interest expenses (x_2). Interest expenses exhibit costs a bank meets for using leveraged funds, which include customer and inter-bank deposits, expenses for the purchase and sale of securities, and the interest on demand notes and other borrowed money. However, bank dividend payments are excluded from the measure of total costs, so the return to bank equity is not included in the measure. General operating expenses (non-interest expenses) account for other essential inputs to commercial bank operations, namely labour and fixed assets. These include payroll expenses, expenses associated with premises, and fixed assets, which also captures the extensiveness of a bank's branch network, taxes, and other expenses.

Table 1 presents the summary statistics of the main variables employed in the calculation of efficiency.

Table 1. Descriptive statistics of bank level variables for 2000–2013

Variable	N	Mean	Standard deviation	Coefficient of variation
Outputs				
y_1 = *Interest income*	339	159.408	393.150	2.466
y_2 = *Non-interest income*	339	34.115	79.565	2.332
Inputs				
x_1 = *Interest expenses*	339	88.292	222.534	2.520
x_2 = *Non-interest expenses*	339	41.522	80.077	1.929

Note: Monetary variables are presented in millions of U.S. Dollars.

4.2. Empirical results

Technical efficiency

Table 2 reports the summary statistics for the efficiency scores for the whole sample during the sample period.[9] The overall mean technical efficiency for the sample equals 0.838, with a standard deviation of 0.072. This implies that banks could have saved about 16% of inputs if they had used the best practice technology. The mean of the technical efficiency scores exhibits quite high values during the period before the global financial crisis, reaching the peak level in 2007. However, the situation deteriorated after 2008 and overall efficiency fell by 20%. The lowest technical efficiency was recorded in 2010 (0.711). This result is supported by the fact that at the end of 2009 and during 2010, three of the five largest Kazakh banks (in terms of total assets) defaulted and restructuring programmes were initiated by the government. For the period after the crisis, the average technical efficiency is 0.761 and the score displays a slight improvement. This indicates that the anti-crisis/stabilisation programmes started by the government were not enough to improve the situation significantly.[10]

Table 2 also reports the average scale efficiencies of banks and allows drawing conclusions about economies of scale for the banks in the sample. The overall scale efficiency is 0.897, suggesting that the banks in the sample, on average, benefitted from economies of scale. The measure of overall economies of scale follows the same pattern as technical efficiency, with the fall in 2010 and improvements afterwards.[11]

Although Kazakh banks have a similar organisational structure, they vary considerably in size. Thus, the sample was divided into five groups with respect to total assets. Size A represents banks with the largest share of total assets, while Size E comprises the smallest banks. *Table 3* reports the efficiency scores according to each asset size category.

The largest banks (those with an asset size greater than $10 billion) turned out to be the most efficient ones, with a mean technical efficiency of 0.961. The least

[9] The efficiency scores in *Table 2* are based on VRS technology and input orientation is used in the calculations. In addition, the DEAP 2.1 developed by Tim Coelli was used to calculate the technical efficiency and total productivity index in the paper. Interested readers can refer to Coelli (1996) and Coelli et al. (1998) for the technical details of the programme and the comprehensive descriptions of the DEA models used in this paper.

[10] The performed t-test for providing statistical inference about the difference of efficiency scores between two sub-periods proved to be statistically significant. This suggests that the impact of the global financial crisis over the banking sector of Kazakhstan was considerable.

[11] The efficiency scores of individual banks in the sample are provided in the *Appendix*.

Table 2. Average technical efficiency and scale efficiency scores by year

Years	Technical efficiency			Scale efficiency		
	Mean	Standard deviation	Coefficient of variation	Mean	Standard deviation	Coefficient of variation
2000	0.985	0.033	0.033	0.966	0.067	0.069
2001	0.861	0.155	0.179	0.955	0.053	0.056
2002	0.865	0.158	0.182	0.909	0.081	0.089
2003	0.868	0.166	0.191	0.943	0.067	0.071
2004	0.866	0.159	0.184	0.927	0.066	0.071
2005	0.863	0.159	0.185	0.948	0.059	0.063
2006	0.885	0.139	0.157	0.965	0.047	0.049
2007	0.901	0.140	0.155	0.904	0.146	0.161
2008	0.841	0.169	0.202	0.917	0.130	0.142
2009	0.772	0.196	0.254	0.843	0.152	0.181
2010	0.711	0.291	0.410	0.795	0.208	0.261
2011	0.734	0.247	0.337	0.841	0.164	0.196
2012	0.792	0.220	0.278	0.832	0.176	0.211
2013	0.794	0.204	0.257	0.809	0.142	0.175
Overall	0.838	0.072	0.086	0.897	0.060	0.067

