THE DETERMINANTS OF BANK EFFICIENCY IN CENTRAL ASIA

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Abstract

This paper examines progress in the transition to a market economy of the banking sector of Central Asia (CA), a region that was late to take on reform and which has largely been ignored in the literature. A comparison to other previous Soviet Republics shows that the banks in the Baltic States have higher profit efficiency compared to those in CA. The results also suggest that state owned banks are less profit efficient than private banks although foreign ownership is not a factor in efficiency levels of banks in Central Asia.

Keywords: Profit Frontiers, Banking Sector Efficiency, Central Asia

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1. Introduction

The literature on emerging country financial systems has shown that a robust banking sector is important for transition countries. It can provide monetary payments at lower cost, mobilise and allocate funds in the most efficient way and improve saving and investment required for sustainable economic growth. However, these intermediation activities were absent in centrally planned economies. Thus, in the early stages of transition to a market economy two major reforms were required. The first was the introduction of a two-tier banking system to separate the central bank from the commercial banking sector. This also included the division of large industrial banks into smaller organisations to create competition in the sector. This resulted in a move away from a system where the primary goal of the banks was to transfer state funds to state-owned enterprises for investment projects approved by central planning to a system suitable for a market economy. The incumbent systems were inefficient in terms of resource allocation and the quality of banking supervision and risk assessment was poor. The second was the establishment of a system of financial intermediation to increase saving and investment. The importance of these reforms was recognised by the governments of all the transition economies. However, while the countries of Central and Eastern Europe and the Baltic States began structural reforms in the 1990's and have to a large extent created efficient banking sectors, in Central Asia this process is still being developed and is currently far from complete.

It has now been two decades since the collapse of the Soviet system and many previous centrally planned economies have established market-based economies with most countries following a similar approach to overcoming the legacy of the Soviet system. Although the speed and sequence of reform varied across countries, all were influenced by the World Bank and International Monetary Fund, the so called Washington consensus, which focused on liberalisation, stabilisation and the privatisation. The mono-banks were abolished and restrictions on internal convertibility of money removed, state control of interest rates was suspended and the privatisation of state-owned banks took place very early although with varying degrees of success (Fries and Taci, 2002).

At the initial stages of reform, the reduction of government subsidies to state enterprises adversely affected the real sector, which resulted in the accumulation of vast amounts of non-performing loans in the financial statements of newly established domestic banks. At the same time, liberal licensing policies governing the entry of new banks, weak regulatory and supervisory laws and a lack of experienced specialists in the banking sector contributed to a banking crisis in most transition countries during the 1990's (Marton and McCarthy, 2008). To avoid a complete collapse of the banking sector, transition governments were required to

oversee legislation that created new bank laws and prudential regulations to facilitate the development of the financial sector. It was also necessary to ensure their implementation, which including training for senior bank officers and central bank personnel. Some governments have been successful in establishing a sound banking sector, while in others high levels of inefficiency remain. There are a number of reasons for this, for example, the initial conditions were important factors in transition country privatisation programmes, but also the maturity of the institutions affected the robustness of the legal system while policy led reforms on interest rates, currency exchange and foreign trade liberalisation had a major influence on the success or failure of the banking system. But, perhaps the most important considerations related to the pre-Soviet history of these nations, an aspect which has been hitherto ignored in any discussion of economic transition.

There has been a plethora of research on the progress of the transition in Central and Eastern Europe, and more recently the Baltic States, particularly on the measurement of banking sector efficiency and models to determine the factors that influence best practice. However, the Central Asian countries have been largely neglected due to lack of data. Thus the objectives of this paper are first to investigate banking sector performance in Central Asia and secondly to explain the difference between efficiency of banks in Central Asia and in the Baltic States. The reason why such a comparison is interesting is that while they have very different histories, both groups of countries are previous constituent republics which were essentially ethnically based administrative units subordinated to the Soviet Union. Thus, they are very different from the countries of Central and Eastern Europe.

The analysis focuses on profit efficiency as the recent literature has moved from the estimation of cost and production functions and started to explore the measurement of efficiency using profit and revenue frontiers. Profit efficiency is concerned with both cost and revenue efficiency, but only under certain conditions would it be likely that the former will equal the sum of the latter. This is because cost (and revenue) efficiency presumes that the observed level of output (input) is already profit maximising, which may or may not be the case in practice, and particularly in countries where most markets are not fully competitive. In addition, there may be differences in the quality of some financial services that are not captured in the output measures. This may make high-quality producers appear to be cost inefficient because of the extra expenses associated with producing the higher quality output. Such a problem may be resolved by using a profit function because high quality should be rewarded in the market by extra revenue that offsets the extra expense.

Existing studies have already established the determinants of profit efficiency in Central Eastern European countries, including the Baltic States, however this has not been established for Central Asia and the region has not been included in any comparative analyses. This is now possible as there are sufficient years of data and the paper uses the most recent information available, which comprises 86 banks in total (48 from Central Asia and 38 from the Baltic States) for the period 1996-2011. The analysis progresses in two stages. The first is the estimation of a stochastic frontier profit function from which the efficiency levels are derived and comparisons made between the Baltic States and the Central Asian countries. The second models the determinants of profit efficiency for the Central Asian countries only as this is already established in the literature for the CEE countries and the Baltic States.

The paper proceeds as follows. Section II discusses the unique characteristics of Central Asia, explains why the region is interesting and important and different from the earlier reforming centrally planned economies and provides the motivation for the comparison with the Baltic States. This is followed by a brief outline of the nature of banking in the two regions. Section III reviews the literature on modelling bank performance and efficiency frontiers in the context of transition economies, including cost and profit functions, which is the approach taken in this paper. Section IV describes the models and data and compares the efficiency scores between the Baltic States and the countries of Central Asia. Section V discusses the results for the determinants of profit efficiency in the Central Asian banking sector. The last section concludes.

