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The anatomy of bank performance during transition: A separate efficient frontier analysis of Ukrainian banks

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Abstract

By drawing on Ukrainian experience, this paper analyzes the anatomy of bank efficiency in a transitional economy. Acknowledging the vast disparities in the business technology of different size banks, in this comprehensive study, we innovatively estimate group-specific (distinct) frontiers for small, medium, and large size banks. The results from separate frontiers reveal that Ukrainian banks record 38% technical inefficiency, 26% pure technical inefficiency, and 17% scale inefficiency on average. Apparently, banks in transition waste about the two fifths of their factor inputs during the production of financial services. The cardinal source of sub-performance in transitional banks seems to be managerial inefficiencies. We also found that banks operating in areas with more political influence and more developed infrastructure outperform the banks operating in politically and economically weaker regions. The results also indicate that larger banks, enjoying public trust in a risky business climate, dominate smaller banks in all forms of efficiency. However, such bias for size causes large banks to suffer from decreasing returns to scale and small banks from idle capacity. Consequently, the policies promoting consolidation between small and large banks may alleviate the excess (idle) capacity for large (small) banks in a transitional economy.

Keywords: *Ukraine, transition countries, bank efficiency, separate frontier*

JEL classification: *G2; D2; G21; G2*

Introduction

The significance of financial industry development and privatization received renewed attention in the context of economic restructuring of transition economies. Over the last two decades, the banking sectors in the post-Soviet transition economies have gradually evolved from the traditional mono-bank system of the central-planning period to a Western-style, geographically and sectorally diversified, two-tiered system of today. New financial markets, institutions, and channels of intermediation have been established almost from scratch. The governments of transitional economies spent enormous amounts of resources to develop a competitive and efficient banking system based on market principles (Yildirim and Phillipatos, 2002; Kyj and Isik, 2008; Fang et al., 2011). The road to a market economy for former Soviet bloc countries has required significant economic and political transformation. Some countries have quickly instituted reforms and attracted the necessary foreign investments for growth and development. Others have been less successful in increasing the transparency of their policies and financial institutions and have been less attractive to foreign investors. With a low level of foreign investment and undeveloped capital markets, some transition countries have had to rely to a significant degree on their own bank-based financial systems for investment capital. Ukraine, with an unsteady history of both economic and legal reforms, has had one of the lowest levels of foreign capital investments and has had to rely on its own internal sources of financing.¹

When compared to other countries in Eastern and Central Europe, Ukraine has many more banks. Thus, one can expect that the existence of many banks may lead to greater competition and augmented degrees of efficiency. Although the Ukrainian banking system is different from most banking markets, given the large number of banks in existence, the Ukrainian bank market is similar to other transition economies in that the market in Ukraine is narrow and shallow; market participants for financial products have been few; information imperfections are substantial, regulations are inadequate and often have been used for purposes other than the soundness of the financial system. Banks in transition economies usually face issues that revolve around competition from better-capitalized foreign banks since these banks have access to inexpensive capital, technology, and more developed customer relations. This has not been the case in Ukraine since foreign penetration into the Ukrainian bank market has been low and segmented, servicing mostly foreign customers. Bank markets in transition and emerging economies also differ considerably from those in industrialized economies. For instance, in most transitional countries, institutions are limited in number and type, thus competition is weak; capital markets are narrow and shallow; market participants for financial products are few; information imperfections are substantial, thus transaction costs are high; regulations are inadequate and often used for other purposes than the soundness of the financial system; and the underlying economies are relatively poor and unsophisticated. In addition, banking sectors of these economies are highly concentrated. It is possible that banks of concentrated markets become less motivated to operate efficiently and productively, as they do not face strong competition from new banks and non-bank financial institutions. The lack of developed money and capital markets also provides comfort for banks of transition countries, as “disintermediation” from depositors and borrowers does not threaten their business as in developed markets. Hence, studies from different regulatory environments and market structures may let us learn the impact of these differences on bank performance.

Two cross-country studies (Grigorian and Manole, 2002; Fries and Taci, 2005) found Ukrainian banks to be among the least efficient ones. Grigorian and Manole (2002) covered 17 Eastern European countries and found significant positive correlations between cost efficiency and GDP per capita and banking market concentration. Fries and Taci (2005) covered 15 post-communist countries (including Ukraine), and found that the level of overall economic development is not significantly related to costs. Their study included a range of countries from Ukraine with a per capita GDP of US\$750 to Slovenia with US\$9441. Although Yildirim and Phillipatos (2002) do not include Ukraine they found a significant positive association between bank costs and real GDP growth. They also found that large banks in transition economies operate in a relatively more competitive environment compared to small banks. Competition is lower in local markets

¹ According to Serhij Tyhytko, the President of the National Bank of Ukraine in 2003, as late as in 2003 the expectation was that the Ukrainian banking system would provide 52.4 billion UAH in credit to business enterprises in Ukraine, and only 4.2 billion UAH would come in as foreign investments.

compared to national and international markets. In a country specific study, Mertens and Urga (2001) evaluated the development of the Ukrainian banking system using a one-year sample (the crisis year 1998) and found that small banks were more cost and scale efficient but less profit efficient than large banks. In their multivariate regression analysis, Kyj and Isik (2008) found that foreign banks with local partners outperform other organizational formats in terms of managerial and scale x-efficiency. They also observed that many small banks are in need of immediate growth to reap economies of scale. They accordingly suggested consolidation policies in the market through mergers and acquisitions to improve the operational performance of the banking industry in Ukraine. In a recent working paper, Pylypiv (2011) measuring a single efficiency index, namely input efficiency, tried to understand what determines the variations in this index and the causes of failures among the Ukrainian banks. She found that input efficiency declined from 2004 to 2007 and then improved from 2008 to 2010. She also reported that foreign banks and small banks are more likely to fail.

Although Ukrainian banks are very small by world standards, there are major differences in their purpose. Some have developed from the old Soviet system banks while other, so-called “pocket banks”, are newly established to service specific clients. Most of the above-mentioned studies, including the Mertens and Urga (2001), Kyj and Isik (2008) and Pylypiv (2011) studies, employ a standard approach and construct common frontiers. The results of a common frontier approach may be difficult to interpret in cases where banks operate in different environments, or banks of different size have different objectives or employ different production technologies (Elyasiani and Mehdian, 1992; Isik et al., 2016a, b). We examine the productive efficiency performance of Ukrainian banks during the mid-transition period (1998-2003) by employing a highly flexible non-stochastic approach, Data Envelopment Analysis (DEA), and consider the technical, pure technical and scale efficiencies of Ukrainian banks by forming separate frontiers for the small, medium, and large sized Ukrainian banks. Because Ukraine gained its independence in 1991 from the Soviet Union in the aftermath of its dissolution at the end of the Cold War, we purposefully selected this mid-transition period to allow the country to overcome the initial tumultuous years of transition to a market economy from a command economy. Also, we wished to give enough time to its banking industry to season and mature, because one goal of this paper is to examine the association between bank performance and experience as measured by the age of banking firms. Furthermore, the period that greeted the new millennium, especially after the so-called Orange Revolution in 2005, is characterized with political and economic disruptions, social unrests, and regional wars, which could hamper a sound and reliable performance analysis. After all, in a highly risky business environment, the efficiency of banks should be of a lesser concern for both state and populace, as one cannot expect smooth functioning from a banking industry, whose survival is critically dependent upon law and order.

Literature Review

Ukrainian Banks during her Transition to the Market Economy

Being part of the former Soviet Union, Ukraine had no tradition of an independent banking system even on the level of other central and east European countries. Before 1989, the Soviet banking system consisted of republican branch banks of the main soviet banks.² Between 1989 and 1991 an attempt was made in the Soviet Union to separate commercial banking from the Central Bank by allowing the creation of a number of small commercial banks and credit cooperatives. Ukraine’s banking system began its new independent era in 1991; during that year, the Ukrainian branch of Central Bank of the Soviet Union, Hosbank, was reorganized as the National Bank of Ukraine (NBU) and the initial Law of Ukraine (“On Banks and Banking Activities”) was hastily adopted. Initially the general license for banking operations and a license for foreign currency transactions was all that was required. Over the years the law has gone through numerous amendments (February 1, 1996; January 17, 2001; September 20, 2001; November 28, 2002; February 6, 2003; May 22, 2003; June 5, 2003; November 20, 2003; June 22, 2004). Initially no specific permits were required to conduct various operations. Capital requirements were very low and no oversight was conducted to determine the sources of capital. As a result, by 1995 the NBU had registered 238 banks.

² *The main Soviet banks were headquartered in Moscow with a branch in each of the 15 republics.*

Table 1 presents descriptive statistics of the Ukrainian banking industry for 1998 to 2003. Although still at very low levels, total assets in real terms have grown almost six-fold during this six-year period. On the other hand, equity has not kept up, falling from 23% to 13% of total assets. Individual deposits have caught up with business deposits reflecting the growth in the economy and/or that the relationship based banking is steadily building up trust among the population. As interest income has decreased, commission income has increased. The inflation from 1992 to 1995, during which banks were allowed to borrow long from the NBU and to lend short, and the multiple exchange rate in these years resulted in banks earning well above-normal profits. This resulted in hundreds of banks being established, with 238 having been established by January 1995, and 311 by early 2004. Many of the banks were established by enterprises for the purpose of servicing those enterprises. The pace has slowed down considerably with only 15 new banks being established in the five-year span from 2000 to 2004. One of the most important and initially profitable assets for Ukrainian banks had been their state debt-holdings. Until 1998, this had provided good earnings for banks. However, when yields began to drop in 1998, the government stopped payments to commercial banks and restructured its obligations by extending their maturities, which resulted in banks losing a significant portion of their liquid assets (Andronov, 1998: 60).

Table 1: Descriptive statistics of the Ukrainian banking industry during transition

	1998	1999	2000	2001	2002	2003
Average TA (in 000s)	119701.11	157932.88	231805.71	310551.47	406981.16	638435.41
No of banks	179	161	153	152	157	157
No of branches	-	-	-	1447	1527	1538
Asset Str (% TA)						
Loans/TA	0.43	0.42	0.48	0.68	0.73	0.62
Investments/TA	0.09	0.07	0.05	0.09	0.07	0.04
Liability Str (% TA)						
Deposits/TA	0.37	0.49	0.51	0.55	0.61	0.67
Business dep/TA	0.22	0.31	0.33	0.31	0.31	-
Individual dep/TA	0.14	0.17	0.19	0.24	0.30	-
Equity/TA	0.23	0.23	0.17	0.17	0.16	0.13
Income Str (% TA)						
Revenue/TA	0.31	0.33	0.26	0.21	0.16	-
Interest inc/TA	0.21	0.20	0.16	0.15	0.11	-
Commision inc/TA	0.05	0.06	0.06	0.05	0.04	-
Currency inc/TA	0.04	0.06	-	-	-	-
Expense Str (% TA)						
Expenses/TA	0.29	0.31	0.26	0.20	0.15	-
Interest exp/TA	0.13	0.14	0.10	0.08	0.06	-
Commission exp/TA	0.02	0.02	0.02	0.01	0.00	-
Currency exp/TA	0.02	0.02	-	-	-	-
Labor exp/TA	0.03	0.03	0.03	0.03	0.04	0.02
Profitability Str						
Net interest inc/TA	0.08	0.06	0.06	0.07	0.05	0.05
Net commis inc/TA	0.03	0.04	0.04	0.04	0.04	0.03
ROA	0.02	0.02	0.00	0.01	0.01	0.01
ROE	0.10	0.09	0.01	0.07	0.07	0.06

All of the banks in Ukraine are considered very small by world standards. The group of “large” banks is made up of former state banks reorganized from the corresponding Soviet banks, and commercial banks that had their start in 1989 or the early nineties. In the 1990s many of these banks had a special relationship with the government: namely they were required to make loans to the state enterprises that had not yet been privatized and they held most of the government debt.³ These banks provided most of the

³ Large banks, especially system banks, have been closely linked to the government. Through the 1990s they contracted with the government to service budgetary receipts and payments. This line of business has decreased or ended for many with the

long-term credits to businesses in Ukraine, with half of the credits being extended to government enterprises. Many of the “small” banks do not serve the general public but are so called “pocket banks” founded by the owners of enterprises with the purpose of servicing their firms or the owners’ interests.

