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MODEL OF ECONOMIC EFFICIENCY ASSESSMENT FOR BUSINESS INCUBATORS IN THE REPUBLIC OF MOLDOVA

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Abstract. Incubators are places where both private and public resources meet the needs of small businesses in the critical stages of development. Community development depends on small businesses, which generate more jobs than larger businesses, as well as more than half of the major innovations. In addition, small businesses are more cost-effective in terms of research and development. Small and medium-sized enterprises face many and varied challenges in the development and operation of their business. Business incubation must be a tool for accessing new technologies, helping its customers to become more innovative, expand their market position and accelerate the development of their business. The best incubation environment is a catalyst for innovative business based on research results. Incubators must demonstrate the existence of their own monitoring procedures to quantify the achievement of objectives and whether they are harmonized with the needs of the incubated businesses. The way the clients are monitored during the incubation is an important indicator to maximize the chances of business survival and to establish growth rates.

Keywords: *business incubator (BI), small and medium enterprises, economic efficiency, technical efficiency, allocation efficiency, turnover.*

Rezumat. Incubatoarele oferă un mediu unde resursele private şi cele publice răspund împreună nevoilor pe care le au firmele mici în etapele critice ale dezvoltării. Dezvoltarea comunității depinde de afacerile mici, acestea generând mai multe locuri de muncă decât afacerile mai mari, precum şi mai mult de jumătate dintre inovaţiile importante. În plus, întreprinderile mici sunt mai eficiente în ceea ce priveşte costurile de cercetare şi dezvoltare. Întreprinderile mici şi mijlocii se confruntă cu numeroase şi variate provocări în dezvoltarea şi funcţionarea afacerii lor. Incubarea afacerilor trebuie să acţioneze ca un instrument de acces la noi tehnologii, ajutând propriii clienţi să devină mai inovativi, să-şi extindă poziţia pe piaţă şi să accelereze dezvoltarea propriei afaceri. Cele mai bune medii de incubare sunt un catalizator al afacerilor inovative care au ca bază de pornire rezultatele cercetării. Incubatoarele trebuie să facă dovada existenţei propriilor proceduri de monitorizare prin care se cuantifică realizarea obiectivelor şi dacă acestea sunt armonizate cu necesitățile incubaților. Modul în care clienţii sunt monitorizaţi pe parcursul incubării este un indicator important pentru maximizarea şanselor de supraviețuire a afacerii şi pentru a stabili ratele de creștere.

Cuvinte-cheie: *incubator de afaceri (IA), întreprinderi mici și mijlocii, eficiență economică, eficiență tehnică, eficiență alocativă, cifră de afaceri.*

Introduction

Business incubators are characterized by encouraging network communication between the incubator's clients, in order to ensure the permanent exchange of information and experience in business development. This implies a certain degree of homogeneity of the incubated businesses, which depends on the type of incubator and the selection criteria for the incubated businesses. Most incubators currently offer adequate office space, adequate support services, professional networking, assistance to incubated businesses even after the completion of the incubation period, but also to local / regional businesses that are not included in the incubator, usually via the Internet (virtual incubation). The microeconomic assessment of the BI's economic performance involves the definition of the indicators that must adequately reflect the activity of decision-making units under the conditions of market economy competition. Traditionally, the partial indicators of BI's economic efficiency subjectively reflect the activity in the field, that's why there frequently appear contradictory situations when the decision-making unit, according to some parameters, is efficient and, according to other parameters, is inefficient.

Methodology and methods for calculating economic efficiency

In order to avoid this economic analysis which does not allow a single conclusion regarding the activity in the field, Farrell proposed an integral indicator that encompasses several aspects of the activity and has an econometric foundation in the calculation technique. Thus, the total economic efficiency is broken down into the components of allocative efficiency and technical efficiency according to the graph in Figure 1.

Allocative efficiency (AE) is assessed as the ratio

$$AE = \frac{OR}{OQ} \tag{1}$$

Technical efficiency (TE) is assessed as the ratio

$$TE = \frac{OQ}{OP} \tag{2}$$

Total economic efficiency (EE) is a product of allocated efficiency and technical efficiency and it represents the total managerial performance of the decision-making unit under market economy conditions.

$$TE * AE = \frac{OQ}{OP} \times \frac{OR}{OQ} = \frac{OR}{OP} = EE \tag{3}$$

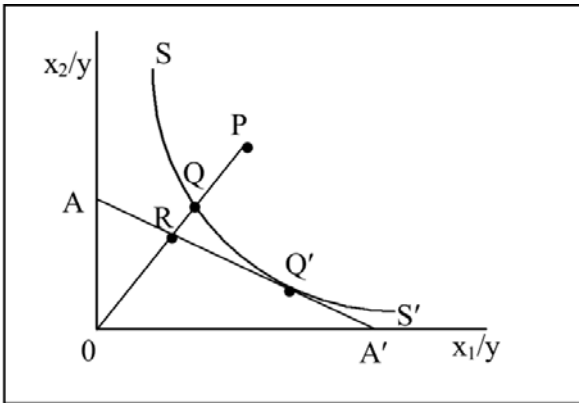

Figure 1. Assessing the efficiency of business incubators in accordance with distance function approach measuring economic growth.