2. Characteristics of Central Asian Economies

During the last two decades, much research has focussed on the transition of the countries of Central and Eastern Europe from a system of central planning to a market economy. However, the countries of Central Asia have been largely ignored due to the lack of reliable information. Therefore, an analysis of the financial sector and level of economic development in Kazakhstan, Kyrgyz Republic, Tajikistan and Uzbekistan is timely. These countries are substantially different from both the early transition countries in Central and Eastern Europe and the other former USSR republics. First, Central Asia is rich in mineral and energy resources with all the benefits that result in terms of economic growth but also the potential internal conflicts associated with this. Second, Central Asia was the poorest region of the former Soviet Union. It was largely rural with very little general infrastructure and few large urban conurbations. Kazakhstan was the only republic with more than half of the population residing in urban areas and therefore the provision of banking services has historically been very sparse across the region. Thirdly, the region is geographically very extensive and political instability

from neighbours such as Afghanistan can be contagious and therefore ensuring economic growth is vital to retain social cohesion and sustained development. Finally, the Central Asian republics were controlled by the communist regime for more than seventy years. This resulted in the lack of a national collective memory of any other form of economic organisation or institutions in these countries and no experience of managing a domestic market economy prior to the collapse of the Soviet Union in 1991. Central Asia was the most conservative part of the Soviet Union and even during the Gorbachev era in the late 1980s when reforms to establish a market economy took place in several countries of Central and Eastern Europe and the Baltic States, these republics did not follow. This provides a sharp contrast to countries such as Hungary, Poland, Slovenia and the former Czechoslovakia, which only had a system of central planning for the period following the Second World War until the 1990s. This historical legacy has a huge impact on how quickly a market economy can be established and emphasises the importance of the historical background and initial conditions at the beginning of the transition in the direction and speed of financial sector development and its impact on economic growth.

Prior to transition, banking institutions in Central Asia and the Baltic States were essentially units of the Soviet banking network, that is, part of the monobank-type banking system. This was created by the banking reforms of 1930-32 and it was not until 1988 that commercial banks were established. The banking system consisted of Gosbank (the State Bank) and a few specialist banks. Gosbank combined the services of both central and specialist banks, thereby taking responsibility for all transactions. As the centre for all accounts, Gosbank monitored the payment of wages and managed the financing of enterprises according to the central plan, which involved extending short-term credit in the form of working capital. In the role of Central Bank, Gosbank issued national currency and acted as banking sector regulator although did not engage in activities undertaken by their western counterparts such as open market operations or setting interest rate policy.

Apart from Gosbank, other banks were established to take responsibility for particular transactions. Sberbank handled personal savings accounts, Promstroybank supported industry and construction projects, Vneshtorgbank was concerned with business related foreign exchange transactions and Agroprombank supported agriculture sector. Gosbank and the specialist banks collected data on expenditure and allocated funds to be used throughout the Soviet economy. In turn, the financial systems of the Soviet Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan and of Estonia, Latvia and Lithuania acted as regional departments of these five Soviet banks.

Banking theory states that a financial system consists of bank and non-bank financial institutions that act as intermediates to satisfy the supply and demand for funds. However, in the former USSR financial markets did not exist and funds were not allocated efficiently. Rather, all investment decisions were made centrally by Gosplan (State Planning Committee of the USSR) and were taken on ideological and political grounds rather than on the basis of economic efficiency.

However, after the collapse of the Soviet Union countries differed in their transition programmes, with the Central Asia republics taking a slow, step-by-step approach to reform while the Baltic States supported a more aggressive path from a planned to a market economy. One crucial part of the transition was the decision to allow the entry of foreign owned financial institutions to the domestic sector and this was embraced more enthusiastically in the Baltic States than in Central Asia, see Table 1. Moreover, banking system reform overall is more advanced in the Baltic States, as shown by the EBRD indices. The rapid advances have continued in other aspects of the economy and the Baltic States are already members of the European Union.

Table 1. Summary of Key Financial Indicators

Countries	Number of Banks (foreign owned)		EBRD Banking Reform index		EBRD Non-banking Reform index	
	2004	2009	2004	2009	2004	2009
Central Asia						
Kazakhstan	35 (15)	39 (14)	3.0	2.7	2.3	2.7
Kyrgyz Republic	19 (9)	21(10)*	2.3	2.3	2.0	2.0
Tajikistan	12 (3)	13 (4)	2.0	2.3	1.0	1.0
Uzbekistan	31 (5)	29 (5)**	1.7	1.7	2.0	2.0
Baltic States						
Estonia	9 (6)	17 (14)	4.0	4.0	3.3	3.7
Latvia	23 (9)	27 (18)	3.7	3.7	3.0	3.0
Lithuania	12 (6)	17 (5)	3.3	3.7	3.0	3.3

Source: EBRD Statistics. These are the most recent data available to date. *2008, **2007

3. Empirical Studies on Banking Efficiency in Transition Countries

Compared with the huge literature on the US market, research on bank efficiency in emerging market economies is relatively scarce. Some studies do focus on transition economies but very few have specifically addressed the late reforming countries of Central Asia, concentrating rather on Central and Eastern Europe where there is a history of competitive banking institutions prior to 1945 and where there are several years of available data. Of these, the majority focus on measuring the performance of banks following privatisation or the impact of foreign ownership on domestic institutions.

An early transition study is Kraft and Tirtiroğlu (1998), which estimated the efficiency of resource allocation and output levels using a stochastic cost frontier. Data from 43 Croatian commercial banks between 1994-1995 show that new banks were not as efficient as long established ones and the older banks were more profitable. However, high profitability does not always indicate high efficiency in banking. Even after privatisation, pre-existing large domestic banks in Croatia remained, providing unfair competition in the sector and creating difficulties for new banks as they tried to become established. In the Croatia context racial conflict during the 1990's discouraged foreign banks from entering this market, although now there is a high level of foreign participation and investment from abroad has increased substantially. Thus, efficiency, especially scale efficiency, has increased as a result of higher levels of competition. A similar study of the financial sector in Poland used non-parametric methods to construct a Malmquist Productivity Index (Piesse and Rogowski, 1997), with results suggesting that the quality of bank management and the level of enumeration were important in an assessment of efficiency and competitiveness.

The affect of enterprise and banking reforms on the banking sector development in a sample of transition economies was investigated by Fries and Taci (2002) using data on 515 banks for 1994-99. Their results showed that the speed of the real expansion of bank loans is lower than that of output growth, even in countries with advanced reform programmes. These findings confirm the need for policy to strengthen the supply response of banks in transition economies. Using the same sample, Fries, Neven and Seabright (2002) investigated the performance and profitability of banks. Firstly, they used patterns of profitability to identify whether these banks exhibit excessive risk-taking behaviour. Although there is no evidence for this in countries with advanced banking and enterprise reforms, poorly capitalised banks do exhibit excessive risk-taking where the system is less developed. Estimates of cost and revenue functions show negative return on equity, although there is considerable progress in terms of smaller margins on loans and increased levels of deposits in those countries where the institutions are more advanced. However, loan management improved in all the sample countries, regardless of the progress of reform.

