COMPARATIVE STUDY ON THE LEVEL OF EFFICIENCY AND ITS DETERMINANTS FOR THE MANUFACTURING INDUSTRY IN CENTRAL AND EASTERN EUROPE

Mogoșeanu Daniela Bianca, Ph. D Student
University of Craiova
Faculty of Economics and Business Administration
Craiova, Romania

Abstract: In this article, we have used a stochastic frontier approach (SFA) in order to analyse the efficiency and determinants of the manufacturing firms from Central and Eastern Europe. The results reveal that firms from Poland, Czech Republic, Hungary have a higher efficiency than firms from Romania and Bulgaria. The evolution in time of the efficiency show that years 2008 and 2009 have brought a decrease of the efficiency's index. This drop-off is caused by the global economic crisis that has reduced the demand and affected the turnover.

JEL classification: C30, G32, L25

Key words: efficiency, inefficiency determinants, manufacturing firms, performance, leverage

1. INTRODUCTION

An essential condition for a sustainable and long-lasting economic growth is that firms should develop efficient activities. This condition is even more important for countries that find themselves in transition towards a market economy. In the past few decades, the economic environment of the emerging countries has suffered significant structural changes. At the beginning of the 1990´s, most of the countries reviewed in our study have implemented economic policies that were aiming to facilitate the passage from a planned, socialist economy to a market economy. Koutsomanoli-Filippaki et al. (2009) shows that the majority of the countries from Central and Eastern Europe have taken similar measures to facilitate the transition towards a market economy: a privatisation process for state-owned companies; introducing a two-pillar banking system; reorganizing and privatising state-owned banks, supporting the liberalisation of the interest and capital account rates; establishing a new regulatory framework; developing capital markets; encouraging foreign capital.

The reforming process of the economic environment in Central and Eastern Europe was one of specific traits for each country in itself. Thus, if Poland, the Czech Republic and Hungary managed to implement a package of measures meant to stimulate the economic growth very quickly, Romania and Bulgaria on the other hand managed to finalize a part of this project just at the beginning of the 2000´s. An authentic test for the reliability of the economical systems from the transition countries was the financial crisis of the year 2008, which affected, more or less, most of the economies. Hence, Montoro and Rojas-Suarez (2012) show that the actual growth of lending in emergent countries from Asia was quite resistant to the financial crisis of 2008, whereas the actual growth of the lending in countries from Eastern Europe was

severely affected, banking systems in Latin America being somewhere in the middle. Also, Klingen (2013) reckons that the countries from the region have suffered more than any other region in the world as a consequence of the global financial crisis which in fact put an end to some unsustainable booms.

The mentioned aspects have fundamentally modified the way in which firms function; firms are forced now to rethink their strategies in terms of performance and efficiency, concepts which are gaining more and more value nowadays. In this study, we aim at making a comparison between the efficiency level of the firms in the emerging countries from the region and also to emphasize on the determinant factors of the level of efficiency over the period 2006 to 2011. The efficiency of the firms and the identification of the determinant factors from the region can be measured through SFA. More specific, in our estimation we will adopt the SFA model proposed by Greene (2005). The contribution of our study to current literature is significant from several points of view. First of all, we have included a large number of observations made on firms from five countries from Central and Eastern Europe. Secondly, our study gives outputs regarding the differences in inefficiency between the countries, and also regarding the factors that influence this level. We consider these records necessary, taking into account also the effects of the economic crisis on firms' activities. Thirdly, we deem that the results obtained are important to understand the way in which the activity of the firms evolved in the period 2006 – 2011.

2. LITERATURE REVIEW

Jones et al. (2008) has employed an SFA model to identify the determinants and the dynamics of the firms´ efficiency for firms in Estonia over the period 1993 to 1999. The main results have shown that: i) in comparison with public companies, companies that are owned by foreign shareholders have a higher rate of efficiency; ii) the size of the firms and the quality of their employees have a positive impact on efficiency; iii) the percentage of the firms that operate at a high level of efficiency had grown in the analyzed time period.

