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EFFICIENCY OF THE BULGARIAN BANKING SYSTEM: TRADITIONAL APPROACH AND DATA ENVELOPMENT ANALYSIS

Working Paper No.22/2008

Efficiency of the Bulgarian Banking System: Traditional Approach and Data Envelopment Analysis

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November 2008

Abstract:

The present paper traces the trends in the development of the Bulgarian banking system focusing on the dynamics of bank efficiency. Although the financial crisis in 1996-1997 and the following shift in monetary regime (introduction of Currency Board Arrangement) exerted significant influence on the development of the banking sector characteristics, the study covers only the period of 1999-2006 because of the lack of consistent available data prior to 1999.

During the period analysed, the impact on bank efficiency of the following factors is studied: change in property, penetration of foreign commercial banks on the local banking market, competition, structure of bank assets and liabilities, central bank policy in regard to credit activity, etc. The limits of traditional accounting approaches to bank efficiency evaluation are discussed, as well as the implementation of non-parametric methods, in particular Data Envelopment Analysis (DEA). Different specifications of DEA like the intermediation and operating approaches were applied to separate groups and sub-groups. The results show that: firstly, foreign banks perform better than domestic and state-owned banks because of the technological and managerial improvements; and secondly, large banks are more efficient than small banks due to decreasing operating costs and scale economies.

Key words: DEA, bank efficiency, Bulgarian banking system, foreign banks

JEL Classification: ?16, G21, C61

The authors would like to thank Fuad Aleskerov, Georgi Ganev, the staff at the Agency for Economic Analysis and Forecasting for their comments and recommendations for the paper improvement. We have benefited from our discussion with participants at the VIII International Academic Conference "Modernization of Economy and Public Development" in Moscow, April 3-5, 2007 and the X International Conference “Policy of Economic and Social Development towards a Knowledge Based Society in Europe” in Sofia, October 5-7, 2007.

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I. Introduction

Bank efficiency is a very important and crucial issue especially in transition economies, where the banking sector has faced a considerable change in ownership structure as a result of privatization, foreign bank entry and competition, liberalization, change in legislative environment and institutional rules. All these factors have exerted some influence on bank performance and efficiency. In addition, the technological changes and knowledge - normally transferred with the increase in foreign ownership in transition economies - have significantly altered the operational environment for banking institutions and bank production technology, which in turn has changed bank efficiency.

There are numerous studies on the banking system efficiency, most of which provide an analysis of banking systems in transition economies. During the last years research has focused on the bank efficiency comparison between the EU members, the new EU members and the candidate countries for full EU membership. The issue of the new and of the future EU members' banking system efficiency is gaining importance in view of the fact that the more efficient the banking systems are, the more the countries will have the capacity to converge to the EU because of the conditions provided through financial intermediation for higher economic growth.

The efficiency of the Bulgarian banking system has been subject to several studies during the last years. Most of them are comparative studies focusing on transition economies in order to measure the effect of privatization on bank performance (Bonin, Hasan and Wachel, 2004a, 2004b; Athanasoglou et al., 2006) and the influence of foreign banks entry and foreign ownership with controlling power on bank efficiency (Havrylchyk and Jurzyk, 2006). The operational efficiency of the Bulgarian banking system has been studied in a pool of transition countries, using modern approaches like deterministic and non-parametric Data Envelopment Analysis (Grigorian and Manole, 2002; Tomova, Nenovsky and Naneva, 2004; Tomova, 2005) or stochastic and parametric Stochastic Frontier Approach (Yildirim and Philippatos, 2002). These analyses provide an estimation of different types of banking inefficiency (average X-inefficiency, average profit-inefficiency or average technological inefficiency), covering the period until 2002. Only Nenkova and Tomova (2003) try to estimate the technical efficiency of the Bulgarian banking system itself, but their data covers only the period December 1999 - June 2001.

We tested two hypotheses on the efficiency of the Bulgarian banking system: hypothesis 1: that foreign-owned banks are more efficient than domestic-owned banks, and hypothesis 2: that large banks in the Bulgarian economy are more efficient than the small ones.

The hypotheses were tested by using two estimation methods of bank efficiency. In addition to traditional accounting indicators, we used an alternative approach - Data Envelopment Analysis (DEA). We were advantaged by using both methods because they not only revealed the bank efficiency of the separate banking units, but also the relative efficiency of the banking units compared to the other units in the system, and because this approach allowed us to check the robustness of the results obtained.

The present paper contributes to the existing analysis of the Bulgarian banking system in two ways. Firstly, the methodology applied has been used for the first time for such a long period of time. Secondly, unlike the previous country and comparative multi-country studies focusing on the entire system's bank efficiency, this paper provides analysis at more disaggregated levels, like groups and sub-groups.

The paper is organized as follows: Section II gives an overview of the history of the Bulgarian banking system and of the banking institutions' major reforms during the transition period. Section III presents the methodology used in bank efficiency estimations and analyses in detail, and discusses the results obtained by using the traditional and DEA approaches. Section IV concludes.

II. History of the Bulgarian banking system

Major institutional reforms in the banking system took place at the end of 1989. The financial sector reform started with the reestablishment of commercial banks. At that time, the Bulgarian National Bank (BNB) performed almost all of the functions of the banking system. It was transformed from a one-tier into a two-tier banking system, with the BNB on the first tier and the commercial banks on the second. The sector-specific banks became universal banks (Miller, Petranov, 2001), collecting deposits and offering credits to different economic sectors. The banking sector reform was backed up by the adoption of a new legislation supporting the functioning of the recently established two-tier banking system. With the 1991 Law on the BNB, the authority defined the objectives and functions of the Central Bank and granted it independence from the government. A year later the Law on banks and credit activity, which defined the different activities banks could perform according to the type of license granted[1], became effective. Following the transformation of 59 branches of the BNB into commercial banks in 1990, the number of banks reached 70. After 1992, it started to decrease as a result of their consolidation[2].

Many state-owned commercial banks turned out to be inefficient since they were forced by the government to provide credits to loss-making state enterprises. The commercial banks' inefficiency was the reason for the establishment of the Bulgarian Consolidation Company (BCC) in 1992 (Miller, Petranov, 2001). The core objectives of the BCC were to consolidate, restructure and privatize state-owned commercial banks. The BNB also tried to encourage the process of consolidation by raising the minimum required capital. From the beginning of the banking system reforms, the authorities decided not to permit foreign banks to enter the local market because of the fear that they could put pressure on domestic commercial banks[3]. Although the banking supervision regulations were developed according to international standards, their enforcement was poor and the licensing policy of the BNB was rather loose (Balyozov, 1999). The delayed privatization and the lack of financial discipline increased the transfer of the state-owned enterprises' losses to the banking system, which together with poor lending practices led to the de-capitalization of several banks.

[1] The banks with full license could operate in the country and abroad, while the banks with restricted license could operate only in the country.

[2] In 1992 the United Bulgarian Bank was created from 22 small banks, in 1993 Express bank and Hebros bank emerged, and in 1995 Biochim took over Sofia bank (see Berlemann, Nenovsky, Hristov, 2002).

[3] The restriction of foreign banks entry was pursued until 1995 and their number at the end of 1995 was only 4 (Berlemann, Hristov and Nenovsky 2002).

Deposit runs started in late 1995, with the BNB performing as a lender of first - instead of last - resort (Berlemann, Hristov and Nenovsky, 2002)[4].

The banking crisis aggravated in 1996 and turned into a large-scale financial crisis, resolved by the introduction of the currency board arrangement in the middle of 1997. A new stage in the banking sector reform was started: entirely new laws on the BNB and commercial banks were adopted, entry of foreign banks was liberalized, supervision policies were strictly applied, and privatization and competition were encouraged. Regardless of the broad improvement in the environment, commercial banks started to optimize their behaviour providing new products and improving their efficiency only a few years ago when the international interest rates fell to extremely low levels, thus pushing the banks to the very natural way of performing banking activities[5].

[4] Several studies provide a detailed analysis on the Bulgarian banking system and the main corner stones in its development. See for example those by Miller and Petranov (1996, 2001), Trifonova (2002), Vucheva (2001), Caporale et al. (2002), etc.

[5] On the issues of financial repression, credit rationing, credit activity and credit capacity see Nenovsky and Hristov (1998), Hristov and Mihaylov (2002), etc.

III. Efficiency of the Bulgarian banking system

We tested the hypotheses by using two methods of bank efficiency measurement. Before going into details on the specific methodologies and analysis of the results obtained, we would like to present some basic classifications used in the estimation procedure. We used a three-group classification of the banks[6]: the first ten banks form the first group, the remaining banks are in the second group, and the last group comprises the foreign bank branches[7]. For the purposes of the study and to ensure the comparison for the analysed period, we reclassified the banking institutions for the period until 2003 in compliance with the three groups' classification.

In order to test the first hypothesis we produced an alternative classification of the bank units. Applying the criterion of the ownership of the banks' capital we obtained three groups: foreign banks with the majority of shares held by foreigners, domestic banks with the majority of shares held by domestic owners, and state-owned banks with a government institution as major shareholder.

By intuition we expect bank efficiency to depend on the activity of the banking system, the legislation, the administrative measures imposed by the central bank and a few external factors. The dynamics of the bank efficiency indicators doesn't reveal any specific trend, because they depend on several factors simultaneously. By means of a more detailed analysis we will try to identify the main factors driving bank efficiency in Bulgaria.

