Financial innovation and the Romanian banking sector efficiency in the context of the financial crisis: Foreign versus domestic banks

Șargu Alina Camelia
"Alexandru Ioan Cuza" University of Iași
Faculty of Economics and Business Administration, Department of Business Administration
B-dul Carol 1 nr.22, Corp C, Et. 6, C805
Iasi, 700505
Romania
E-mail: s_alina_camelia@yahoo.com

Roman Angela
"Alexandru Ioan Cuza" University of Iași
Faculty of Economics and Business Administration, Department of Business Administration
B-dul Carol 1 nr.22, Corp C, Et. 6, C805
Iasi, 700505
Romania
E-mail: aboariu@uaic.ro

Abstract
Over the last years foreign banks have gained the majority share of the banking assets from the new EU member states and at least in theory, these banks should be more efficient than their domestic peers as they tend to benefit and use more financial innovations in their daily activities. In turn, this can lead to an accumulation of sufficient capital and know-how by the foreign banks which will allow them to sustain an efficient activity even in some adverse cases – like the financial and economic crisis which started in 2007. Thus, the aim of our paper is to investigate if foreign banks present on the Romanian banking market between 2002 and 2010 have been more efficient than their domestic peers, while also taking into account the effects of the financial and economic crisis. In order to achieve this purpose our metrological approach was based on the Data Envelopment Analysis and on an empirical analysis that investigates the determinants of cost efficiency, among which we can count the financial innovation. The results of our research underlined that on the Romanian banking market, foreign banks are more efficient than their domestic peers, being able to better use their advantages. Also, during the researched period the efficiency of the banking sector has not been improved, moreover, between 2007 and 2010, it has registered a drop which can be attributed to the depreciation of the macroeconomic environment under the influence of the international financial and economic crisis.

Keywords: Financial innovation, Financial crisis, Data Envelopment Analysis, Romanian banks' efficiency, Ownership
JEL codes: G21; C33

1. Introduction

The role of foreign banks in the banking systems of the new EU member states represents a current issue, strongly debated in the last period, the case of Romania being no particularity, especially taking into account the essential transformations which took place in this banking system over time. Thus, the first governments of Romania, after the fall of the columnist regime, in the first part of the 1990, have promoted the idée of a minimal presence of foreign banks on the national market, considering more opportunely to preserve a national banking system. Afterwards, until 1997, foreign banks were allowed to operate in the Romanian banking system mostly as greenfield investments or through the acquisition of distressed national banking institutions, being allowed to take only a minority share in the privatisation process. But, once Romania has stated its aspirations of becoming a full time member of the European Union, the necessary political motivation has been provided in order to lift the restrictions regarding the entry of foreign banks on the Romanian banking market and thus

facilitate the participation of these banking institutions in the privatisation process of Romanian state banks. As a result of these policies the share of banking assets held by foreign owned banks has raised from 15,2% in 1998 to 78,1% in 2010 (NBR, 1998; NBR, 2010).

Regarding the main academic papers which are focused on the problems related to bank efficiency and the role of foreign banks in the national banking systems, most of the studies are undertaken in the case of the United States of America and the EU-15 countries (Berger and Humphrey, 1997). Most of these researches underline the fact that in the more advanced banking systems, foreign banks tend to register a more reduced level of efficiency for the activities that they undertake compared with their domestic peers. Despite these results, there is also a series of cases in which foreign banks from certain developed states have managed to be more efficient than their domestic peers (Berger et al., 2000). Even if the academic literature dedicated to the new European Union member states is relatively much smaller than the one focused on the EU-15 countries, there are several studies which sustained the idée that foreign banks are more efficient in the case of the new members stats than the domestic ones (Grigorian and Manole, 2002; Hasan and Marton, 2003; Havrylchyk, 2005; Dardac and Boitan, 2008; Toçi, 2009). A much argued reason for these developments is represented by the fact that foreign banks are entering the new European Union member states markets for different reasons, aiming not only to follow their costumers but also to exploit local opportunities (Clarke et al., 2001).

Taking into account these aspects the research that we have undertaken aims at completing the existing literature on this theme by offering a view on the efficiency of the Romanian banking sector and its determinants - among which we can mention financial innovation, our sample of banks covering almost 91,3% of the total banking assets of the Romanian sector in 2009, thus making this one of the most comprehensive researches undertaken so far on this subject. The purpose of our research is to analyse if foreign banks present on the Romanian banking system tend to be more efficient that their domestic peers, especially in the context in which the foreign institutions have a tendency to use more financial innovations in practice than their local competitors. Foreign banks are using in practice more financial innovations because they benefit from the technical progresses and the banking operations undertaken by their parent banks, these institutions having a direct interest in the development and implementation of financial innovations mainly because they are located in more developed markets, where the competition level is very high.

In order to achieve this aim we will use a nonparametric approach based on the Data Envelopment Analysis, estimating the cost, allocative, technical, pure technical and scale efficiency. Afterwards, we will use a series of parametric (T test) and nonparametric (Wilcoxon Rank-Sum, Kruskal–Wallis, Kolmogorov–Smirnov) tests in order to establish if foreign and domestic banks come from the same population. Nevertheless, we have analysed, using a Tobit regression, the way in which a series of banks characteristics like the capitalisation level, the nonperforming loans ratio, the raise of the assets, the size of the bank, the variance of the return on assets and especially the adoption of the financial innovations influences the efficiency of the studied banks.

2. The main contributions of foreign banks to the innovation of the Romanian banking sector

The Romanian banking system has undergone through a series of fundamental changes since the fall of communism in the winter of 1989, changes which can be summarised in four stages. *The first stage, between 1989 and 1996,* was characterised by the reforming of the communist banking sector and the adoption of a two level banking model. On the first level was the National Bank of Romania which assumed only the role of supervision and control, while the second level was composed by the other commercial banks. During this period several international reputable banks followed their clients to Romania and established subsidiaries (Societe Generale) or opened branches (Raiffeisen Zentralbank Oesterreich). During this period the activities of foreign banks in Romania were limited to servicing foreign enterprises and their presence wasn't considered competition by the domestic banks.

The second stage, which took place between 1997 and 2000, was characterised by a series of financial scandals and bankruptcies which prompted the adoption of a new banking law in 1998 and the implementation of several reforms in order to stabilise and raise the safety of the Romanian banking sector. Also in this period, the privatisation process started with the acquiring of Banca

Română pentru Dezvoltare by Societe Generale in 1998, being considered the biggest privatisation of a Romanian bank to that date. After the 1999 foreign debt crisis and the statement of the EU membership aspirations, the new Romanian government decided to start a strong privatisation process of the main Romanian banks.