Amornkitvikai and Harvie (2010) employed not also an SFA modelling, but also a DEA pattern to estimate the technical efficiency and to analyse the elements that influence the inefficiency of the firms working in the manufacturing industry. In the study, 178 Thailand stock exchange ranked companies were included, the data being extracted for the period 2000-2008. The results obtained have shown that efficiency is influenced by factors such as: leverage, remuneration of the managers, type of ownership (public or private), exports and the size of the company. Also, liquidity, external financing, research and development expenses have a great influence on efficiency.

D´Orio (2001) used an SFA model to analyze the efficiency of buyout firms in Great Britain. The results indicate the fact that all the observed firms have recorded an increase in performance before the buyout, the rationalization process that anticipates the buyout being efficient. The author considers that a private behaviour for public management is efficient only if there is a change in the objectives that the manager should meet. Another fact indicated by the results obtained is that a significant factor in reducing inefficiency is the quality of the management.

Díaz and Sánchez (2008) have analyzed the performance of small and medium-sized firms from the manufacturing industry in Spain during 1995-2001. The authors

focused on identifying the level of inefficiency and its determinants. The authors show that small and medium-sized enterprises are less inefficient than bigger companies.

3. METHODOLOGY AND DATA

To measure the efficiency of firms from manufacturing industry we used the methodology proposed by Greene (2005). In order to estimate the efficiency, Greene (2005) proposed the following model:

$$Y_{it} = \alpha_i + \beta' x_{it} + v_{it} + u_{it} \quad (1)$$

$$v_{it} \sim N(0, \sigma_v^2) \quad (2)$$

$$u_{it} \sim N^+(0, \sigma^2) \quad (3)$$

The estimations were made based on 19.909 observations for firms from Poland, the Czech Republic, Hungary, Romania and Bulgaria. The firms develop their activity in the manufacturing industry, and the observations are focused on the period 2006-2011. We have chosen this time period, because it captures both the years of economic growth, 2006-2008, and also the period when the economies of the mentioned states have entered recession. The data were collected from the Orbis Database.

The translog function used to estimate the efficiency level of the firms is expressed as:

$$\ln(V_{it}) = \alpha_i + \sum_{j=1}^{2} \gamma_j \ln y_{jit} + \sum_{j=1}^{2}\sum_{k=1}^{2} \gamma_{jk} \ln y_{jit} \ln y_{kit} + \vartheta_1 t + \vartheta_{11} t^2 + \sum_{j=1}^{2} \theta_j \ln y_{jit}\, t + \text{country\_dummy} + \delta_t + v_{it} - u_{it} \quad (4)$$

where i and t stand for the company and year. In the selection of the variables included in our analysis, we will pursue the approach employed by Jones et al. (2008), Margono and Sharma (2006), Baten et al. (2006), Schettini et al., Díaz and Sánchez (2008). The dependent variable is the added value. We have chosen the added value, in the disadvantage of other elements such as the total sales or turnover, because we deem this reflects best the ability of the firms to create value. In the model we included two input elements: the number of employees and the fixed assets. All the monetary values were deflated by using the prices index based in 2006, obtained from the IMF´s data base, to leave out the effect of inflation. Table no. 1 presents descriptive data for the variables used in the estimation. For every country included in the study we created a dummy variable to see the differences of efficiency. We drop one of the variable (firms from Romania) to avoid multicollinearity.

Table no. 1 – Descriptive statistics

	Mean	SD	Min.	Max.
Added Value (th. US $)	10953.19	36521.26	1	1927755
Fixed assets (th. US $)	23960.99	80645.29	1	2590076
Number of employees	308.417	657.647	1	15825

Just like previously stated, an important objective of the study is set in the identification of the determinant factors for inefficiency. In the variables that influence efficiency we included factors specific to the internal environment of the company, more precisely: return on equity (ROE); solvency ratio; tangibility ratio and logarithm of total assets. The variables specific to each internal environment capture different strategies adopted by each company.

We have included return on equity rate in our function to observe the way in which profitability is influencing the efficiency of firms. ROE is frequently used in the literature review to reflect the ability of the firms to be profitable, to make profit to the satisfaction of their shareholders. Naturally, an increase of this rate should lead to a reduction of the level of inefficiency of the firms.