Table 3. Technical efficiency and scale efficiency scores by asset size

Size		Technical efficiency			Scale efficiency		
Asset size category	Number of banks	Mean	Standard deviation	Coefficient of variation	Mean	Standard deviation	Coefficient of variation
Size A	3	0.961	0.133	0.138	0.897	0.1218	0.136
Size B	5	0.821	0.129	0.158	0.880	0.097	0.111
Size C	9	0.822	0.174	0.212	0.912	0.115	0.126
Size D	5	0.789	0.222	0.282	0.903	0.105	0.116
Size E	8	0.794	0.263	0.331	0.843	0.211	0.251

Note: The size groups of the banks are based on the 2013 asset size values. Asset size values are presented in USD millions. Size A: 10,000+; Size B: 5,000–10,000; Size C: 1,000–5,000; Size D: 500–1,000; and Size E: 0–500.

efficient banks were in the lower-middle category (asset size between $0.5–1 billion), followed by the smallest banks of category E (asset size less than $0.5 billion), which performed a little better. Medium-sized and upper-medium-sized banks showed almost the same scores of technical efficiency. Consequently, there seems to be a clear relationship between size and technical efficiency. As for the scale efficiency, the results suggest that scale economies exist at every production scale. Hence, banks in each category of asset size in the sample exhibit increasing returns to scale and can reduce costs by expanding production. This contradicts

Table 4. Technical efficiency and scale efficiency scores by ownership type

Ownership type	Technical efficiency				Scale efficiency		
	Number of banks	Mean	Standard deviation	Coefficient of variation	Mean	Standard deviation	Coefficient of variation
Domestic	18	0.819	0.194	0.237	0.904	0.111	0.123
Foreign	12	0.841	0.209	0.248	0.855	0.182	0.213

the findings of other empirical studies where larger banks were usually seen to be facing scale diseconomies or decreasing scale economies (Berger et al. 1997).

According to the findings of most papers on efficiency analysis, foreign banks utilise their resources to produce output more efficiently than their domestic counterparts. To examine the validity of this evidence for the Kazakh banking system, all banks in the sample were categorised according to their ownership type. The efficiency scores are reported in *Table 4.* In line with previous findings, banks with foreign ownership turned out to be technically more efficient than domestic ones. However, the difference between the scores is not large, accounting for only 2.2%. The results further indicate that both foreign and domestic banks exhibit economies of scale.

Correlates of efficiency scores

After computing the efficiency scores of banks in the sector, some authors regressed efficiency scores on several independent variables to explain efficiency determinants. Since efficiency scores are bounded between 0 and 1, the function is required to be a monotonic increasing function that projects from the real line to the [0, 1] interval. Hence, we used the logistic functional form as suggested in Mester (1996) and regressed the efficiency scores against some various firm-specific variables. The second stage regression model was specified as follows:

$$EFF_{it} = f(ROA_{it}, EQ_{it}, TL_{it}, DEP_{it}, \ln TA_{it}, PLL_{it}, FINVEST_{it}, LIQUID_{it}, D1, D2_t) + \varepsilon_{it} \quad (3)$$

where EFF_{it} represents the efficiency score of bank i at time t. The set of variables that characterise the structure of the banking industry may affect banking technology and service quality, and thus influence bank efficiency. The description of each variable and its expected effect on efficiency is presented in *Table 5.*