In this context, applications have been developed to assess the technical efficiency of enterprises as an integrated indicator of economic performance that is not contradictory and that is a complex analysis of the relationship between results (outputs) and initial resources in the core business (inputs). For practical applications of the study there was used the DEAP Software (computerized data analysis program), developed by Tim Coelli in 1996 [1], during his work for the Center for Efficiency and Productivity Analysis. Its theoretical landmarks are briefly described below.

In 1951, Koopmans defined technical efficiency as follows: *„The efficiency of an enterprise consists of **the technical efficiency** that reflects the ability of the business unit to achieve maximum output for the given set of inputs and **the allocation efficiency** that reflects the company's ability to use inputs in optimal proportions, relative to the respective market prices "[*3]. The definition of technical efficiency measuring was given by Debreu, in 1951, and by Farrell, in 1957. In order to quantitatively express the efficiency of a decision unit it is necessary to define the expected results of extreme performance, which can be minimum for inputs and maximum for outputs. To this end, the concept of an efficient frontier has been introduced, which shows the maximum performance of decision-making units and is a limit to which every company must strive under the conditions of market economy competition. The effective boundary for the decision units included in the technologies defined above is described in the space of the input coefficients ξ, , as follows:

$$TE = \left\{ \xi = (\xi_1, \xi_2, ..., \xi_M) \middle| \xi_i = \min_k \min_\mu \frac{\mu x_i^0}{f^k(\mu x_i^0)}, 1 \le i \le M, 1 \le k \le K \right\} \quad (4)$$

where, μ is a positive scalar, and μ X^0 is an achievable input.

Thus, we can say that the efficient boundary corresponds to the requirements of the decision units z = (y, - x) for which the input coefficients ξ reach their minimum values along the radial direction μ x^0, for any achievable input vector x^0. The set of outputs is a closed set, lower bounded and it satisfies the convexity property in the strict vicinity.

To this end, we will also give some definitions of efficiency and of the measure of production efficiency.

Koopmans definition: The input-output vector (x, y) is technically efficient if and only if *(x,y) ∈ Eff GR* . The input x is technically efficient to the output vector *y* if and only if *x∈EffL(y)*; the output *y* is technically efficient to the input vector *x*, if and only if *y∈ Eff L(x)*. *Eff GR* represents the efficiency curve of possible input-output combinations, *Eff GR= {(x,y)∈ GR* and *(x',y'}∉ GR* for $0 \le x' \le x$ şi $y' \ge y$ }, *Eff L(y)* represents the efficiency curve of the input in relation with the output, *L(y)={x|(x,y)∈GR}, y ∈ IR^M_+*, *Eff L(x)* represents the efficiency curve of the output in relation to the input, *Eff L(x)= {y|(x,y)∈GR*}.)

Debreu-Farrell's definition is: The radial measure of the technical efficiency for the input vector *x* in a production process (x, y) is calculated as follows: TE_1(x,y)= min {θ: θx ∈L(y)}, where θ=1 indicates the radial technical efficiency, and θ>1 indicates the degree of radial technical inefficiency [1].

$$\begin{cases} \max\limits_{\phi,\lambda} \phi \\ -\phi y_i + Y\lambda \ge 0 \\ x_i - X\lambda \ge 0 \\ N_1^{'}\lambda = 1 \\ \lambda \ge 0 \end{cases} \quad (5)$$

So, we have the production process defined by the input vector $X=(X_1, X_2,...X_n)\in R^n$ and by the output vector $Y=(Y_1, Y_2,...Y_n)\in R^m$. The aim of the research is to compare each producer in relation to the "best" we found, using performance measurement. This is possible by solving the following problem by: $(X_0, Y_0)$is the input-output vector of production, which has been evaluated, and (X_i, Y_j) is the input-output vector corresponding to the *i* production. The fractional-nonlinear optimization model (4) can be brought to such a linear form that we can make the following change of variables $u=t\mu, v=tv$ where $t=(\mu^T Y_0)^{-1}$. Following this, the proposed model can be written in such a way that the dual problem of the oriented input problem is presented by X which is the input matrix and Y which is the output matrix; and λ represents the efficiency score index.