Stage three took place between 2000 and 2004 and represented a period of intense privatisations. Two major Romanian banks, Banca Agricolă and Bancpost were privatised during this period of time. The first was acquired by Raiffeisen Zentralbank Oesterreich in 2002 and the second by the EFG Eurobank Ergasias in the same year, after initially was sold to General Electric Capital Corporation and Banco Portugues de Investimento in 1999. These evolutions were also stimulated by the fact that Romania had begun her EU ascension and also by the fact that the macroeconomic environment became more stable. In general, the main advantages represented by the extension of the foreign banks presence in Romania have been represented by a higher competition in banking sector, leading to high quality and more variety of services at cheaper prices (Stoica and Căpraru, 2007, p. 732).

Table 1: Summary statistics of the banks that are active in Romania and part of our sample between 2002 and 2010

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total number of banks in Romania*	31	30	32	33	31	31	32	31	32
Total number of banks in our panel	20	22	25	26	25	25	25	25	20
The number of domestic banks in our panel	8	8	8	8	5	5	4	4	4
The number of foreign banks in our panel	12	14	17	18	20	20	21	21	16
The share from the total assets held by the banks from our panel	77,6%	83,5%	84,3%	86,2%	84,7%	92,8%	92,1%	91,3%	79,5%
The share from the total assets held by the foreign banks from our panel	35,0%	42,0%	46,7%	48,6%	73,3%	80,7%	80,7%	77,0%	65,0%
The share from the total assets held by the domestic banks from our panel	42,6%	41,5%	37,6%	37,6%	11,4%	12,1%	11,4%	14,3%	14,5%

** without the branches of the foreign banks operating in Romania*

Source: National Bank of Romania, annual reports for the period 2002-2010

The fourth stage has started in 2005 and represents a period of fast growth and development for the Romanian banking sector, at least until 2008 when the effects of the financial and economic downturn have hit strong the Romanian macroeconomic landscape. During this period the position of foreign banks has grown stronger, culminating with the privatization of the main Romanian bank, Banca Comercială Română, in 2007 for the record sum of 3,75 billions of Euros, from which 2,2 were gained by the Romanian state. Thus, at the end of 2009 77,9% of the total Romanian banking assets were held by foreign banks. Also there were 31 banks and 10 branches of foreign banks active in Romania, from which only 5 were domestic institutions, the state owning only one bank (CEC Bank) and being a majority holder in another (Banca de Export-Import a României - Eximbank).

In regard to the adoption of financial innovations in the Romanian banking system, from a historical perspective, we can distinguish two main periods. Thus, in a first period between 1989 and

1999 the domestic banks have played the main role in adopting and implementing financial innovations in the Romanian banking system.

In this way, in 1995, Banca Română de Dezvoltare, which at the time was controlled by the Romanian state, was launching the first credit card on the Romanian market entitled PRIMA. Shortly after this, still in 1995, Banca Comercială Română also a state owned bank has registered the first transaction through an ATM in Romania.

But with the turn of the millennium, foreign banks were the ones which took the initiative. This fact has been mainly determined by the desire of these banks to conserve their market share, which they have obtained as a result of the acquiring of local banks in the privatization process, through the offering of innovative products and services which will meet costumer's demands and even develop new niches for banking goods and services. Also, starting with 1999 foreign banks have extended their operations on the Romanian banking market, managing in 11 years to dominate this sector.

In regard to the banking products, their development has grown with the enhancement of the loans granting process, especially as a direct result of the consumer loans development, starting with 2001. Although the exact timing of some of these developments cannot be accurately pinpointed, a defining moment was represented by the establishing Raiffeisen Banca pentru Locuințe by Raiffeisen România, this being the first saving-lending bank in Romania. In 2011, Millenium Bank lunched the e-cont, the first banking account for which the possible costumer doesn't need to go to the bank in order to open it.

Probably the most spectacular evolution in the banking sector has been registered by cards, ATMs and the internet banking. Thus, in 1999 Banca Turco-Română launches the first internet banking service in Romania, entitled BTR.net. Although this hasn't helped very much this banking institution in avoiding the bankruptcy it marks the moment in which the banks that were operating in Romania have started to import and implement state of the art financial innovations. This premier is very important because starting from this point forward ATMs are becoming more flexible in regard to the operations which can be undertaken through them, thus helping the banks in solving their proximity issues.

At 20 May 2004, Raiffeisen Bank installs the first automated foreign exchange machine (AFXM), followed shorthly by Banca Comercială Română. In the first week of usage, the AFXM installed by Raiffeisen Bank has intermediated exchanges of over 70.000 euro, thus underling the fact that at the costumers level there is no resistance in using such devices.

In October 2005, Pro Credit Bank, becomes the first ever Romanian bank which issues chip cards under the VISA logo, while in April 2006 ING Bank becomes the first bank in Romania to issue chip card under the Mastercard logo.

In November 2008 Garanti Bank launches in Romania the first contactless card which uses Mastercard Pay Pass technology. Afterwards, in 2010, BRD – the second largest bank in Romania by assets – adopts also the Mastercard Pay Pass technology and signs a series of partnerships with local public transportation services, Sibiu becoming in 2011 the first ever European city were public transportation travels can be paid using either Mastercard or Maestro Pay Pass contactless cards.

In January 2011 City Bank has opened in Romanian the first smart banking agency, in which an ATM allows customers to withdraw cash in dual currency, either RON or euro.

We must also underline the fact that the introduction of financial innovations is a process which generates competitive advantages only on short and very short term. In the absence of a legislation which should protect patents, innovative products and services once they were introduced to the public and their reliability has been proven are extremely rapid copied by most of the players from the market, practically cancelling the first-mover competitive advantage.

If in the '90 the domestic banks were the ones which implemented financial innovations into practice, through which they helped the modernization of the Romanian banking system and its development so it could reach the standards of the more mature markets. By contrast, with the turn of the millennium foreign banks, which have gained tremendous market shares in the last decade, were the ones which introduced innovative technologies in the Romanian banking system, aiming rather to achieve a superior level of sophistication of their products and services and thus being able to better conserve their market shares.

3. Literature review

Most of the academic literature on the subject related to the cost efficiency problems is focused on the United States of America and the example of the developed economies (Berger and Humphrey, 1997; Goddard et al, 2001, Weill, 2004; Angelidis and Lyroudi, 2006). There are also a series of studies which are focused on the case of the developing economies, but their number is still relatively low. Most of the studies are focused on the case of the Asian states, where countries like: Thailand (Sufian and Habibullah, 2010), South Korea (Sufian, 2011), Singapore (Rezvanian and Mehdian, 2002), Pakistan (Hardy and Bonaccorsi di Patti, 2001) and India (Debasish, 2006) have been extensively researched. The interesting dynamic of the banking system from Turkey has also been the subject of several researches on this topic (Isik and Hassan, 2002, Aydin et al., 2009). There are also a series of studies which are focused on the case of the countries from Central and Eastern Europe and also on the ones from the Commonwealth of the Independent States (Croatia - Kraft and Tirtiroglu, 1998; Poland - Opiela, 2001; Ukraine - Mertens and Urga, 2001; CEE - Grigorian and Manole, 2002; Hungary - Hasan and Marton, 2003; Visegrad Countries- Stavárek, 2003, Romania - Dardac and Boitan, 2008; Kosovo - Toçi, 2009).