The solvency ratio, measured as the ratio of current assets to its current liabilities, reflects the influence that the self financing policy may have on the firms´ efficiency. Normally, the growth of the current ratio should have a positive impact on efficiency, from the creditors´ perspective; a bigger ratio would reflect the trust of the investors in the viability of the business, and also lower costs for detbs. On the other hand, firms that have a higher solvency ratio can miss out investment opportunities.

The liquidity ratio is included in our study to capture the way in which the risk of liquidity influences the level of efficiency. Its effect on efficiency can either be positive, or negative, depending on the firms' ability and experience with handling efficiently their available resources. A very high liquidity rate could mean investment opportunities that firms ignore, whereas a very low liquidity rate could generate costs associated to cash deficiency.

In the function of inefficiency we included also the tangibility ratio. The tangibility ratio is a structure rate that reflects the input of the corporal immobilizations in total assets. An increase of this rate should lead to an increase in efficiency, especially when this increase is generated by the purchase of new production technologies.

The logarithm of total assets is a measure for extending the firms and could be a determinant factor for their efficiency. On the other hand, some firms can be more efficient in comparison with others as a result of the economies of scale resulted from the size of the company. Alternatively there are also smaller firms that are efficient.

4. RESULTS

The determination of efficiency, through using the maximum likelihood estimation function, was done by using the Stata 10.1. As previously stated, we estimated a modelling specified by Greene (2005). The complete results are presented in the table no. 2. If we look at the data, most of the coefficients are significant statistically. This aspect indicates that the results obtained are consistent and robust.

Regarding the function of production, all the coefficients associated to the input variables are positive and significant. Also, the square root coefficients of the input variables are positive. Judging by this information, we can state that, in general, higher inputs (such as a higher number of employees or an increase of the fixed assets) will also lead to a growth in the added value. The result obtained meets the expectations.

The study on the efficiency level of the firms reveals important aspects for the countries analysed. In comparison with Romania, most of the countries included in our study have obtained better results. More precisely, firms from Poland, at a similar value of available resources, generate a 20, 79% higher added value than firms in Romania; firms from the Czech Republic generate a 24, 76 % higher added value; and firms from Hungary generate a 23, 52% higher added value. Firms from Bulgaria generate a lower added value than firms in Romania with 6, 58%. Considering the results obtained, we can see that Poland, the Czech Republic and Hungary make up a unitary group in terms of the generated results. Therefore, the firms from these countries operate more efficiently in comparison with Romanian firms, the differences being quite visible. On the other hand, firms from Romania and Bulgaria form a second group, the differences between these countries being less high. Practically, associating these results with the level of development in the analysed countries we can see a similarity between the two variables. Thus, the level of economic development and the efficiency of the firms are two interdependent variables.

Table no. 2 – Stochastic frontier estimates

Dependent variable ln(VA)	Coefficient	Std. error
Independent variables		
ln(FA)	0.1046*	0.0168
ln(NE)	0.4115*	0.0197
$\ln(FA)^2$	0.0437*	0.0032
$\ln(NE)^2$	0.0261*	0.0053
ln(FA) × ln(NE)	-0.0232*	0.0074
Year	0.0374*	0.0072
$Year^2$	-0.0036*	0.0007
ln(FA) × year	-0.0177*	0.0019
ln(NE) × year	0.0215*	0.0024
Bulgaria's firms	-0.0658*	0.0053
Czech Republic firms	0.2476*	0.0051
Hungary's firms	0.2352*	0.0060
Poland firms	0.2079*	0.0065
Constant	2.1061*	0.0487
Effects on u_{it}		
ROE	-0.0061*	0.0002
Tangibility ratio	0.0043*	0.0001
Solvency ratio	-0.0021*	0.0001
Liquidity ratio	0.0003	0.0006
Log(assets)	-0.3517*	0.0105
τ_0	2.4802*	
χ_0	-0.8823*	
σ_v	-3.3510*	

*Note: *denotes test statistic significance at the 1% level.*

Hereinafter, we will analyse the impact of the variables specific to the internal environment of the firms on the level of inefficiency, the analyse revealing some important aspects. The results obtained indicate the fact that the rate of return on equity influences negatively the inefficiency of the firms. Therefore, firms that have a higher ROE are more efficient. The result is in line with the expectations, if we consider the fact that, generally, firms with a performance management are also the firms who match efficiently the available resources with the results obtained.