The lifting of restrictions on foreign ownership of newly privatised banks has been a major focus of research on the transition. Buch (1997) was an early examination of the role of foreign banks in the Czech Republic, Estonia, Hungry and Poland using data from 1989 to 1995. The results found that liberalisation and market entry of foreign banks into the banking sector of transition economies improved competition, encouraged knowledge transfers, allowed more efficient allocation of financial resources and helped to prevent future non-performing loans from accumulating. Moreover, sequencing was important and the domestic banks in transition States needed to be capitalised early to allow them to reduce their existing non-performing loans before allowing foreign investors to enter. This was to protect the incumbent banks from unfair competition before they were operating efficiently. This was confirmed by Bonin and Wachtel (1998) who followed the development of the banking sector in the three fast-track Eastern European economies, Poland, Hungry and the Czech Republic. Each established a two-tier banking system, removed bad loans from the balance sheet and recapitalised the banks, and undertook privatisation programmes to transfer ownership from the state to private investors, both domestic and foreign, although the level of foreign ownership varied between countries.

Another study using Croatian bank data from 1995 to 2000 found that foreign banks were on average most efficient and that new banks were more efficient than long established ones (Jemric and Vujcic, 2002), contrary to the earlier study by Kraft and Tirtiroğlu (1998) discussed above. Jemric and Vujcic (2002) also note that strong equalisation in terms of average efficiency was evident in the Croatian banking market, both between and within banks. Small banks had high efficiency scores, which were justified by their position as niche players. The results suggested that the most significant cause of inefficiency amongst the long established State-owned banks was firstly the size of the workforce, suggesting over-employment, and second, high levels of fixed assets. That is, between one half and two-thirds of the inefficient banks had excess labour and too high costs of fixed assets.

In a multiple country study, Fries and Taci (2005) investigated how the transformation of banking system has progressed in 15 Eastern European countries for 1994 to 2001. Parametric and non-parametric measures of efficiency are compared and the stochastic frontier was the preferred method. Privatised banks with majority foreign ownership were the most efficient. Thus, there is a consensus emerging that private ownership and control increases

competitiveness and efficiency and the only difference is the speed at which this is apparent in the data. More recently, Tochkov and Nenovsky (2010) examined the efficiency levels and their determinants of Bulgarian banks for the period 1999-2007. Their results indicated that foreign banks were more efficient than domestic private banks although the gap is diminishing over time. Additionally, the results show that capitalisation, liquidity and enterprise restructuring improved efficiency although banking reforms had a negative impact, which is difficult to justify. And finally, Karas et al. (2010) examine whether efficiency is related to bank ownership in Russia and find that foreign banks are more efficient than domestic private banks, confirming the literature on foreign ownership. However, their evidence indicates domestic public banks are more efficient than domestic private banks and the efficiency gap between them did not fall even after the introduction of deposit insurance in 2004.

However, the issue of public versus private ownership and efficiency may be a function of the underlying level of development. Claessens et al. (2000) examined the effect of foreign bank entry into the domestic sector using 7900 bank observations from 80 countries for 1988 to 1995. These included the Czech Republic, Hungary, Lithuania, Poland and Russia in the transition economy group and several OECD countries in the market economy group. The paper investigated whether foreign and domestic banks have different net interest margins, overheads, tax liability and profitability. The results suggest that domestic banks have lower profits than foreign banks in developing countries while the opposite is true in developed countries. This is due to greater competition and higher levels of efficiency in banks in long established market economies. In addition, there is evidence that the reduction in profitability and margins in domestic banks in developing countries is associated with the increased presence of foreign banks and skills transfer and knowledge spillovers in general benefit the domestic sector. This is unlikely to be the case in OECD countries as these are the home nations of the foreign banks in emerging and developing markets.

A number of studies have considered the impact of foreign ownership using cost and profit frontiers. Bonin et al. (2005) investigated the effects of ownership, especially by a strategic foreign owner, on bank efficiency for eleven transition countries in an unbalanced panel data from 1996 to 2000. Using a stochastic frontier approach, they estimated profit and cost efficiency taking account of both time and country effects directly. In second-stage regressions, the study used the efficiency measures along with return on assets to investigate the influence of ownership type. They concluded that privatisation by itself was not sufficient to increase bank efficiency as state-owned banks were not appreciably less efficient than domestic private banks. They found that foreign-owned banks were more cost-efficient than other banks and that they also provided better service. A similar paper by Nikiel and Opiela (2002) considered the characteristics of bank customers and used a distribution-free approach to study the efficiency of 43 Polish banks from 1997 to 2000. Inefficiency from random factors was separated into that affecting costs and profits, and the characteristics of the banks were explored by examining foreign ownership, asset size and customer-type variables. Foreign banks were found to be generally more cost-efficient than domestic banks, but this was due to a concentrated on foreign customers. Foreign banks with many domestic customers were found to be no more cost-efficient than private domestic banks.

Also using profit and cost frontiers, Hasan and Marton (2003) examined the development of the Hungarian banking sector between 1993 and 1997 to estimate inefficiency. The establishment of a two-tier banking sector, privatisation and the entry of foreign banks were the most significant factors in strengthening the banking system. Moreover, banks with foreign involvement are more profit and cost efficient than their domestic counterparts. However, a cost function is rarely possible for transition economies as data on prices are poor and where they exist there is little variation across the sector. More recently Fang et al. (2011) examined the cost and profit efficiency of the banking sector in six countries of South-Eastern Europe for the period 1998-2008. Using a stochastic frontier approach the result show average cost efficiency of 68.59% and the average profit efficiency of 53.87%. Estimation of the determinants of bank efficiency indicates that foreign banks have higher profit efficiency, but lower cost efficiency. However, the efficiency gap between foreign, domestic and state banks are also shrinking over time. Additionally, the results show institutional development has a positive impact on bank efficiency.