Licensing requirements, liquidations procedures, and capital requirements were established. In 1998, IAS were approved and required for the banking sector. The initial minimum capital requirement in the national currency was the equivalent of 500,000 USD, but the hyperinflation that began in 1993 led to the eventual devaluation of initial paid in capital to 3,000 USD in 1995. Although the NBU kept raising the capital requirement, existing banks were allowed to continue operations without meeting these requirements. By 1995 the paid in capital of 95% of the banks was below the minimum requirement. In these early days, characterized by minimal regulation,, multiple exchange rates and large differences between the rates that commercial banks received on loans and the rates paid on deposits, banking in Ukraine was extremely lucrative (see Table 2). Speculation of banks during those years led the Ukrainian Parliament in 1996 to amend the Banking Law in order to strengthen the NBU’s regulatory powers.⁴ With (Resolution of the Parliament of Ukraine #24/96-AD) Instruction No. 10, new licensing requirements, capital requirements, risk criteria and liquidations procedures were established. The capital requirement for new entrants was raised to ECU 1,000,000. For existing banks the requirements were much more lenient and a time line was extended by which they were required to reach the necessary capital: €100,000 by June 1, 1996; €250,000 by October 1, 1996; €500,000 by January 1, 1997; €750,000 by July 1, 1997; and €1,000,000 by January 1, 1998. The revision to the law impacting banks in January 2001 increased the capital requirements to €3 million for banks operating in one administrative region and to EUR million for banks operating throughout the country.

Together with these requirements, the NBU was given the right/ability to issue separate licenses for different banking operations and was authorized to withdraw operating licenses from banks that did not meet the capital requirements. However, the increased regulation did not solve the problems with the existing commercial banks, since the capital requirement was postponed for a year and exemptions were granted to existing banks. Pressure from regional politicians resulted in postponements being granted to some small regional banks that were unable to meet the minimum capital requirements or risk criteria, but most of these banks ultimately entered liquidation. Pressure from the central government led to postponements being granted to the former state banks (eight of which had been privatized) that had and were granting loans to state enterprises and other large banks with networks throughout the country. Small banks that were associated with large private firms were refused a grace period and had to come up with the capital requirements or their licenses were revoked. Interestingly, the higher capital requirements did not result in many consolidations.

Table 2: Commercial banks annual interest rates

Year	On loans	On deposits
1992	76	68
1993	221.1	187.3
1994	201.7	171.0
1995	107.1	64.2
1996	77	34.3
1997	49.1	18.2
1998	54.4	22.9
1999	53.6	20.8
2000	40.3	13.5
2001	31.9	11.2
2002	24.8	7.8
2003	17.7	7.8

Source: Bulletin National Bank of Ukraine, March 2005

establishment of the State Treasury. However, budgetary and NBU funds still made up from 9-16% of the liabilities of the system banks from 1998 – 2002, with these banks holding between 75%(1998, 2002) to 85% (1999) of these funds from 1998 to 2002.

⁴ *Early transition years also saw many foreign undercapitalized banks of questionable reputations that folded by 1998.*

Large banks were also the main losers from the decline in the Treasury bill market and devaluation of the national currency (hryvna) following the Russian bank crisis in 1998 and when legislation was enacted creating a moratorium on the seizing of collateral assets of state enterprises or enterprises that were partially owned by the state. Since foreign banks did not issue loans to Ukrainian banks, they did not have significant loans outstanding in August 1998 like the Russian banks did; however, Ukrainian banks did accept deposits in US dollars and provided credit to firms in foreign currency. The devaluation of the currency caused deterioration on many firms' balance sheets, making it difficult for the firms to repay their loans, which resulted in bad loans (37.8% as of August 1, 1998) on the balance sheets of Ukrainian banks (Kovtun, 1998: 1). As a result of the events of 1998, the "large" banks in Ukraine suffered the most. However, the tightening regulations required a much larger capital requirement for "small" banks. This can be seen in the differences between the composition of bank assets, liabilities and capital for the different sized banks in Table 3.

In 2003, equity to total assets of large, medium, and small banks were 11 percent, 21 percent, and 44 percent respectively. When compared to differences that exist among US commercial banks, these capitalization differences are much more significant (e.g.; 8%, 11% and 13% for the large, medium, and small US banks, respectively). Capitalization, the equity ratio ($EqTA$) measures both how well capitalized the banks are and how risky they are. Empirical studies usually found that well capitalized firms are more efficient (Berger and Mester, 1997; Isik and Hassan, 2002 and 2003). These size differences may play a role in defining bank efficiency. We posit that the Ukrainian banking system, although consisting of a relatively large number of banks, actually consisted of banks with different objectives that employed different production techniques and were treated differently by the NBU. Their cost structures are different and they should be analyzed separately, just as investment banks, commercial banks and savings banks in western economies are analyzed separately; a critical treatment discussed further below.

The Need for Separate Efficient Frontiers for Comparisons of Different Size Banks

Different sized banks may not be providing the same products or servicing the same type of customers. In fact, the banking literature reports several differences between large and small banks in the nature of their businesses (Aly et al., 1990; Berger and Mester, 1997; Isik and Hassan, 2002 and 2003; Isik et al., 2016b), which proclaim certain operational advantages for larger bank:

1. Large banks have more diversified portfolio of services. They serve many different markets, foreign or domestic, and offer more different services. Thus, they do not solely depend on a specific sector or a product as a source of revenue, which makes them more resilient against possible economic shocks.
2. Large banks are usually able to raise funds at lower cost. Unlike small banks, they have better access to various financial markets both abroad and inside. Besides, because of their well-diversified assets, they may carry less equity, which is difficult and expensive to obtain.
3. Large banks attract more astute management due to the resources available to them.
4. Large banks can invest in advanced technology and update their aging technology better than small banks. Because such investments are expensive, they require large transaction volume and customer base to validate the large costs.
5. Large banks usually operate in metropolitan areas, where competitive pressures are greater. Small banks usually operate in rural areas, small towns, and cities.
6. Large banks may utilize economies of scale opportunities because as the volume of bank outputs increases, the per unit costs decline.
7. Small banks tend to specialize in retail banking, while large banks tend to specialize in wholesale banking.
8. Small banks possess less complex organizational charts than large banks, thus, the internal relations in small banks are usually less formal. Large banks are red tape dominated to ensure the span of control.

Table 3: Average common sized balance sheets for Ukrainian banks in 2003

Balance Sheet Items	Large Banks	Medium Banks	Small Banks
Cash and balances with the NBU	0.08	0.08	0.09
Securities for refinancing with NBU	0.01	0.00	0.00
Due from other banks	0.14	0.15	0.16
Assets held in trading securities	0.02	0.02	0.06
Loans	0.65	0.61	0.53
Investment securities	0.01	0.03	0.03
Fixed and intangible assets	0.05	0.08	0.09
Accounts Receivable	0.01	0.01	0.02
Other assets	0.02	0.02	0.02
Total assets	1.00	1.00	1.00
Deposits of other banks	0.18	0.15	0.08
Deposits of clients	0.67	0.60	0.41
Other deposits	0.01	0.00	0.00
Debt securities issued by the Bank	0.00	0.00	0.00
Accrued expenses	0.01	0.01	0.00
Other liabilities	0.02	0.03	0.06
Total liabilities	0.89	0.79	0.55
Share capital	0.06	0.15	0.38
Treasury stock	0.00	0.00	0.00
Issue difference	0.00	0.00	0.01
Reserves and other Bank's funds	0.02	0.01	0.02
Revaluation of intangible assets	0.01	0.02	0.03
Retained earnings	0.02	0.03	0.01
Total equity capital	0.11	0.21	0.45
Total liabilities and equity capital	1.00	1.00	1.00

Because we do not know the technology (frontier) of the fully efficient firms in theory, we need to estimate it from the observations in practice. To this end, we compare all banks to the best practice banks on the frontier. A common frontier assumes similar technologies and products across banks. However, the purpose of providing investment capital and servicing to its owners, combined with different bank requirements, can result in different best practices isoquants for different sized banks.

A common frontier approach becomes difficult to interpret as the common frontier might then be misspecified giving rise to biased estimates of bank efficiency. In a comparison analysis of performance, data should only be pooled and efficiency measures calculated relative to a common frontier only when large and small banks share the same operating characteristics - legal treatment, goal, technology, organizational structure, culture, etc. However, as the banking literature suggests and as we saw in the previous section, the size of a bank (measured by its assets, deposits, or equity) can have a highly significant effect on its nature of business. Hence, when comparing the financial or operational performance of banking firms with one another, it is best to compare the banks of similar size. Similar size banks tend to offer the same or similar services, thus, one can be more confident that performance analyses have some validity.

As a result, some bank studies have attempted to figure out the average cost and efficiency for smaller banks separately from the cost and efficiency calculations for larger banks (Berger et al., 1987; Berger et al., 1993, Guzman, 2000; Hassan et al., 2010; Isik et al., 2016a, b). Although all banks in Ukraine can be classified as very small banks by world standards, as aforementioned, significant differences exist between relatively large and small banks in Ukraine in terms of organizational form, production location, service menu, and branching. As a matter of fact, Havrylchuk (2006) in her study of the Polish banking industry found efficiency scores for pure technical and scale efficiency to be significantly lower when using the

common frontier as compared to those for separate frontier when comparing domestic and foreign banks for the period 1997-2001.

Given these reasons, as a kind of unique treatment, we estimate a separate frontier for large, medium, and small banks for each year under study (1998-2003). So, every year, we compare every size bank to its own group specific frontier to avoid the challenge of comparing the “Davids” to “Goliaths” of banking. For this study, to estimate separate efficient frontier, we opted to use a highly flexible non-parametric frontier approach, an *input-orientated* DEA technique, to measure the technical efficiency scores of the Ukrainian banks.

The DEA linear programming model estimates a non-stochastic envelopment frontier over the data points such that all observed points lie on or below the frontier. Thus the frontier represents the set of best-practice observations for which no other decision making unit or linear combination of units employs as little or less of every input without changing the output quantities or produces as much or more of every output without altering the input quantities used.

Total technical efficiency (TE) includes both pure technical efficiency (PTE) and scale efficiency (SE); that is, efficient level of both inputs and outputs. Figure 2 illustrates the decomposition of TE into its components for one input (L: Labor) and one output (FA: Financial Assets). If we assume that all sizes of banks share the same technology and enjoy constant returns to scale (CRS), hence face no scale inefficiencies, we obtain the CRS frontier [*Omtn*]. If we relax the assumption of CRS, we attain the VRS frontier [*prstuv*] by assuming that banks may operate with variable returns to scale (VRS) due to some scale problems resulting from financial or market constraints. Let's assume that a small bank operates at point *f*. Adopting the input orientation, technical efficiency at point *f* is given by km/kf with respect to the CRS frontier and by ks/kf with respect the VRS frontier.⁵

The former index is called technical efficiency (TE), the latter is called pure technical efficiency (PTE) in the literature. However, while the point *s* on the VRS common frontier is deemed technically efficient, it is not scale efficient. This production level is an incorrect scale for cost minimization. Scale efficiency (SE) represents a proportional reduction in input usage if the bank can attain the optimum production level where there are constant returns to scale (CRS). Thus, if the bank can move from point *f* to *s*, it eliminates its pure managerial inefficiency, but if it can also move from point *s* to *m*, it also eradicates its scale inefficiency. Thus, $SE=km/ks$. It follows that $TE=PTE*SE$, i.e.; $(km/kf) = (ks/kf) * (km/ks)$.