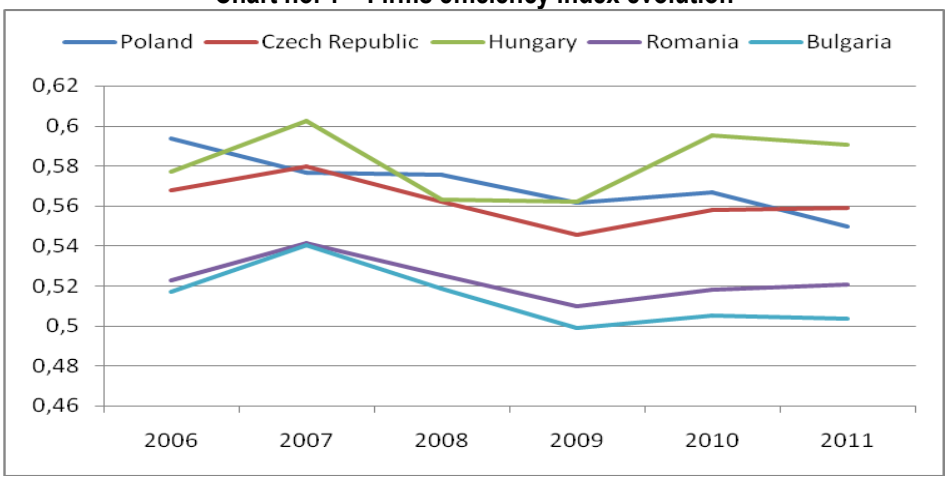
Tangibility ratio has a positive impact on inefficiency. Consequently, firms with a higher rate of tangibility ratio are more inefficient. The result is rather surprising, but it could be explained either by a low rate in productivity, or by an inadequate usage of the additional means of production. The liquidity ratio has no influence on the level of inefficiency of the firms, the coefficient associated to it being negative, although statistically insignificant.

The solvency ratio has a negative influence on inefficiency. So, firms with a high level of self financing are more efficient. As we see it, the lower cost associated to these funds and the fact that firms with a higher rate of liquidity attract funds with lower indebting costs are elements that explain the result obtained.

By looking at the influence that the size of a company has on inefficiency, we can see the fact that large firms are more efficient than smaller firms. The result is a predictable one if we take into consideration that the economic actors developing a more significant activity benefit from the economies of scale. Therefore, large firms manage to reduce the unitary prices by producing more goods, increasing the production process; the medium costs will drop by distributing the fixed costs to a bigger production.

The method employed allows us to identify the efficiency index calculated according to Batesse and Coelli (1992). In the following chart we presented the evolution of the efficiency index, calculated as average for all the countries included in our study, during 2006-2011. The results obtained back up the previous statements. Practically, we can see that firms from Poland, the Czech Republic and Hungary have the highest level of efficiency, whereas Romanian and Bulgarian firms have a lower level.

Chart no. 1 – Firms efficiency index evolution



Also, if we analyse the evolution in time we notice that for all countries the years 2008 and 2009 have brought a decrease of the efficiency's index. This drop-off is caused by the global economic crisis that has reduced the demand and affected the turnover.

We will continue our empirical approach by estimating an SFA model only for firms in Romania. Romanian research literature, unlike other countries, has not applied SFA modelling to study the level of efficiency for the manufacturing firms. However, Nițoi (2009) and Andrieș (2011) have used SFA in order to study the efficiency of Romanian banks. Therefore, we find our approach towards this issue to be even more useful.

In the model, we have included 5.131 observations on large, medium-sized and small-sized firms in the manufacturing industry for the time period 2006-2011. The data were collected through Orbis Database. The expression of the translog function, used to quantify the efficiency of the firms, is similar with the one presented in the equation (4). Therefore, the added value is the dependent variable, and the two inputs are the number of employees and the fixed assets. All the monetary values have been deflated by using the prices index based in 2006, extracted from the IMF´s database, to avoid the effect of inflation. In table no. 3, we have presented descriptive data for the variables used in the estimation. A secondary objective set in this estimation is also the identification of the level of efficiency per categories of firms. Hence, we have created a dummy variable for large firms, for medium-sized firms and for small-sized firms. We have left out the first variable to avoid multicollinearity. In this way we will see if there are differences in efficiency between the three categories of firms.