3.1. Traditional accounting approach

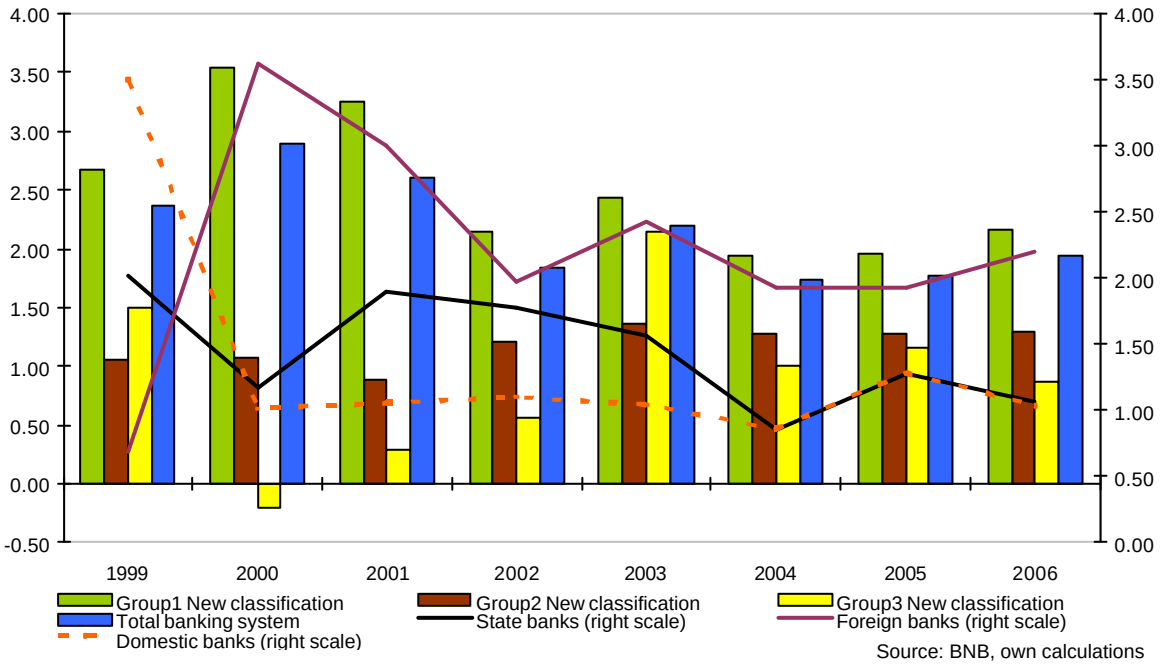
First, we focus on the analysis of standard bank efficiency indicators, like return on assets (ROA) and return on equity (ROE). We also analyse several ratios in relation to the banks' total assets – that is to say operating profit, net interest income, non-interest expenditures and exchange rate revaluations.

[6] Until 2003 the bank groups were five. The classification was made on the basis of the amount of banking assets. The first group included banks with total assets of more than BGN 800 mln. (before 2000 – BGN 500 mln.), the second group included banks with total assets of more than BGN 300 mln., the third group included banks with total assets of more than BGN 100 mln., the fourth group included banks with total assets of less than BGN 100 mln., and the fifth group included the branches of foreign banks.

[7] The BNB has modified the existing classification since June 2007. As before, the groups are three, with the first group including the top 5 banking institutions in terms of realized assets instead of the top 10.

The return on assets indicator shows a relatively high efficiency of the Bulgarian banking system[8], because of the high profits realised in the sector (figure 1). Starting from a very high level (4.98 at the end of 1997), it decreased for a year and then started to step up reaching 2.89 in 2000. The high values of ROA in 1997 might be explained by the profits realized by the banks from the exchange rate movements as a result of the national currency depreciation, especially in the first half of the year. After the deep financial crisis, in July 1997 the Bulgarian currency was pegged to the Deutsche Mark (DEM), later to the Euro and the banking system lost this opportunity. As a result the growth rates of the banks net profits started to decelerate and the ROA slowed down. After 2000 the decrease in the indicator was driven by the decline in the interest rates on the international markets[9], and by the depreciation of the USD against the Euro (Bulgarian lev respectively) in 2002. During the following years the ROA remained relatively stable, with the exception of 2003, when a considerable credit growth in the banking system was observed[10] (figure 3).

Figure 1: Return on Assets (net profit in % of total assets)



Source: BNB, own calculations

The ROA developments of the different bank groups reveal that the ROA of the first group has the same dynamics as the ROA of the total banking system. Actually, the first group determines the dynamics of the ROA in the banking system because it comprises more than

[8] For the purpose of comparison the three EU countries with the highest ROA are Romania (1.79), Estonia (1.67) and Latvia (1.66) (ECB, 2007).

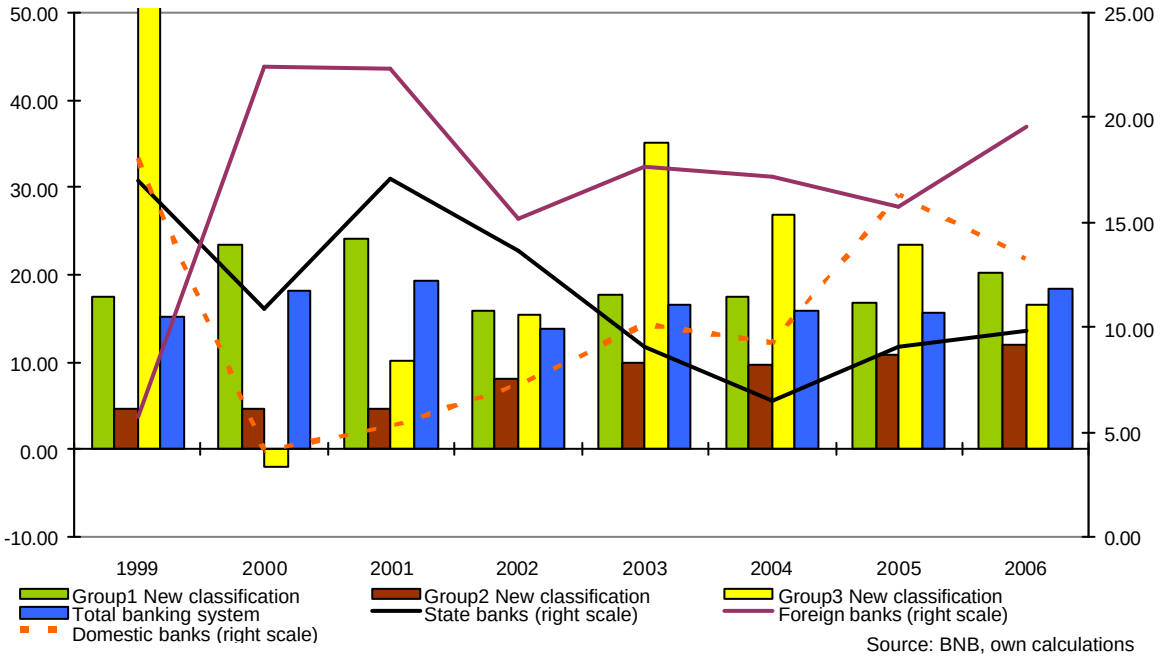
[9] In 2001 the main part of the bank assets was claims on financial institutions or banks assets invested abroad. The share of claims on financial institutions was 33.1% of the total bank assets, whereas the share of claims on non-financial assets was 33.9% of the total assets in 2001.

[10] The credit growth in 2003 was 49.4%, while in 2001 and 2002 it was respectively 37.2% and 45.5%.

75% of the total assets in the banking system (79.5% in 1999). The ROA of the second group proceeds in a relatively steady way, with the exception of 2001 when the interest rates dropped and of 2003 when the credit growth surged.

According to the ownership classification, a considerable change in the ROA of foreign and domestic banks is observed. In 2000 Bulbank was sold to a strategic foreign bank and this contributed to the significant increase in the ROA of the foreign banks group. As the ROA of Bulbank increased more than sixty percent, it could be claimed that privatisation has some effect on bank efficiency. In 2003 there was a new spike in the ROA of foreign banks when bank DSK was privatised, which confirms the stated thesis. After this period there were no more new foreign entries and the ROA stabilised. At the end of 2006 there was another increase, this time due to the better performance of the foreign banks and probably to decreased non-interest expenditures as a result of technological improvements. It should be pointed out that after 2000 the foreign banks had the highest profitability measured by the ROA indicator, which could be explained with the transfer of the technological advance, experience and knowledge of foreign banks to the bank management of the privatised domestic banks.

Figure 2: Return on Equity Capital (equity capital in % of total assets)



Source: BNB, own calculations

Since 2002 state-owned and domestic banks have had the same ROA, which could be explained with the high competition in the sector (see the Annex I)[11].

Bank efficiency, measured by the return on equity (ROE), is also relatively high[12]. In 1999 it decreased to 15.2% in comparison with 1997, when it was 40.5%. The Currency board adoption, the strong monetary rules and the new capital requirements have contributed to this slowdown. It stepped up for a while in 2000 and 2001, while in 2002 it registered a decrease again, mainly due to the exchange rates revaluations. In the following years the indicator remained relatively stable with the exception of 2006, when it went up because of the deceleration of capital augmentation.

The ROE is different for each banking group. The third group had the largest volatility with the indicator moving in the range of -1.96 to 130.5%. The second banking group had a moderate increase in the ROE, especially after the spike in 2002. The data shows that the indicator for the entire banking system is determined by the dynamics of the indicator for the first and third group.

Concerning the ownership structure, foreign banks have the highest efficiency due to the reasons stated above. The dynamics of ROE follows the dynamics of ROA. However, the efficiency of domestic banks followed an upward trend after the privatisation of Bulbank in 2000. In 2006 there was a slight decrease of the indicator due to the restrained opportunities for net profits of domestic banks as a result of the central bank measures for curbing bank credit activities (figure 3). Additional factors are the price increase of financial resources attracted by domestic banks (in 2006 interest rates on term deposits in BGN increased by 0.23 percentage points to 3.47%) and the competition in the bank sector, mainly in regard to deposits collection (figure 4). At the same time, state-owned banks are characterised by decreasing bank efficiency, which has reached its lowest level in the banking system during the last four years.

[11] We measure the competition with the Herfindahl index and the concentration coefficient in regard to bank assets, claims on non-financial institutions and other clients and deposits of non-financial institutions and other clients.

[12] For the purpose of comparison the three EU countries with the highest ROE are Latvia (26.4), Estonia (24.4) and Czech Republic (23.5) (ECB, 2007).