On the other hand, if technologies (frontiers) of small and large banks are not the same, the efficiency measures for each group of banks have to be computed relative to a separate frontier constructed for that particular group. To illustrate the difference, consider the VRS frontiers in Figure 1, where *prstuv* and *abtc* represent the frontiers based on pooled (VRS common) and separate (VRS separate) frontiers respectively. The TE of bank *f* relative to these frontiers can be measured respectively as: $TE(\text{common}) = ks/kf$ and $TE(\text{separate}) = kb/kf$.

For the common and separate frontiers to be identical (coincide), the probability distribution functions of TE (common) and TE (separate) should coincide. However, given the reasons discussed above, there is a significant probability that banks of different sizes have distinct technology. Hence, in this study, we construct a separate frontier for small, medium, and large bank groups and compare each bank to its relative group specific frontier. For the least and the most efficient units in the sample, the efficiency indexes attain values between 0 and 1, respectively.

⁵ Technical efficiency (TE) measures whether a bank employs the minimum amount of inputs to produce a given amount of outputs, or, conversely, whether a bank produces the maximum level of outputs given fixed amount of inputs, as compared to banks operating on the efficient frontier. “Pure” technical efficiency (PTE) indicates a proportional reduction in input usage if inputs are not wasted given the current production level, which may be scale inefficient. Scale efficiency (SE) refers to a proportional reduction in input usage if the bank can attain the optimum production level, in which there are constant returns to scale (CRS). Thus, total TE includes both PTE and SE, that is to say, inefficient levels of both inputs and outputs.

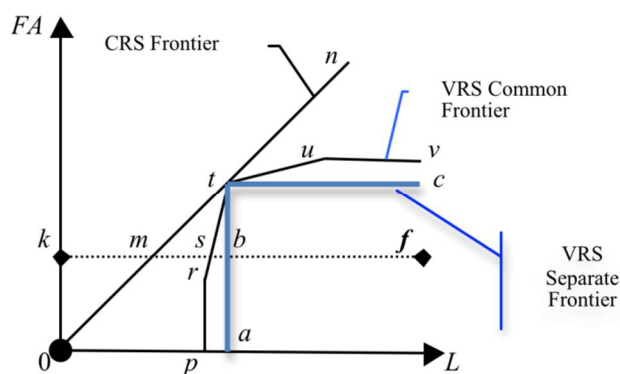


Figure 1: Technical efficiency measures under common and separate frontiers

Table 4: Sample selection for the efficiency measurement of the Ukrainian commercial banks

	1998	1999	2000	2001	2002	2003
Total # of observations	179	159	153	152	157	157
Eliminations						
UkrEximBank	1	1	1	1	1	1
One-year old banks	5	1	-	3	5	4
Zero inputs	27	7	5	4	3	1
Personnel expense	26	5	5	2	1	-
Funds	1	2	-	2	2	1
Zero outputs (both)	1	1	1	-	-	-
Net # of observations	145	149	146	144	148	151

Research and Methodology

It should be noted that although the above points regarding the performance of different sizes of banks have some merits, they should be empirically tested. They are just a priori (ex ante) true statements. Therefore, we test the following hypotheses employing a non-stochastic frontier approach, the DEA technique using separate frontiers:

H1: Within its group size, technical, pure technical, and scale efficiencies of large banks have increased since 1998.

H2: Because large banks operate in a more competitive environment, technical efficiency and pure technical efficiencies within this group are higher.

H3: There is no difference in scale efficiency among the different sized banks in Ukraine when separate frontiers are employed.

In order to measure bank efficiency and test the above hypotheses, we obtained balance sheet and profit/loss data from the NBU either directly or from *Visnyk*, a financial publication of the NBU, and from *Financovi Ryski*. Ownership data was purchased from a consulting firm in Ukraine. Except for the two state banks, Oshchadny Bank (savings) and UkrExImbank (foreign trade), all banks are considered private banks. As summarized in Table 4, for the six-year period, 957 observations were available; however, we excluded the two state banks, banks with missing data, and one-year old banks because they have quite erratic behavior and may not be in full operation in the first year.

That left 883 observations that met our criteria for inclusion in this study. For each year the number of banks available was divided into three groups: large, medium, and small.⁶ We model Ukrainian banks as multi-input and multi-output firms. There exist two approaches about what constitutes the inputs and outputs of banks in practice.

⁶ Descriptive statistics on the composition of bank balance sheet statements (percentage mix of bank sources and uses of funds for year-end 2003) are presented in Table 3.

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Table 5. Summary statistics of outputs and inputs for the Ukrainian banks during transition

		1998		1999		2000		2001		2002		2003		All	
		Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev
All															
	Loans	57825	179065	67231	185432	112149	263260	207067	456682	299403	711381	397345	981348	191284	565841
	Securities	11758	39901	12122	43109	12603	37276	29632	151090	28488	128408	24545	58825	19865	88879
	Funds	80749	226956	107729	278035	172064	425188	223459	567941	333191	807172	539920	1304177	244507	725274
	Capital	13913	56582	16019	58893	19986	63875	23138	64722	30366	78196	39619	99702	23930	72409
	Labor	4889	19139	5153	19662	7472	25768	10825	37872	13230	44427	15713	49765	9578	35116
Size															
LARGE	Loans	159982	286763	178075	295115	286826	408329	517457	696372	760562	1104780	1030579	1526074	492489	911147
	Securities	30802	65475	30916	71855	32511	60434	82027	255348	75577	216842	56901	93828	51505	149536
	Funds	224441	355108	294944	429657	458672	656939	584625	883012	869616	1245223	1427369	1998045	648230	1159412
	Capital	38076	94320	42100	98091	51141	105178	57583	104205	74960	124601	97257	158292	60429	117335
	Labor	13252	31855	13921	32774	19779	42584	28404	62308	34987	72874	41098	81112	25343	57930
MEDIUM	Loans	10780	6536	19713	11017	38539	17030	76080	25698	111291	33421	132062	46894	64781	53164
	Securities	3605	5604	3729	4556	3877	4662	4651	5784	6522	7441	11084	10427	5594	7197
	Funds	16424	9398	26802	13073	51957	16229	65881	25357	112493	34138	167289	57791	73660	60709
	Capital	2867	4098	4563	5232	6695	5421	7963	6489	11890	10610	16645	14623	8454	9724
	Labor	1069	685	1146	813	2071	1822	2821	2424	3695	2774	4867	3475	2613	2611
SMALL	Loans	3693	2061	6121	4335	14645	7965	27664	13019	31817	18637	36608	23669	20225	18850
	Securities	1036	1304	2098	2668	1826	2621	2220	3361	3868	5674	6021	8286	2876	4913
	Funds	2723	2278	5187	4194	11412	7882	19872	11833	23780	18757	35197	27618	16511	18762
	Capital	1025	1550	1914	2453	2758	3110	3867	4273	4771	5177	5633	5365	3350	4216
	Labor	426	272	566	321	816	584	1250	1046	1253	856	1458	1001	966	835

Table 5 (Cont'd) Summary statistics of outputs and inputs for the Ukrainian banks during transition

		1998		1999		2000		2001		2002		2003		All	
		Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev
Ownership															
DOMPUR E	Loans	59800	188327	73452	201779	112154	279253	200153	481419	285223	746270	370067	1028036	190130	603384
	Securities	12556	44815	13352	48547	12946	40385	32730	164202	29037	135851	22926	59710	20919	96859
	Funds	86429	245006	119961	304437	175642	452959	216755	599346	319550	847662	488572	1316107	242191	756868
	Capital	14957	61262	17527	64494	20865	67890	22529	65886	30630	81493	37119	98934	24391	75372
	Labor	5406	20809	5577	21363	7720	27112	10968	39568	13802	47061	14643	49691	9906	36950
DOMMAJ	Loans	162397	297235	112732	221748	150544	280929	239377	409064	251627	268692	310654	310372	199696	295849
	Securities	19893	30584	13549	18652	13319	21135	22677	49267	31925	57871	35956	40386	21947	37678
	Funds	185990	319691	164839	297559	245200	452921	269170	499328	295631	356762	432673	449684	258704	391743
	Capital	51015	96687	32174	68185	36135	73142	45479	93227	36889	70133	50826	82976	41029	75879
	Labor	15770	31743	10746	25436	14399	33661	18700	44611	10044	15832	15014	19721	14135	29585
FORMAJ	Loans	14294	9243	56259	36124	145192	120350	374304	82401	503810	187326	540266	248224	347821	261031
	Securities	5542	6153	14055	17369	5918	7643	8398	9585	21971	15718	49624	68535	23388	40656
	Funds	24485	32419	52822	8149	155143	137281	365021	121365	520366	184931	702403	341247	400549	329782
	Capital	6718	8398	10698	7512	13565	6867	30437	24452	36434	30840	47987	35711	30025	28464
	Labor	1685	2114	2375	1846	3748	1891	7433	4875	9550	9128	12984	9993	7888	7842
FORPUR E	Loans	30658	58077	55818	58221	158563	138777	321280	270121	528465	431068	695237	742958	302400	438707
	Securities	18922	16809	8961	15273	5368	11943	8185	10947	16850	23001	9119	13075	11119	15306
	Funds	51059	73746	87524	83491	191978	150085	358707	357194	550066	456601	825236	822423	350005	490728
	Capital	3923	2052	7092	7060	5805	3502	10878	9841	12958	13208	15336	14665	9431	9944
	Labor	2117	1099	3607	691	4444	1569	5783	3459	6908	3341	9484	4077	5451	3528

The *production approach* views banks as firms producing services - such as performing transactions and processing loan applications considers deposits as *output*. Noting that the process requires only physical inputs, such as labor and capital, the input vector (and thus total costs) should be exclusive of deposits (and related expenses). The *intermediation approach* considers deposits as *inputs* since it views banks as the conduit of funds between depositors and borrowers. Banks employ labor, capital, and deposits in their intermediation function. Thus, the input vector (and total costs) should include deposits (and related expenses in addition to operation costs). Because of the unavailability of data on the number of deposit and loan accounts, we adopted the intermediation approach when defining bank inputs and outputs in this study.⁷

Accordingly, under the intermediation approach, our output vector includes total loans and investment portfolio, whereas the input vector encompasses funds, capital, and labor. *Total loans* output incorporates all types of lending activities (both commercial/industrial credits and individual loans). *Investment portfolio* output contains other earning assets of banks such as marketable (public and private) securities. We proxy *loanable funds* input by all types of loanable funds (total liabilities less other liabilities). *Labor* input is measured by the sum of wages, salaries, and benefits paid for the full-time employees on the payroll. *Capital* input is approximated by the book value of fixed assets, such as headquarter buildings, branch offices, furniture and fixtures, computing equipments, ATMs, etc used in the production of banking services. All bank variables are in annual terms expressed in thousands of inflation adjusted Ukrainian currency (UAH).⁸ Table 5 presents descriptive statistics of input and output data for the whole industry (All), different sizes of banks (Size) and ownership forms (Ownership). As can be seen from the table, all input and output metrics are increasing over time, apparently reflecting the growth of the economy and level of financial intermediation in the country.