Table no. 3 – Descriptive statistics

	Mean	SD	Min.	Max.
Added Value (th. US $)	7450.447	26109.16	1	631180
Fixed assets (th. US $)	22605.81	67580.63	1	1165705
Number of employees	336.8688	838.6132	1	15825

The main objective of the model is still the identification of the way in which factors specific to the internal environment of a company affect the level of efficiency. Between the variables that influence inefficiency we have also included variables similar to the ones employed in the previous model, more precisely: return on assets (ROA); solvency ratio; liquidity ratio; tangibility ratio and logarithm of total assets. Alternatively, we will estimate a second model, by replacing solvency ratio with the leverage ratio in order to quantify the impact that the financing policy has on efficiency. The results are presented in table no. 4. As we can see, most of the coefficients are statistically significant, providing reliability to our results.

In this model too, in the case of the function of production, all the coefficients associated to the input variables are positive and significant. Moreover, the square root coefficients of the input variables are positive. Considering these aspects, we can say that, in general, an increase in the number of employees or the growth of the fixed assets (bigger inputs) will generate a growth in the added value, namely the output. The result obtained indicates good news for the firms. On the other hand, this result must be accompanied by a higher efficiency, as much as possible, to maximize the effects obtained.

Table no. 4 – Stochastic frontier estimates for Romanian firms

Model 1			Model 2		
Dependent variable ln(AV)	Coefficient	Std. error	Dependent variable ln(AV)	Coefficient	Std. error
Independent variables			Independent variables		
ln(FA)	0.0941*	0.0320	ln(FA)	0.0926*	0.0320
ln(NE)	0.4407*	0.0341	ln(NE)	0.4397*	0.0342
$\ln(FA)^2$	0.0488*	0.0069	$\ln(FA)^2$	0.0490*	0.0069
$\ln(NE)^2$	0.0553*	0.0079	$\ln(NE)^2$	0.0551*	0.0079
ln(FA) × ln(NE)	-0.0461*	0.0135	ln(FA) × ln(NE)	-0.0458*	0.0136
Year	0.0824*	0.0123	Year	0.0820*	0.0123
$Year^2$	-0.0094*	0.0013	$Year^2$	-0.0093*	0.0013
ln(FA) × year	-0.0047	0.0037	ln(FA) × year	-0.0049	0.0038
ln(NE) × year	0.0015*	0.0040	ln(NE) × year	0.0018	0.0040
Medium firms	-0.0543*	0.0106	Medium firms	-0.0542*	0.0106
Small firms	-0.1794*	0.0175	Small firms	-0.1804*	0.0175
Constant	2.1621*	0.0631	Constant	2.1642*	0.0632
Effects on μ_{it}			Effects on μ_{it}		
ROA	-0.0356*	0.0014	ROA	-0.0355*	0.0014
Tangibility ratio	0.0032*	0.0002	Tangibility ratio	0.0032*	0.0002
Solvency ratio	0.0007*	0.0001	Leverage ratio	-0.0008*	0.0001
Liquidity ratio	0.0013	0.0010	Liquidity ratio	0.0013	0.0010
Log(assets)	-0.1828*	0.0122	Log(assets)	-0.1832*	0.0122
τ_0	1.5729*	0.0814	τ_0	1.6989*	0.0910
χ_0	-2.0981*	0.1026	χ_0	-1.9224*	0.1098
σ_v	-4.0197*	0.0508	σ_v	-4.0249*	0.0510

Medium-sized firms, at a similar value of available resources, generate a 5, 43% lower added value in comparison with large firms. Small firms are also less efficient from this point of view, the added value being, in this case, with 17, 94% lower.