Figure 3: Credit to Non-financial Institutions and Other Clients (% of total assets)

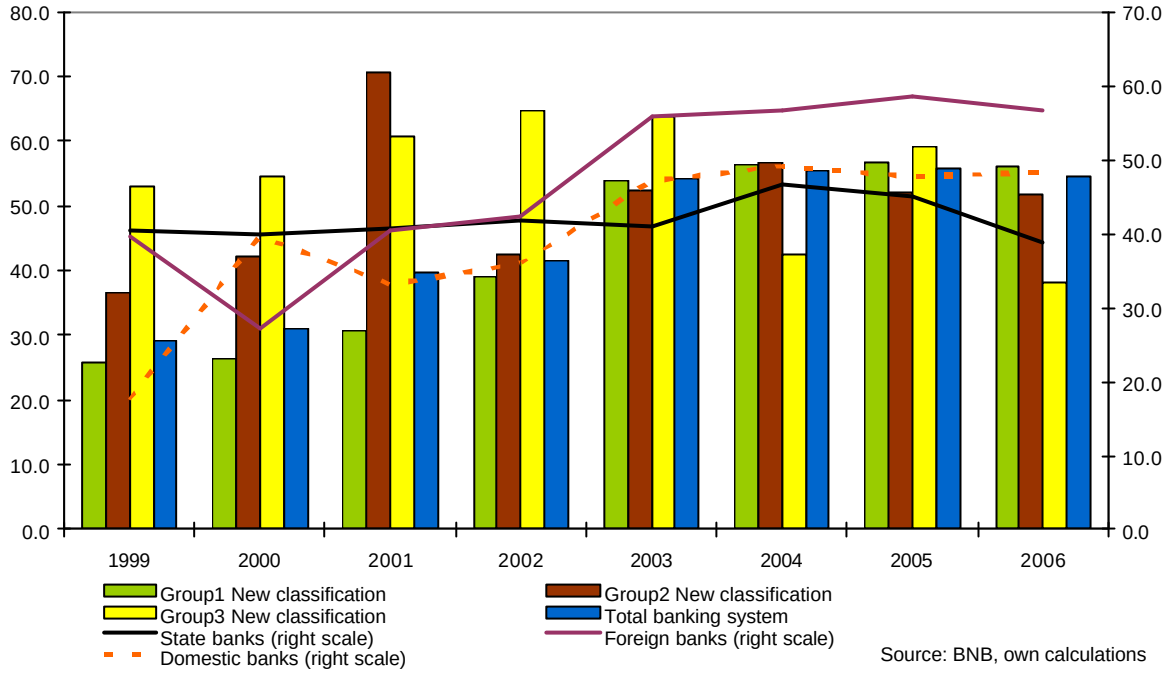


Figure 4. Deposits to Non-financial Institutions and Other Clients (% of total assets)

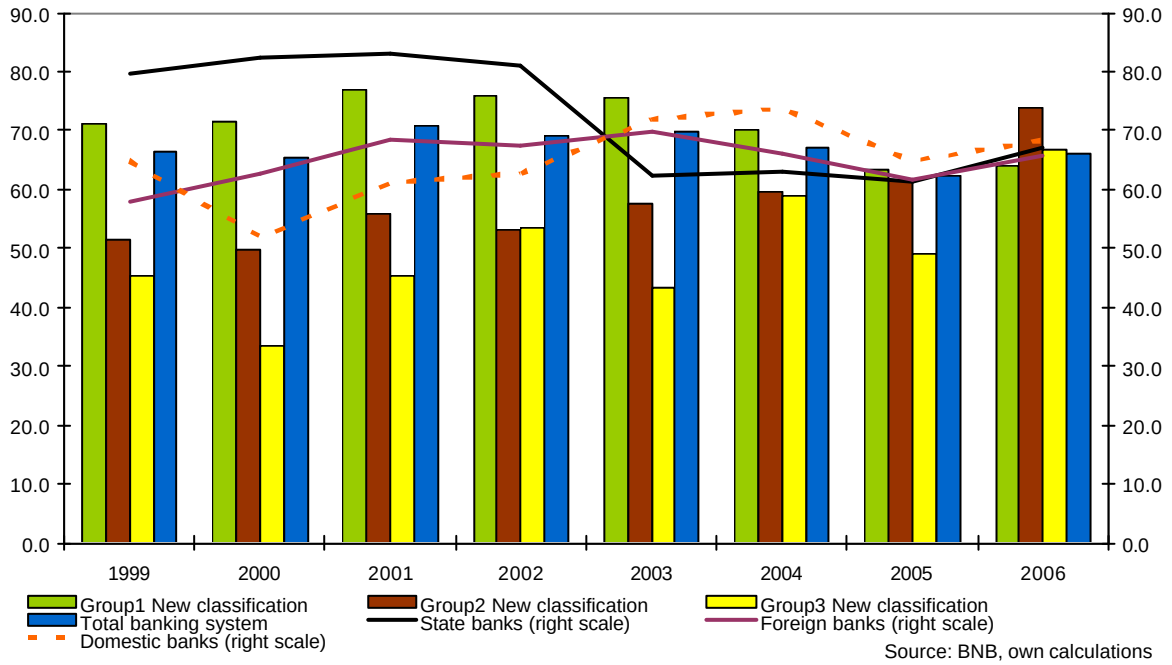
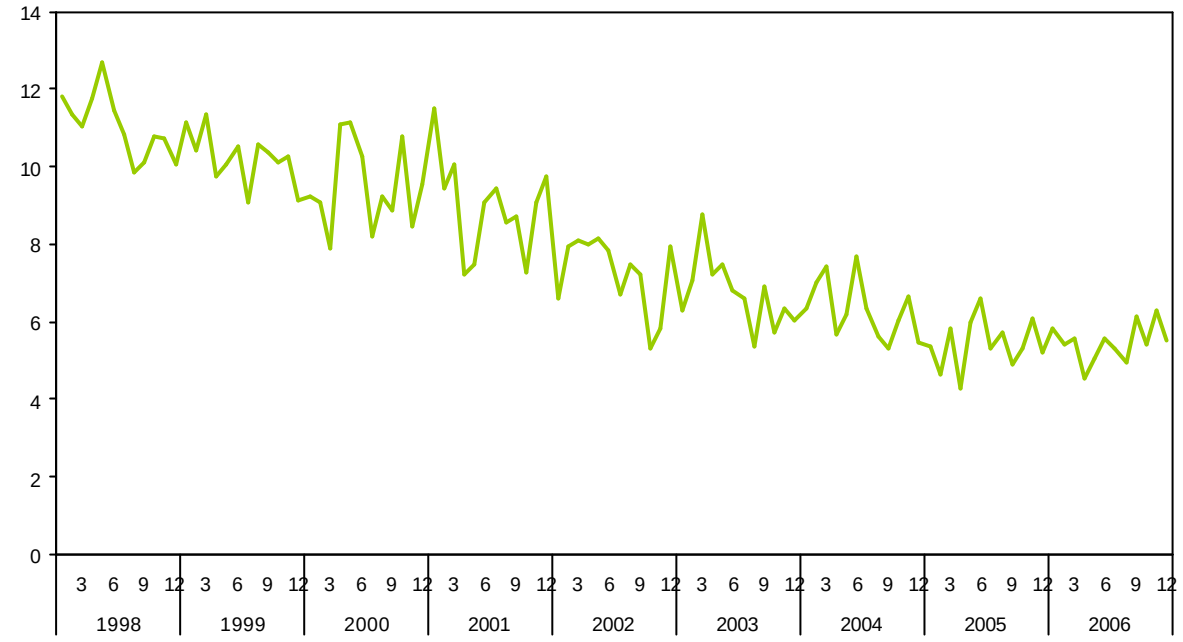


Figure 5: Interest Rate Spread (percentage points)

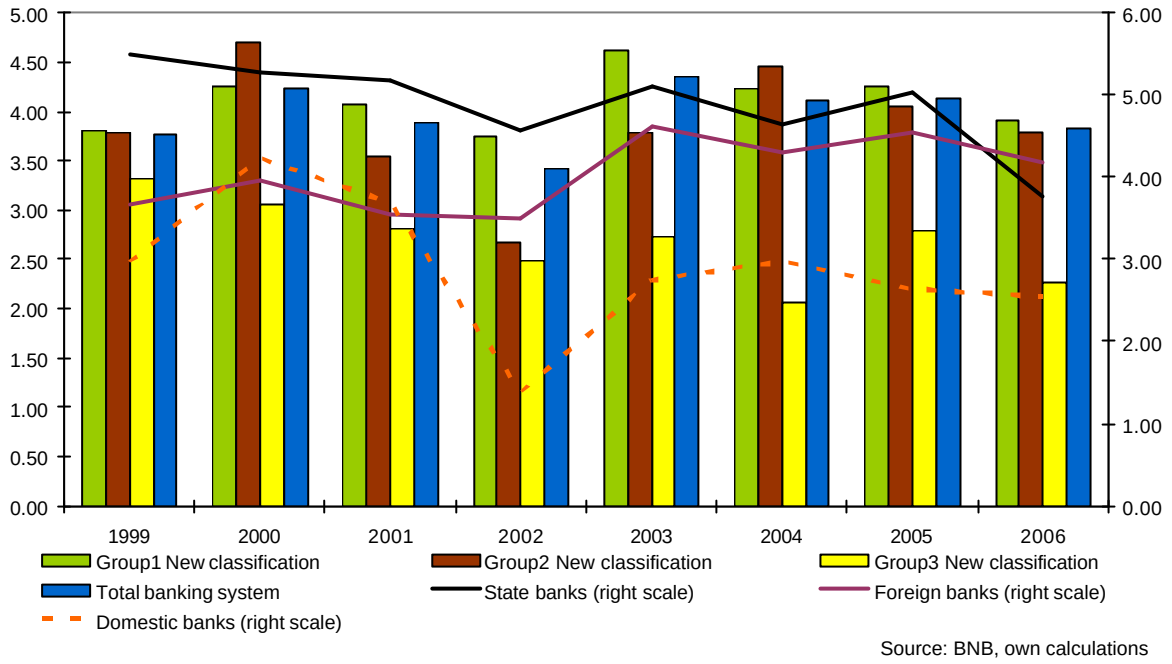


Source: BNB, own calculations

The declining interest spread[13] in the country lowers the cost of credit and encourages the implementation of investment projects, thus stimulating the economic growth. Although the interest spread in Bulgaria is about 3-3.5 percentage points higher than its average level in the EU, it has followed a stable downward path with the financial integration and continued process of intermediation deepening (figure 5). Although the net non-interest income contribution to the total income generation has been steadily increasing, the net interest income remains the most important source of income for the Bulgarian banking system, mainly because of the high interest spread (figure 6). However, since 2004 there has been a slight decrease in the net interest income (more pronounced for the second group of small and medium-sized banks), which reflects the higher costs of financing and the slowdown of credit activity.

[13] The interest spread is the difference between the interest rates on short-term loans and interest rates on term deposits.