Discussion of the First Stage Empirical Results

In this study, following Kyj and Isik (2008), we divide the total sample of banks into three group sizes - with equal number of observations according their total assets – small banks (SMALLB), medium banks (MEDIUMB), and large banks (LARGE). We wished to have approximately an equal number of banks in each group because small sample size in a DEA study has the potential of yielding higher values of efficiency. Efficiency measures for each bank were obtained with relation to its own group (separate) frontier. Table 6 presents the mean values of separate frontier technical efficiency, (TE), pure technical efficiency, (PTE), and scale efficiency (SE) estimates, for each year from 1998 to 2003. When looking at the entire sample, the mean efficiency measures calculated relative to the separate frontiers average 0.618 for TE, 0.741 for PTE, and 0.826 for SE. The mean technical efficiency (TE) scores over the six years range from a low 0.481 in 1999 to a high of 0.741 in 2003, pure technical efficiency (PTE) from a low of 0.632 in 1999 to a high of 0.822 in 2003, and scale efficiency (SE) scores from a low of 0.766 in 1998 to a high of 0.891 in 2003. Technical *inefficiencies* in the Ukrainian banking are driven more by poor management decisions (PTE) than operating at incorrect scale (SE), but the gap appears to be narrowing.

Table 7 presents the TE, PTE, and SE for banks divided by size into small banks (SMALLB), medium banks (MEDIUMB), and large banks (LARGE) groups. Based on these raw efficiency scores over the six years, large and medium banks appear to have become more technically efficient, pure technically efficient, and scale efficient. Whereas in 1998, large banks on average wasted 0.62 of their resources by 2003 they were wasting only 0.19 of their resources. On the other hand, in 1998 small banks on the average were wasting 0.47 of their resources and by 2003 they were still wasting 0.39 of their resources. Competition appears to have increased all three mean technical efficiencies for large and medium banks. Concentration in the Ukrainian banking system has decreased over the years. The top 10 banks held 60% of all bank assets in 1998 and 54% in 2003. Empirical evidence shows that banks operating in less concentrated

⁷ Also, bad loans and off-balance sheet items can be added to the model to better explain the efficiency differentials across the banks, however, the insufficient data do not let us incorporate them into our analysis. Asides from them, future studies may also take into account state-debt holdings in explaining or measuring bank efficiency in Ukraine, as they are among the most important assets for some Ukrainian banks.

⁸ The exchange rate of the Ukrainian hryvna has been pegged to the US dollar over this period and inflation has been in the range from a high of 28.7 in 1999 to a low of 0.8 in 2002.

markets are more efficient (Berger and Hannan, 1998). The Russian bank crisis of 1998 appears to have had a short-lived effect on Ukrainian banks with efficiency scores for all three sized groups increasing after 1999.

Table 6: The anatomy of banking industry efficiency during transition in Ukraine – *separate frontier*

	Mean	Median	StdDev	Min	Max
1998					
TE	0.499	0.413	0.293	0.002	1.000
PTE	0.647	0.629	0.296	0.060	1.000
SE	0.766	0.857	0.242	0.012	1.000
1999					
TE	0.481	0.396	0.282	0.005	1.000
PTE	0.632	0.581	0.293	0.046	1.000
SE	0.772	0.850	0.236	0.105	1.000
2000					
TE	0.576	0.518	0.261	0.004	1.000
PTE	0.720	0.692	0.253	0.120	1.000
SE	0.799	0.868	0.204	0.009	1.000
2001					
TE	0.692	0.680	0.229	0.195	1.000
PTE	0.811	0.863	0.194	0.336	1.000
SE	0.849	0.892	0.167	0.296	1.000
2002					
TE	0.718	0.747	0.221	0.169	1.000
PTE	0.816	0.867	0.200	0.177	1.000
SE	0.878	0.929	0.145	0.369	1.000
2003					
TE	0.741	0.785	0.222	0.085	1.000
PTE	0.822	0.885	0.196	0.113	1.000
SE	0.891	0.952	0.130	0.368	1.000
All					
TE	0.618	0.621	0.273	0.002	1.000
PTE	0.741	0.789	0.255	0.046	1.000
SE	0.826	0.897	0.198	0.009	1.000

Table 8 presents the results by *ownership*. Based on raw efficiency scores, foreign banks [FORBNK] seem to dominate local banks [DOMBNK] in terms of TE, PTE and SE. Among the foreign ownership forms, those banks with some local ownership (majority foreign banks [FORMAJ]) outperform purely foreign owned foreign banks (pure foreign banks [DOMPURE]); perhaps having a domestic partner helps these banks to eliminate some operational problems in a lesser known market.

Table 9 exhibits the efficiency results by production location. The efficiency of a bank may be not determined primarily by how large its operations are or by who owns it, as the quality of its work force and economic conditions in its market area may be far more important to its success (Kyj and Isik, 2008). In other words, performance is substantially influenced by whether a bank operates in a major financial center, smaller city or rural area. In our sample, more than 50% of the banks in Ukraine are headquartered in the capital city Kiev.

We have 11 distinct locations in Ukraine, 9 regions where major cities are located and 2 “dummy” regions, one that represents all the areas east of Kiev, other east, and one that captures the areas west of Kiev, other west. The results indicate that the banks headquartered in industrialized regions are more TE [64% vs 59%] and PTE [77% vs 70%] than those headquartered in rural regions. Among the 11 regions, the most TE, PTE and SE region is Donetsk [75%, 84%, and 88%], a major industrial area; the least TE and PTE region is Lviv [46% and 55%] and the least SE region is other east [78%], relatively rural regions.

Table 7: The anatomy of bank efficiency during transition by size - separate frontier

	LARGEB			MEDIUMB			SMALLB		
	#	Mean	StdDev	#	Mean	StdDev	#	Mean	StdDev
1998									
TE	48	0.381	0.255	49	0.590	0.256	48	0.525	0.329
PTE	48	0.603	0.294	49	0.705	0.262	48	0.633	0.325
SE	48	0.658	0.261	49	0.820	0.212	48	0.818	0.219
1999									
TE	49	0.466	0.288	50	0.458	0.257	50	0.519	0.300
PTE	49	0.694	0.274	50	0.569	0.257	50	0.632	0.334
SE	49	0.675	0.273	50	0.812	0.206	50	0.827	0.196
2000									
TE	48	0.631	0.225	49	0.512	0.254	49	0.587	0.290
PTE	48	0.801	0.200	49	0.646	0.251	49	0.716	0.280
SE	48	0.794	0.206	49	0.789	0.212	49	0.813	0.197
2001									
TE	48	0.657	0.207	48	0.700	0.227	48	0.719	0.250
PTE	48	0.789	0.187	48	0.805	0.202	48	0.838	0.194
SE	48	0.833	0.152	48	0.864	0.151	48	0.851	0.196
2002									
TE	49	0.795	0.128	49	0.764	0.178	50	0.598	0.278
PTE	49	0.871	0.127	49	0.854	0.151	50	0.725	0.262
SE	49	0.915	0.091	49	0.897	0.134	50	0.822	0.180
2003									
TE	50	0.812	0.144	50	0.803	0.159	51	0.611	0.276
PTE	50	0.865	0.139	50	0.878	0.128	51	0.725	0.257
SE	50	0.941	0.083	50	0.912	0.098	51	0.822	0.164
All									
TE	292	0.625	0.266	295	0.637	0.257	296	0.593	0.293
PTE	292	0.771	0.231	295	0.742	0.241	296	0.711	0.285
SE	292	0.804	0.220	295	0.849	0.179	296	0.825	0.191

Both Donetsk and Kiev (although it includes the mining area), are not as depressed economically as the other regions. During this transition period there was a saying in Ukraine: "Look at Kiev separately from the rest of Ukraine". Donetsk has a controlling clan of oligarchs, which has been very powerful in the government administration in the capital. The competition among banks headquartered in Kiev may drive PTE (managerial efficiency). Donetsk and Odessa also show display more scale efficiency than Kiev. This is in line with the fact that Donetsk is the largest region by population, yet the number of banks headquartered in Donetsk is less than 10% of Kiev. According to *learning by doing hypothesis*, established banks are expected to dominate de novo banks in terms of performance (DeYoung and Hasan, 1998; Isik, 2008; Isik and Topuz, 2016). In order to understand the effect of bank age and experience on bank efficiency, we constructed Table 9, which presents the mean efficiencies of Ukrainian banks by age. As the banks might not be in full operation in their first years after foundation, we extracted one-year-old banks from the analysis. According to *learning by doing hypothesis*, established banks are expected to dominate de novo banks in terms of performance (DeYoung and Hasan, 1998; Isik, 2008; Isik and Topuz, 2016). In order to understand the effect of bank age and experience on bank efficiency, we constructed Table 9, which presents the mean efficiencies of Ukrainian banks by age. As the banks might not be in full operation in their first years after foundation, we extracted one-year-old banks from the analysis. It is clear that most of the Ukrainian banks are relatively young; the oldest bank is just 15 years of age. The banks with the highest TE (73%), PTE (82%) and SE (90%) scores are 14 years old, while the banks with the lowest TE (52%), PTE (71%) and SE (70%) are 3 years old. Because, in addition to size, ownership, location, and age variables, there may be other factors involved at play, the efficiency differentials between these organizational forms will be further analyzed in the second stage analysis in a multivariate regression framework.

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Table 8: The anatomy of bank efficiency during transition by *ownership* - separate frontier

	Pure Domestic Banks[DOMPURE] [1]			Majority Domestic Banks[DOMMAJ] [2]			Majority Foreign Banks[FORMAJ] [3]			Pure Foreign Banks[FORPURE] [4]			Domestic Banks [DOMBNK] [1+2]			Foreign Banks [FORBNK] [3+4]		
	#	Mean	StdDev	#	Mean	StdDev	#	Mean	StdDev	#	Mean	StdDev	#	Mean	StdDev	#	Mean	StdDev
1998																		
TE	111	0.492	0.286	5	0.465	0.201	2	0.504	0.409	6	0.528	0.335	118	0.485	0.284	8	0.522	0.323
PTE	111	0.643	0.286	5	0.712	0.276	2	0.625	0.531	6	0.734	0.291	118	0.639	0.288	8	0.707	0.321
SE	111	0.760	0.244	5	0.699	0.256	2	0.829	0.050	6	0.642	0.329	118	0.758	0.243	8	0.689	0.292
1999																		
TE	115	0.482	0.264	8	0.321	0.168	2	0.567	0.613	7	0.517	0.357	124	0.476	0.265	9	0.528	0.378
PTE	115	0.632	0.281	8	0.549	0.295	2	0.757	0.344	7	0.805	0.230	124	0.630	0.282	9	0.794	0.235
SE	115	0.770	0.228	8	0.667	0.253	2	0.630	0.523	7	0.646	0.367	124	0.765	0.230	9	0.642	0.368
2000																		
TE	120	0.562	0.254	8	0.502	0.224	3	0.691	0.345	6	0.646	0.341	128	0.558	0.252	9	0.661	0.321
PTE	120	0.719	0.250	8	0.618	0.223	3	0.701	0.344	6	0.676	0.354	128	0.713	0.249	9	0.684	0.329
SE	120	0.781	0.211	8	0.822	0.169	3	0.984	0.015	6	0.962	0.042	128	0.783	0.208	9	0.969	0.036
2001																		
TE	121	0.691	0.228	9	0.597	0.257	3	0.700	0.203	6	0.741	0.228	130	0.685	0.231	9	0.727	0.208
PTE	121	0.804	0.197	9	0.782	0.202	3	0.869	0.227	6	0.866	0.178	130	0.803	0.196	9	0.867	0.181
SE	121	0.855	0.164	9	0.763	0.230	3	0.804	0.067	6	0.853	0.174	130	0.848	0.170	9	0.837	0.143
2002																		
TE	131	0.708	0.222	7	0.802	0.167	4	0.821	0.099	6	0.767	0.312	138	0.713	0.220	10	0.789	0.241
PTE	131	0.812	0.199	7	0.847	0.130	4	0.894	0.125	6	0.823	0.323	138	0.814	0.196	10	0.851	0.254
SE	131	0.870	0.149	7	0.942	0.085	4	0.923	0.051	6	0.937	0.110	138	0.874	0.148	10	0.931	0.088
2003																		
TE	131	0.738	0.219	5	0.727	0.178	6	0.867	0.114	7	0.792	0.320	138	0.733	0.219	13	0.826	0.241
PTE	131	0.826	0.191	5	0.763	0.141	6	0.930	0.083	7	0.799	0.317	138	0.819	0.192	13	0.860	0.240
SE	131	0.883	0.135	5	0.941	0.078	6	0.934	0.111	7	0.976	0.048	138	0.885	0.132	13	0.957	0.082
All																		
TE	729	0.618	0.266	42	0.560	0.253	20	0.740	0.258	38	0.664	0.318	776	0.614	0.266	58	0.690	0.299
PTE	729	0.744	0.247	42	0.707	0.234	20	0.831	0.235	38	0.785	0.275	776	0.740	0.248	58	0.801	0.260
SE	729	0.823	0.196	42	0.799	0.213	20	0.879	0.172	38	0.835	0.253	776	0.822	0.197	58	0.850	0.227