The literature is less prolific on the Baltic States although some papers include these countries along with other transition economies. Dracos (2003) considered net interest margins in Belarus, Bulgaria, Czech Republic, Estonia, Hungry, Latvia, Lithuania, Poland, Romania, Slovakia and Ukraine. This used a dealership model, where banks are assumed to be risk-averse dealers in the credit market. Risk aversion of banks is justified on three grounds; (a) a dealer cannot satisfy depositors request for liquidity (liquidity shock), (b) a dealer holds an unmatched portfolio of assets and liabilities (interest rate risk), and (c) bank credit borrowers cannot match their obligations (default risk). Given these scenarios, the transition process has been successful to some extent as margins have decreased over time. Additionally, the results indicate that foreign bank entry has also contributed to the reduction of margins. More recently Brissimis et al. (2008) examined the relationship between banking sector reform and bank performance using efficiency and total factor productivity for a

sample of EU member countries including those in Eastern European countries and the Baltic States. Not surprisingly, banking sector reform was found to have a positive impact on efficiency.

Finally, a few studies focus on Central Asia. These include Fries and Taci (2002), Fries, Neven and Seabright (2002), Grigorian and Manole (2002) and Peresetsky (2010) on Kazakhstan, Fries and Taci (2002) on the Kyrgyz Republic and Djalilov and Piesse (2011) on Kazakhstan, the Kyrgyz Republic, Tajikistan and Uzbekistan, although in all cases the data are very incomplete. Now there is reasonable time series data for individual banks in the region to allow a further examination of the national banking sectors to provide further insights into this difficult but interesting and potentially critical group of countries. Further, it allows comparisons with banks of the Baltic States, given their common status as previous Republics of the Soviet Union.

4. Modelling Bank Performance in Transition Economies

Over the last two decades the banking industry of the transition economies has experienced various structural, institutional, regulatory and technological changes and the introduction of modern methods of communication and complex financial instruments has considerably changed the banking activities in these post-communist countries. Banking is central to the economy and therefore it is particularly important that progress in the sector is measured and understood. Furthermore, banking in the late reforming transition economies remains largely regulated by government. The interesting focus is the similar recent history of the former Soviet Republics, their common legacy of central direction by Gosbank in Moscow but their different paths to reform following independence. Comparisons between the two groups are expected to be a function of the speed of growth and quality of the institutions, their different initial conditions and the extent to which the state has removed restrictions on foreign ownership.

The first stage in modelling bank performance is to define inputs and outputs as bank activities are based on the flow of funds into and out of the organisation. Traditionally, banking research has taken one of two approaches. The first is that a bank undertakes financial intermediation between lenders with funds and borrowers who require funds for investment purposes (the intermediation approach) while the second considers the bank as a productive firm, which produces financial services using labour and capital (the production approach). Alternative methods are the Asset, User cost and Value Added approaches to describe bank functions and identify bank outputs (Berger and Humphrey (1992)). In the Asset approach, banks are simply intermediaries between liability holders and those who receive bank assets. Therefore, liabilities are considered inputs while loans and other assets are outputs. However, this has some limitations as it excludes some other important services provided by most banks to their depositors (for example, investment advice, insurance, brokerage, etc.). The User cost approach determines bank output based on each instruments' net contribution to bank revenue, that is, if the financial cost of a liability is smaller than its opportunity cost, or if the financial return of an asset is higher than its opportunity cost, an instrument is considered to be an output, otherwise it is an input (Berger and Humphrey (1992)). However, this approach is very sensitive to data changes, which may cause some instruments to be outputs in one period and inputs in another and this is very destabilising in a linear programming model. Also it is difficult to measure the net contribution of each instrument as some implicit revenues exist in banks. Finally, the Value Added approach supports the view that all liabilities and assets have some output characteristics. Instruments with higher Value Added, determined by actual operating cost, are considered outputs, while others are treated as unimportant outputs or as inputs. This differs from the User cost approach in that Value Added is based on actual operating cost rather than determining these costs explicitly (Grigorian and Manole (2002); Berger and Humphrey (1992)). Thus, in the Value Added approach major products such as deposits (demand, savings and time accounts (or inflation)) and loans are considered to be outputs as they attract the majority of Value Added in the sector, while products with insignificant Value Added (purchased funds, federal funds, foreign deposits etc.) are inputs since they require very small amounts of capital and labour.

4.1 Efficiency measurement

Efficiency measurement is now established in the literature and is particularly appropriate to the financial services sector as the nature of inputs and outputs are common across countries and organisations.[1] Over the last few decades many studies in production economics have focused on measuring the efficiency of different sectors and firms in a number of countries. Although many different methods have been used, all are based on the transformation function, particularly that which describes a production technology at the level of the organisation. The aim is to maximise value under the available technology, prices or other limitations. Assuming a common set of constraints, efficiency is measured as the distance between individual production entities and the best practice frontier.

The measurement of firm level efficiency was first proposed by Farrell (1957). This considers a simple production process of two inputs and one output to introduce efficiency measurement. However, any change in output can be attributed to changes in: (1) inputs; (2) technical efficiency; and (3)

technical progress. However, the measurement here is dual: (1) the minimum amount of inputs needed to produce the given amount of output (input-oriented efficiency measurement); alternatively, (2) the maximum amount of output produced with the given amount of inputs (output-oriented efficiency measurement). If the productive unit exhibits constant-returns-to-scale (CRS), the measurements for technical efficiency defined by these two approaches will be equal. The efficiency of a firm is measured by the distance from the frontier defined by the available technology. That is, a firm can be *technically efficient* if it produces the maximum amount of output with the transformation of available inputs and *allocatively efficient* if it minimises costs by the choice of this input combination to produce the maximum amount of output. If the firm is both technically and allocatively efficient, then it produces the maximum amount of profit and becomes *profit efficient*. In this case, the firm chooses the correct mix of inputs minimising the production costs with the given input prices, produces the maximum amount of output using the available technology and correct production scale, and reaches the highest possible profit. Thus, a firm becomes technically, allocatively and scale efficient. The efficiency of a firm is measured by the distance from the frontier defined by the available technology. That is, a firm can be *technically efficient* if it produces the maximum amount of output with the transformation of available inputs and *allocatively efficient* if it minimises costs by the choice of this input combination to produce the maximum amount of output. If the firm is both technically and allocatively efficient, then it produces the maximum amount of profit and becomes *profit efficient*. In this case, the firm chooses the correct mix of inputs minimising the production costs with the given input prices, produces the maximum amount of output using the available technology and correct production scale, and reaches the highest possible profit. Thus, a firm becomes technically, allocatively and scale efficient.