Most of the studies undertaken so far tend to agree on the functions performed by banks and thus use the intermediation approach (Kraft and Tirtiroglu, 1998; Rezvanian and Mehdian, 2002; Isik and Hassan, 2002; Bonin et al., 2005). Also, there is a series of studies which are trying to combine the intermediation and the production approach considering the acquired funds both as inputs and outputs (Hasan and Marton, 2003) or using a model regarding the banking activities which consist of two stages, first the production stage followed by the intermediation stage (Denizer et al, 2000).

In regard to the right methodological approach that we should use in our research, over the last years there has been an ongoing debate on this theme. Almost half of the studies undertaken on this theme are using the Data Envelopment Approach (Grigorian and Manole, 2002; Rezvanian and Mehdian, 2002; Toçi, 2009), while the other half either uses the Stochastic Frontier Analysis (Kraft and Tirtiroglu, 1998; Mertens and Urga, 2001; Hasan and Marton, 2003; Bonin et al., 2005) or the Distribution Free Approach (Hardy and Bonaccorsi di Patti, 2001; Opiela, 2001). Some researchers are using both parametric and nonparametric analysis in order to ensure the robustness of the obtained results (Isik and Hassan, 2002; Rezvanian and Mehdian, 2002). Taking into account the extremely dynamic economic environment in which the banks from the developing and emerging countries are activating, most of the researches estimate separate frontiers for each of the analysed years, being thus able through this approach to underline also the way in which the liberalisation, deregulation and in some cases the European integration processes have affected the efficiencies of the banks from the respective markets.

Taking into account the empirical results of these studies we can conclude that in regard to the cost efficiency of the banks from the developing and emerging countries, these institutions tend to be least efficient and register higher fluctuation of their efficiency than the banks that are active in the developed countries. Thus, in the case of Turkey, the cost efficiency was in 1988 of 78,2% and it dropped to 68,5% in 1996 (Isik and Hassan, 2002), while in Pakistan the efficiency of the banks has risen from 48,5% before the reforms period to 72,8% in the post reforms period (Hardy and Bonaccorsi di Patti, 2001).

Analysing also the efficiency of the foreign banks, these studies have provided evidence that these institutions are able to better use their advantages and managed to register a higher level of efficiency than the domestic banks (Bhattacharyya et al., 1997; Isik and Hassan, 2002; Hasan and Marton, 2003; Bonin et al., 2005). Some of these studies have also conducted a series tests in order to establish if foreign and domestic banks come from the same population and if they should use a common or separated frontiers for the two types of banks, usually, both parametric and nonparametric tests being unable to reject the null hypothesis that foreign and domestic banks are coming from the same population (Isik and Hassan, 2002).

In general, the creation of a two-level banking system based on the principles of the free market, the implementation of new methods and instruments for bank regulation and supervision, financial or bank crises, the large volume of subprime loans, the entering of foreign banks through the privatization process or the creation of branches or subsidiaries, the creation of new banks, the acquisitions and mergers at the level of the banking sector, the expansion of modern bank products

and technologies – all these factors have had significant effects on the efficiency and profitability of the banking sector from the countries of Central and Eastern Europe (Stavarek and Poloucek, 2004, p. 75)

4. Methodology

The debate regarding the way in which cost-efficiency should be measured in the case of the banking institutions is a longstanding process, which is far from coming to a universal solution. The main focus of the debate is represented by the methodology which should be used in order to construct a frontier that will take into account the best practiced banks so that the rest of the sample could be measured coherently against this frontier. So far the methodology used by most of the studies in this matter can be divided into econometric models which use Stochastic Frontier Analysis, the Thick Frontier Approach, and the Distribution Free Approach and linear programming technique, namely Data Envelopment Analysis.

In order to measure the evolution of the Romanian banks we have used the Data Envelopment Analysis (DEA) approach, this method being developed by Charnes et al. (1978). This approach has been used in many studies on the developing and emerging economies (Denizer et al., 2000; Sathye, 2001; Isik and Hassan, 2002; Rezvanian and Mehdian, 2002; Toçi, 2009), being considered the best approach for this type of macroeconomic environment (Grigorian and Manole, 2002).

There are several reasons for which we have chosen to use the Data Envelopment Analysis approach in our study. The main reason is that DEA can perform well with just a small number of observations, this being an important factor as we want to be able to calculate the efficiency separately for each year in order to underline the effects of regulatory changes and the implementation of financial innovations. In this regard, our database is far more complete than most of the studies that use DEA for measuring banking efficiency. Also by using DEA there are no explicit functional forms on the data and the analysis can be performed well despite the assorted size of the banking institutions. The main disadvantage of this approach is represented by the fact that the analysis is very sensitive to outlying observations, this being the reasons why we have performed some sensitivity tests in our research.

We will present in the following paragraphs a short description of the Data Envelopment Analysis. Assume that there is data on K inputs and M outputs for each of N banks. For *i* bank these are represented by the vectors x_i and y_i, respectively. Let us call the *K* x *N* input matrix – *X*, and the *M* x *N* output matrix – *Y*. To measure the cost efficiency for each bank we calculate a ratio of all outputs over all inputs, such as ($u^{|}y_i/v^{|}x_i$) where *u* is an *M* x 1 vector of output weights and v is a *K* x 1 vector of input weights. To select optimal weights we specify the following mathematical programming problem:

$$\max_{u,v} (u^{|}y_i/v^{|}x_i) \qquad (1)$$

$u^{|}y_j/v^{|}x_j \leq 1, \quad j = 1,2,...,N,$

$u,v \geq 0$

The above formulation has a problem of infinite solutions and therefore we impose the constraint $v^{|}x_i = 1$, which leads to:

$$\max_{\mu,\rho} (u^{|}y_i/v^{|}x_i) \qquad (2)$$

$\rho^{|}x_i = 1,$

$\mu^{|}y_i - \rho^{|}x_j \leq 0, \quad j = 1,2,...,N,$

$\mu, \rho \geq 0,$

where we change notation from *u* and *v* to μ and ρ, respectively, in order to reflect transformation.

Using the duality in linear programming, an equivalent envelopment form of this problem can be derived:

$$\min_{\theta,\lambda} \theta \qquad (3)$$

$-y_i + Y\lambda \geq 0,$
$\theta x_i - X\lambda \geq 0,$
$\lambda \geq 0,$

where θ is a scalar and λ is a vector of N x 1 constants. The value of θ obtained will be the efficiency score for the i bank, which will range between 0 and 1. In should be noted that the problem should be solved N times, ones for each bank.