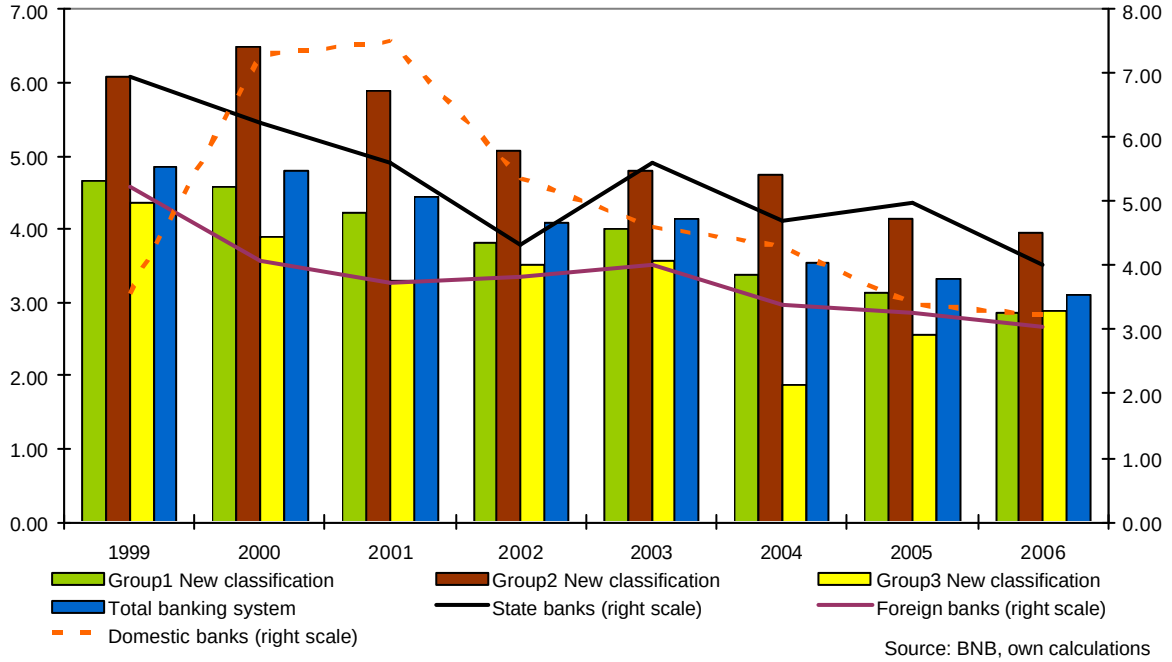
Figure 6: Net Interest Income (% of total assets)



Source: BNB, own calculations

Another positive impact on bank efficiency comes from the non-interest expenditures of the banks (figure 7). The administrative costs have followed a downward trend since 2000, driven by the improvement of banking institution management all over the system. The most significant drop is observed in the domestic banks group, as their administrative costs converge rapidly towards those of foreign banks.

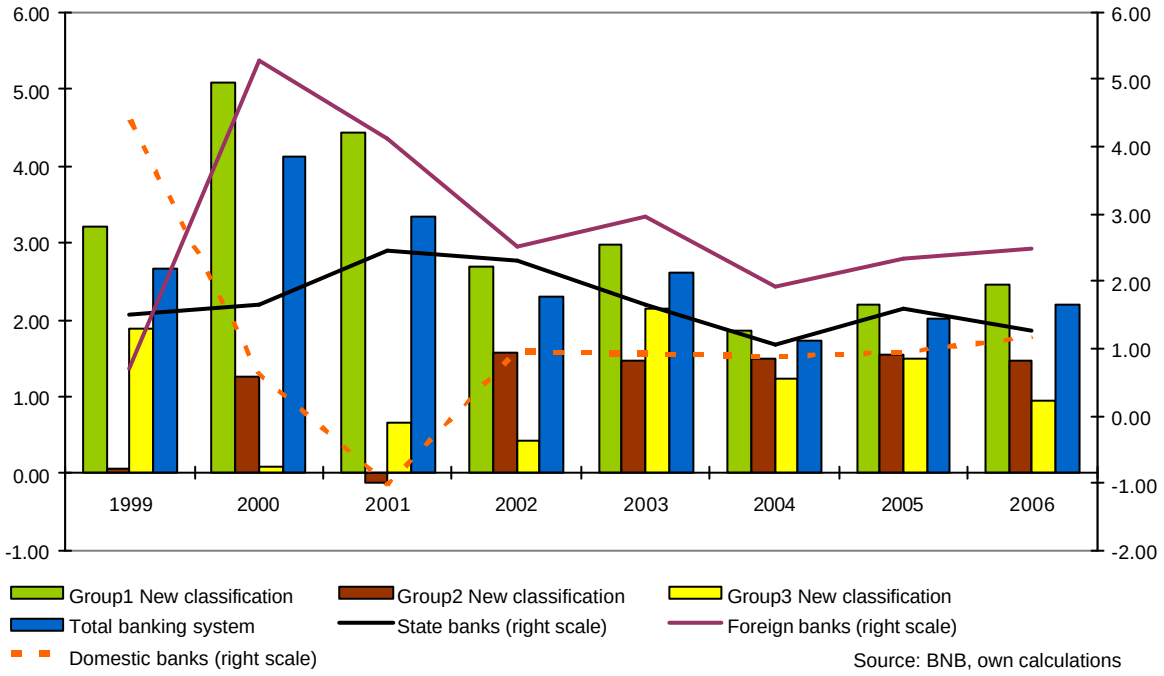
Figure 7: Non-Interest Expenditures (% of total assets)



Source: BNB, own calculations

The tendencies observed are reflected in the dynamics of the operating profit to total assets ratio, which after a significant drop in the period 2000-2003 has stabilized and started to grow again. Together with the declining interest spread and decreasing non-interest expenditures, this reflects the improved efficiency of banking institutions. The most efficient is the group of large banks, due to the economies of scale, and – as regards the second classification – the group of foreign banks, due to the flexibility of financing and the better access to managerial and technological improvements. The stabilization of the operating profit observed in the group of domestic banks proves that, as a whole, this group is improving its potential to operate under increased competition pressure, thus contributing to the process of transformation of the banking system into a more efficient one.

Figure 8: Operating Profit (% of total assets)



On the basis of the analysis of the traditional indicators for bank efficiency, we have come to the following conclusions:

First, the efficiency of the entire banking system is determined by the efficiency of the largest banks in the banking system, which comprise the first banking group. The largest banks are more efficient than the small ones because of the opportunities to take advantage of the economies of scale.

Second, the most efficient banks in terms of ROA and ROE are the foreign ones because of the transfer of technological knowledge and experience in the management of privatized domestic banks. Foreign banks increase the competition in the banking system, which in its turn drives domestic banks to start a process of transformation in order to operate more

efficiently. Thus, domestic banks have undergone a significant drop in their administrative costs by management improvements.

Finally, the net interest income remains the most important source of income for the Bulgarian banking system because of the relatively high interest spread in the country. Thus, the whole banking system has a relatively higher efficiency as compared to the rest of the EU banking systems, due to the relatively high profits realized in the sector.

3.2 Data Envelopment Analysis

DEA is a specific methodology for the analysis of relative efficiency for multiple inputs and outputs by the evaluation of all decision-making units (DMUs)[14] and the measurement of their performance in regard to the best practice banks, which determine the so-called efficient frontier (See Annex II). The most important advantage of DEA is that it does not require assumptions about the production function's analytical form in advance. At the same time, as the rest of the models, DEA also has some disadvantages. First, it is sensitive to extreme observations; and second, it does not decompose the banks' deviation from the efficient production frontier into inefficiency and random error components.

We used both the traditional and the DEA approach to bank efficiency in order to obtain a clearer and more complete picture of bank performance and efficiency. Both methods have important advantages. The traditional accounting approach provides opportunities for a better comparison of the tendencies and it measures the performance of the bank in terms of profitability. In turn, the DEA approach enables the determination of multiple outputs and inputs in the efficiency score calculation, and it measures the technical efficiency of the banking institutions. At the same time, the DEA treats the bank as an enterprise with a specific production process, taking into account the particular production factors and allowing for optimal decision making.

The DEA is more complex and sophisticated than traditional methods, because it is a deterministic non-parametric approach, using multiple inputs and outputs. At the same time, unlike the parametric approaches [Stochastic Frontier Approach (SFA), Distribution Free Approach (DFA) and Thick Frontier Approach (TFA)] it doesn't need too long time series.

There are various models of DEA. We chose to apply the ones most frequently used: the CCR-model and the BCC-model. The CCR-model was developed by Charnes, Cooper and Rhodes (Charnes et al. (1978)). Its specific assumption is that the DMU operates under constant returns to scale (CRS). The BCC-model was defined by Banker, Charnes and Cooper (Banker et al. (1984)). It estimates efficiency under the assumption of variable

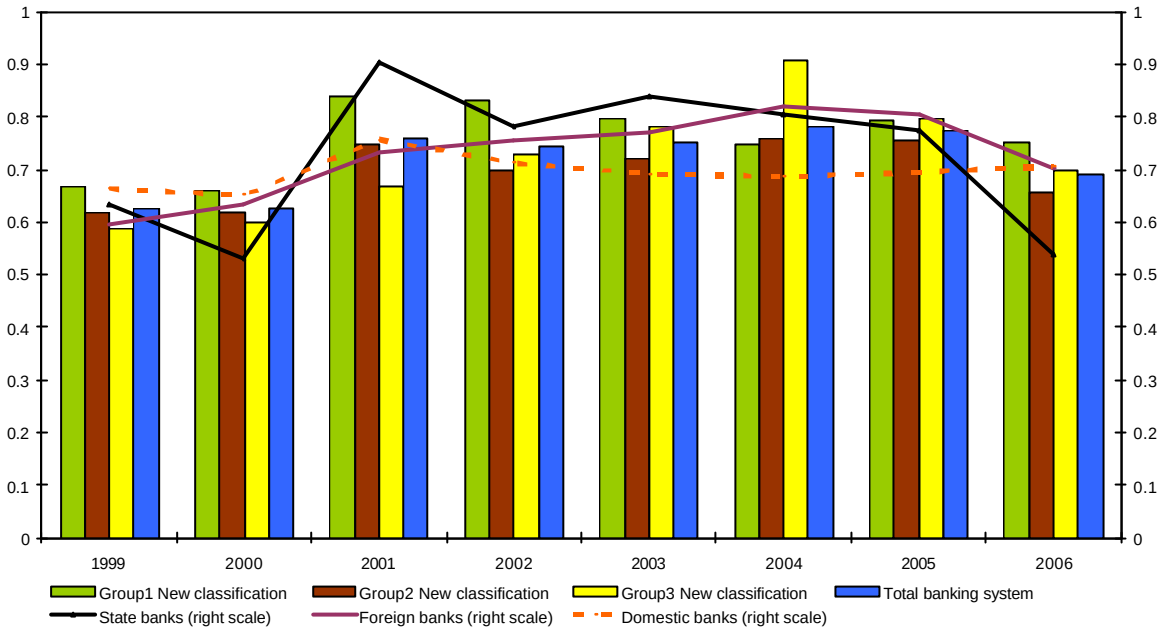
[14] In our study the DMUs are commercial banks.

returns to scale (VES). The efficiency scores calculated by the BCC-model are higher than the efficiency scores estimated by the CCR-model. The BCC-model compares DMUs with DMUs, operating in the same region of returns to scale, while the CCR-model compares DMUs in the whole sample. To perform the efficiency score calculation we used the software DEAFrontier, developed by Joe Zhu.