The best practice frontier can be constructed using either a parametric or nonparametric techniques. The non-parametric method uses linear programming, while econometric models estimate deterministic or stochastic frontiers. The approach can be deterministic, where all deviations from the frontier are attributed to inefficiency, or stochastic, where it is possible to discriminate between random errors and differences in inefficiency. Both allow the calculation of firm level efficiency. The stochastic frontier model was proposed by Aigner, Lovell and Schmidt (1977), and extended to include the characteristics of the firm that explain the inefficiency, following the work of Battese and Coelli (1995). Further, the stochastic frontier method conforms to production theory and offers flexibility.[2] In this paper the stochastic frontier was used to estimate profit efficiency. A cost or profit frontier[3] is estimated that decomposes the error term into random disturbances that are distributed *iid* and a firm specific element that is assumed to have a positive half normal distributed above (below) the cost (profit) frontier. This captures aspects such as the level of managerial competence, governance issues or approach to risk.

The second part of the paper focuses in explaining differences in the efficiency levels, both by bank and by region, and compares the progress of transition in Central Asia and the Baltic States. Thus, profit efficiency is modelled as a function of the quality of the institutions and the extent of foreign ownership in the banking sector.

4.2 Data and variable definitions

Outputs and inputs for the efficiency measurement are chosen in such a way that the main functions of banks such as profit maximisation, risk management, service provision, intermediation, and utility provision are represented. According to Grigorian and Manole (2002) these functions could be combined into two larger groups: profit maximisation (a combination of profit maximisation and risk management) and service provision (a mixture of service provision, intermediation and utility provision). However, it is reasonable to assume a bank that is maximising profit also attempts to improve service quality. Therefore, any bank operation has some elements of profit maximisation as well as service provision.

Following Colwell and Davis (1992), and taking account of data limitations for the sample countries, the Asset approach that considers banks as financial intermediaries is used here. Moreover, some recent studies show that the intermediation approach is preferable to the production approach in inter-bank studies, because the production models are unable to weight the contribution of each banks' service to total output and thereby fails to cover important bank activities. Therefore, the following data are used: Total Profit, outputs (Total Loans and Net Fees and Commissions), inputs (Price of Borrowed Funds and Overheads), and netputs[4] (Total Equity divided by Total Loans and Loan Loss Provisions divided by Total Loans). The definitions and sources are in Table 2.

Table 2. Variable Definitions

Total Profit		Net Income after Tax from Income Statement
Inputs		
1.	Price of Borrowed Funds	Total Interest Expenses from Income Statement divided by Total Interest Bearing Funds (liabilities) from Balance Sheet.
2.	Overheads	This is Expenses and is equal to the summation of Staff Costs, Operating Expenses, Depreciation and Amortisation.
Outputs		
1.	Total Loans	Gross Loans from Balance Sheet.
2.	Net Fees and Commissions	This is taken from the Income statement (bank revenue)
Netputs		
1.	Total Equity divided by Total Loans	Total Equity and Total Loans are from Balance Sheet
2.	Loan Loss Provisions divided by Total Loans	Loan Loss Provisions are from Income Statement and Total Loans are from Balance Sheet

Source: Bankscope

Although the region of interest is Central Asia, the Baltic States are included in the frontier analyses to investigate the difference in profit efficiency of the banking sector in these countries. The sample countries are Kazakhstan, the Kyrgyz Republic, Tajikistan and Uzbekistan from Central Asia[5] and Estonia, Latvia and Lithuania from the Baltic region. The data are from *Bankscope* and include 86 banks (48 from Central Asia with 387 observations and 38 from the Baltic States with 389 observations) for 1996-2011. These are the most recent data available and it is important to briefly note limitations. First, *Bankscope* data only include the financial statements of banks audited by internationally recognised auditing companies and currently, not every bank in Central Asia is audited by these companies due to the high costs incurred. Nevertheless the sample is representative of the region. Second, the ownership data are available only for the year of the most recent financial statement. Therefore, websites of each bank were visited to obtain ownership data as past studies have shown this to be an important determinant of profit efficiency in banks. Only active banks with a minimum three years of financial statements are included in the sample. Macroeconomic data, namely, growth (percentage change of GDP), inflation (percentage change in consumer prices) as well as EBRD reform indices measuring banking sector reform and reform of non-bank financial institutions, are from EBRD Statistics 2011.

The descriptive statistics are in Table 3. From the table it is clear that the Baltic States exhibit lower mean profit with a smaller standard deviation indicating less difference in profit among the banks in Estonia, Latvia and Lithuania. These countries were affected negatively by the financial crisis in 2007-2008, which had a significant impact on the profits of the banks in the region over recent years. However, in Central Asia the mean of total loans is smaller and with a lower standard deviation. Table 3 also indicates that the Baltic States generate more net fees and commissions, but their expenses on overheads are higher compared to those of the Central Asian banks. The price of borrowing funds is higher in Central Asia and this suggests that either they have higher interest expenses or lower levels of interest bearing funds. Either way, there is less competition in the sector. Banks in Central Asia have higher equity share of total loans and of loan loss provisions as a share of total loans where the latter indicates that these banks are likely to be spending more on writing off nonperforming loans as they are still at an early stage of the transformation. Table 3 shows that there are some negative values in the data, therefore a common amount was added to all observations to reach a minimum positive unit and avoid difficulties with the natural log of a negative value, consistent with the literature (Fang et al., 2011).

Table 3. Descriptive Statistics (US$ millions)

	Total Profit	Total Loans	Net Fees and Commissions	Price of Borrowed Funds	Overheads	Total Equity / Total Loans	Loan Loss Provisions/ Total Loans
Central Asia							
Mean	-17.42	1171.90	15.82	0.05	37.08	4.67	0.03
Maximum	6686.54	21452.00	229.14	0.37	544.99	1446.71	2.98
Minimum	-8645.69*	0.03	-84.21	0.00	0.05	-0.75	-0.72
Standard Deviation	712.23	3263.60	31.23	0.04	66.64	73.61	0.16
Observations	387	387	387	387	387	387	387
Baltic States							
Mean	-36.13	2071.11	19.61	0.03	97.60	4.22	0.01
Maximum	522.39	53572.19	546.69	0.11	3395.68#	429.00	0.58
Minimum	472.04	6132.60	40.76	0.02	400.17	33.65	0.11
Standard Deviation	472.04	6132.60	40.77	0.02	400.17	33.65	0.11
Observations	389	389	389	389	389	389	389

Notes: * A state owned bank - BTA Bank JSC (Kazakhstan). # Versobank AS (Estonia) which experienced many mergers and acquisitions in the recent past.