Table 5. Correlates of efficiency

No.	Variable	Definition	Description and expected effect on efficiency
1	ROA	$\frac{\text{Net income}}{\text{Total assets}}$	This is a measure of bank performance. It provides an idea as to how efficient management is at using its assets to generate earnings. This indicator of bank profitability is intended to measure deposit takers' efficiency in using their assets. ROA is expected to be positively related to efficiency.
2	EQ	$\frac{\text{Stochholders' equity}}{\text{Total assets}}$	This ratio is a proxy to the capital adequacy ratio, which represents the capitalisation of a bank or the capability of banks to maintain solvency. Higher bank capitalisation may affect bank efficiency through a greater incentive for sound banking and efficiency (Fries – Taci, 2005). This ratio should be positively related to efficiency on the grounds that banks with a high efficiency will have higher profits and hence will be able to retain more earnings as capital.
3	TL	$\frac{\text{Total loans}}{\text{Total assets}}$	This leverage ratio shows the portfolio composition. It controls for the structure of banks' assets and accounts for banks' lending behaviour. The higher value of this ratio indicates that a bank is loaned up and its liquidity is low. A larger percentage of loans out of total bank assets leads to a higher credit risk exposure.
4	DEP	$\frac{\text{Total deposits}}{\text{Total assets}}$	This ratio controls for the structure of banks' liabilities. Bank deposits are considered as the primary source of funds for traditional commercial banking. Loan financing through deposits reduce the banks' liquidity risk and, hence, positively affect bank efficiency by reducing costs associated with risk management.
5	LnTA	Natural logarithm of total assets	This variable is used to control for the banks' size. The relationship between the bank's size in terms of total assets and efficiency is ambiguous. Many empirical applications found smaller banks to be more efficient, while others claimed a reverse relation. Mostly, the results depend on the sample of the dataset, the level of development of the relevant banking sector, and whether a single-country or cross-country comparison is undertaken. Subsequently, the precise direction of the effect of a bank's size on its efficiency is not expected a priori.
6	PLL	$\frac{\text{Impairment for loan losses}}{\text{Total loans}}$	This ratio is used as a proxy to the ratio of non-performing loans (NPLs) over total loans. It represents the portion of overdue loans and loans being close to default in the total loan portfolio. This ratio shows the asset quality and is intended to identify problems with the asset quality of the loan portfolio. It enables the control for variation in risk-taking strategies among banks and indicates the degree of quality in bank management to finance projects with lower risk. The relationship between PLL and efficiency is supposed to be negative.

Table 5. continued

No.	Variable	Definition	Description and expected effect on efficiency
7	FINVEST	Total investment securities / Total assets	This ratio indicates to what extent a bank participates in the market for financial instruments and derivatives. It also shows the fraction of the investment securities portfolio in total assets. Kasman (2003) found a significant negative correlation between investment securities and inefficiency for Turkish banks. He suggests that banks that invested more in government papers tend to operate more efficiently.
8	LIQUID	Total liquid assets (except securities) / Total assets	This is a liquid asset ratio that controls for the liquidity risk of a bank. The level of liquidity indicates the ability of the deposit-taking sector to withstand shocks to their balance sheet.
9	Dummy 1	Ownership structure	The ownership structure may influence the level of bank efficiency. A bulk of empirical investigations on bank efficiency found foreign-majority banks to be more efficient than their domestic peers (Fries – Taci 2005; Grigorian – Manole 2002). The score "1" is assigned if more than 50% of the bank's share is owned by foreigners at the time *t*, and "0" means otherwise.
10	Dummy 2	Impact of the global financial crisis	To properly cover the crisis impact with regard to lags it could take, the dummy is constructed as the sum of 2009 and 2010. It takes values of "1" for these years for every bank in the sample, and "0" for others. The coefficient of Dummy 2 is anticipated to have a negative sign.[12]

[12] Kazakhstan was severely affected by the global financial crisis of 2007. The first signs of the crisis began to appear already in 2006. Banks operating in the sector borrowed from abroad the equivalent of 44% of GDP and loaned a substantial part of those funds to non-tradable sectors between 2005 and 2006. As financial conditions tightened with the onset of the global financial crisis, banks lost access to foreign financing, triggering a decline in stock and real estate prices, and a strong deceleration in non-oil economic activity, particularly in the construction sector. The devaluation of national currency by 25% in 2009 worsened the banks' external debt servicing problems, prompting the government to restructure the external obligations of three large banks (Alliance Bank, Temirbank, and BTA Bank) and acquire minority shares in another two (Kazkommertsbank and Halyk Bank) in order to prevent a collapse of the banking system.