In order to calculate cost efficiency under assumption of variable returns to scale we add the following convexity constraint:

$$N1'\lambda = 1 \qquad (4)$$

In order to calculate allocative efficiency, we assume that w_i is a vector of input prices for the i bank and solve the following minimization problem:

$$\min_{\lambda x_i^*} w_i' x_i^* \qquad (5)$$

$-y_i + Y\lambda \geq 0,$
$x_i^* - X\lambda \geq 0,$
$\lambda \geq 0.$

where x_i^* is the cost-minimizing vector of input quantities for the i bank, given the input prices w_i and the output levels y_i.

In order to carry out our study we had to choose the right nature of the banking activity. In other words, in the academic literature on the subject there are two competing approaches regarding the nature of the banking activity, namely the production and the intermediation approaches (Sealey and Lindley, 1977). We consider that the main function of a banks is to intermediate funds between depositors and borrowers at the lowest reachable cost and thus we have chosen for our study the intermediation approach (see also: Gilbert and Wilson, 1998; Kraft and Tirtiroglu, 1998; Rezvanian and Mehdian, 2002; Isik and Hassan, 2002; Dardac and Boitan, 2008).

The Data Envelopment Analysis approach has allowed us to calculate the overall cost, technical, allocative, pure technical, and scale efficiency. Thus, technical efficiency (TE) represents the ability of a bank to obtain maximum outputs at a given level of inputs or to use a minimal level of inputs to obtain a given level of outputs. The allocative efficiency (AE) represents the ability of a bank to select the optimal mix of inputs at a certain level of prices in order to be able to produce a given level of outputs. The overall cost efficiency (CA) represents the product of the technical and allocative efficiency. Also, the technical efficiency can be decompressed into scale efficiency (SE) and pure technical efficiency (PTE). Pure technical efficiency (PTE) is simply technical efficiency (TE) devoid of scale effects, i.e., the difference between technical efficiency and pure technical efficiency represents the cost of operating at an incorrect scale.

5. Data

The data that we have used in our research are focused on the banks that operate in Romania between 2002 and 2010. The balance sheets and the income statements have been taken from Bankscope, a Bureau van Dijk database and also from the banks' from our panel official end-of-year unconsolidated balance sheets and financial statements based on international accounting standards. The panel is composed by banks which together own 91,3% from the total assets of the Romanian banking system, making our panel one of the most comprehensive ever used in such a research. We have excluded from our panel the banks which are not engaged in universal banking model activities (e.g. Porsche Bank, Raiffeisen Banca pentru Locuințe, BCR Banca pentru Locuințe), and also the banks for which we have not found complete data sets.

Table 2: Summary statistics of the variables used in the DEA model (millions of RON)

	Domestic		Foreign	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
2002				
Number of banks	8		12	
Outputs				
Loans	881,961	2030,853	659,625	917,092
Government Securities	325,048	521,370	278,817	575,585
Off-balance items	485,843	1258,723	357,183	522,171
Inputs				
Deposits	2230,671	4620,985	1110,567	1631,886
Fixed assets	312,424	669,191	122,217	303,955
Labor	3250,750	5147,790	844,250	1378,270
Prices of inputs				
Price of deposits	0,204	0,199	0,124	0,105
Price of fixed assets	3,879	6,772	4,634	6,939
Price of labor	0,042	0,034	0,044	0,028
2005				
Number of banks	8		18	
Outputs				
Loans	2833,952	5550,322	1677,317	2523,307
Government Securities	453,429	555,117	305,989	594,384
Off-balance items	1041,615	2439,686	527,850	803,335
Inputs				
Deposits	4034,937	7502,325	2183,183	3785,699
Fixed assets	325,137	622,455	134,767	256,342
Labor	3543,250	4812,780	1203,556	1659,472
Prices of inputs				
Price of deposits	0,098	0,133	0,055	0,026
Price of fixed assets	1,061	2,708	1,131	2,662
Price of labor	0,041	0,020	0,047	0,023
2009				
Number of banks	4		21	
Outputs				
Loans	5592,500	5620,508	7934,728	11931,496
Government Securities	1049,950	1144,739	837,876	902,762
Off-balance items	1171,950	1049,690	2059,594	3366,076
Inputs				
Deposits	7832,100	7680,026	6360,233	9599,049
Fixed assets	328,200	370,876	254,626	430,605
Labor	3765,250	3098,893	2239,248	2743,989
Prices of inputs				
Price of deposits	0,059	0,036	0,078	0,034
Price of fixed assets	0,301	0,191	0,381	0,630
Price of labor	0,084	0,070	0,070	0,029

Source: author's calculations

Using an approach based on the intermediation function of the banks, we have specified three types of inputs (capital, labour and deposits) and three types of outputs (loans, government securities and off-balance items) for each bank from our panel. The variables used in our analysis are expressed in RON, except obviously for labour which is expressed as the total number of employees. In order to be able to analyse the quality of the loans portfolio we have deducted from the total amount of loans

granted the value of the loans loss provisions (see the research undertaken by Grigorian and Manole, 2002). We have chosen to use in our analysis the value of the government securities held by the banks in our panel as the total value of the private securities held is extremely low in the balance sheets of our panel banks, this fact being attributed to the low development of the capital market from Romania.

In order to be able to calculate the allocative efficiency we have compounded the prices for our inputs. The price of capital is compounded as the ratio between the value of assets revolution and the value of the total assets. The price of labour is compounded as the ratio between the total value of the expenses with the salaries and the bonuses granted to the employees and the total number of employees. The price of deposits is compounded as the ratio between the value of the total interest expenses paid for the attracted deposits and the total value of the deposits held by the bank.

In table 2 we have summarised the separate values for the inputs, outputs and the prices of inputs for the domestic and foreign banks from our panel. If we carefully analyse these results we can come to several quick conclusions. First of all, we can observe a raise of the average size of the foreign banks during the analysed period. This can be attributed partially to the fact that foreign banks have benefited from a series of cheap financing lines from their parent banks and also to the fact that in 2006 the largest Romanian bank by assets has been privatised. Second of all the foreign and domestic banks portfolios tend to have a different structure. Foreign banks tend to hold a higher volume of credits while domestic banks preferred to invest more in government securities. Nevertheless, domestic banks tend to be more engaged in off balance transactions, at least until 2006, as a result of the economic boom period which has preceded the crisis. Also, foreign banks have extended their activities which are reflected by off balance items by offering a wider range of services than the traditional ones.