4.3 Estimation of the profit frontier and efficiency levels

The production function is limited to a single output but banks produce multiple services. However, the profit function is less restrictive and gives a wider range of parameter estimates. Thus it is convenient to allow a mix of outputs so profit is maximised as the sum of the value of all the outputs, (PiYi), minus the costs of the inputs, subject to the constraint of the transformation function. Assuming that banks maximise expected profits, the normalised restricted profit function (Lau, 1976), with the conditioning factors included as fixed inputs, is used to model bank behaviour. With a multiple output technology producing outputs Y(y_1,..,y_m), with the respective expected output prices P (p_1,..,p_m), using n inputs X (x_1,..,x_n) with prices W (w_1,..,w_n) a general expression for expected profits can be defined:

$$\pi = \sum_{i=1}^{m} p_i y_i - \sum_{j=1}^{n} w_j x_j = P'Y - W'X \qquad (1)$$

The estimation of profit efficiency in this paper follows the non-standard or alternative specification and is modelled as a stochastic frontier.[6] Using a translog functional form, the profit efficiency model is specified:

$$\begin{aligned} Ln(TP/w_1) &= \alpha_0 + \alpha_1 \ln(w_2/w_1) + 0.5\alpha_2 \ln(w_2/w_1)^2 + \sum_{k=1}^{k} \beta_k \ln(y_k) + 0.5\sum_{k=1}^{2}\sum_{k^*=1}^{2} \beta_{kk^*} \ln(y_k)\ln(y_{k^*}) \\ &+ \sum_{i=1}^{2} \phi_i \ln(n_i) + 0.5\sum_{i=1}^{2}\sum_{i^*=1}^{2} \phi_{ii^*} \ln(n_i)\ln(n_{i^*}) + \sum_{k=1}^{2} \theta_k \ln(y_k)\ln(w_2/w_1) + \sum_{k=1}^{2}\sum_{i=1}^{2} \rho_k \ln(y_k)\ln(n_{i^*}) \\ &+ region\ dummy + \upsilon + \mu \end{aligned} \qquad (2)$$

where *v* is an efficiency term and assumed to have a half-normal distribution and *u* is random noise and represents the factors beyond bank management control. However, given the model is a profit frontier the bank specific component of the error term, *v*, is negative as profit inefficiency moves the bank below the best practice frontier. The TP is Total Profit and w, y as well as z represent inputs, outputs and netputs respectively. To impose linear homogeneity of input prices the specification is normalised by one input price (w1). A regional dummy is included to control for the differences between the Baltic States and the Central Asian countries. The efficiency of bank *i* at time *t* in the context of the stochastic frontier profit function can be expressed in terms of the residuals

$$TE_{it} = E[\exp(-U_{it})|(V_{it} - U_{it})] \qquad (3)$$

4.4 Results: profit function and bank level efficiency

Table 4 reports the estimated coefficients from the profit function. The results show that the stochastic frontier is the appropriate model as shown by the value of Wald Chi-square. They also indicate that Total Loans, Net Fees and Commissions and Total Equity divided Total Loans have a significant and positive impact on bank profits in the Baltic States and Central Asian countries. This is consistent with the theoretical assumption that a larger loan book and greater net fees and commissions plus total equity as a share of loans results in higher profit.

Table 4. Stochastic Frontier Profit Function Estimates

Variables	Coefficients	Standard errors	z	P>|z|
Total Loans	26.09	7.48	3.49	0.00
Net Fees and Commissions	10.25	4.47	2.29	0.02
Overheads/Price of Borrowed Funds	-11.53	11.15	-1.03	0.30
Total Equity/Total Loans	18.20	3.87	4.70	0.00
Loan Loss Provisions/Total Loans	1.23	1.29	0.96	0.34
Total Loans^2/2	-1.81	1.06	-1.70	0.09
Net Fees and Commissions^2/2	0.61	0.016	3.87	0.00
(Overheads/Price of Borrowed Funds)^2/2	-1.65	0.29	-5.79	0.00
(Total Equity/Total Loans)^2/2	-0.23	0.073	-3.19	0.00
(Loan Loss Provisions/Total Loans)^2/2	0.04	0.027	1.31	0.19
Total Loans*Net Fees and Commissions	-1.30	0.56	-2.30	0.02
Total Loans* (Overheads/Price of Borrowed Funds)	0.99	1.23	0.81	0.42
Total Loans* (Total Equity/Total Loans)	-1.13	0.56	-2.02	0.04
Total Loans* (Loan Loss Provisions/Total Loans)	-0.40	0.14	-2.95	0.00
Net Fees and Commissions* (Overheads/Price of Borrowed Funds)	-0.22	0.34	-0.64	0.52
Net Fees and Commissions* (Total Equity/Total Loans)	-0.89	0.52	-1.72	0.09
Net Fees and Commissions* (Loan Loss Provisions/Total Loans)	0.44	0.14	3.16	0.00
(Overheads/Price of Borrowed Funds)* (Total Equity/Total Loans)	1.76	1.24	1.43	0.15
(Overheads/Price of Borrowed Funds)* (Loan Loss Provisions /Total Loans)	-0.44	0.96	-4.55	0.00
(Total Equity/Total Loans)*(Loan Loss Provisions/Total Loans)	-0.54	0.15	-3.48	0.00
Constant	-167.71	36.22	-4.63	0.00
Number of observations	737	Wald chi square	1575.15	
Log Likelihood	-309.93	Prob>chi squared	0.00	

The efficiency scores are reported in columns 2–5 in Table 5. These are for the entire period for Kazakhstan and Uzbekistan, 2000-2011 for the Kyrgyz Republic and 2004- 2011 for Tajikistan, due to missing data. These suggest that for all countries profit efficiency significantly improved over the period, although Tajikistan is the smallest in the region and lags behind, which is not surprising as this is the least developed country in Central Asia. The overall mean is the highest in Kazakhstan, with the Kyrgyz Republic and Uzbekistan in second and third positions, respectively. These results are consistent with the EBRD reform scores for banking and non-banking financial institutions as shown in Table 1. The efficiency scores for the Baltic States are in columns 6–8. These suggest that Latvia had the lowest profit efficiency score in 1996 compared to that of Estonia and Lithuania, however, it significantly improved over the period and converged with the levels of Estonia and Lithuania. The profit efficiency scores of the Baltic States were highly volatile for the period 1996-2003. However, starting from 2004 the profit efficiency of Estonia, Latvia and Lithuania stabilised and remained above 70% for most of the subsequent years.