In addition to the specification of the DEA-model used, it is necessary to determine the factors which will be used as measures of inputs and outputs. Several approaches to DEA have been used, depending on the data availability and the economic treatment of banking institutions as producers of financial services or mediators of funds between savers and investors. In the literature, the following approaches could be identified: the operating approach, the intermediation approach, the production approach, the value-added approach, the user cost approach and the asset approach (Jemric and Vujcic (2002), Pawlowska (2005), Grigorian and Manole (2002)). In fact, there is no consensus on which of the available approaches to DEA should be used for the efficiency score estimation. We decided to use the operating and the intermediation approach, as they are in line with the specific treatment of Bulgarian banks' behaviour and fit in very well with the data available on individual banks.

The operating approach estimates the efficiency from the cost/revenues perspective, while the intermediation approach treats the banks as units, which transform a set of production factors into final banking products. In the operating approach, we used two variables for the inputs: interest and related costs and non-interest costs; while for the outputs we took the interest and related revenues and the non-interest revenues. In the intermediation approach the production factors used are the fixed assets, the number of employed and the deposits, while the final products are covered by loans and securities.

Figure 9: Efficiency Score by the Operating Approach (CRS)

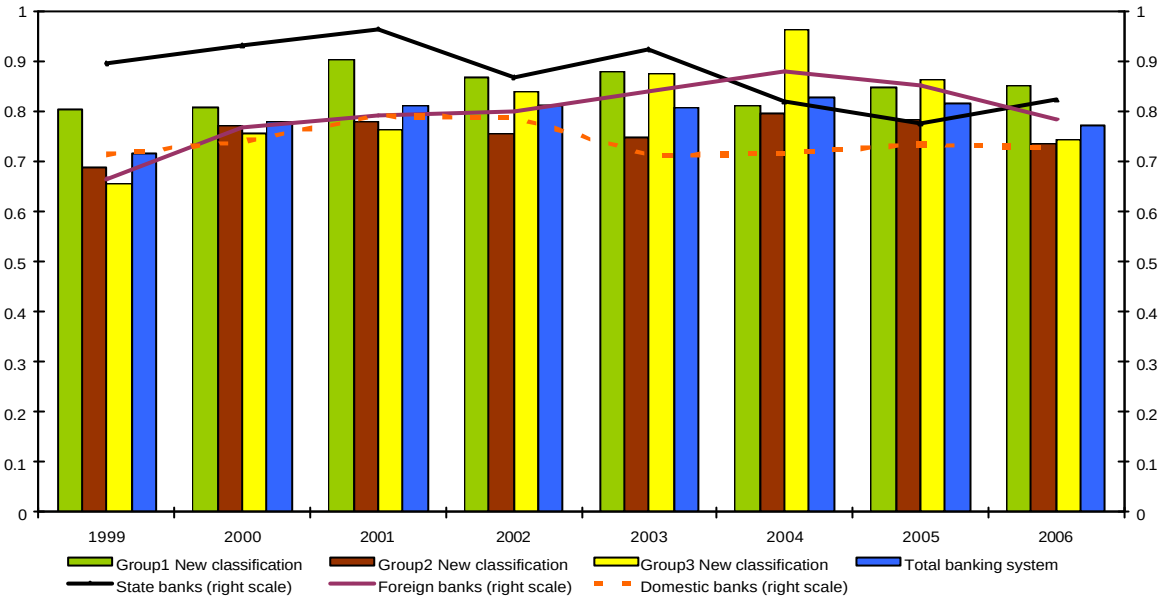


Source: own calculations

Before presenting the efficiency results according to the operating approach specification of DEA, it is necessary to explain how the scores should be interpreted. In 1999 the average efficiency score of the total banking system was 0.63, which means that the average bank used only 63% of its inputs efficiently to produce its current outputs. In comparison, the average efficiency of banks in 2006 was 0.69, which means that 69% of the inputs were efficiently used.

The calculations obtained when using the CRS-model show that there is a relatively large asymmetry among banks (see Figure 9 and the detailed results in Annex III). There was a tendency to increase in the average efficiency of the total banking system until 2005, when it reversed as a result of the credit measures adopted by the central bank. The drop in efficiency in 2006 was due to the rise in interest and related costs of foreign banks, as a result of their policy to attract financial resources from abroad under the circumstances of international liquidity costs increasing faster than those on the local market. At the same time, the domestic banks maintained relatively stable efficiency levels with equalisation in terms of average efficiency in the group. It has been measured by standard deviation, which over time falls dramatically.

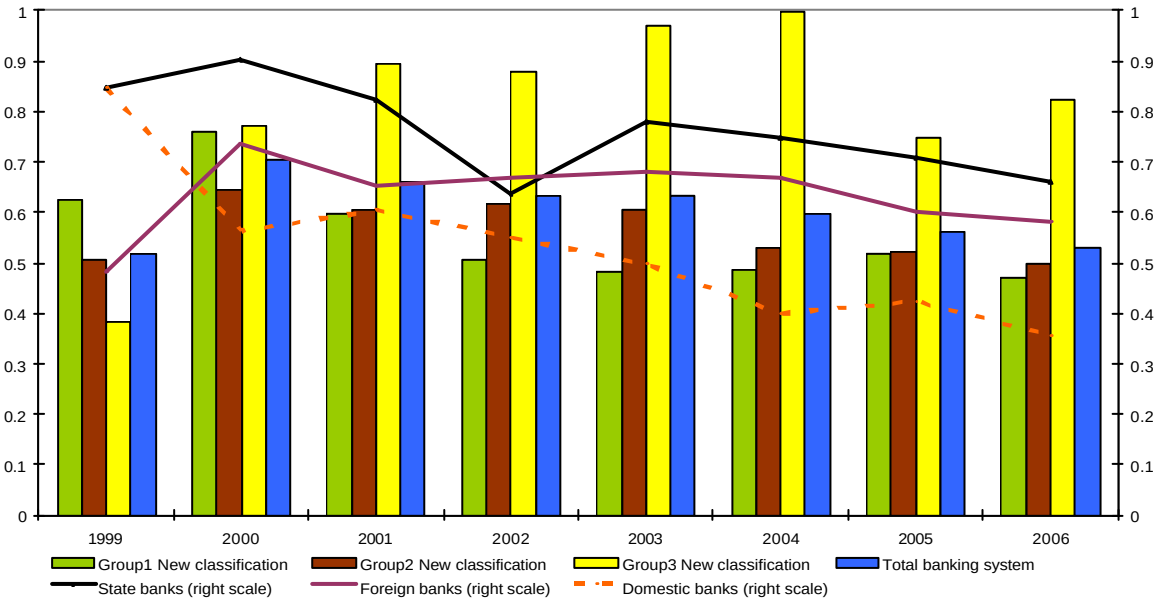
Figure 10: Efficiency Score by the Operating Approach (VRS)



Source: own calculations

According to the VRS-model (see Figure 10), we observed less dramatic changes in technical efficiency and a higher number of efficient banks. The average efficiency of the total banking system declined again in 2005 and 2006, but the drop was less pronounced due to the rising efficiency of the top 10 banks. The share of administrative costs in the total costs has been substantially cut down as a consequence of the changed ownership structure in the large banks group. Foreign participation influenced the transfer of knowledge and better management practices, including the optimisation of administrative costs, which led to a higher efficiency in the group.

Figure 11: Efficiency Score by the Intermediation Approach (CRS)



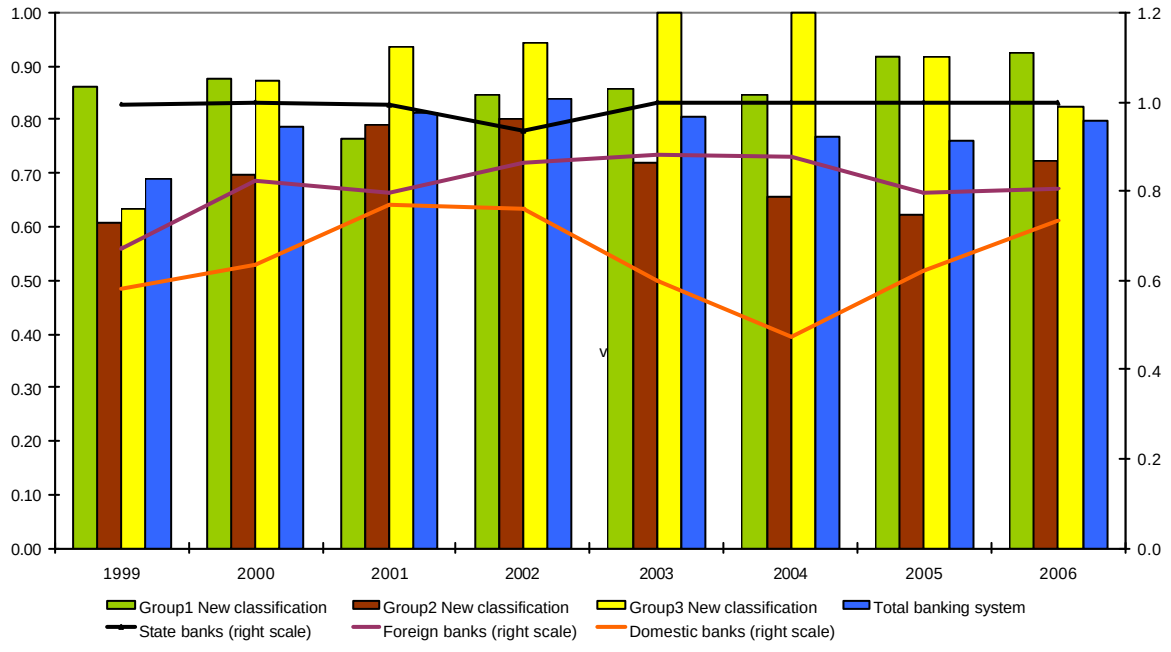
Source: own calculations

The intermediation approach provides another perspective of what happens to bank efficiency when the actual production process is regarded as a "black" box. In this case, efficiency is simply estimated upon the amount of outputs produced by a certain amount of inputs.