Contrary to the results obtained in the researches undertaken in the case of other states (Isik and Hassan, 2002), the foreign banks from Romania tend to have a lower price of deposits, at least until 2007, after which there is a equalisation of prices between them and the domestic banks. This evolution can be attributed to the fact that starting with 2007 foreign banks, as a result of the depreciation of the international macroeconomic environment, have been forced to repay a series of credit lines that they had opened from their parent banks, this leading to the fact that foreign banks were willing to attract deposits by offering even a premium over the average interest rate of the market at that point. Taking into account the fact that most of the foreign banks present on the Romanian banking market have acquired local banks during the privatisation process, which held an important part of the total deposits of the banking sector and operated a large network of branches and agencies, any raise of the interest rate that these banks would undertake implied a exponential increase of the cost that the bank had with the administration of deposits.

Also in table 2, we have underlined the significant differences that exist between the foreign and domestic banks in the case of the Romanian banking system, in regard to the price of two of the inputs, namely the price of labour and the price of capital. The fact that foreign banks tend to pay a higher price for the human resources that they employ is because on the one hand the top management of these banks is composed from foreign specialists which must be indemnified for the fact that they work abroad and on the other hand because of the human resources policy that these institutions are having by paying higher wages and bonuses packages in order to secure the services of the best workers from this field. This situation has changed however once the international financial turbulences have started, foreign banks being among the first ones which have cut their costs and implicitly reduced their personal expenses (e.g. through the freezing or the cut of wages and the suspension of any type of bonuses). Foreign banks have also the tendency to pay a higher price for the capital that they employ mainly because they are more focused on using in practice state of the art technologies which are never cheap to acquire or maintain. Domestic banks have also started to adopt such a strategy, which explains the relatively equalisation of these costs toward the end of the analysed period.

6. Empirical findings

In order to analyse the efficiency of the banks which operated in Romania during the analysed period we have estimated the cost (CE), allocative (AE), technical (TE), pure technical (PTE) and scale (SE) efficiencies using the Data Envelopment Analysis approach. Also, in order to have a more

detailed imagine of the analysed problem we have estimated the efficiencies of the foreign and domestic banks against a common and afterwards against a separate frontier for each type of bank.

Table 3: Summary statistics of the average efficiencies estimated for the domestic and foreign banks from our panel against a common respectively separate frontier for the period 2002-2010

	Separate frontiers		Common frontiers	
	Domestic	**Foreign**	**Domestic**	**Foreign**
2002				
CE	0,749	0,661	0,408	0,656
AE	0,789	0,782	0,726	0,779
TE	0,940	0,839	0,546	0,836
PTE	0,984	0,917	0,707	0,916
SE	0,955	0,913	0,816	0,911
2003				
CE	0,775	0,530	0,310	0,530
AE	0,844	0,794	0,659	0,800
TE	0,918	0,636	0,430	0,624
PTE	0,924	0,837	0,625	0,739
SE	0,993	0,756	0,704	0,843
2004				
CE	0,699	0,495	0,422	0,493
AE	0,730	0,676	0,662	0,744
TE	0,924	0,721	0,570	0,646
PTE	0,978	0,898	0,684	0,781
SE	0,944	0,816	0,863	0,852
2005				
CE	0,723	0,534	0,341	0,531
AE	0,836	0,748	0,696	0,810
TE	0,861	0,703	0,456	0,636
PTE	0,974	0,815	0,603	0,763
SE	0,886	0,868	0,779	0,838
2006				
CE	0,808	0,588	0,470	0,584
AE	0,903	0,768	0,883	0,800
TE	0,892	0,738	0,520	0,706
PTE	0,903	0,849	0,591	0,819
SE	0,987	0,870	0,866	0,860
2007				
CE	0,794	0,512	0,348	0,506
AE	0,880	0,772	0,858	0,782
TE	0,889	0,619	0,376	0,607
PTE	0,934	0,799	0,504	0,791
SE	0,953	0,770	0,781	0,764
2008				
CE	0,640	0,492	0,382	0,470
AE	0,729	0,793	0,818	0,806
TE	0,857	0,606	0,421	0,559
PTE	0,948	0,808	0,482	0,784
SE	0,904	0,772	0,812	0,737
2009				
CE	0,764	0,601	0,380	0,395
AE	0,905	0,798	0,805	0,789
TE	0,840	0,739	0,450	0,570
PTE	0,860	0,842	0,522	0,794
SE	0,973	0,883	0,856	0,744
2010				
CE	0,579	0,679	0,410	0,521
AE	0,695	0,813	0,759	0,808
TE	0,814	0,833	0,623	0,721
PTE	0,833	0,932	0,626	0,858
SE	0,977	0,890	0,992	0,831

	Separate frontiers		Common frontiers	
	Domestic	**Foreign**	**Domestic**	**Foreign**
All				
CE	0,726	0,566	0,392	0,527
AE	0,812	0,772	0,763	0,780
TE	0,882	0,715	0,488	0,656
PTE	0,926	0,855	0,594	0,805
SE	0,957	0,838	0,830	0,820

Source: author's calculations

In table 3 we have summarised the results of the undertaken analysis. In regard to the average efficiency of the banks from our panel we have discovered that these are registering a smaller value compared with the ones from previous studies (Grigorian and Manole, 2002). This result can be attributed to the fact that our panel of banks is much larger than in the previous studies and that it includes also a series of smaller banks. Also, the analysed period is different and it includes the first effects of the financial and economic crisis which started in 2007. Furthermore, we have observed that the average technical efficiency of the Romanian banks is below the average registered in the European Union (Brissimis, 2006).

Even if when we take into account the separate frontier the domestic banks seem to be more efficient than the foreign banks, if we correlate these results with the results obtained when using a common frontier we can argue that domestic banks are more inefficient than foreign banks, the first case underlying just the fact that these banks are having a very close inefficiency level. The differences register in the case of the common frontier, respectively in the case of two separate frontiers have determined us to undertake a series of tests in order to establish if foreign and domestic banks are coming from the same population. Using a methodology similar to the ones used in previous academic studies (e.g. Isik and Hassan, 2002) we have performed a series of parametric and nonparametric tests in order to accept or reject the null hypothesis according to which the banks from our panel are coming from the same population. Table 4 summarises the results obtained after we have performed these tests. The results underline the fact that the null hypothesis cannot be rejected at 5% significance, thus, foreign and domestic banks are coming from the same population and this is the reason why in our case it is recommended to use a common frontier in order to estimate the efficiency of the banks from our panel. These results, despite the fact that are not fully in accordance with the academic literature (Havrylchyk, 2005) are not singular (e.g. Sathye, 2001; Isik and Hassan, 2002).

As we have stated before, foreign banks tend to registered a higher *cost efficiency* (52,7%) than the domestic banks (39,2%). These results imply that foreign banks have a higher capability to better implement in their daily activities financial innovations and utilise the expertise that they posses in order to compensate for the possible disadvantages that may arise from the fact that are unfamiliar with the local market. These results are in concordance with the ones obtained in the case of similar researches undertaken before (Bhattacharyya et al., 1997; Kraft and Tirtiroglu, 1998; Isik and Hassan, 2002; Grigorian and Manole, 2002; Hasan and Marton, 2003).