Table 5. Mean profit efficiency scores for Central Asia and Baltic States

Year	Kazakhstan	Kyrgyz Republic	Tajikistan	Uzbekistan	Estonia	Latvia	Lithuania
1996	0.38	-	-	0.18	0.85	0.48	0.76
1997	0.69	-	-	0.27	0.81	0.79	0.67
1998	0.59	-	-	0.25	0.73	0.61	0.67
1999	0.71	-	-	0.34	0.77	0.63	0.58
2000	0.64	0.23	-	0.42	0.68	0.65	0.63
2001	0.58	0.35	-	0.43	0.57	0.66	0.71
2002	0.64	0.52	-	0.50	0.63	0.75	0.78
2003	0.62	0.68	-	0.48	0.69	0.78	0.81
2004	0.63	0.72	0.27	0.38	0.73	0.80	0.84
2005	0.65	0.63	0.45	0.36	0.76	0.79	0.82
2006	0.61	0.72	0.48	0.50	0.76	0.80	0.78
2007	0.66	0.70	0.61	0.62	0.74	0.75	0.74
2008	0.68	0.63	0.33	0.66	0.74	0.73	0.69
2009	0.68	0.63	0.31	0.64	0.68	0.80	0.71
2010	0.73	0.75	0.37	0.67	0.77	0.80	0.74
2011	0.70	0.80	0.34	0.68	0.81	0.80	0.72
Total	**0.64**	**0.61**	**0.40**	**0.46**	**0.73**	**0.73**	**0.73**

In Table 6, the two regions are compared. As expected from the relative progress through the transition for these countries, the Baltic States are overall more efficient. The mean is higher in the Baltic States, however, the Central Asian countries had a higher growth in efficiency over the period, with the aggregate scores 0.2782 in 1996 and 0.6306 in 2011. The fall in Central Asia in 2000, 2001 and 2004 is likely to be due to the entry of the Kyrgyz Republic and Tajik banks as efficiency in the early years was very low. The Baltic States had efficiency scores ranging from 70% to 78% for the whole period, with a lower growth rate, but from a higher starting point.

Table 6. Comparison of profit efficiency in Central Asia and the Baltic States

Year	Profit Efficiency		
	Central Asia	**Baltic States**	**Difference**
1996	0.28	0.70	-0.42
1997	0.48	0.76	-0.28
1998	0.42	0.67	-0.25
1999	0.53	0.66	-0.13
2000	0.43	0.65	-0.22
2001	0.45	0.65	-0.20
2002	0.55	0.72	-0.17
2003	0.59	0.76	-0.17
2004	0.50	0.79	-0.29
2005	0.52	0.79	-0.27
2006	0.58	0.78	-0.20
2007	0.65	0.75	-0.10
2008	0.57	0.72	-0.15
2009	0.57	0.73	-0.16
2010	0.63	0.77	-0.14
2011	0.63	0.77	-0.14
Overall	**0.52**	**0.73**	**-0.21**

4.5 Factors determining bank efficiency

This section uses the profit efficiency scores to model the determinants of bank performance. The review of the literature above indicated the importance of ownership, whether by the state or private shareholders, and of the impact of foreign control of financial institutions. In addition, since the sample is comprised of banks in countries in transition to a market economy the progress of reform of the institutions is important. The model is specified:

$$Efficiency_{it} = \beta_0 + \beta_1 State\ dummy_i + \beta_2 Foreign\ \ dummy_i + \beta_3 EBRD_{it} + \beta_4 EBRD_{it-1} + \beta_5 controls_{it} + \ time + time * \ foreign\ ownership + time * state\ ownership + \mu_{it} \quad (4)$$

where the dependent variable is obtained from the stochastic profit frontier and independent variables are ownership, macroeconomic indicators (growth and inflation) and EBRD reforms (banking reform and reform of non-bank institutions). A foreign ownership dummy and a state ownership dummy are defined by the majority of bank shareholders and when both of them are equal to 0 it refers to the benchmark group – domestic private banks. Reform is the arithmetic mean of two EBRD reform indices, Banking and Non-banking institutional reform as both are important in the process of the transition. These are not included separately as there is a high correlation between the indices and using the mean captures both aspects of the transition.

Three variables are included to control for size, capitalisation and risk, proxied by the natural logarithm of loans, equity and loan loss provisions, following Hasan and Marton (2003). The first period lag is used to avoid potential reverse causality between profit efficiency and bank specific features. In addition, a time trend is included. Following Fang (2011) the product of the time trend and foreign ownership and the time trend and state ownership are used to account for potentially different effects of these changes on profit efficiency. To control for macroeconomic effects growth and inflation are included to capture fluctuations in economic activity, following Yildirim and Philippatos (2007). Finally, a dummy variable is added to account for the international financial crisis of 2007-8. No variables are used to control for country specific features as EBRD reform scores are measured at a country level.

Generalised Least Squares (GLS) estimation allow for four basic variance structures: cross-section specific heteroskedasticity, period specific heteroskedasticity, contemporaneous covariances and between period covariances. In this paper, the determinants of profit efficiency are modelled using GLS with both cross-section and period Seemingly Unrelated Regression (SUR) estimators where the first corrects for heteroskedasticity and contemporaneous correlation and the second corrects for heteroskedasticity and general correlation of observations within a cross-section. Thus, the advantage of these specifications is that they correct for the variance structures noted above. The results of GLS with cross-section and period SUR specifications are in (2) and (3) columns of Table 7 respectively. The third specification, however, includes only control variables with results in (4) column. The fourth GLS specification does not use GLS weights such as cross-section and period SUR and includes all the variable as in the first and the second specifications. The results of the fourth specification are in (5) column of Table 7.

5. Results and Discussion

As noted above, the specification included ownership by foreign and state entities and where these are both omitted the reference is the benchmark group - domestic private banks. Table 7 shows that the state owned banks are associated with lower profit efficiency compared to domestic private banks. Although the results of the first and the fourth specification indicate foreign owned banks are associated with higher profit efficiency compared to domestic private banks the variables are insignificant in the second and the third specifications. There is a similar situation for the interaction between trend and foreign ownership and the lagged value of loans, where the first is significant only in the second specification and the second is significant only in the first specification. Therefore these variables do not appear to be robust. This differs from the results by Hasan and Marton (2003) where the Hungarian banking sector has benefited from foreign ownership and these banks outperformed the domestic banks in terms of profit efficiency.