Using the CRS intermediation approach (see Figure 11 and Annex IV), we obtained a much lower average efficiency score for the total banking system as compared with the operating approach models. This is due to much lower average efficiency scores of large banks. As the intermediation approach does not account for the transaction costs per unit of output, which are much higher for smaller banks, the CRS assumption is the only one appropriate for them.

The VRS-model is more appropriate when calculating average banking efficiency, because large banks in Bulgaria account for about 75% of the total assets in the banking system. This assumption is further supported by the presence of factors like increasing competition, changes in regulation and technological improvement, which might prevent the banks from operating at the optimal scale or substantially change the production frontiers. In addition, this statement is supported by the results obtained when using the software solver. The estimations showed that, during the period analysed, there were only few banks operating on the optimal scale. When we dropped the strict assumption for constant returns to scale and allowed for variable returns to scale, the solver showed that most of the banks were operating under decreasing or increasing returns to scale.

Figure 12: Efficiency Score by the Intermediation Approach (VRS)



Source: own calculations

With the VRS-model of intermediation approach we observed a much higher average bank efficiency than with the models presented before (see Figure 12). According to detailed

results, efficiency was driven by the top 10 banks, where a huge improvement in the technological process took place through two channels. First, there was a substantial shift from capital to labour ratio (fixed assets per employee), which grew about 3 times as much during the period analysed. And second, the labour productivity increased seven times (loans and securities per employee).

Using the ownership classification, we found that the high bank efficiency of the total system reflects the efficiency-net effects of the foreign bank presence on the local market. They are the main providers of new technologies and better administrative cost management implementation. The presence of foreign banks stimulated competition in the financial sector and put a lot of pressure on domestic banks. As a result, they went through a process of optimisation of their activities which led to an improvement in their efficiency scores, more visible during the last two years. At the same time, the general trend of efficiency equalisation was observed in their group.

Regarding state-owned banks we should point out that the sample is small and diminishing, so we could not rely on the estimated efficiency scores. Most of the privatization deals were closed during the first years of the period analysed, while some mergers are currently leading to a further consolidation of the banking system.

On the basis of the analysis of the estimated efficiency scores for the different groups and sub-groups, we have come to the following conclusions:

First, by the operating approach to DEA we observed a tendency to increase in the average efficiency of the banking system, which was interrupted in the last year of the period analysed. This might be a consequence of the credit measures imposed by the central bank. By the intermediation approach, we found that the average efficiency of the banking system is lower compared to the operating approach results because of the efficiency scores of the largest banks. This is due to the fact that the intermediation approach does not account for the transaction costs per unit of labour.

Second, the applied intermediation and operating approaches to DEA showed that there was an equalisation in the Bulgarian banking system during the period analysed.

Third, foreign banks have a relatively higher efficiency compared to domestic and state-owned banks, as a result of the transfer of knowledge and of a better management practice, including administrative cost optimisation.

Finally, the VRS-model is more appropriate when calculating the average efficiency of large banks and of the total banking system, because increasing competition, technological improvement and regulatory changes affect the banks' behaviour and prevent some of them from operating at their optimal level.

IV. Conclusion

In the present paper we estimated and analysed the efficiency of the Bulgarian banking system by splitting it into several major groups, according to the ownership structure and bank assets. We used standard indicators for bank efficiency, namely return on assets, return on capital, operating profit, net interest income, non-interest expenditures and exchange rate revaluations. In order to check the robustness of the results obtained, we used the DEA approach to bank efficiency score measurement. The lack of data concerning particular banks prior to 1999 prevented us from providing a consistent analysis for the period preceding the Currency board establishment. However, using the official data we drew some conclusions on the current state of the banking system profitability and confirmed the initial hypotheses.

On the basis of our analysis, we came to the conclusion that during the period analysed foreign banks performed better than domestic and state-owned banks. Their efficiency was higher than that of other banks because of the technological improvements and better managerial knowledge and experience. Actually, the privatization of state-owned banks had a positive impact not only on the efficiency of the privatised banks, but also on the entire system.

In addition, large banks turned out to be more efficient than small ones. The reasons were the decreasing operating costs and the advantage of scale economies realisation. The accumulation of large financial resources, the need for better management and the increased competition in the banking system put pressure on domestic banks, which inevitably led to an increase in their non-interest expenditures. Although such investments are a greater burden for small banks, they are expected to augment the banks' capacity to further improve their efficiency in the future. In fact, competition also led to equalisation of the average efficiency not only in the separate groups, but also in the whole system.

Considering the importance of efficiency development in the banking system, especially in a highly competitive and dynamic environment as the one where the Bulgarian banking intermediaries operate, the topic requires further research. We intend to use the so-called Malmquist index in order to decompose efficiency change into technical and scale efficiency and to provide better time comparisons. With the accumulation of longer time series, we also plan to apply some parametric approaches to bank efficiency measurement in order to account for other financial, institutional and macroeconomic factors, which impact not only on the technical, but also on the economic efficiency of banks.

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Annexes

Annex I

Table 1: Measures of Concentration in the Banking Sector

	XII.1999	XII2000	XII.2001	XII.2002	XII.2003	XII.2004	XII.2005	XII.2006
Bank assets								
Herfindahl Index	0.12	0.11	0.09	0.08	0.08	0.07	0.07	0.07
Concentration Coefficient (%)	57	55.2	51.4	49.9	47	44.2	42.19	41.18
Claims on non-financial institutions and other clients								
Herfindahl Index	0.08	0.07	0.07	0.07	0.07	0.08	0.08	0.08
Concentration Coefficient (%)	43.6	42	41.1	41.85	43.15	45.36	44.98	44.19
Deposits of non-financial institutions and other clients								
Herfindahl Index	0.13	0.13	0.11	0.1	0.09	0.08	0.08	0.07
Concentration Coefficient (%)	61.7	62.2	58.2	55.8	53.07	50.32	46.79	43.79

Source: Miller and Petranov (1996), BNB, AEAF, own calculations.

Annex II

The efficiency score[15] in the presence of multiple input and output factors is defined as:

$$\text{Efficiency} = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}}$$

The optimal weights are obtained by solving the following mathematical programming problem:

$$\max_{u,v} (u' y_i / v' x_i) \qquad \text{(AII.1)}$$

$$\text{Subject to } u' y_j / v' x_j \leq 1 \quad j = 1,2,....,I$$
$$u, v \geq 0$$

For each of I firms there are N inputs and M outputs. In this case the column vectors x_i and y_i respectively represent the set of inputs and outputs for the i-th firm, while the data for all I firms is represented by the NxI input matrix, X, and the MxI output matrix, Y.

The following *multiplier form* avoids the problem of obtaining an infinite number of solutions by imposing a new constraint:

$$\max_{u,v} (u' y_I) \qquad \text{(AII.2)}$$

$$\text{Subject to } v' x_I = 1$$
$$u' y_j - v' x_j \leq 0 \quad j = 1,2,..., j_0,...,I$$
$$u, v \geq 0$$

The equivalent *envelopment form* of this linear programming problem is the one preferable to solve, as it involves fewer constrains than the multiplier form (AII.2):

$$\min_{q,l} q \qquad \text{(AII.3)}$$

$$\text{Subject to } -y_I + \mathrm{Y} l \geq 0$$
$$q x_I - \mathrm{X} l \geq 0$$
$$l \geq 0$$

Here *?* is a scalar, and ? is an Ix1 vector of constants (i.e. weights). The value of *?* obtained is the efficiency score of the i-th firm and it satisfies *?* = 1, where a value of 1 indicates a point on the frontier, i.e. a technically efficient firm. To obtain the value of *?* for each firm, the linear programming model must be solved I times.

The presented approach to the linear programming problem (AII.2) assumes constant returns to scale (CRS). The CRS problem can be easily modified to account for VRS by adding a convexity constraint, which allows to envelope the data points more tightly than under the CRS specification and thus provides technical efficiency scores that are greater than or equal

[15] The presented specifications of the DEA models are based on the book "An Introduction to Efficiency and Productivity Analysis", by Coelli et al. (2005), Springer Science and Business Media Inc., 2nd Ed., where more detailed information on efficiency measurement models can be found.

to those obtained using the CRS model (see AII.5). The VRS linear programming problem is:

$$\min_{q,l} q \qquad \text{(AII.4)}$$

Subject to $-y_I + \mathrm{Y}l \geq 0$

$qx_I - \mathrm{X}l \geq 0$

$\mathrm{I1}^1 = 1$

$l \geq 0$

Where I1 is an *I*x1 vector of ones.

The technical efficiency scores (TE) under the CRS and VRS specifications are related by the scale efficiency effect (SE), which is netted when calculating technical efficiency under the VRS. The relation is:

$$TE_{CRS} = TE_{VRS} \text{ x } SE \qquad \text{(AII.5)}$$

Annex III

Operating approach

	1999	2000	2001	2002	2003	2004	2005	2006
Total banking system								
				Constant returns to scale				
Number of DMUs	34	35	35	34	35	35	34	32
Number of efficient DMUs	5	5	7	6	7	8	7	5
Average efficiency	0.62521	0.62656	0.75886	0.74366	0.75189	0.78059	0.77358	0.69179
Average inefficiency ((1-M)/M)	0.599468	0.596012	0.317767	0.344702	0.329977	0.281084	0.29270	0.44552
Median efficiency level	0.599569	0.589527	0.75452	0.744566	0.725317	0.802422	0.74633	0.656706
Minimal efficiency level	0.193809	0.191409	0.300053	0.44169	0.347347	0.42749	0.48328	0.30577
Maximal efficiency level	1	1	1	1	1	1	1.00000	1
Standard deviation	0.219436	0.228723	0.187176	0.170559	0.182134	0.175708	0.15694	0.192454
				Variable returns to scale				
Number of DMUs	34	35	35	33	35	35	34	32
Number of efficient DMUs	7	11	13	8	9	11	11	8
Average efficiency	0.716155	0.778436	0.810752	0.811301	0.806991	0.828409	0.815609	0.771595
Average inefficiency ((1-M)/M)	0.396345	0.284627	0.233422	0.232588	0.239171	0.207133	0.226078	0.296017
Median efficiency level	0.725399	0.795413	0.819341	0.841807	0.846098	0.858396	0.798569	0.737339
Minimal efficiency level	0.267167	0.423542	0.50156	0.477995	0.417855	0.428046	0.498267	0.5292
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.219588	0.191869	0.178885	0.16315	0.187659	0.170501	0.16184	0.17156