Table 6. Descriptive statistics of bank characteristics

Variables	N	Mean	Standard deviation	Coefficient of variation
ROA	339	0.017	0.072	4.283
EQ	339	0.277	0.276	0.998
TL	339	0.576	0.195	0.339
DEP	339	0.516	0.217	0.421
LnTA	339	5.920	2.103	0.118
PLL	339	0.087	0.113	1.307
FINVEST	339	0.117	0.100	0.857
LIQUID	339	0.223	0.173	0.778

Note: Correlates variables are presented in ratios, except for *LnTA,* which stands for natural logarithm of total assets expressed in USD millions.

Table 7. Second stage regression results

	Coefficient	Standard error
C	0.245	0.185
ROA	0.669*	0.150
EQ	0.168**	0.075
TL	0.189	0.142
DEP	–0.105	0.069
LnTA	0.024*	0.007
PLL	–0.283*	0.107
FINVEST	0.359**	0.160
LIQUID	0.271***	0.152
D1	0.028	0.023
D2	–0.092*	0.029

Note: *, **, and *** denote significance level at 1%, 5%, and 10%, respectively.

Table 6 presents the descriptive statistics of the variables that represent bank characteristics.[13] The results of the second-stage regression model are reported in *Table 7*.[14]

Return on asset (ROA) is positively and significantly related to efficiency, suggesting that banks with higher efficiency tend to be more profitable. This result is consistent with findings by Kasman (2003) for Turkish banks and Girardone et al. (2004) for Italian banks. The bank capitalisation has a significant positive

[13] The correlation matrix of the variables reported in *Table 6* is presented in *Table A.2*. in the *Appendix*.

[14] Efficiency scores are based on VRS technology and input-oriented method. However, regression results with the efficiency scores that derived from the output-oriented method are very similar. Although they are not reported, they are available from the authors upon request.

coefficient, suggesting that more efficient banks tend to have higher levels of equity. This supports the findings of Fries – Taci (2005). This is quite predictable since more efficient banks would have more profits through retaining more earnings as capital. The coefficient of provision for loan losses (PLL) is significant and negative, suggesting that riskier banks are more inefficient. As a result of the financial crisis, the portion of overdue loans in the loan portfolio of banks increased and reached 30% of total loans. The worst is that most of these loans are accounted for by the largest banks in the sector with substantial market share (e.g. BTA Bank, Alliance Bank). This leads to the inefficiency of not only those banks, but to the inefficiency of the sector as a whole. The coefficients of liquidity and investment securities are significantly positive, suggesting that banks that have higher liquidity and security ratios are more efficient.

The size of the bank has a significant positive impact on efficiency. This implies that larger banks tend to be more efficient than smaller ones and hence the consolidation of smaller banks may lead to improving cost structure. Surprisingly, the dummy for bank ownership was positive, but statistically insignificant. The positive sign justifies the aforementioned outcome that foreign banks tend to operate more effectively than their domestic counterparts. This is in line with findings of Fries – Taci (2005), Grigorian – Manole (2002), and Djalilov – Piesse (2011). In general, this result is obvious, since foreign banks may benefit from their parent companies abroad (headquarters) in terms of transferring new banking technologies, financial innovations, and managerial and organisational structure, which were successfully utilised in other branches. These may lower total costs for foreign banks and make them more efficient. Moreover, the higher efficiency of foreign-majority banks may be associated with the extent of the competitive pressure they face.