The results also indicate that the reforms in both banking and non-banking institutions have an immediate positive impact on profit efficiency in Central Asia. This is consistent with the results by Brissims et al. (2008) for the EU member countries of Central and Eastern Europe (CEE), including the Baltic States. However, the reforms in both banking and non-banking institutions become insignificant once macroeconomic variables such as GDP growth as well as inflation are excluded from the models. Clearly these effects are interrelated. In addition, the reform indices themselves are not entirely transparent. For example, the EBRD banking reform metric for Kazakhstan is not monotonic and moved from a value of three for 2004-8 but decreases to 2.7 for 2009-10. This can be explained by difficulties in measuring or a lapse in some aspect of institutional reform. But is it important to note that these are the best data available even though they may be incomplete.

Table 7. Determinants of Profit Efficiency in Central Asia

Variables	Dependent Variable: Profit Efficiency							
	GLS Cross-section		GLS Period SUR		GLS, no weights, only control variables		GLS, no weights, all variables	
	(2)		(3)		(4)		(5)	
Constant					0.9581***	(0.2336)		
State dummy	-1.79***	(0.55)	-1.99***	(0.68)	-0.71*	(0.42)	-1.97***	(0.67)
Foreign dummy	0.31*	0.16)					0.36*	(0.19)
Reform	0.17***	(0.06)	0.16**	(0.07)			0.19***	(0.06)
Reform(-1)								
Loans(-1)	0.022*	(0.013)						
Equity(-1)								
Loan Loss Provisions(-1)								
Crisis dummy (2007 and 2008)	0.06***	(0.02)	0.06***	(0.02)	0.04**	(0.02)	0.06***	(0.02)
Trend								
Foreign*Trend			0.03**	(0.01)				
State*Trend	0.13***	(0.04)	0.15***	(0.05)	0.05*	(0.03)	0.14***	(0.05)
Growth					X	X		
Growth(-1)	-0.01***	(0.00)	-0.01**	(0.00)	X	X	-0.01**	(0.00)
Inflation					X	X		
Inflation(-1)					X	X		
AR(1)	1.19***	(0.15)	1.13***	(0.10)	0.85***	(0.04)	1.11***	(0.09)
AR(2)	-0.33***	(0.12)	-0.24**	(0.10)			-0.23**	(0.10)
Adjusted R-squared	0.77		0.78		0.72		0.76	
Durbin Watson Statistic	1.98		1.80		1.74		1.77	

Standard errors are in parentheses.

Surprisingly, the results here show that the financial crisis in 2007-2008 had a positive impact on profit efficiency for the banks in Central Asia, which is inconsistent with the existing literature (Fang et al., 2011).[7] However, given the Central Asian States are not integrated into the international financial system this is probably picking up some unobserved factor. The coefficient on the interaction between state ownership and the time trend is positive, indicating that the state owned banks started to catch up with domestic private owned banks and are more profitable in recent years. This supports the results by Fang et al. (2011) and, perhaps, the restructuring, modernisation and competition policies of the banking system in the Central Asia over the last two decades have substantially improved the governance of the institutions. Surprisingly, the lagged value of economic growth has a negative impact on profit efficiency. This differs from the results for the EU member countries paper by Brissims et al. (2008) where there is a significant positive impact where the ratio of total investment to GDP is used as a macroeconomic indicator. Again, unexpected results simply reaffirm the need for further research into a region that is still emerging and has a largely underdeveloped financial system.

6. Conclusion

Over the last two decades the countries of the Central Asian region implemented restructuring policies which significantly improved the banking sector. However, these countries followed step-by-step (evolutionary) approach of the transition from planned to market economy. Other former republics of the former Soviet Union, such as the Baltic States, adopted a more aggressive approach and are already members of the EU. Therefore it is important to investigate the differences in profit efficiency and examine whether the determinants of the profit efficiency in the Baltic States are the same as those in Central Asian banks. Thus, this paper compares profit

efficiency in these regions and finds that the Baltic States have higher scores, however the banks in the Central Asia significantly improved their profit efficiency during the period under review. In the analysis of the determinants of profit efficiency the paper focuses only on the Central Asian States as this region has been largely neglected in the literature compared to the established CEE countries and the Baltic region.

Using a stochastic frontier profit function this paper shows that mean profit efficiency is higher in the Baltic States compared to the countries of Central Asia, although the latter are catching up. Existing studies of Central and Eastern European countries show that foreign owned banks outperformed domestic banks in terms of profit efficiency and banking and non-banking institutional reforms have had a significant positive impact on efficiency. The results for the Central Asian countries also indicate that the reforms have had an immediate positive impact on profit efficiency, although the coefficient becomes insignificant once the macroeconomic variables such as GDP growth and inflation are excluded from the model. Additionally, the results for foreign owned banks are not convincing as they are less robust. However, the results are the same for state owned banks indicating that they are less profit efficient compared to domestic private banks. The results for the impact of macroeconomic indicators on profit efficiency are inconsistent, that is, current economic growth and inflation have no significant impact for the Central Asian countries, while the ratio of total investment to GDP in CEE countries, including the Baltic States, have had a significant positive effect on the profit efficiency (Brissims et al. (2008).

Little is known about the impact of the banking sector in Central Asia and with the exception of Kazakhstan the reforms are progressing very slowly. The financial intermediary function of banks with respect to domestic and business activity is sluggish at best. However, efforts are being made to improve the efficiency of the sector and future policy interventions must focus on bank performance as the foundation for economic growth in the region.

Notes

[1] For a comprehensive summary of methods to measure bank efficiency see Berger (2007).

[2] Fried, Lovell and Schmidt (1993) for a comprehensive survey of methods and applications, Coelli, Rao and Battese (1998) for further models and Berger et al. (1993b), Berger and Humphrey (1997) and Kumbhakar and Lovell (2000) for applications to banking.

[3] Berger et al. (1995) and Berger and Mester (1997) consider a profit function to be preferable for measuring bank efficiency.

[4] In the context of production, netput variables are positive if the quantity is an output of the production process and negative if it is an input to the production process.

[5] Turkmenistan was excluded as the data are unreliable or missing.

[6] The function is specified in terms of output quantities and input prices. Markets in Central Asia are imperfect with robust state intervention, particular in the manipulation of output prices. A similar situation is discussed in Humphrey and Pulley (1997).

[7] Fang et al., (2011) included a crisis variable but got insignificant results using a sample of SEE countries, including Albania, Bulgaria, Croatia, Macedonia, Romania and Serbia.

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