In the problem studied by the DEAP type models, the degree of performance of a business incubator is evaluated in terms of its ability to extend the output vector, assuming that there is "the best" one [2]. In conclusion, a producer is considered technically efficient if the optimum value ϕ is close to 1, otherwise it is inefficient. Model (4) is output-oriented, so output-oriented is an efficient frontier of BI's activity. In both cases of the dual problem, the basic result remains the following: the efficiency of a production unit increases as the coefficient ϕ, λ approaches 1.

Results and discussions. For this study, the data collected by the author for 2014-2017 were used, they were based on the statistical forms of business incubators in Republic of Moldova. This data set allows us to calculate the data of the variables used in the given model. The mathematical model, using the output and input data, regarding the business incubators is presented below. The values of the average technical efficiency for the BI network in the Republic of Moldova for the period 2014-2017 obtained according to the mathematical calculations of the economic model are presented in table 1.

Table 1

Technical efficiency of BA within the period 2014-1017

No.	Incubator's name	2014	2015	2016	2017
1.	Soroca	1,000	1,000	0,997	1,000
2.	Leova	0,453	0,448	0,351	0,405
3.	Rezina	1,000	1,000	1,000	0,273
4.	Singerei	1,000	0,778	0,577	0,610
5.	Dubasari	1,000	1,000	1,000	1,000
6.	Ceadir-Lunga	1,000	0,441	0,628	0,510
7.	Nisporeni	0,095	1,000	1,000	1,000
8.	Stefan-Vodă	1,000	1,000	1,000	0,886
9.	Cimislia	1,000	0,246	1,000	0,425
Arithmetic mean per sample		0,838	0,768	0,839	0,679

Source: Developed by the author based on own calculations.

So, it can be mentioned that the TE values are located in the range from 0 (low economic performance) to 1 (high economic performance). In the record year 2014, the TE value represents 0.838 and it is a good performance in BI's activity. Respectively, in 2017 a low performance was registered, obtaining a TE value = 0.679. The trend of the evolution of BI's economic activity is presented in Figure 2 and can serve an indicator for the investors who would like to support and develop the entrepreneurial environment in the rural area of the Republic of Moldova.

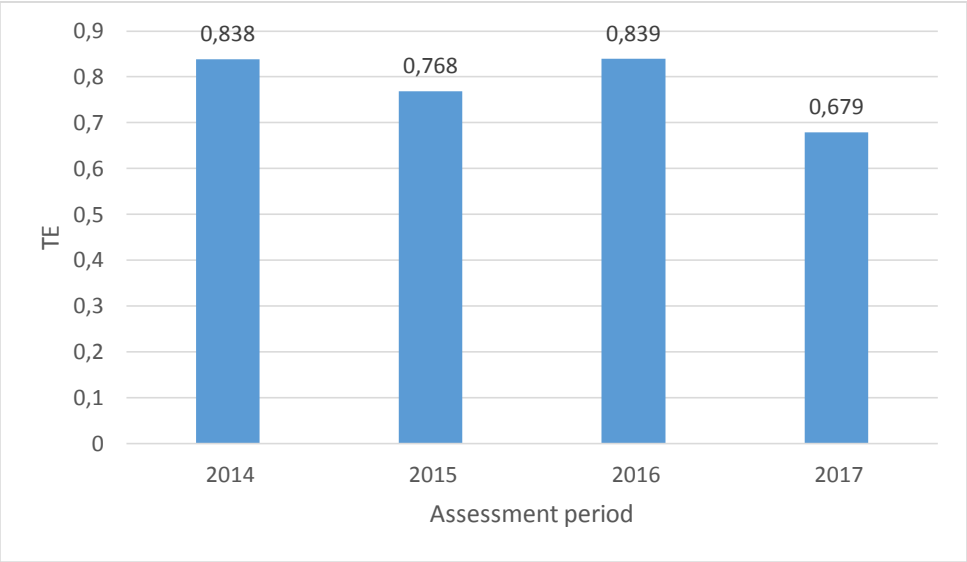

Figure 2. Graphic representation of the technical efficiency of BI, 2014-2017

Source: Elaborated by the author.

Considering that investors and, in particular, resident companies are sensitive to information on the economic performance of each incubator with an assessment of the contribution of each factor included in the data envelopment analysis model, Table 1 presents a comprehensive description of the economic agents' activity. For example, for 2017 the high performance incubators were: Soroca, Dubasari and Nisporeni, which are located on the efficient DEAP border and represent an objective for the incubators with TE subunit. Respectively, Rezina incubator has the lowest TE value and cannot be a target for resident companies to be incubated in the field. Also, the orientation of resident companies towards incubators depends on the trend of TE evolution during the assessment period. At Rezina BI, which has a decreasing trend, there are some gaps in the resources use that can ensure economic performance. Conversely, it can be stated that Dubasari BI presents a major technical efficiency throughout the assessment period, regardless of the fact that it has a small lease area and a small number of residents. It is an incubator required for investors, and resident companies are correctly selected, based on their field of activity.