Group1 New classification

				Constant returns to scale				
Number of DMUs	10	10	10	10	10	10	10	10
Number of efficient DMUs	2	1	1	3	2	2	2	1
Average efficiency	0.66605	0.65847	0.84052	0.83268	0.79496	0.74856	0.79309	0.75197
Average inefficiency ((1-M)/M)	0.501385	0.518661	0.18974	0.200946	0.257927	0.335904	0.260896	0.329839
Median efficiency level	0.625301	0.597747	0.852255	0.793301	0.802465	0.782777	0.746328	0.718653
Minimal efficiency level	0.428059	0.325125	0.61238	0.680747	0.541371	0.42749	0.568586	0.595192
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.203318	0.198526	0.124088	0.124516	0.156598	0.194692	0.149758	0.118751
				Variable returns to scale				
Number of DMUs	10	10	10	10	10	10	10	10
Number of efficient DMUs	3	4	5	4	3	3	4	3
Average efficiency	0.80439	0.80873	0.902937	0.86849	0.877555	0.810071	0.848324	0.851218
Average inefficiency ((1-M)/M)	0.243177	0.236507	0.107497	0.151423	0.13953	0.234459	0.178794	0.174788
Median efficiency level	0.82526	0.804584	0.967421	0.861512	0.960248	0.862732	0.911078	0.840182
Minimal efficiency level	0.555205	0.447997	0.66988	0.696046	0.547792	0.428046	0.57063	0.596162
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.173095	0.197142	0.122866	0.12369	0.166491	0.199983	0.169492	0.132844

Group2 New classification

				Constant returns to scale				
Number of DMUs	17	17	18	18	19	19	18	18
Number of efficient DMUs	3	2	5	2	4	3	3	3
Average efficiency	0.61701	0.61995	0.74827	0.69906	0.71983	0.75726	0.75517	0.65654

Average inefficiency ((1-M)/M)	0.620709	0.613038	0.336417	0.430484	0.389212	0.320546	0.324211	0.523141
Median efficiency level	0.586936	0.571133	0.741547	0.667464	0.678585	0.720622	0.751076	0.627909
Minimal efficiency level	0.193809	0.243918	0.300053	0.44169	0.347347	0.526243	0.483282	0.30577
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.251288	0.225486	0.210152	0.178802	0.207888	0.169749	0.163524	0.215593
Variable returns to scale								
Number of DMUs	17	17	18	18	19	19	18	18
Number of efficient DMUs	4	4	6	2	4	4	4	4
Average efficiency	0.689291	0.770547	0.778557	0.75494	0.748631	0.795696	0.782079	0.733903
Average inefficiency ((1-M)/M)	0.450765	0.297779	0.284428	0.324609	0.335771	0.256762	0.278643	0.362577
Median efficiency level	0.716472	0.760676	0.764158	0.756778	0.727149	0.838266	0.793436	0.649676
Minimal efficiency level	0.267167	0.484996	0.50156	0.477995	0.417855	0.550285	0.498267	0.5292
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.250554	0.172554	0.189516	0.178558	0.199886	0.162894	0.161686	0.181303

Group3 New classification

Constant returns to scale								
Number of DMUs	7	8	7	6	6	6	6	4
Number of efficient DMUs	0	2	1	1	1	3	2	1
Average efficiency	0.58676	0.60072	0.66943	0.72908	0.78164	0.90784	0.79629	0.69999
Average inefficiency ((1-M)/M)	0.704276	0.664657	0.493797	0.371588	0.279359	0.10151	0.255828	0.428586
Median efficiency level	0.608489	0.576593	0.601013	0.70329	0.741628	0.947422	0.743712	0.687722
Minimal efficiency level	0.368239	0.191409	0.517595	0.526036	0.64465	0.699426	0.578889	0.424528
Maximal efficiency level	0.797327	1	1	1	1	1	1	1
Standard deviation	0.17247	0.291353	0.171823	0.179237	0.13105	0.120096	0.16933	0.239629
Variable returns to scale								
Number of DMUs	7	8	7	6	6	6	6	4
Number of efficient DMUs	0	3	2	2	2	4	3	1
Average efficiency	0.655346	0.757333	0.76185	0.837506	0.874191	0.962564	0.861671	0.742148
Average inefficiency ((1-M)/M)	0.525911	0.320424	0.312595	0.194021	0.143915	0.038892	0.160536	0.34744
Median efficiency level	0.712704	0.800159	0.716705	0.854946	0.899708	1	0.881715	0.690909
Minimal efficiency level	0.407401	0.423542	0.521482	0.619108	0.660575	0.853456	0.687759	0.586775
Maximal efficiency level	0.896265	1	1	1	1	1	1	1
Standard deviation	0.183086	0.242514	0.191994	0.17861	0.13197	0.061906	0.153429	0.184699

State banks (right scale)

Constant returns to scale								
Number of DMUs	5	4	4	3	2	2	2	2
Number of efficient DMUs	1	0	1	0	1	1	1	0
Average efficiency	0.63343	0.52925	0.90425	0.78113	0.83929	0.80506	0.77351	0.53839
Average inefficiency ((1-M)/M)	0.578702	0.889463	0.105884	0.280193	0.19148	0.242137	0.292805	0.857398
Median efficiency level	0.586936	0.583733	0.886906	0.783472	0.839292	0.805064	0.773512	0.538388
Minimal efficiency level	0.360939	0.350377	0.843205	0.732091	0.678585	0.610129	0.547024	0.4628
Maximal efficiency level	1	0.599161	1	0.827835	1	1	1	0.613976
Standard deviation	0.255179	0.119913	0.074126	0.047915	0.227275	0.275681	0.320303	0.106898
Variable returns to scale								
Number of DMUs	5	4	4	3	2	2	2	2
Number of efficient DMUs	3	2	3	1	1	1	1	1
Average efficiency	0.896155	0.931468	0.964592	0.868015	0.923049	0.817444	0.775303	0.822223
Average inefficiency ((1-M)/M)	0.115878	0.073574	0.036708	0.152054	0.083366	0.223326	0.289818	0.216215

Median efficiency level	1	0.961068	1	0.858312	0.923049	0.817444	0.775303	0.822223
Minimal efficiency level	0.644195	0.803737	0.858367	0.745732	0.846098	0.634887	0.550606	0.644446
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.157626	0.092728	0.070817	0.127412	0.108825	0.258174	0.317769	0.251415

Foreign banks (right scale)

				Constant returns to scale				
Number of DMUs	17	21	22	21	23	23	23	22
Number of efficient DMUs	1	4	4	5	5	7	6	5
Average efficiency	0.59641	0.63357	0.73348	0.75334	0.77050	0.81947	0.80457	0.70051
Average inefficiency ((1-M)/M)	0.676708	0.578359	0.363364	0.327416	0.297862	0.220306	0.242907	0.427534
Median efficiency level	0.608489	0.589527	0.732765	0.74744	0.729406	0.811494	0.757332	0.688298
Minimal efficiency level	0.193809	0.191409	0.300053	0.44169	0.415808	0.529875	0.578889	0.30577
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.199266	0.243535	0.200112	0.182101	0.166723	0.161748	0.142216	0.21704
				Variable returns to scale				
Number of DMUs	17	21	22	21	23	23	23	22
Number of efficient DMUs	1	7	7	6	7	9	9	7
Average efficiency	0.665469	0.76785	0.791323	0.800721	0.838393	0.878357	0.851158	0.783235
Average inefficiency ((1-M)/M)	0.502699	0.302337	0.263706	0.248875	0.192758	0.13849	0.17487	0.276756
Median efficiency level	0.712704	0.795019	0.817989	0.820791	0.916483	0.92193	0.827626	0.761673
Minimal efficiency level	0.270949	0.423542	0.50156	0.477995	0.425016	0.550285	0.629236	0.5292
Maximal efficiency level	1	1	1	1	1	1	1	1
Standard deviation	0.19572	0.19972	0.185347	0.177236	0.176278	0.140935	0.135318	0.182077

Domestic banks (right scale)

				Constant returns to scale				
Number of DMUs	12	10	9	10	10	10	9	8
Number of efficient DMUs	3	1	2	1	1	0	0	0
Average efficiency	0.66258	0.65077	0.75628	0.71208	0.69162	0.68628	0.69440	0.70618
Average inefficiency ((1-M)/M)	0.509245	0.536641	0.322262	0.404334	0.445877	0.457139	0.440099	0.416079
Median efficiency level	0.599569	0.607843	0.728573	0.670851	0.635345	0.644195	0.688139	0.656145
Minimal efficiency level	0.265369	0.325125	0.537406	0.511846	0.347347	0.42749	0.483282	0.595192
Maximal efficiency level	1	1	1	1	1	0.948271	0.965563	0.916183
Standard deviation	0.245327	0.236783	0.171382	0.175123	0.212166	0.17423	0.152779	0.117805
				Variable returns to scale				
Number of DMUs	12	10	9	10	10	10	9	8
Number of efficient DMUs	3	2	3	1	1	1	1	0
Average efficiency	0.712961	0.73945	0.789873	0.787968	0.711554	0.715723	0.733717	0.726927
Average inefficiency ((1-M)/M)	0.402602	0.35235	0.266027	0.269086	0.405374	0.397189	0.362923	0.375655
Median efficiency level	0.726663	0.73833	0.761007	0.768927	0.679558	0.694486	0.691533	0.65748
Minimal efficiency level	0.267167	0.44800	0.538008	0.525918	0.417855	0.428046	0.498267	0.596162
Maximal efficiency level	1	1.00000	1	1	1	1	1	0.966638
Standard deviation	0.247375	0.18764	0.174867	0.168342	0.200324	0.182626	0.18298	0.135719