The second dummy variable, responsible for the effect of the global financial crisis, is found to be significantly and negatively related to efficiency, indicating that the global financial crisis had inversely affected the country's banking sector. Being one of the countries in Central Asia that had actively participated in the international financial markets, the country has been severely affected by the crisis. However, the negative impacts over the economy occurred with a lag, as the downturn of the banking system happened at the end of 2009 and during 2010. As was pointed out before, the government undertook decisive actions to stabilise the banking sector. However, bank nationalisation was not followed by a coherent divestiture plan. In addition, the large stock of non-performing loans (NPLs) that emerged during the crisis has not been resolved. High NPLs depress bank profitability and render banks quite vulnerable to further deteriorations in credit quality. They also limit banks' ability to increase capital in order to meet the envisaged tightening of capital requirements (IMF, Financial System Stabil-

ity Assessment, 2014). In 2012, the "Troubled Asset Fund" (later renamed "Fund of Non-performing Loans") under the supervision of the NBK was established, which aims at enhancing the post-crisis recovery of second-tier banks by improving the quality of loan portfolios. For the purpose of improving the system of risk management, the BASEL III principles are planned to be introduced. This may positively affect the efficiency of banks, yet the results will not show up in the short-run. It is worth mentioning that the financial crisis forced the authorities of Kazakhstan to revise the requirements of banks, putting emphasis on quality, rather than on growth. Increased capital adequacy requirements and the introduction of other prudential constraints on risk-taking combined with the private ownership of banks and an objective of profitability may strengthen the incentive of banks for efficiency improvements.[15]

Total factor productivity

The Malmquist total factor productivity (TFP) change for Kazakh banks over the period 2001–2013 is reported in *Table 8*. The figures in each column are the annual geometric means of the results of individual banks. An index greater than 1 indicates a positive TFP growth, while an index lower than 1 indicates a decrease of TFP. The TFP change is mainly decomposed into technical change (TC) and technical efficiency change (TE). An improvement in TC is a shift in the best-practice frontier, whereas an improvement in TE is considered as "catching-up". The TE is further decomposed into scale efficiency change (SE) and pure efficiency change (PE) components. The main advantage of the decomposition is that it provides information on the sources of the overall productivity change in the banking sectors of the sampled countries.

The results in the table indicate that banks in Kazakhstan experienced a significant productivity growth over the sample period. The overall TFP index equals 1.021 or, stated differently, productivity has grown by 2.1% on the average during the time period considered. From an analysis of the decomposition of the Malmquist index, the productivity growth seems to have been brought about

[15] One of the referees pointed out that the endogeneity problem could arise in the estimation of the model specified in Eq. (6) since some of the moderator variables in this equation enter the computation of efficiency scores. Taking this issue into account, we also estimated the model's parameters using the GMM method. More specifically, the two-step GMM-system estimator developed by Arellano – Bover (1995) and Blundell – Bond (1998) was used to control for the possible endogeneity problem in the model. The results of the regression are very similar with the results presented in *Table 7*. To be consistent with the related literature, the regression results are not presented. However, they are available from the authors upon request.

Table 8. Total factor productivity

Year	Technical efficiency change (TE)	Technical change (TC)	Pure efficiency change (PE)	Scale efficiency change (SE)	TFP change
2000/2001	0.824	1.260	0.847	0.973	1.038
2001/2002	0.951	1.060	0.987	0.964	1.008
2002/2003	1.057	0.927	1.017	1.040	0.979
2003/2004	0.983	1.048	1.004	0.980	1.031
2004/2005	1.005	1.076	0.982	1.023	1.081
2005/2006	1.050	1.009	1.045	1.004	1.059
2006/2007	0.983	0.939	1.016	0.967	0.923
2007/2008	0.962	1.020	0.980	0.981	0.981
2008/2009	0.828	1.349	0.904	0.916	1.117
2009/2010	0.779	0.997	0.823	0.947	0.776
2010/2011	1.169	0.957	1.089	1.074	1.119
2011/2012	1.091	1.013	1.103	0.989	1.105
2012/2013	0.993	1.120	1.010	0.983	1.112
Overall	0.969	1.054	0.982	0.987	1.021

mainly by a positive technical change (5.4%). These results are consistent with the findings of Mukherjee et al. (2001), Casu et al. (2004), and Kasman et al. (2013) that examined the productivity of banks operating in the US and EU member countries, where technical change was found to drive the productivity growth. In addition, the results indicate that Kazakh banks do not exploit the catching-up effect and the size of technical change is generally greater than the size of the technical efficiency change over the sample period. The results also show that Kazakh banks are scale inefficient.