Developments in Returns to Scale of the Transitional Banks in Ukraine

Because scale inefficiency appears to be one of the major problems driving overall technical inefficiency of Ukrainian banks (by about 22%), it is worthwhile to focus on their returns to scale. Table 11 and 12 report the developments in the returns to scale of Ukrainian banks by size, ownership, and location. The law of diminishing returns refers to what occurs to output when a bank alters only one input, say labor or capital, and holds all other inputs constant. Whereas, *returns to scale (RTS)* tell us what happens to a bank's output if *all* inputs are changed. Thus, we define *RTS* as the increases in output that result from increasing all inputs by the same percentage. Obviously, there are three possible cases: 1) *increasing returns to scale (IRS)* occurs when 1% increase in inputs produces more than 1% increase in outputs; 2) *constant returns to scale (CRS)* occur when 1% increase in inputs results in exactly 1% increase in outputs; and 3) *decreasing returns to scale (DRS)* happen when 1% increase in inputs leads to less than 1% increase in outputs. Because a bank's cost curves are determined by its technology, whether a bank faces IRS, CRS, or DRS influences its long run costs. *Economies of scale* are present when, as output increases, long run average cost decreases. Whereas, *diseconomies of scale* are present, as output increases, long run average cost increases. Both IRS and DRS represent non-optimal output levels, thus scale inefficiencies.

Table 9: The anatomy of bank efficiency during transition *by geographic location* - separate frontier

Cities	Scores	1998		1999		2000		2001		2002		2003		All	
		#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean
PANEL A.															
1. Kiev	TE	72	0.468	74	0.464	75	0.603	75	0.711	77	0.734	79	0.759	452	0.626
	PTE	72	0.639	74	0.642	75	0.740	75	0.834	77	0.835	79	0.833	452	0.756
	SE	72	0.728	74	0.740	75	0.806	75	0.848	77	0.880	79	0.897	452	0.818
2. Kharkiv	TE	14	0.539	13	0.485	12	0.579	12	0.584	12	0.701	11	0.788	74	0.606
	PTE	14	0.610	13	0.618	12	0.718	12	0.730	12	0.814	11	0.885	74	0.722
	SE	14	0.828	13	0.750	12	0.767	12	0.792	12	0.849	11	0.879	74	0.810
3. Donetsk	TE	6	0.701	7	0.645	7	0.630	8	0.818	8	0.866	9	0.784	45	0.748
	PTE	6	0.840	7	0.773	7	0.735	8	0.884	8	0.938	9	0.852	45	0.841
	SE	6	0.812	7	0.830	7	0.869	8	0.930	8	0.914	9	0.909	45	0.882
4. Lviv	TE	5	0.333	6	0.309	4	0.385	4	0.541	4	0.615	4	0.676	27	0.459
	PTE	5	0.431	6	0.362	4	0.531	4	0.592	4	0.702	4	0.790	27	0.547
	SE	5	0.822	6	0.871	4	0.829	4	0.915	4	0.888	4	0.851	27	0.862
5. Crimea	TE	7	0.564	8	0.521	8	0.493	5	0.736	5	0.647	6	0.759	39	0.603
	PTE	7	0.730	8	0.610	8	0.722	5	0.750	5	0.729	6	0.799	39	0.717
	SE	7	0.783	8	0.836	8	0.684	5	0.966	5	0.881	6	0.938	39	0.833
6. Zaporizha	TE	5	0.371	6	0.477	6	0.589	5	0.636	5	0.835	4	0.859	31	0.614
	PTE	5	0.515	6	0.677	6	0.670	5	0.749	5	0.856	4	0.916	31	0.721
	SE	5	0.796	6	0.662	6	0.903	5	0.873	5	0.976	4	0.926	31	0.849
7. Politava	TE	2	0.347	3	0.392	3	0.636	3	0.670	3	0.590	3	0.581	17	0.547
	PTE	2	0.389	3	0.468	3	0.808	3	0.771	3	0.812	3	0.732	17	0.680
	SE	2	0.882	3	0.841	3	0.804	3	0.847	3	0.771	3	0.784	17	0.818

Table 9 (Cont'd): The anatomy of bank efficiency during transition by geographic location - separate frontier

Cities	Scor es	1998		1999		2000		2001		2002		2003		All	
		#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean
PANEL A.															
8. Odessa	TE	9	0.561	10	0.613	9	0.595	9	0.718	9	0.674	9	0.711	55	0.645
	PTE	9	0.679	10	0.690	9	0.688	9	0.829	9	0.756	9	0.738	55	0.729
	SE	9	0.781	10	0.896	9	0.859	9	0.839	9	0.882	9	0.951	55	0.869
9. Other east	TE	6	0.483	5	0.399	5	0.399	5	0.656	4	0.579	5	0.610	30	0.518
	PTE	6	0.653	5	0.461	5	0.637	5	0.886	4	0.695	5	0.727	30	0.675
	SE	6	0.749	5	0.906	5	0.668	5	0.723	4	0.817	5	0.833	30	0.780
10. Other west	TE	7	0.602	6	0.384	6	0.454	7	0.607	8	0.627	8	0.593	42	0.553
	PTE	7	0.731	6	0.554	6	0.554	7	0.780	8	0.727	8	0.737	42	0.689
	SE	7	0.806	6	0.710	6	0.848	7	0.792	8	0.869	8	0.825	42	0.812
11. Dnipropetrovsk	TE	10	0.573	11	0.551	11	0.595	11	0.702	12	0.697	12	0.736	67	0.645
	PTE	10	0.725	11	0.737	11	0.803	11	0.802	12	0.802	12	0.835	67	0.786
	SE	10	0.811	11	0.779	11	0.738	11	0.882	12	0.861	12	0.877	67	0.826
PANEL B.															
Industrialized	TE	88	0.496	92	0.488	93	0.604	94	0.719	96	0.738	100	0.759	563	0.638
[1+3+11]	PTE	88	0.662	92	0.663	93	0.747	94	0.834	96	0.838	100	0.835	563	0.766
	SE	88	0.743	92	0.751	93	0.802	94	0.859	96	0.879	100	0.896	563	0.824
Relatively rural	TE	55	0.507	57	0.470	53	0.527	50	0.641	52	0.682	51	0.707	318	0.585
[2+4+5+6+7+8	PTE	55	0.623	57	0.580	53	0.673	50	0.766	52	0.776	51	0.797	318	0.699
+9+10]	SE	55	0.802	57	0.805	53	0.792	50	0.832	52	0.875	51	0.881	318	0.830

Table 10: The anatomy of bank efficiency during transition *by age* - separate frontier

Age	Scores	1998		1999		2000		2001		2002		2003		All	
		#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean
2	TE	10	0.599	5	0.644	1	0.403	.	.	4	0.986	5	0.769	25	0.696
	PTE	10	0.728	5	0.781	1	0.574	.	.	4	1.000	5	0.863	25	0.803
	SE	10	0.693	5	0.776	1	0.703	.	.	4	0.986	5	0.863	25	0.791
3	TE	9	0.410	8	0.350	5	0.757	1	0.665	.	.	3	0.882	26	0.523
	PTE	9	0.590	8	0.714	5	0.804	1	0.774	.	.	3	0.938	26	0.717
	SE	9	0.684	8	0.453	5	0.932	1	0.859	.	.	3	0.932	26	0.696
4	TE	7	0.631	9	0.463	9	0.627	5	0.883	1	0.753	1	1.000	32	0.637
	PTE	7	0.686	9	0.630	9	0.672	5	1.000	1	0.853	1	1.000	32	0.730
	SE	7	0.876	9	0.752	9	0.937	5	0.883	1	0.883	1	1.000	32	0.864
5	TE	13	0.598	7	0.704	9	0.455	9	0.720	5	0.943	1	0.978	44	0.658
	PTE	13	0.687	7	0.788	9	0.710	9	0.806	5	1.000	1	1.000	44	0.775
	SE	13	0.885	7	0.905	9	0.668	9	0.894	5	0.943	1	0.978	44	0.854
6	TE	36	0.560	14	0.420	8	0.774	10	0.714	9	0.680	3	0.929	80	0.603
	PTE	36	0.657	14	0.518	8	0.933	10	0.879	9	0.778	3	0.930	80	0.712
	SE	36	0.832	14	0.807	8	0.817	10	0.816	9	0.878	3	0.999	80	0.835
7	TE	26	0.462	36	0.592	15	0.480	7	0.826	10	0.766	7	0.675	101	0.581
	PTE	26	0.677	36	0.724	15	0.651	7	0.940	10	0.827	7	0.779	101	0.730
	SE	26	0.693	36	0.811	15	0.736	7	0.876	10	0.922	7	0.859	101	0.788

Table 10 (Cont'd): The anatomy of bank efficiency during transition by age - separate frontier