In the case of our approach we have split the cost efficiency into *allocative efficiency* and *technical efficiency*. The results summarised in table 3 underline the fact that there is sufficient place for an improvement of the allocative efficiency. The high value registered by the allocative inefficiency can be attributed to the high fluctuation of the input prices, which negatively affect the capacity of the banks managers to develop long term plans.

We have also observed that the allocative inefficiency is smaller than the technical inefficiency, which implies that the main dominant source of cost inefficiency is rather technical than allocative. The high level of technical inefficiency compared with the allocative inefficiency suggests that the managers of the banks which operate in Romania are capable of choosing the right mix of inputs at a given price level, but were unable to use all the input factors as efficient. This is the reason why, overall we can argue that in the case of the banks which operate in Romania their overall inefficiency can be attributed to a larger extent to the underutilisation or the waste of the existent resources and to a lesser extent to the improper choosing of the right mix of inputs.

Table 4: Summary statistics of the results of the parametric and nonparametric test undertaken in order to establish if foreign and domestic banks come from the same population

	Name of the test							
	t-test		**Wilcoxon Rank-Sum test**		**Kruskal-Wallis test**		**Kolmogorov-Smirnov test**	
Test statistics	**t**	**(prob>t)**	**z**	**(prob>z)**	**χ^2**	**(prob> χ^2)**	**D**	**(prob>D)**
2002								
CE	1,992	(0,062)	1,929	(0,054)	3,871	(0,049)	1,187	(0,120)
AE	0,501	(0,623)	0,309	(0,758)	0,121	(0,729)	0,548	(0,925)
TE	2,997	(0,008)	2,199	(0,028)	5,006	(0,025)	1,369	(0,047)
PTE	2,308	(0,033)	1,697	(0,090)	3,013	(0,083)	1,187	(0,120)
SE	1,089	(0,291)	1,273	(0,203)	1,720	(0,190)	0,913	(0,375)
2003								
CE	1,546	(0,138)	1,740	(0,082)	3,149	(0,076)	1,209	(0,108)
AE	1,263	(0,221)	1,263	(0,207)	1,682	(0,195)	1,048	(0,222)
TE	1,653	(0,114)	1,877	(0,061)	3,652	(0,056)	1,209	(0,108)
PTE	1,009	(0,325)	0,921	(0,357)	0,913	(0,339)	0,766	(0,601)
SE	1,529	(0,142)	1,365	(0,172)	1,958	(0,162)	1,048	(0,222)
2004								
CE	0,521	(0,607)	0,641	(0,522)	0,449	(0,503)	0,772	(0,591)
AE	0,600	(0,554)	0,990	(0,322)	1,039	(0,308)	0,772	(0,591)
TE	0,716	(0,481)	0,757	(0,449)	0,618	(0,432)	0,532	(0,940)
PTE	0,849	(0,405)	0,903	(0,367)	0,869	(0,351)	0,652	(0,789)
SE	-0,136	(0,893)	0,146	(0,884)	0,031	(0,861)	0,480	(0,975)
2005								
CE	1,573	(0,129)	1,889	(0,059)	3,674	(0,055)	1,079	(0,195)
AE	1,178	(0,250)	0,500	(0,617)	0,279	(0,598)	0,490	(0,970)
TE	1,708	(0,101)	1,972	(0,049)	4,000	(0,046)	1,209	(0,107)
PTE	1,565	(0,131)	1,305	(0,192)	1,778	(0,182)	1,046	(0,224)
SE	0,667	(0,511)	0,553	(0,580)	0,339	(0,560)	0,654	(0,786)
2006								
CE	0,794	(0,435)	1,053	(0,292)	1,182	(0,277)	1,000	(0,270)
AE	-0,737	(0,469)	0,442	(0,659)	0,226	(0,634)	0,600	(0,864)
TE	1,599	(0,123)	1,630	(0,103)	2,770	(0,096)	1,100	(0,178)
PTE	2,225	(0,036)	1,766	(0,077)	3,241	(0,072)	1,100	(0,178)
SE	-0,082	(0,935)	0,102	(0,919)	0,018	(0,892)	0,500	(0,964)
2007								
CE	0,999	(0,328)	1,223	(0,221)	1,580	(0,209)	1,000	(0,270)
AE	-0,726	(0,475)	0,679	(0,497)	0,509	(0,476)	0,700	(0,711)
TE	1,613	(0,120)	1,597	(0,110)	2,658	(0,103)	1,100	(0,178)
PTE	0,120	(0,026)	1,630	(0,103)	2,770	(0,096)	1,000	(0,270)
SE	-0,131	(0,897)	0,034	(0,973)	0,005	(0,946)	0,400	(0,997)
2008								
CE	0,535	(0,598)	0,889	(0,374)	0,859	(0,354)	0,851	(0,464)
AE	-0,126	(0,901)	0,074	(0,941)	0,012	(0,912)	0,502	(0,963)
TE	0,922	(0,366)	1,186	(0,236)	1,496	(0,221)	1,026	(0,244)
PTE	2,218	(0,037)	1,816	(0,069)	3,434	(0,064)	1,375	(0,046)
SE	-0,545	(0,591)	0,222	(0,824)	0,067	(0,795)	0,502	(0,963)
2009								
CE	0,118	(0,907)	1,038	(0,299)	1,155	(0,283)	0,938	(0,342)
AE	-1,326	(0,198)	1,112	(0,266)	1,320	(0,251)	0,938	(0,342)
TE	0,829	(0,416)	0,927	(0,354)	0,929	(0,335)	0,829	(0,497)
PTE	1,926	(0,067)	1,260	(0,208)	1,683	(0,195)	0,917	(0,370)
SE	-0,845	(0,407)	0,852	(0,394)	0,791	(0,373)	0,655	(0,785)
2010								
CE	0,742	(0,469)	0,850	(0,396)	0,815	(0,367)	0,819	(0,514)
AE	0,440	(0,666)	0,106	(0,915)	0,025	(0,873)	0,504	(0,961)
TE	0,672	(0,511)	0,265	(0,791)	0,102	(0,750)	0,756	(0,617)
PTE	1,772	(0,095)	1,381	(0,167)	2,055	(0,152)	0,882	(0,418)
SE	-1,832	(0,086)	2,071	(0,038)	4,511	(0,034)	1,386	(0,043)

Source: author's calculations

Between 2002 and 2010 the efficiency of both foreign and domestic banks hasn't improved but rather slightly decreased in average. If we examine table 3, it becomes obvious the fact that the efficiency has dropped between 2006 and 2009 with approximately 19,1% and 32,4% in the case of the domestic banks, respectively in the case of the foreign banks, as a direct effect of the international financial and economic crisis. In 2010 the foreign and domestic banks have registered a raise of the overall efficiency, mainly as a result of the relative stabilisation of the macroeconomic environment but also as a result of the austerity measures taken by the authorities.