The high technical change as a composition of productivity growth is attributed to the extensive level of investment in capital by Kazakh banks. On the one hand, the period 2000–2007 can be characterised as the high economic growth period in which the economy demanded more banking services, and therefore banks extended their branches around the country to provide services faster. This led banks to increase their investment spending on the acquisition of new buildings (or rental expenses), hardware, software, and hiring more personnel. On the other hand, rapid developments and the availability of information technology have resulted in many new financial products and services such as bank credit and debit cards, electronic banking, commercial paper market, and securitisation. To stay competitive in the market, banks had to invest heavily in new technology and in setting up electronic banking facilities during the last decade. These developments increased both banks' fixed costs and the time period that was required for the fully utilised advanced technology to enhance efficiency. It is expected

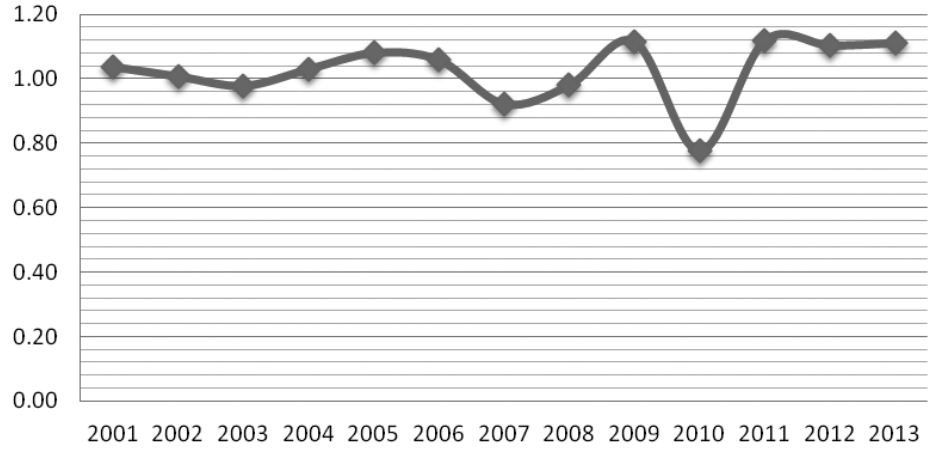

Figure 1. Evolution of TFP change

that banks would significantly improve their cost structures and raise efficiency in the near future as the costs of telecommunications continuously decrease.

The evolution of mean TFP change is presented in *Figure 1*. The mean TFP change fluctuates along the 14 years of our sample. Although there does not seem to be a clear trend, Kazakh banks have become more productive between 2002–2005 and less productive between 2005–2007. The negative impact of the global financial crisis on the TFP change can be observed in 2009/2010, when the latter decreased by nearly 30%.

5. CONCLUSION

The banking system of Kazakhstan has its own peculiarities and development path. It has undergone structural transformation from being a planned to a market-oriented one. Due to the lack of effective regulation and proper law in licensing in the early years of independence, the number of commercial banks rapidly increased. However, with the establishment of the NBK, the sector has gradually become modern and competitive. Hence, the objective of this paper is to calculate the technical efficiency and productivity of the commercial banks over the period 2000–2013.

The results indicate that the mean technical efficiency level in the Kazakh banking system is 0.838, suggesting that the banks in the sample have to increase their efficiency level by 16.2% to be able to operate on the efficiency frontier. The

source of the overall inefficiency lies in the excess use of resources and output shortfalls. Large banks seem to be more efficient than smaller ones. Considering the existence of economies of scale for all bank size categories, a greater consolidation of small- and medium-sized banks would bring more cost advantages to the sector. Hence, it could be suggested that increasing the scale of operations of banks, which would improve banks' efficiency, should take place in the form of extending production levels by promoting mergers and acquisition activities among the small and medium-sized banks.