Age	Scores	1998		1999		2000		2001		2002		2003		All	
		#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean	#	Mean
8	TE	28	0.401	26	0.461	33	0.748	16	0.727	5	0.766	9	0.772	117	0.601
	PTE	28	0.575	26	0.605	33	0.844	16	0.811	5	0.844	9	0.874	117	0.724
	SE	28	0.718	26	0.821	33	0.886	16	0.894	5	0.911	9	0.888	117	0.833
9	TE	8	0.463	28	0.380	24	0.525	32	0.801	16	0.693	5	0.710	113	0.595
	PTE	8	0.550	28	0.539	24	0.714	32	0.881	16	0.795	5	0.758	113	0.720
	SE	8	0.856	28	0.725	24	0.717	32	0.903	16	0.863	5	0.930	113	0.812
10	TE	7	0.392	8	0.445	24	0.442	23	0.648	33	0.771	15	0.730	110	0.620
	PTE	7	0.678	8	0.580	24	0.586	23	0.814	33	0.840	15	0.809	110	0.746
	SE	7	0.672	8	0.779	24	0.783	23	0.803	33	0.918	15	0.896	110	0.836
11	TE		.	7	0.319	11	0.526	22	0.589	24	0.637	33	0.760	97	0.632
	PTE		.	7	0.501	11	0.672	22	0.699	24	0.763	33	0.835	97	0.744
	SE		.	7	0.720	11	0.787	22	0.840	24	0.838	33	0.889	97	0.841
12	TE		.		.	7	0.448	12	0.567	21	0.658	24	0.689	64	0.630
	PTE		.		.	7	0.635	12	0.737	21	0.797	24	0.778	64	0.761
	SE		.		.	7	0.764	12	0.749	21	0.828	24	0.878	64	0.825
13	TE		.		.		.	7	0.463	12	0.608	32	0.729	51	0.664
	PTE		.		.		.	7	0.604	12	0.755	32	0.820	51	0.775
	SE		.		.		.	7	0.793	12	0.814	32	0.879	51	0.852
14	TE		.		.		.		.	7	0.759	4	0.687	11	0.733
	PTE		.		.		.		.	7	0.844	4	0.772	11	0.818
	SE		.		.		.		.	7	0.902	4	0.892	11	0.898
15	TE		.		.		.		.		.	6	0.715	6	0.715
	PTE		.		.		.		.		.	6	0.762	6	0.762
	SE		.		.		.		.		.	6	0.931	6	0.931

The results indicate that over the mid-transition period, 67% of the Ukrainian banks analyzed/included in sample have experienced DRS, 23% IRS, and 10% CRS. These results are indicating that regardless of size, location, and time, the vast majority of banks are operating at a non-optimal production point in their long run average cost curve in terms of inputs savings (either DRS or IRS) and suffering mainly from overproduction. It is clear that if these banks double their input sources, their outputs will less than double. It may be that the Ukrainian public with historical mistrust issues with banks favor large banks and bring about overcapacity in those banks. These results and existence of substantial number of banks in Ukraine with respect to other transition countries may mean that Ukraine is an over-banked market. One policy implication is that most Ukrainian banks may reap cost and input savings provided that they lower their production scales or if there were fewer banks in the system. Consolidation between non-large banks may yield the same desired efficiency gains. Policy makers may encourage mergers and acquisitions (M&As) between banks with DRS and banks with IRS as large banks with excess capacity may eliminate the idle capacity in smaller banks.

Table 11: The anatomy of banks' return to scale during transition *by size & ownership* - separate frontier

Groups	RTS	1998	1999	2000	2001	2002	2003	Total
All								
	CRS	16	15	17	11	15	14	88
	DRS	97	84	80	92	118	123	594
	IRS	32	50	49	41	15	14	201
	Total	145	149	146	144	148	151	883
Size								
LARGEB	CRS	6	3	2	2	3	4	20
	DRS	39	39	44	46	46	46	260
	IRS	3	7	2	0	0	0	12
	Total	48	49	48	48	49	50	292
MEDIUMB	CRS	4	6	6	4	4	1	25
	DRS	36	21	23	32	43	47	202
	IRS	9	23	20	12	2	2	68
	Total	49	50	49	48	49	50	295
SMALLB	CRS	6	6	9	5	8	9	43
	DRS	22	24	13	14	29	30	132
	IRS	20	20	27	29	13	12	121
	Total	48	50	49	48	50	51	296
Ownership								
DOMPURE	CRS	11	10	13	10	13	12	69
	DRS	79	66	61	73	105	106	490
	IRS	21	39	46	38	13	13	170
	Total	111	115	120	121	131	131	729
DOMMAJ	CRS	0	0	0	1	1	0	2
	DRS	5	6	7	7	5	5	35
	IRS	0	2	1	1	1	0	5
	Total	5	8	8	9	7	5	42
FORMAJ	CRS	0	0	0	0	0	0	0
	DRS	2	2	3	3	4	6	20
	IRS	0	0	0	0	0	0	0
	Total	2	2	3	3	4	6	20
FORPURE	CRS	1	1	2	0	1	2	7
	DRS	4	6	4	6	4	4	28
	IRS	1	0	0	0	1	1	3
	Total	6	7	6	6	6	7	38

Table 12: The anatomy of bank return to scale in during transition *by location* - separate frontier

City	RTS	1998	1999	2000	2001	2002	2003	Total
1. Kiev	CRS	8	9	9	5	8	8	47
	DRS	47	45	47	54	62	62	317
	IRS	17	20	19	16	7	9	88
	Total	72	74	75	75	77	79	452
2. Kharkiv	CRS	3	1	3	1	1	1	10
	DRS	8	5	5	7	11	10	46
	IRS	3	7	4	4	0	0	18
	Total	14	13	12	12	12	11	74
3. Donetsk	CRS	2	1	1	3	2	1	10
	DRS	3	4	2	4	6	7	26
	IRS	1	2	4	1	0	1	9
	Total	6	7	7	8	8	9	45
4. Lviv	DRS	5	4	3	3	4	4	23
	IRS	0	2	1	1	0	0	4
	Total	5	6	4	4	4	4	27
5. Crimea	CRS	0	2	1	0	0	1	4
	DRS	5	3	3	2	4	5	22
	IRS	2	3	4	3	1	0	13
	Total	7	8	8	5	5	6	39
6. Zaporizha	CRS	0	1	0	0	0	0	1
	DRS	4	3	5	4	5	4	25
	IRS	1	2	1	1	0	0	5
	Total	5	6	6	5	5	4	31
7. Politava	DRS	2	2	2	2	3	3	14
	IRS	0	1	1	1	0	0	3
	Total	2	3	3	3	3	3	17
8. Odessa	CRS	1	1	0	0	2	1	5
	DRS	7	6	5	4	6	7	35
	IRS	1	3	4	5	1	1	15
	Total	9	10	9	9	9	9	55
9. Other east	DRS	4	1	1	2	4	5	17
	IRS	2	4	4	3	0	0	13
	Total	6	5	5	5	4	5	30
10. Other west	CRS	0	0	1	0	1	0	2
	DRS	6	5	0	2	5	7	25
	IRS	1	1	5	5	2	1	15
	Total	7	6	6	7	8	8	42
11. Dnipropetrovsk	CRS	2	0	2	2	1	2	9
	DRS	6	6	7	8	8	8	43
	IRS	2	5	2	1	3	2	15
	Total	10	11	11	11	12	12	67

Discussion of the Second Stage Empirical Results

The variations of efficiencies (inefficiencies) across banks may be associated with factors that affect competition or create different environments under which banks operate; therefore, we examine what factors relate to the degree of efficiency (inefficiency). We use the conventional procedure. A point estimate of efficiency is obtained for each bank and then the estimated efficiency is regressed on/or correlated with a set of variables representing factors that may affect the efficiency (inefficiency) level. Because heteroscedasticity can emerge when estimated parameters are used as dependent variables, we do not apply ordinary least squares (OLS) (Saxonhouse, 1976). We follow Mester (1993) and Isik and Hassan (2003) and run generalized least squares (GLS) multiple regressions utilizing estimates of various efficiency (EFF) measures obtained in stage one as the dependent variables. Table 13 displays the multivariate regression results for Model 1 (a more parsimonious form) and Model 2 (a more detailed form) for

robustness check. Model statistics for multivariate regressions such as R-square, F-value and Durbin-Watson (DW) are also presented in the table.⁹ The independent variables are grouped into five main categories: 1) economic environment, 2) production scale, 3) ownership structure, 4) production location, and 5) other bank traits.

$$EFF_i = a_0 + a_1Yr99 + a_2Yr00 + a_3Yr01 + a_4Yr02 + a_5Yr03 + a_6MEDIUMB + a_7LARGE B + a_8FORBNK + a_9IndCities + a_{10}Ages-10 + a_{11}Ages-15 + a_{12}SecTA + a_{13}NonDepTA + a_{14}FeelncTA + a_{15}EqTA + a_{16}MarPower + a_{17}ProdDiv + e$$

Dummy variables Yr99, Yr00, Yr01, Yr02, and Yr03 (Yr98 is excluded as the base year) are used to account for the changes in the banking environment. The year variables basically represent the non-crisis years during which the economy grew and more years in the transition stage. All managerial efficiency indexes, TE, PTE, and SE, appear to have increased significantly, particularly so after 1999. During the 1990s a number of business schools were established in Ukraine and foreign governments and supranational organizations sponsored overseas training programs for young Ukrainian managers. Ukrainian economy turned around in 2000 and started to grow, when then led to positive impacts on bank's productive performance. As discussed in detail above, theoretically, larger banks might be more efficient since they may be able to hire a better management team, might be more closely monitored by their owners, and may be located in larger more competitive markets. Small banks may be inefficient because they operate under increasing returns to scale and may need to grow to reap economies of scale (Isik et al; 2016a,b).

Table 13. The anatomy of correlates of banking efficiency during transition – separate frontier

	TE			PTE			SE		
MODEL 1.	coeff.	t-stat	p-value	coeff.	t-stat	p-value	coeff.	t-stat	p-value
Constant		1.005	0.315		4.064	0.000		13.882	0.000
Yr99	0.035	0.944	0.346	0.041	1.050	0.294	0.026	0.612	0.541
Yr00	0.228	5.877	0.000	0.213	5.278	0.000	0.136	3.121	0.002
Yr01	0.410	10.141	0.000	0.373	8.882	0.000	0.227	4.998	0.000
Yr02	0.501	11.829	0.000	0.437	9.916	0.000	0.298	6.259	0.000
Yr03	0.620	13.678	0.000	0.526	11.165	0.000	0.362	7.111	0.000
MEDIUMB	0.283	6.801	0.000	0.247	5.719	0.000	0.154	3.289	0.001
LARGE B	0.347	6.636	0.000	0.295	5.430	0.000	0.180	3.058	0.002
FORBNK	-0.030	-0.941	0.347	-0.037	-1.132	0.258	0.012	0.326	0.744
Indust. Cities	0.020	0.671	0.503	0.043	1.375	0.169	-0.026	-0.768	0.443
Age6-10	-0.073	-1.661	0.097	-0.086	-1.880	0.060	0.024	0.497	0.619
Age11-15	-0.158	-3.129	0.002	-0.161	-3.075	0.002	-0.037	-0.658	0.511
SecTA	0.287	9.586	0.000	0.223	7.156	0.000	0.210	6.242	0.000
NonDepTA	0.251	7.284	0.000	0.250	6.963	0.000	0.045	1.153	0.249
FeelncTA	0.024	0.816	0.415	0.018	0.598	0.550	0.036	1.105	0.270
EqTA	0.392	8.052	0.000	0.426	8.423	0.000	0.070	1.276	0.202
MarPower	-0.003	-0.085	0.932	0.232	6.704	0.000	-0.249	-6.644	0.000
ProdDiv	-0.112	-3.689	0.000	-0.096	-3.066	0.002	-0.083	-2.443	0.015
R2	0.341		0.000		0.288	0.000		0.168	0.000
MODEL 2.	coeff.	t-stat	p-value	coeff.	t-stat	p-value	coeff.	t-stat	p-value
Constant		2.033	0.042		4.900	0.000		13.125	0.000
Yr99	0.044	1.193	0.233	0.048	1.247	0.213	0.029	0.686	0.493
Yr00	0.243	6.188	0.000	0.224	5.472	0.000	0.142	3.199	0.001
Yr01	0.427	10.274	0.000	0.387	8.919	0.000	0.230	4.877	0.000
Yr02	0.515	11.788	0.000	0.448	9.831	0.000	0.295	5.957	0.000
Yr03	0.628	13.741	0.000	0.533	11.176	0.000	0.351	6.769	0.000

⁹ Some panel data techniques, such as fixed effect or random effect models, may be employed to help better control for potential heterogeneity bias or the confounding effects of omitted variables that are stable over time. Taking this view into account, we have also run such models for robustness analysis. We observed that the results are fairly stable across models. For space, we have not reported those results. However, they are available from the authors upon request.