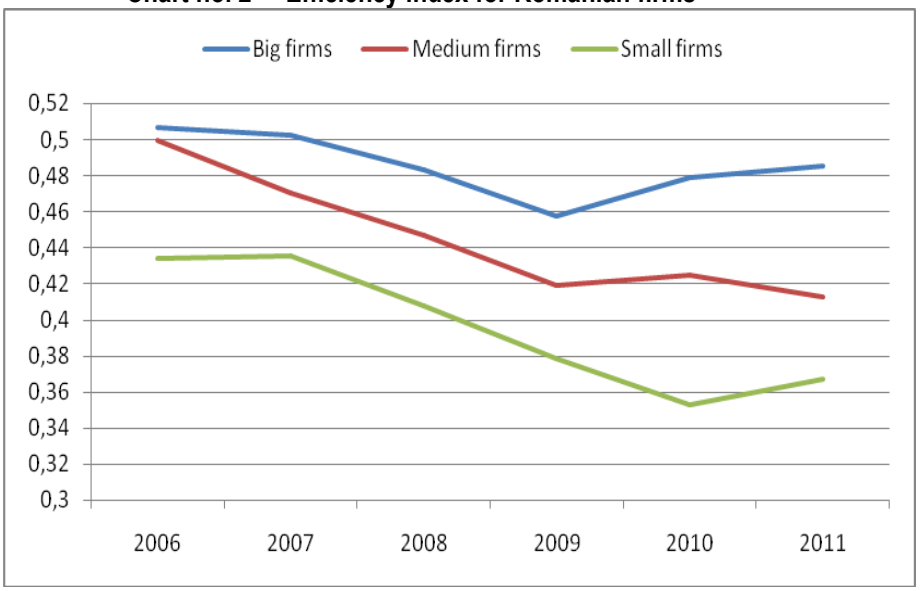
ROA influences positively the efficiency of the firms in Romania. Thus, firms with a higher ROA are more efficient, confirming the fact that a performance management is also an efficient one too. Tangibility ratio has a positive influence on inefficiency. For the firms in Romania also, liquidity ratio does not influence efficiency.

What is rather surprising is the result obtained while trying to see the influence the solvency ratio has on inefficiency. Contrasting with the results obtained for all the firms from Central and Eastern Europe, the analysis based only on Romanian firms shows a positive influence of solvency ratio on inefficiency. In this case, the growth of the equity capital in total liabilities generates a growth in the level of inefficiency (a decrease in efficiency). As previously stated, we have replaced in the model the solvency ratio with the leverage ratio, calculated as a ratio between total debts and total assets (model 2). As we can see, the leverage ratio rate has a negative influence on inefficiency, which means that a growth in the input of the total debts in asset will lead to an increased efficiency for the firms. None the less, the impact of the leverage ratios

is quite low, an increase with 1% of this rate generating an increase with 0.08% in the efficiency of the firms.

In the following chart, we presented the evolution in time of the efficiency index for all three categories of firms. As we can see, the global economic crisis has affected significantly the value of this index, the index recording lower values both in 2008 and in 2009.

Chart no. 2 – Efficiency index for Romanian firms



Moreover, after this period, the firms have not managed to come back to the efficiency level of the years prior to the crisis. An important aspect is that the maximum value of the efficiency index is 100; reaching such value could mean a total efficiency. Also, remarkable enough are the very low medium values of all the three categories of firms, meaning they operate a lot more below their potential of efficiency.

5. CONCLUSIONS

In this article we have studied the efficiency and the determinants for the manufacturing industry from Central and Eastern Europe over the period 2006 to 2011 using a SFA model. In comparison with Romania, most of the countries included in our study have obtained better results. Firms from Poland, Czech Republic and Hungary form a unitary group in terms of the efficiency. Therefore, the firms from these countries operate more efficiently in comparison with Romanian firms, the differences being quite visible. On the other hand, firms from Romania and Bulgaria form a second group, the differences between these countries being less high. Then we performed a study on the efficiency of firms for the Romanian firms. We have noticed that ROA influences positively the efficiency of the firms in Romania. The leverage ratio rate has a negative influence on inefficiency, which means that a growth of total debts will lead to an increased efficiency for the firms. The global economic crisis has affected

significantly the value of the efficiency index, the index recording lower values both in 2008 and in 2009.

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