Foreign banks were found to allocate their resources more efficiently as compared to domestic banks. Hence, the entry of foreign banks should be encouraged, which could improve the performance of banks by providing a wider range of financial services. This could also increase competition, the quality of services, and the availability of financial products in the sector. Foreign banks possess more sophisticated systems for evaluating and managing risks, more experience in the use of derivative products, and benefit from knowledge transfer through the higher skilled human capital. The global financial crisis also indicated that branches of foreign banks in Kazakhstan performed well relative to their local counterparts. While all three banks, which defaulted on their obligations during the crisis were domestic-majority owned, foreign banks managed to overcome the crisis with better key indicators and succeeded to maintain their NPL ratios at low levels. Overall, the presence of foreign banks in the system may also improve bank regulation and supervision, since these banks may demand improved systems of regulation and supervision from the regulatory authorities in the recipient countries. This may contribute to improving the quality of the banking operations of domestic banks.

To identify the determinants of efficiency, we fit a second stage regression, using the computed efficiency scores. The results suggest that efficient banks appear to have higher return on asset, liquidity, and equity ratios. The results also show that banks that invested more in securities tend to be more efficient and banks that have higher provision for loan losses, which is used as a proxy for nonperforming loans ratio, tend to be less efficient. Finally, the bank size has a significantly positive impact on bank efficiency.

As for the productivity growth, the results indicate that the Kazakh banking sector seems to have experienced a significant productivity growth during the sample period. The results also suggest that the improvement in productivity seems to have been brought about by technical change. Improvements in communication and data processing as well as the introduction of online banking during the last decade provided banks with opportunities to raise productivity and to begin delivering many services by electronic means. Even the smaller banks are automating increasingly more of their operations, and banking firms of all sizes are finding cost-effective ways to introduce new products and compete

more directly with each other. All of these trends suggest that cost control should be a central objective of bankers and that utilising resources in an efficient and effective manner will be of paramount importance to banking success.

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APPENDIX

The Malmquist TFP index measures the change in total output with respect to changes in the inputs. To avoid an arbitrary choice of reference technology, the input–oriented Malmquist productivity index is defined as the geometric mean of M (Fare et al. 1994):

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})} \times \frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})} \right]^{0.5} \quad \text{(A.1)}$$

where $M(\cdot)$ indicates the Malmquist productivity index and $D(\cdot)$ represents the distance function. A value of $M(\cdot)$ greater than 1 indicates a productivity growth between periods t and $t + 1$; a value less than 1 indicates a decline in productivity between periods t and $t + 1$, and a value equal to 1 indicates no change in productivity (Kasman et al. 2013).

A useful feature of the Malmquist index is that it enables us to decompose the change in TFP into a technical change (a shift of the production frontier) and efficiency change (movement towards the production frontier) components. Following Fare et al. (1994), this decomposition is defined as:

$$M\ (x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D^t(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})} \left[\frac{D^{t+1}(x^t, y^t)}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^{t+1}, y^{t+1})} \right]^{0.5}. \quad \text{(A.2)}$$

The ratio outside the brackets is referred to as technical efficiency change (TE), which measures the change in the efficiency of a bank relative to the best practice frontier. The term in the bracket indicates the technical change (TC) between periods t and $t + 1$. It reflects the improvement or deterioration of best practice banks. Both components can be greater than, less than, or equal to 1.

In the case of CRS production technology, as indicated above, there are only two sources of productivity growth: technical efficiency change and technical change. However, if the production technology exhibits variable returns to scale, VRS, there are two additional sources of productivity growth: pure technical efficiency change and scale efficiency change. Hence, the efficiency change shown in Eq. (A.2) can be decomposed into pure efficiency change (PE) and scale efficiency (SE) change. Using this decomposition, the Malmquist TFP index can be denoted as follows (Kasman et al. 2013):

$$M\ (x^{t+1}, y^{t+1}, x^t, y^t) = PE * SE * TC. \quad \text{(A.3)}$$

Table A.1. Average technical and scale efficiencies for individual banks over 2000–2013