Table 13 (Cont'd): The anatomy of correlates of banking efficiency during transition – separate frontier

	TE			PTE			SE		
MEDIUMB	0.300	7.037	0.000	0.262	5.891	0.000	0.169	3.503	0.000
LARGEGB	0.354	6.621	0.000	0.303	5.429	0.000	0.193	3.179	0.002
DOMMAJ	-0.071	-2.444	0.015	-0.058	-1.897	0.058	-0.038	-1.160	0.246
FORMAJ	0.020	0.692	0.489	0.021	0.689	0.491	0.004	0.121	0.904
FORPURE	-0.064	-2.008	0.045	-0.067	-2.019	0.044	-0.004	-0.104	0.917
Kharkiv	0.034	1.111	0.267	0.022	0.693	0.488	-0.010	-0.297	0.767
Donetsk	0.070	2.351	0.019	0.050	1.616	0.107	0.051	1.503	0.133
Lviv	-0.038	-1.283	0.200	-0.079	-2.520	0.012	0.066	1.934	0.053
Crimea	-0.019	-0.634	0.526	-0.023	-0.722	0.471	0.002	0.072	0.943
Zaporizha	-0.016	-0.554	0.579	-0.022	-0.705	0.481	0.005	0.141	0.888
Politava	-0.013	-0.453	0.650	-0.007	-0.246	0.806	-0.002	-0.058	0.954
Odessa	0.053	1.757	0.079	0.010	0.331	0.741	0.083	2.439	0.015
OthEast	-0.037	-1.289	0.198	-0.022	-0.724	0.469	-0.021	-0.632	0.527
OthWest	-0.013	-0.429	0.668	-0.016	-0.505	0.614	0.014	0.400	0.689
Dnipropet.	0.015	0.508	0.612	0.016	0.517	0.605	0.024	0.721	0.471
SecTA	0.284	9.325	0.000	0.216	6.802	0.000	0.215	6.225	0.000
NonDepTA	0.245	7.016	0.000	0.247	6.791	0.000	0.039	0.973	0.331
FeelncTA	0.013	0.436	0.663	0.009	0.305	0.760	0.033	1.014	0.311
EqTA	0.386	7.830	0.000	0.424	8.248	0.000	0.068	1.222	0.222
MarPower	0.008	0.230	0.818	0.241	6.915	0.000	-0.248	-6.556	0.000
ProdDiv	-0.115	-3.734	0.000	-0.097	-3.015	0.003	-0.090	-2.556	0.011
Age	-0.140	-3.592	0.000	-0.134	-3.298	0.001	-0.031	-0.709	0.479
Adj-R2	0.354		0.000	0.297		0.000	0.169	0.000	
DW	1.694			1.579			1.783		
#	883			883			883		

Earlier studies on US banks have produced conflicting results. Cebenoyan et al. (1993), Mester (1993), Mester (1996), Berger and Hannan (1998), and Chang et al. (1998) did not find a significant relation between efficiency and bank size. Aly et al. (1990) found a significant relationship between size and pure technical efficiency yet no significant results for overall, technical, or allocative efficiencies. Berger et al. (1993) found scale efficiency, and Miller and Noulas (1996) found a positive relation between size and efficiency. Studies have also found significant negative relation between size and efficiency (Hermalin and Wallace (1994); DeYoung and Nolle (1996). Isik and Hassan (2003) found that medium Turkish banks are both more PTE and SE than small and large ones.¹⁰ We first ranked the Ukrainian banks according to their total assets, and then divided them into three equal size categories (in terms of number of observations): small banks, SMALLB (excluded from the regressions as the base group), medium banks, MEDIUMB, and large banks, LARGEGB. Dummy variables were used to present bank size to allow for nonmonotonicity and nonlinearities in the relationship between size and efficiency. The results indicate that larger banks (both medium and large) are more technically, pure technically, and scale efficient than small banks. The National Bank of Ukraine (NBU) defines four different sizes of banks. For a robustness check, the results were rerun with the National Bank of Ukraine's classification of small (SMALLB-NBU), medium (MEDIUMB-NBU), large (LARGEGB-NBU) and huge (HUGEGB-NBU) banks, as presented in Table 14. No differences were noted in the three efficiency scores between medium and small banks, and huge and small banks, but large banks were significantly more pure technically efficient and less scale efficient. All of the system banks are in the huge bank category. The results suggest that their special relation with the government provides them with monopoly power that may allow them to use too much input per unit of output.

¹⁰ Mertens and Urga (2001) found that for 1998 small banks in Ukraine were more cost efficient, but less profit efficient than large and medium banks. Small banks also operated under significant economies of scale, while large and medium ones operate under diseconomies.

Table 14: The anatomy of correlates of bank efficiency by NBU size variables – separate frontier

	TE			PTE			SE		
MODEL 1.	coeff.	t-stat	p-value	coeff.	t-stat	p-value	coeff.	t-stat	p-value
Constant		4.264	0.000		7.201	0.000		16.341	0.000
Yr99	0.019	0.483	0.629	0.023	0.585	0.559	0.022	0.527	0.598
Yr00	0.205	5.059	0.000	0.180	4.316	0.000	0.141	3.169	0.002
Yr01	0.415	9.341	0.000	0.375	8.161	0.000	0.231	4.739	0.000
Yr02	0.495	10.426	0.000	0.437	8.914	0.000	0.286	5.480	0.000
Yr03	0.614	12.393	0.000	0.515	10.074	0.000	0.362	6.669	0.000
MEDIUMB-NBU	0.104	2.509	0.012	0.068	1.583	0.114	0.080	1.765	0.078
LARGEB-NBU	0.120	2.694	0.007	0.137	2.969	0.003	0.008	0.168	0.867
HUGEB-NBU	-0.072	-1.332	0.183	0.033	0.590	0.555	-0.149	-2.501	0.013
FORBNK	-0.021	-0.643	0.521	-0.036	-1.063	0.288	0.024	0.677	0.498
Indust. Cities	0.032	1.025	0.305	0.051	1.610	0.108	-0.018	-0.529	0.597
Age6-10	-0.093	-2.068	0.039	-0.107	-2.312	0.021	0.019	0.376	0.707
Age11-15	-0.178	-3.453	0.001	-0.188	-3.531	0.000	-0.037	-0.654	0.513
SecTA	0.280	9.128	0.000	0.216	6.836	0.000	0.206	6.120	0.000
NonDepTA	0.227	6.413	0.000	0.222	6.066	0.000	0.040	1.025	0.306
FeelncTA	0.020	0.688	0.492	0.017	0.550	0.583	0.032	0.985	0.325
EqTA	0.230	5.287	0.000	0.285	6.363	0.000	-0.019	-0.409	0.683
MarPower	0.115	2.142	0.032	0.249	4.470	0.000	-0.093	-1.565	0.118
ProdDiv	-0.125	-4.042	0.000	-0.106	-3.321	0.001	-0.093	-2.733	0.006
R ²	0.308		0.000	0.263		0.000	0.167		0.000
MODEL 2.	coeff.	t-stat	p-value	coeff.	t-stat	p-value	coeff.	t-stat	p-value
Yr99	0.026	0.675	0.500	0.030	0.747	0.455	0.024	0.557	0.578
Yr00	0.218	5.327	0.000	0.191	4.527	0.000	0.143	3.171	0.002
Yr01	0.430	9.450	0.000	0.390	8.270	0.000	0.228	4.532	0.000
Yr02	0.509	10.435	0.000	0.452	8.962	0.000	0.277	5.139	0.000
Yr03	0.620	12.428	0.000	0.524	10.142	0.000	0.346	6.254	0.000
MEDIUMB-NBU	0.101	2.445	0.015	0.066	1.536	0.125	0.080	1.743	0.082
LARGEB-NBU	0.118	2.636	0.009	0.138	2.979	0.003	0.005	0.095	0.924
HUGEB-NBU	-0.056	-1.032	0.302	0.050	0.885	0.376	-0.144	-2.393	0.017
DOMMAJ	-0.050	-1.670	0.095	-0.044	-1.434	0.152	-0.020	-0.603	0.547
FORMAJ	0.023	0.758	0.449	0.020	0.626	0.532	0.012	0.349	0.727
FOPURE	-0.047	-1.442	0.150	-0.061	-1.798	0.073	0.016	0.455	0.649
Kharkiv	0.043	1.376	0.169	0.029	0.911	0.363	-0.005	-0.134	0.893
Donetsk	0.087	2.842	0.005	0.067	2.135	0.033	0.057	1.697	0.090
Lviv	-0.043	-1.394	0.164	-0.079	-2.481	0.013	0.059	1.740	0.082
Crimea	-0.018	-0.588	0.557	-0.019	-0.588	0.557	-0.001	-0.030	0.976
Zaporizha	0.002	0.079	0.937	-0.004	-0.132	0.895	0.014	0.426	0.670
Politava	-0.022	-0.759	0.448	-0.015	-0.502	0.616	-0.007	-0.225	0.822
Odessa	0.026	0.847	0.397	-0.013	-0.410	0.682	0.068	1.993	0.047
OthEast	-0.047	-1.597	0.111	-0.029	-0.944	0.345	-0.029	-0.867	0.386
OthWest	-0.031	-1.011	0.312	-0.029	-0.908	0.364	0.000	0.007	0.995
Dnipropet.	-0.007	-0.216	0.829	-0.001	-0.047	0.963	0.011	0.323	0.746
SecTA	0.272	8.722	0.000	0.206	6.381	0.000	0.208	6.012	0.000
NonDepTA	0.221	6.129	0.000	0.218	5.856	0.000	0.035	0.869	0.385
FeelncTA	0.008	0.274	0.784	0.007	0.238	0.812	0.028	0.849	0.396
EqTA	0.218	4.950	0.000	0.277	6.079	0.000	-0.028	-0.570	0.569
MarPower	0.111	2.065	0.039	0.244	4.383	0.000	-0.097	-1.629	0.104
ProdDiv	-0.125	-3.941	0.000	-0.102	-3.110	0.002	-0.099	-2.815	0.005
Age	-0.153	-3.790	0.000	-0.158	-3.785	0.000	-0.023	-0.514	0.608
Adj-R ²	0.319			0.271			0.166		0.000

Except for the two state banks, Oshchadny Bank (savings) and UkrExImbank (foreign trade), all banks are considered private banks. Four of the private and the two state banks are system banks as explained previously. As mentioned, UkrExImbank is not included in our sample. Although 114 of the private banks that operate are open stock companies and the others are closed stock companies, there is no structural difference between them since in the sample period none were publicly traded. For ownership structure, we consider domestic versus foreign ownership. Most of the early studies on domestic versus foreign bank profitability and cost efficiencies considered the US banking system. Early studies addressing scale and scope did not find significant differences in performance between domestic-owned and foreign-owned banks in the US (Haupt, 1983; Goldberg, 1982). Studies found that foreign-owned banks in the US had lower costs of capital and lower costs of funds (Zimmer and McCauley, 1991; McCauley and Seth. 1992; Terrel, 1993). Studies concentrated on the US banking system found domestic US banks to be more efficient than foreign-owned banks in the US (DeYoung and Nolle, 1996; Mahajan et al. 1996; Chang et al. 1998). Foreign banks appeared to trade efficiently for market share in the US. Studies on emerging countries have found foreign banks to be more efficient. Isik and Hassan (2002 and 2003) found that in Turkey foreign private banks are significantly more efficient than private domestic banks, but that public banks dominate both private domestic and private foreign.