Another reason that has prevented the banks which operate in Romania to improve their efficiency is represented by the rapid growth of the loans granted in several segments and the V shape evolution of the nonperforming loans during the analysed period of time. Also, during this period of time the general structure of the banking assets has registered a dramatic change. Once cheap revenue sources like governmental bonds and the loans granted to state owned enterprises were depleted, most of the banks had to develop their activities in different segments of the market, retail loans, and especially consumer credits, becoming the new focus point of the banking activity. The banking assets have register during the analysed period an extreme increase, consumer credits registering a compound annual growth rate (CAGR) of 54% (NBR, 2010). Because of the extreme rapid growth rate of the banking assets and the start of the problems at the macroeconomic level in 2007, the banks managers from Romania were confronted with a series of problems related to the costs control and the management of the risks to which banking institutions were exposed as a result of these evolutions, the ratio of the nonperforming loans, after a period of stabilisation between 2002 and 2005 (in which it dropped from 9,2% to 2,6%) has registered a sudden increase, reaching at the end of 2010 7,8% (World Bank, 2010).

Continuing the analysis we have decomposed the *technical efficiency* into *scale efficiency* and pure *technical efficiency*. After we have eliminated the scale factor, we were able to observe that a large part of the banks are registering a higher pure technical efficiency than in the case of the technical efficiency, with the foreign banks registering a value for the pure technical efficiency of 80,5% while domestic banks registered just 59,4%. The value registered by the foreign banks is comparable with the one registered by the banks from the developed economies.

7. The impact of financial innovation and other banks' characteristics on the efficiency of the Romanian banking system – Tobit model estimation

In order to analyse the main factors which influence the estimated efficiency level of the banks, the academic literature has used three main techniques: 1) the first category of studies uses a multivariate regression analysis in order to estimate the efficiency level of the banks through parametric and nonparamtric methods, using the results as dependent variables and a series of other factors as explicative variables (e.g. the studies undertaken by Favero et Papi, 1995; Grigorian and Manole, 2002; Isik and Hassan, 2002; Havrylchyk, 2005); 2) the second category of studies applies the longitudinal graphical approach through which the long term trend of the reached efficiency level is analysed, using a series of graphic representations in order to underline the relationship between the estimated level of efficiency and each of the determined factors (e.g. Barr et al, 1999); 3) the third category of studies uses the analysis of the main components (e.g. Lensink, Meesters and Naaborg, 2008 or Sturm and Williams, 2008).

Taking into account the results obtained in our research we will use the multivariate regression analysis. We will use thus the already estimated levels of efficiency for the banks from our panel as dependent variables (cost efficiency, technical efficiency and allocative efficiency) and a series of banks characteristics as explicative variables. Because of the fact that our dependent variables take values between 0 and 1, the regression analysis based on the least squared model cannot be performed in this case. This is the reason why in our case the most suitable approach is represented by the usage of the Tobit regression, which allows the usage of truncated dependable variables. This type of regression starts from the hypothesis that the estimated efficiency which the banks from our sample can reach is a truncated normal and exponential distribution, the method of the maximum possibilities being used.

The relationship between the dependent variables represented by the estimated efficiency level and the other independent variables is explained through the following Tobit model:

$$\theta_{nj}^{*} = \begin{cases} \sum_{k=0}^{1} z_{kj}\delta_k + \mu_j, \text{ if } \theta_j > 0 \\ 0, \text{ if } \theta_j < 0 \end{cases} \quad (6)$$

where: $\mu_j \sim N(0,\sigma^2)$, z_{kj} - represents the variable vector which explained the efficiency level reached and n - represents the number of observations.

The probability function for the estimation of the unknown variable from the Tobit model with the points a=0 and a=1 is:

$$L = \prod_{y_t > a} \frac{1}{\sigma} f\left(\frac{y_i - \delta_{z_t}}{\sigma}\right) \prod_{y_t < a} f\left(-\frac{\delta_{z_t}}{\sigma}\right) \quad (7)$$

The program that we have used in our analysis was EViews 7, through which we have done six separate Tobit regression analyses for each of the obtained efficiency levels through the DEA method for the two types of banks, foreign respectively domestic. We have used seven explicative variables in our analysis, namely: the growth of assets, the ratio between loan loss provisions and total loans, capitalisation, the ratio between total loans and total assets, variance of ROA, log of total assets and nevertheless the indicator for financial innovation (which is estimated as the ratio between the total number of ATMs held by a banks and the total number of employees of that bank). The obtained results are summarised in table 5.

Table 5: The results of the Tobit regression regarding the influence of the banking characteristics on the estimated efficiency level

Dependable variables ⇨	Domestic banks			Foreign banks		
	CE	TE	AE	CE	TE	AE
⇩ Banks characteristics						
Assets growth	0,33 (0,10)	0,14 (0,12)	0,74 (-0,04)	0,04 (0,13)	0,02 (0,15)	0,30 (0,05)
Loans loss provisions / total loans	0,58 (-0,52)	0,48 (-0,52)	0,41 (-0,81)	0,04 (-1,11)	0,21 (-0,67)	0,01 (-1,02)
Total loans / Total assets	0,02 (-0,64)	0,01 (-0,56)	0,25 (-0,33)	0,12 (-0,55)	0,12 (-0,36)	0,01 (-0,47)
Capitalisation	0,01 (0,02)	0,01 (0,02)	0,63 (0,01)	0,06 (-0,01)	0,41 (-0,01)	0,02 (-0,01)
Variance of ROA	0,19 (-0,02)	0,12 (-0,01)	0,39 (-0,02)	0,48 (0,01)	0,62 (0,01)	0,38 (0,01)
Log of total assets	0,01 (0,19)	0,01 (0,16)	0,12 (0,11)	0,01 (0,01)	0,04 (0,07)	0,01 (0,08)
Financial innovation indicator	0,04 (-0,01)	0,05 (-0,01)	0,02 (-0,02)	0,35 (0,02)	0,52 (0,03)	0,29 (0,01)
Constant	0,27 (-0,46)	0,30 (-0,34)	0,21 (0,55)	0,04 (0,48)	0,03 (0,49)	0,01 (0,86)
Number of observations	54	54	54	157	157	157

** Growth of assets: ratio between total assets of the current year and the assets held in the previous year; Loans loss provisions / total loans: ratio between total provisions for loans depreciation and the total value of granted loans; Capitalisation: the ratio between own capitals and the value of the total assets; Variance of ROA: the variance of the return on assets; Log of total assets; Financial innovation indicator: the ratio between the total number of ATMs held by a bank and the total number of that bank employees.*

Source: author's calculations

Based on the results summarised in table 5 we can conclude that in the case of the *domestic banks* a high level of efficiency is negatively correlated with the quality of the loans portfolio (loans loss provisions/total loans) and the variance of ROA, and is positively correlated with the growth of

the total assets. The ratio between total loans and total assets, the capitalisation of banks, their size and the financial innovation indicator do not affect in a significant way the efficiency of the domestic banks from our panel. The efficiency of the *foreign banks* is negatively correlated with the ratio between total loans and total assets, while a positive correlation is registered with the variance of ROA respectively the indicator for financial innovation. In the case of the foreign banks the growth of the assets, the quality of the loans portfolio, their capitalisation and their size do not directly affect the estimated level of efficiency.