The economic analysis of the BI's activity determines how intensly are linked the factors that are included in the nonparametric model of the linear programming. The evaluation of the factors' share in ensuring the technical efficiency depends on the Pearson correlation coefficient and the comparison of the resources contribution in obtaining the expected result implies the evaluation of the SWOT analysis. For example, the turnover has a positive value of the correlation coefficient for the entire record period within the range from 0.309 to 0.529 in 2017 and indicates a high intensity of the link between factor and TE of 50%. We can conclude that this factor (turnover) represents a substantial contribution to the activity of resident companies that are in the incubator. Regarding the factor which has a negative contribution to economic performance, it can be mentioned that the number of start-ups correlates negatively throughout the record period and is placed within the range from -0.186 to -0.824 in 2014 with a highly negative intensity between factor and TE of 60%. In this context, it can be stated that the number of start-ups, as an initial resource in the activity of the incubator, is a burden that requires other factors with a positive contribution to technical efficiency. An unforeseen conclusion from the correlative analysis of Table 2 is the contribution of the factor of the number of residents with a value of the

minor correlation coefficient (below 20%), which does not substantially influence the economic performance in the development of BI.

Table 2

Correlation analysis of BI's performance indicators with technical efficiency for the assessment period 2014-2017

Performance indicators	Technical efficiency			
	TE 2014	TE 2015	TE 2016	TE 2017
Turnover	0,437	0,467	0,309	0,529
Number of residents	-0,112	0,083	0,249	0,111
Start-ups	-0,824	-0,367	-0,186	-0,266
Number of jobs	0,116	0,299	0,019	0,218
Total space for rent	-0,324	-0,050	0,200	0,334

Source: Elaborated by the author based on own data.

In order to improve the BI's activity, it is necessary to define the criteria for optimizing the use of resources necessary for the development of BI and maximizing the output by restructuring the internal activity of the economic agent. Figure 3 shows the activity of a BI located on the efficient frontier of the primary data set, which has TE = 1,000 and is the goal, to which the other members of the BI sample should aim. As a result of the comparative analysis of the incubators, the turnover, in the amount of 18800 thousand lei, does not need to be modified in the restructuring option, as shown in output 1 of figure 3. Also the input structure is optimal to obtain an economic performance maximum.

```
Results for firm :1
Technical efficiency :1
         original    radial      slak projected
           value  movement  movement     value
  input1   17.0000    0.0000   -0.0000   17.0000
  input2    4.0000    0.0000   -0.0000    4.0000
  input3  190.0000    0.0000   -0.0000  190.0000
  input4 1200.0000    0.0000   -0.0000 1200.0000
 output1 18800.0000    0.0000    0.0000 18800.0000
LISTING OF PEERS:
    peer  lambda weight
```

Figure 3. Assessment of the technical efficiency of Soroca BI depending on the factors included in the nonparametric model DEAP.

Source: Elaborated by the author.

It is obvious that the analyzed Soroca BI is a promoter example in the RIAM activity. In order to improve the resources of the BI's activity, there can be analyzed the data presented in figure 4 based on Leova BI. The technical efficiency is minor and represents 0.4052 for the record year 2017. The optimization criteria of this incubator can be defined at the output level by increasing the turnover by 6017 thousand lei or decreasing the consumptions by decreasing the input1 by 2.21, decreasing input 2 by 6. 23, input 3 to be reduced by 28.36 and the total area can be maintained at the same level. Incubator 5 can serve an example to follow; it is located on the efficient border for Leova BI with the distance function $\lambda = 0.748$ and incubator 7 with the distance function $\lambda = 0.251$. Obviously, incubator 5 is preferable, which does not require substantial modifications to optimize economic activity.

Results for firm :2
Technical efficiency :0.4052

	original value	radial movement	slak movement	projected value
input1	16.0000	0.0000	-2.2165	13.7835
input2	11.0000	0.0000	-6.2306	4.7694
input3	60.0000	0.0000	-28.3624	31.6376
input4	724.0000	0.0000	-0.0000	724.0000
output1	4100.0000	6017.2309	0.0000	10117.2309

LISTING OF PEERS:

peer	lambda weight
7	0.2518
5	0.7482

Figure 4. Assessment of the technical efficiency of Leova BI.
Source: Prepared by the author.

Conclusions. The non-parametric DEAP approach in the analysis of BI's activity has the advantage that the integrated TE indicator represents a broad information and is not contradictory compared to traditional economic indicators that show a partial economic performance. An increased degree of efficiency in BI can help increase turnover, product innovation and companies' access to financial services, which can improve the prospects for growth and economic prosperity. In this sense, there are inefficient and fragile, state-dominated, low-income BIs. Therefore, it is important to identify those incubators that can be a promoter example for BIs with low efficiency.

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