Annex IV

Intermediation approach

	1999	2000	2001	2002	2003	2004	2005	2006
Total banking system								
				Constant returns to scale				
Number of DMUs	34	35	35	34	35	35	34	32
Number of efficient DMUs	6	10	10	5	9	9	7	6
Average efficiency	0.5159	0.7055	0.6599	0.6312	0.6340	0.5970	0.5608	0.5305
Average inefficiency ((1-M)/M)	0.9383	0.4175	0.5154	0.5843	0.5772	0.6751	0.7832	0.8851
Median efficiency level	0.4676	0.7360	0.6525	0.5950	0.5583	0.5265	0.4753	0.4669
Minimal efficiency level	0.0068	0.0214	0.1659	0.2395	0.2147	0.1452	0.0000	0.1539
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3252	0.3019	0.3005	0.2417	0.2814	0.3003	0.2875	0.2705
				Variable returns to scale				
Number of DMUs	34	35	35	34	35	35	34	32
Number of efficient DMUs	12	18	15	18	17	16	15	14
Average efficiency	0.6883	0.7888	0.8120	0.8390	0.8068	0.7694	0.7622	0.7988
Average inefficiency ((1-M)/M)	0.4529	0.2678	0.2315	0.1919	0.2395	0.2997	0.3120	0.2519
Median efficiency level	0.7329	1.0000	0.9708	1.0000	0.9242	0.9288	0.8428	0.9502
Minimal efficiency level	0.0929	0.1617	0.2354	0.2930	0.2411	0.2085	0.1305	0.3010
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.2971	0.2627	0.2531	0.2173	0.2510	0.2641	0.2631	0.2491
Group1 New classification								
				Constant returns to scale				
Number of DMUs	10	10	10	10	10	10	10	10
Number of efficient DMUs	2	3	1	0	0	1	0	0
Average efficiency	0.6246	0.7599	0.5974	0.5078	0.4835	0.4842	0.5195	0.4708
Average inefficiency ((1-M)/M)	0.6010	0.3160	0.6740	0.9693	1.0684	1.0651	0.9249	1.1240
Median efficiency level	0.6045	0.8140	0.6440	0.4978	0.4141	0.3889	0.4357	0.4857
Minimal efficiency level	0.1986	0.2586	0.2208	0.2395	0.3267	0.2996	0.3105	0.2776
Maximal efficiency level	1.0000	1.0000	1.0000	0.7898	0.8924	1.0000	0.9436	0.6339
Standard deviation	0.2846	0.2629	0.2362	0.1808	0.1929	0.2285	0.1945	0.1176
				Variable returns to scale				
Number of DMUs	10	10	10	10	10	10	10	10
Number of efficient DMUs	4	7	4	5	6	5	6	7
Average efficiency	0.8617	0.8768	0.7654	0.8459	0.8567	0.8457	0.9191	0.9239
Average inefficiency ((1-M)/M)	0.1604	0.1406	0.3065	0.1822	0.1673	0.1825	0.0880	0.0823
Median efficiency level	0.8943	1.0000	0.9109	0.9885	1.0000	0.9718	1.0000	1.0000
Minimal efficiency level	0.6118	0.4668	0.2354	0.2930	0.4539	0.3446	0.6282	0.6664
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.1491	0.2068	0.2939	0.2426	0.2016	0.2383	0.1415	0.1274
Group2 New classification								
				Constant returns to scale				
Number of DMUs	17	17	18	18	19	19	18	18
Number of efficient DMUs	3	4	5	2	4	3	3	3
Average efficiency	0.5072	0.6431	0.6039	0.6167	0.6069	0.5297	0.5210	0.4982
Average inefficiency ((1-M)/M)	0.9714	0.5550	0.6558	0.6216	0.6476	0.8880	0.9196	1.0072

Median efficiency level	0.4218	0.7001	0.5945	0.5950	0.5583	0.4953	0.4465	0.3716
Minimal efficiency level	0.0068	0.0214	0.1659	0.2534	0.2147	0.1452	0.1219	0.1539
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3324	0.3217	0.3343	0.2345	0.2799	0.2806	0.2713	0.2844
				Variable returns to scale				
Number of DMUs	17	17	18	18	19	19	18	18
Number of efficient DMUs	5	6	7	8	5	5	4	4
Average efficiency	0.6094	0.6972	0.7901	0.8006	0.7195	0.6565	0.6237	0.7234
Average inefficiency ((1-M)/M)	0.6410	0.4342	0.2656	0.2491	0.3898	0.5233	0.6032	0.3823
Median efficiency level	0.5756	0.7816	0.9123	0.8403	0.8147	0.6182	0.5937	0.7243
Minimal efficiency level	0.0929	0.1617	0.2483	0.3627	0.2411	0.2085	0.1305	0.3189
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3078	0.2972	0.2574	0.2221	0.2772	0.2625	0.2611	0.2600

Group3 New classification

				Constant returns to scale				
Number of DMUs	7	8	7	6	6	6	6	4
Number of efficient DMUs	1	3	4	3	5	5	4	3
Average efficiency	0.3818	0.7700	0.8931	0.8804	0.9709	0.9980	0.7491	0.8248
Average inefficiency ((1-M)/M)	1.6194	0.2987	0.1197	0.1358	0.0300	0.0020	0.3350	0.2124
Median efficiency level	0.2620	0.8279	1.0000	0.9599	1.0000	1.0000	1.0000	1.0000
Minimal efficiency level	0.0113	0.0558	0.5141	0.5292	0.8254	0.9882	0.0000	0.2993
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3530	0.3146	0.1786	0.1844	0.0713	0.0048	0.4190	0.3504
				Variable returns to scale				
Number of DMUs	7	8	7	6	6	6	6	4
Number of efficient DMUs	3	5	4	5	6	6	5	3
Average efficiency	0.6321	0.8732	0.9350	0.9427	1.0000	1.0000	0.9161	0.8252
Average inefficiency ((1-M)/M)	0.5820	0.1452	0.0695	0.0608	0.0000	0.0000	0.0916	0.2118
Median efficiency level	0.5615	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Minimal efficiency level	0.2704	0.4685	0.5919	0.6560	1.0000	1.0000	0.4963	0.3010
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3578	0.1966	0.1517	0.1404	0.0000	0.0000	0.2056	0.3495

State banks (right scale)

				Constant returns to scale				
Number of DMUs	5	4	4	3	2	2	2	2
Number of efficient DMUs	1	2	2	1	1	1	1	1
Average efficiency	0.8459	0.9026	0.8214	0.6359	0.7792	0.7476	0.7089	0.6601
Average inefficiency ((1-M)/M)	0.1822	0.1080	0.2174	0.5726	0.2834	0.3376	0.4107	0.5150
Median efficiency level	0.8667	0.9635	0.8233	0.5145	0.7792	0.7476	0.7089	0.6601
Minimal efficiency level	0.6793	0.6832	0.6389	0.3932	0.5583	0.4953	0.4177	0.3202
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.1261	0.1502	0.2063	0.3211	0.3123	0.3569	0.4117	0.4807
				Variable returns to scale				
Number of DMUs	5	4	4	3	2	2	2	2
Number of efficient DMUs	4	4	3	2	2	2	2	1
Average efficiency	0.9953	1.0000	0.9925	0.9362	1.0000	1.0000	1.0000	0.9992
Average inefficiency ((1-M)/M)	0.0047	0.0000	0.0076	0.0681	0.0000	0.0000	0.0000	0.0008
Median efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9992
Minimal efficiency level	0.9764	1.0000	0.9698	0.8086	1.0000	1.0000	1.0000	0.9984

Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.0105	0.0000	0.0151	0.1105	0.0000	0.0000	0.0000	0.0011

Foreign banks (right scale)

				Constant returns to scale				
Number of DMUs	17	21	22	21	23	23	23	22
Number of efficient DMUs	4	7	7	4	7	7	6	5
Average efficiency	0.4839	0.7355	0.6533	0.6690	0.6807	0.6699	0.6016	0.5822
Average inefficiency ((1-M)/M)	1.0665	0.3596	0.5306	0.4948	0.4691	0.4929	0.6622	0.7178
Median efficiency level	0.3496	0.7735	0.6993	0.6508	0.7153	0.6473	0.5542	0.5024
Minimal efficiency level	0.0113	0.0214	0.1659	0.3122	0.3363	0.2016	0.0000	0.2178
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.3423	0.3179	0.3167	0.2264	0.2691	0.2873	0.2998	0.2733
				Variable returns to scale				
Number of DMUs	17	21	22	21	23	23	23	22
Number of efficient DMUs	6	12	10	11	14	13	12	12
Average efficiency	0.6727	0.8213	0.7969	0.8633	0.8809	0.8775	0.7973	0.8038
Average inefficiency ((1-M)/M)	0.4866	0.2175	0.2548	0.1583	0.1352	0.1395	0.2543	0.2441
Median efficiency level	0.6805	1.0000	0.9766	1.0000	1.0000	1.0000	1.0000	1.0000
Minimal efficiency level	0.2704	0.1617	0.2354	0.4586	0.4274	0.4480	0.3257	0.3010
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.2894	0.2531	0.2584	0.1852	0.1838	0.1771	0.2537	0.2659

Domestic banks (right scale)

				Constant returns to scale				
Number of DMUs	5	10	9	10	10	10	9	8
Number of efficient DMUs	1	1	1	0	1	1	0	0
Average efficiency	0.8459	0.5635	0.6041	0.5504	0.4978	0.3992	0.4235	0.3559
Average inefficiency ((1-M)/M)	0.1822	0.7745	0.6554	0.8169	1.0090	1.5049	1.3612	1.8094
Median efficiency level	0.8667	0.5499	0.5998	0.5105	0.3829	0.3121	0.4173	0.3319
Minimal efficiency level	0.6793	0.2160	0.1733	0.2395	0.2147	0.1452	0.1219	0.1539
Maximal efficiency level	1.0000	1.0000	1.0000	0.9792	1.0000	1.0000	0.7024	0.6019
Standard deviation	0.1261	0.2656	0.2963	0.2584	0.2835	0.2501	0.2030	0.1378
				Variable returns to scale				
Number of DMUs	12	10	9	10	10	10	9	8
Number of efficient DMUs	2	2	2	5	1	1	1	1
Average efficiency	0.5825	0.6359	0.7688	0.7588	0.5977	0.4746	0.6197	0.7350
Average inefficiency ((1-M)/M)	0.7168	0.5727	0.3008	0.3179	0.6730	1.1069	0.6136	0.3605
Median efficiency level	0.6077	0.5780	0.9097	0.8807	0.5922	0.4564	0.6475	0.7171
Minimal efficiency level	0.0929	0.2181	0.2483	0.2930	0.2411	0.2085	0.1305	0.4346
Maximal efficiency level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Standard deviation	0.2959	0.2646	0.2791	0.2872	0.2910	0.2204	0.2607	0.2153