Contrary to our expectations, the rapid *growth of the assets* has not significantly affected the ability of the managers to efficiently administrate their banks. If in the case of the foreign banks this evolution tends to be statistically insignificant in the case of the domestic banks we can observe a statistically significant and positive relationship. This is mainly because, despite the fact that Banca Comercială Română, the largest Romanian bank by assets, has registered a rapid growth of its assets, it was able to successfully manage them especially in the perspective of its privatisation. On the other hand the transformation of CEC into a commercial bank has determined an increase of the assets management efficiency but also of the operations in order to handle the high competition that it was facing. Nevertheless, the ambition of Banca Transilvania to achieve a higher position in the Romanian banking system has lead to an extension of its operations but also to an increase of its overall efficiency.

Regarding *the quality of the loans portfolio* we can observe that the development of the operations in the case of the domestic banks has lead to an increase of the number of nonperforming loans which have generated a series of additional costs associated with the monitoring and the recovery of these types of loans. In the case of the foreign banks the lack of statistically significance for this factor implies that these banks have manages to use their superior know-how and innovative risk management techniques in order to efficiently manage their nonperforming loan portfolio (foreign banks have used more their option to sell the nonperforming loans to repo firms).

We were unable to find a significant relationship between *the ratio of total loans and total assets* and the estimated efficiencies of the domestic banks. Foreign banks tend to be more efficient as the value of this ratio is smaller. In his research Altunbas et al. (2000) considers that this ratio represents an indicator for the liquidity risk and because of that a negative relationship could indicate the fact that the least efficient banks are also the least liquid. However, this consideration appears not to be valid in the case of the Romanian banking system which registers an extremely high level of liquidity, this fact being underline by the value of the liquidity indicator (effective liquidity/needed liquidity) which was 1,35 in 2010 (NBR, 2010, p. 83).

An interesting result has been registered in the case of the correlation between the estimated efficiencies and the *variance of ROA*. Thus, in the case of the *domestic banks* we have registered a negative and statistically significant correlation between the efficiency of these banks and the variation of their ROA, this fact underling the impossibility of these banks to engage in riskier operations which they could complete successfully. The results are consistent with the previous findings from researches undertaken in the case of the United States of America (Berger and Mester, 1997). Contrary, foreign banks are registering a positive and statistically significant correlation between their efficiency and the variance of ROA, which underlines the fact that these institutions are having the potential to engage in riskier operations and finish them successfully. The results obtained in the case of the foreign banks are consistent with the ones from the researches undertaken in the case of Turkey (Isik and Hassan, 2002) and more recently in the case of Poland (Havrylchyk, 2005). Thus, Isik and Hassan (2002) are arguing that "*the managers of the more inefficient banks tend to be more passive in assuming higher risks in order to obtain higher profits*".

In order to underline the impact of the financial innovation on the efficiency of the foreign and domestic banks we have constructed *a financial innovation indicator*, which is estimated as the ratio between the total number of ATMs owned by a banks and the total number of employees of that bank. We have chosen to use this indictor for two reasons. A first reason is represented by the availability of the data needed in order to construct this indicator. Unfortunately, data about the usage of other financial innovations in practice are rather scarce and the obtained panel would have been extremely small and rather unrepresentative. The second reason is represented by the fact that ATMs are offering in practice a multitude of services to customers, existing almost a constant development of new ways in which these devices can be used (e.g. foreign exchange and dual currencies withdrawals being just

two of the latest developments) and proving their utility countless times, this being confirmed also by Paul Volcker which considered that "*ATMs represent the single most important financial innovation of the last 25 years*".

Thus, in regard to the *financial innovation indicator*, this has a different impact on the efficiency of the foreign respectively the domestic banks. The insignificant statistically connection that exists between the financial innovation indicator and the efficiency of the domestic banks underlines the fact that although these banks have adopted in practice many financial innovations they were unable to fully use them in an skilful way in order to enhance their overall efficiency. These facts come to complete the hypothesis according to which domestic banks tend to rather adopt financial innovations only when they have proven their reliability in practice. By contrast, the positive and statistically significant correlation between the technical and allocative efficiency of foreign banks and the financial innovation indicator underlines the capacity of these banks to use financial innovations in order to increase their real efficiency and the way they use their resources. We can conclude that the foreign banks that operate in the Romanian banking sector tend to be more efficient than their domestic peers as a result of a much faster and better adoption and usage of financial innovations in practice.

8. Concluding remarks

Concluding, in our research we have analysed if between 2002 and 2010 the foreign banks which operate in the Romanian banking system have the tendency to use more financial innovations in their daily activities and tend to adopt sooner these innovations and thus are more efficient than the domestic banks. We have used the Data Envelopment Analysis approach which has allowed us to estimate five types of efficiencies, namely: cost, allocative, technical pure technical and scale efficiencies. We have also made a series of nonparametric and parametric test in order to establish if the domestic and foreign banks which operate in the Romanian banking system are coming from the same population. Finally, we have performed a Tobit regression in order to establish the factors which determine the efficiency of the Romanian banking system, financial innovation playing a significant role in the achievement of a superior efficiency in the case of the foreign banks in contrast with the case of the domestic banks.

In our research we have underlined the fact that the average foreign banks efficiency was 52,7% while the efficiency of the domestic banks was only 39,2%. Deepening the analysis, we have split the cost efficiency into technical and allocative efficiency, which has allowed us to underline the fact that the superior average efficiency registered by the foreign banks is a consequence of their ability to obtain a higher productivity level in the case of the used outputs (technical efficiency) and also because of the fact that these bank have been able to take superior decisions regarding the right mix of inputs that must be used at a certain level price (allocative efficiency). The parametric and nonparametric tests which we have performed could not reject the null hypothesis that the banks which operate in the Romanian banking system have a common efficiency frontier. During the analysed period the overall efficiency of the Romanian banking sector didn't improve significantly. Moreover, *between 2006 and 2009 the overall efficiency of this sector has registered the highest drop from the whole analysed period, which can be attributed to the depreciation of the macroeconomic environment as a result of the international economic and financial crisis which started in 2007*.

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