No.	*Bank Name*	Input-oriented			Output-oriented		
		CRS TE	*VRS TE*	*Scale*	*CRS TE*	*VRS TE*	*Scale*
1	JSC Kazkommertsbank	0.998	1.000	0.998	0.998	1.000	0.998
2	JSC BTA Bank	0.752	0.876	0.847	0.752	0.908	0.808
3	JSC Alliance Bank	0.751	0.812	0.923	0.751	0.819	0.914
4	JSC Temirbank	0.668	0.737	0.897	0.668	0.760	0.869
5	JSC ATF Bank	0.746	0.820	0.909	0.746	0.826	0.902
6	Halyk Bank of Kazakhstan	0.835	0.995	0.839	0.835	0.997	0.837
7	JCS Bank CenterCredit	0.720	0.805	0.896	0.720	0.812	0.888
8	JSC Kaspi Bank	0.781	0.896	0.872	0.781	0.902	0.866
9	JCS Eurasian Bank	0.736	0.827	0.884	0.736	0.843	0.866
10	JSC Tsesnabank	0.640	0.723	0.884	0.640	0.748	0.854
11	Alfa Bank OJSC	0.862	0.896	0.958	0.862	0.903	0.949
12	JSC Delta Bank	0.686	0.736	0.932	0.686	0.738	0.928
13	JSC Kazinvestbank	0.631	0.679	0.928	0.631	0.699	0.901
14	JSC Nurbank	0.731	0.801	0.908	0.731	0.812	0.894
15	Zaman Bank	0.982	1.000	0.982	0.982	1.000	0.982
16	KZI Bank–Kaz Ziraat International Bank	0.890	0.955	0.928	0.890	0.968	0.916
17	SB JSC 'Sberbank of Russia'	0.710	0.863	0.838	0.710	0.868	0.834
18	JSC Asia Credit Bank	0.806	0.848	0.938	0.806	0.864	0.918
19	Qazaq Banki (former Senym–Bank)	0.676	0.748	0.900	0.676	0.753	0.888
20	SB JSC Punjab National Bank Kazakhstan	0.541	0.666	0.824	0.541	0.587	0.934
21	JSC Bank RBK	0.787	0.809	0.965	0.787	0.831	0.931
22	Citibank Kazakhstan	0.906	0.959	0.946	0.906	0.964	0.940
23	SB JSC HSBC Bank Kazakhstan	0.669	0.874	0.783	0.669	0.898	0.754
24	Bank Pozitiv (BHI Global Banking)	0.527	0.709	0.797	0.527	0.789	0.659
25	JSC RBS Kazakhstan	0.418	0.839	0.534	0.418	0.902	0.464
26	Home Credit Bank	0.721	0.933	0.769	0.721	0.910	0.809
27	JSC Capital Bank (former TAIB Kazakh Bank)	0.488	0.774	0.709	0.488	0.713	0.744
28	SB JSC Bank of China	1.000	1.000	1.000	1.000	1.000	1.000
29	Fortebank JSC (former Metrokombank)	0.365	0.418	0.867	0.365	0.482	0.750
30	Subsidiary JSC Bank VTB (Kazakhstan)	0.360	0.449	0.797	0.360	0.560	0.649

Note: CRS and VRS denote constant returns to scale and variable returns to scale, respectively.

Table A.2. Correlation matrix of efficiency correlates

	ROA	EQ	TL	DEP	LnTA	PLL	FINVEST	LIQUID
ROA	1							
EQ	0.024	1						
TL	0.043	0.059	1					
DEP	–0.104	–0.827	–0.161	1				
LnTA	0.009	–0.392	0.053	0.312	1			
PLL	–0.350	0.070	–0.083	0.033	0.058	1		
FINVEST	0.217	0.018	–0.793	0.058	–0.006	0.085	1	
LIQUID	–0.196	–0.027	–0.359	0.067	–0.135	–0.124	–0.201	1

Note: ROA, EQ, TL, DEP, LnTA, PLL, FINVEST, and LIQUID represent return on asset, the ratio of shareholders' equity to total assets, the ratio of total loans to total assets, the ratio of total deposits to total assets, the natural logarithm of total assets, the ratio of impairment for loan losses to total loans, the ratio of total investment securities to total assets, and the ratio of liquid assets (except securities) to total assets, respectively.