The results from the studies on cost efficiency in European transition economies vary. Kraft and Tirtiroglu (1998) and Matousek and Taci (2002) did not find foreign banks in Croatia or in the Czech Republic, respectively, to be more cost efficient than domestic-owned banks. Hasan and Marton (2001) found foreign banks in Hungary to be significantly more profit efficient than domestic banks. Hungary's banking system is dominated by foreign capital with over 75% of the banks being foreign owned. Fries and Taci (2005), investigating 15 Central and Eastern European transition economies, found that the privatized majority owned foreign banks are more cost efficient than newly established foreign and domestic banks, with privatized majority domestic-owned banks being the least cost efficient. We divide Ukrainian banks into two categories and four sub-categories: DOMBNK, domestic ownership (DOMPURE, pure domestic and DOMMAJ, majority domestic), and FORBNK, foreign ownership (FORPURE, pure foreign and FORMAJ, majority foreign). Domestic ownership or pure domestic are used as the base dummy variables, respectively.

We find no significant differences in technical efficiency, pure technical efficiency and scale efficiency between domestic ownership and foreign ownership after controlling for other factors. When ownership is broken down into pure domestic, majority domestic, majority foreign, and pure foreign, majority domestic ownership appears to be significantly more technically and purely technically inefficient than pure domestic ownership. This may be as a result of a conflict between organizational culture of domestic managers (who are also usually domestic owners) and foreign owners. Purely foreign owned banks, which serve mostly foreign investors and do not compete with the local banks tend to also have lower TE and PTE, most likely due to information problems. As discussed, the efficiency of a bank may be not determined primarily by how large its operations are or by who owns it, as the quality of its work force and economic conditions in its market area may be of far greater importance to its success. To investigate the impact of geography on bank performance, we categorize bank headquarters by regions where major cities are located and where at least two banks were headquartered. Accordingly, we identified 11 districts in the country, with Kiev dummy being the base case. Multivariate regressions of efficiency indicate that pure technical efficiency in Lviv is negatively correlated with Kiev. Donetsk, a major industrial area, has a significantly positive correlation.

The composition of bank assets and liabilities and other bank traits may also play a role in defining bank efficiency. Therefore, we included the ratio of securities to total assets (SecTA), nondeposits to total assets (NonDepTA), fee income to total assets (FeeIncTA), equity to total assets (EqTA), market share (MarPower), product diversification (ProdDiv) and age to control for other factors that may drive bank efficiency. **Security investment (SecTA)**: Banks whose assets are substantially skewed towards investment securities can be found to be more technically efficiency than those investing mostly in loans as production of securities investment demands less labor and capital when compared to loans. Consistent with such expectations, we found that banks carrying relatively greater investment portfolio tends to have

more TE, PTE, and SE scores. **Use of purchased funds (NonDepTA)**: In addition, as a funding and liability management strategy, banks that proportionately make additional use of non-deposit sources can save substantially from capital and labor expenses and in turn may record higher technical efficiency. Retail banks that dominantly rely on core deposits to finance their assets should operate large branch networks and employ a larger workforce, which may raise overhead costs and lower technical efficiency. Accordingly, our results indicate that banks that utilize more purchased funds and less deposits are more technically and pure technically efficient.

Producing fee income (FeeIncTA): In recent years, banks have tried to diversify their revenue sources to rely less on interest income, which is very volatile and cyclic. Modern banks have discovered new ways to generate fee income such as foreign exchange trading commissions, fiduciary income, service charges on transaction deposits, money transfer, financial advising, securities underwriting, etc. Such non-traditional banking services can be provided using the same facilities and personnel allocated to traditional banking, which would increase the productivity and efficiency of factor inputs. Our results generally indicate a positive but statistically insignificant relationship between efficiency and fee income. **Capitalization (EqTA)**: The equity ratio measures both how well capitalized and how risky the banks are. Insolvency risk rises for banks with thinner capital cushion. The *moral hazard problem* postulates that with little investment stake to lose, owners of less capitalized firms tend to have less incentive to control and monitor management, aggravating agency costs and inefficiency in banks. Empirical studies usually report that well capitalized banks are more efficient (Berger and Mester, 1997). Our results confirm those earlier studies from other countries. The well-capitalized Ukrainian banks tend to significantly outclass less capitalized Ukrainian banks in terms of both TE and PTE. This finding may be associated with the lack of trust in commercial banks in the country. Because equity serves as *collateral* in the event of bank failure, the public chooses to bank with capially strong banks to reduce the risk of their savings loaned to these financial institutions.

Market power (MarPower): Market structure may be important in defining banking efficiency, as well. The Cournot model of oligopolistic behavior predicts that market power be positively related to profitability and efficiency, as banks with market power can charge higher prices, deter competition and transform more outputs per inputs (Berger 1995; Berger and Mester, 1997; Isik and Hassan, 2003; Isik et al., 2016a,b). We use market share of the bank in total assets of the industry (*MarPower*) to measure market power. Our results suggest that banks with greater market power seem to be significantly more pure technically efficient (PTE). Banks with greater market share tend to have lower scale efficiency. Evidently, their larger size results in decreasing returns to scale as most of the large banks in Ukraine were found to be suffering from excess production.

Product diversification (ProdDiv): Product diversity may result in higher operation efficiencies. Factors of production might be shared by several outputs; for example, a bank teller might serve both checking and saving accounts customers. Likewise, excess capacity on the bank's processing devices (i.e., computers) may help the bank enhance the scope of products it produces as well as its scale. Nevertheless, there might be a critical point at which scale diseconomies appear (i.e., producing many products increases the bank's unit costs). Having different product lines might require complicated hierarchical management structures and organizational forms that can increase the bank's costs and agency problems. There are a number of empirical studies, which investigated the impact of product diversity on efficiency. Aly and *et al.* (1990) found that product diversity is negatively related to cost (overall), allocative (AE), technical (TE), and pure technical (PTE) efficiencies of the US banks. Similarly, Ferrier *et al.* (1993) found that banks with greater product diversity tended to have lower cost efficiency. Also, in this line, Chaffai and Dietsch (1995) compared the efficiency of universal (less specialized) banks with that of non-universal (more specialized) banks in Europe and found that the former is less cost efficient than the latter. Likewise, Isik and Hassan (2003) reported a negative relationship between product diversification and efficiency for Turkish banks. On the contrary, DeYoung (1994) found that banks shifting from making bank loans to producing a broader mix of services experienced higher (not lower) efficiency. Our results imply that banks with greater diversification tend to have significantly lower TE, PTE, and SE. These results are consistent with the

majority of outcomes/findings from previously conducted studies. It seems that there are significant scope diseconomies (as well as scale diseconomies) in Ukrainian banking.

Bank Age (Age): In order to assess the role of bank age and experience on efficiency, we divided Ukrainian banks into three categories according to length of their existence: 2-5 years (*Age2-5* being the base dummy variable), 6-10 years (*Age6-10*), and 11 to 15 years (*Age11-15*). The results from both Model 1 and Model 2 suggest that there is a significant negative association between technical efficiency and bank age. The older the banks are (both *Age6-10* and *Age 11-15*), the less efficient they are, contradicting the findings of DeYoung and Hassan (1998) on US banks and confirming the findings of Isik (2008) on Turkish banks and the findings of Isik and Topuz (2016) on US REITs. New banks in Ukraine are coming into a more saturated competitive market, which is relationship based due to the basic mistrust of bankers that resulted from the inflation that wiped out savings in the years of transition. With the large number of banks, declining interest rates, and competition becoming fiercer as banks aggressively pursue the limited number of Ukrainian credit worthy companies, new banks must be more efficient to survive in this increasingly competitive market.

Conclusion

The transition from a command economy to a market economy has been difficult for Ukraine. With low external investment, most of the investment capital has been domestic. Since its independence in 1991, over 300 banks have been registered in Ukraine. These banks serve different functions; have different operating characteristics – scale, legal treatment, goal, technology, organization, culture, etc. Some of them are universal; others serve only their owners or western firms. Employing a highly flexible non-stochastic frontier approach, using three *separate frontiers* for three different sized groups, large, medium and small, we estimate technical efficiency, pure technical efficiency, and scale efficiency, and consider the impact of size, ownership, location, age, and other bank traits on these efficiency measures.

We find that although Ukrainian banks are relatively inefficient, their efficiency scores have increased significantly after the early years of transition, following Russia's debt moratorium and at the beginning of the new millennium. We also find that scores for large and medium banks have increased more than for small banks. Although all banks in Ukraine are very small by international standards, their relative size in Ukraine affects their efficiencies. Administrative and compliance requirements during the sample period resulted in voluminous documentation and red tape. The lack of trust of the populace that had lost everything in the early nineties has created a situation where expansion in the banking system could occur only through more staff and more physical structures. The mentality of overstaffing and over-employment still remains when no outside competition forces it to change. Although there are a relatively large number of banks in Ukraine with respect to other transition countries, the lack of strong foreign participation in the banking sector did not create a competitive climate that would lead to greater efficiency.

Ukraine may be overbanked because it appears to have too many undercapitalized and very small banks providing a plethora of services. To compete with the multinational banks that will inevitably come, large Ukrainian banks can grow by acquiring small banks that operate under increasing returns to scale. In doing so, large banks can transfer their better pure technical efficiency (managerial know-how) to their acquisitions. Likewise, small banks with their idle capacity and increasing returns to scale can trim the "fat" (excess scale) from the large acquirers. A similar policy recommendation from an earlier paper on Ukrainian banking (Mertens and Urga, 2001) supports the consolidation or downsizing requirement in this emerging economy. The results also indicate that in areas where few banks exist, pure technical efficiency is significantly lower, competition is weak and infrastructure is poor. Most banks in Ukraine are headquartered in the capital city Kiev. A substantial number of banks are headquartered in several of regions outside of Kiev. However, the branches of banks headquartered in other regions service more than ten of the twenty-five regions. In Ukraine, a headquartered bank invests on the average about 121 million UAH in the region where it is headquartered, but only 32 million UAH in the region where its branch is located (Patrikatz and Krochmaluk, 2004). Therefore, further geographic diversification of banks might not only increase scale efficiency but also economic development.

It should be noted that this paper is exploratory in nature for transitional banks. Thus, future papers on Ukrainian banking can be improved upon in several ways. They may apply a different efficiency technique, such as stochastic frontier approach, SFA, to the same data set to see if the results are robust against different assumptions. Likewise, given the input price data availability, other efficiency concepts, such as price efficiency or profit efficiency, can be computed to see how optimally Ukrainian banks choose the *mix* of inputs factors given their prices (allocative/price efficiency) and how effectively they control costs and boost earnings at the same time (profit efficiency). Also, reflecting the nature of modern banking today, off balance sheet activities can be incorporated into the measurement of efficiency when the data becomes available. Furthermore, our results reveal marked differences in average efficiency over time, thus the association between external factors and bank efficiency can be investigated further and closely by using macroeconomic variables such as GNP growth, inflation, interest rates, exchange rates, etc. Our results also signify some market power. Hence, future researchers can examine the impact of market structure in general and the degree of competition in particular on efficiency more thoroughly. This can be achieved by employing either traditional measures such as concentration ratios and Herfindahl-Hirschman index (HHI) or a more recent approach by Panzar and Rosee (1987). In addition, taking into account the shifts in production frontier over time, a more appropriate dynamic analysis of efficiency increase and technical progress in Ukrainian banking can be accomplished using the Malmquist-type total factor productivity change indexes.

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