

DATA ENVELOPMENT ANALYSIS OF FACTORS FOR FOREST INDUSTRY WAGES AND SALARIES LEVELS IN NUTS 2 REGIONS OF BULGARIA

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ABSTRACT

Determining the economic efficiency of entire enterprises or of certain processes in the use of resources is a topic of constant relevance. Bulgaria's forest industry is a specific sector that provides employment to the population in all regions of the country. So far, many studies have been done on the economic efficiency of the forestry sector in the country. Human resources in the sector, as well as labor costs, were also investigated. In the present study, a methodology is applied that determines the economic efficiency of employment compared to the salaries paid. In this way, the study determines the optimality in the ratio of employment / wages and answers the question to what extent in each of the regions of the country companies have managed to provide productive jobs with good pay.

Key words: economic efficiency, employment, factors, wages, regions.

INTRODUCTION

Assessing the economic efficiency of business is a leading problem in research. In addition, great attention is paid to labour productivity and wages. Efficiency estimation as well as identification of sources of its appearance is a precondition to improve the performance of any enterprise (see Vincová, 2009). Martić et. al. (2009) define the economic efficiency as achievement of enterprise's goals with minimum resources. Some authors (see Rosa et. al., 2013) define the cost efficiency like the representative of total efficiency. Some researchers preferring the parametric and others the non-parametric approach (Murillo-Zamorano, L. R., 2004). Many researchers rely on so-called parametric approaches in which the production function is being modelled. (Sisay et. al, 2015, Murillo-Zamorano, 2004, Asogwa et. al., 2011) implement parametric frontier approach in attempt to model the stochastic production function. Parametric approaches require appropriate database, which is not al-

ways available, or is not possible direct comparison of the variables due to multicollinearity, endogeneity etc. This is not an issue in nonparametric models. This is the reason many authors to prefer these methods. Data Envelopment Analysis (DEA) methodology includes different models. They compare different enterprises (Decision Making Units) or other type of economic systems through so-called virtual output and virtual inputs. DEA estimates efficiency in the form of scores. In DEA, the estimated frontier envelopes the input/output data of the most efficient decision making units (DMU) (Aldeseit, B., 2013). According to Li et. al (2017) the appropriate model If the enterprises operate in optimal scale, is Charnes et. al (1978) CCR (Constant Returns to Scale) model, otherwise is applicable the BCC (Variable Returns to Scale) model, which estimates the pure technical efficiency. BCC assumes that the scale of each DMU is different from another. Thus, the model estimates the quality of each input, or the amount of production, or any type output that has been delivered as a result of this

quality. In constant returns to scale, the quality of input/output is mixed with the effect of the returns to scale.

In DEA research on forest industry Sari et. al. (2018) and Ma (2016) and estimate the efficiency of furniture enterprises, until Trigkas et.al (2012) assess the efficiency of production of wooden materials and furniture innovations. So far, there are not many researches on Bulgarian forest industry based on DEA. Krišťáková et. al. (2021) applied DEA for productivity measurement of wood-processing enterprises along with Mamquist Productivity Index for Bulgaria and Slovakia. Neykov et. Al (2020^{1,2,3}) used DEA for economic efficiency estimation in Bulgarian forest industry and combined forestry-industry units in the country. There are also not many publications, which present wages as an element of DEA models. Authors like Yousfat et. al. (2015) and Mikušová (2015) used wages of academic staff like input in DEA models. Haas et. al. (2004) and Moreno and Lozano (2015) also implemented wages as input, but in sport areas.

For now there are no researches on wages, based on DEA in Bulgarian forest industry. In the current study, we aim to estimate the efficiency of wages, but as an output. By this way, it is possible to be assessed the efficiency of wages according to different inputs and to answer the question if these inputs generate the sufficient amount of costs for wages and salaries or people are not paid enough.

METHODOLOGY OF RESEARCH

The study uses a model with a constant return on scale and a model with variable return on scale. The results are combined into a coefficient of efficiency by scale to highlight the effect of scale or number of staff, as well as the rate of share of wages in total industry.

Mathematical equations of the implemented DEA input-oriented models are following:

CCR for the period t:

min θ

$$\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{i0} \quad (1)$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq y_{r0}$$

where λ_j are individual scalars of each DMU_j $j \in [1, n]$, x_{ij} are amounts of inputs of type i in DMU_j, x_{i0} is the amount of i -th input of DMU₀ being under efficiency estimation. If the additional constraint $\sum_{j=1}^n \lambda_j = 1$ is added, the model becomes the BCC with variable returns to scale.

For DMUs were chosen the each region for each year. By this way the regions are compared to the best performance they had during the period of research. For inputs were involved Share of Employment in Manufacturing in the region and Number of Enterprises. The output are Costs for wages and salaries.

Scale efficiency is expressed by the following equation:

$$SE = \Theta * CCR / \Theta * BCC$$

For the research were used data from Eurostat Structural Business Statistics for NUTS2 regions for the period 2010–2019.

Limitations on the study are placed according to data availability for NUTS2 regions. There were not calculated wages per person employed due to the methodological specifics of data collection by Eurostat. The costs for wages is the most accurate indicator for the analysis.

RESULTS AND DISCUSSION

Changes in the annual labour costs are shown on Figure 1. They are compared to the increase of the employed in the production.

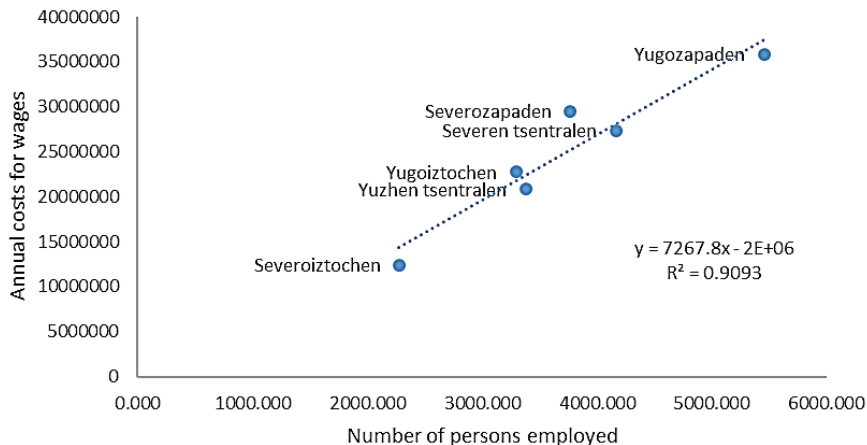


Figure 1: Relations between persons employed and annual marginal costs of enterprises for wages in EUR

The Figure 1 presents that the main driver for increasing wage costs is the number of staff. The regression line marks the mean values in the increase or so called the marginal costs for wages. This means that the one more person employed leads to 14400 BGN increment of the annual wage costs. It is obvious that some regions increase costs

disproportionately to those employed in production. It is interesting that in the poorest region in EU – Severozapaden the marginal costs for wages are above the average. This is maybe due to enterprises efforts to maintain people to work in them. The best paid region is Yugozapaden and the worst Severoiztochen. Results for NUTS2 regions efficiencies are presented in figure 2.

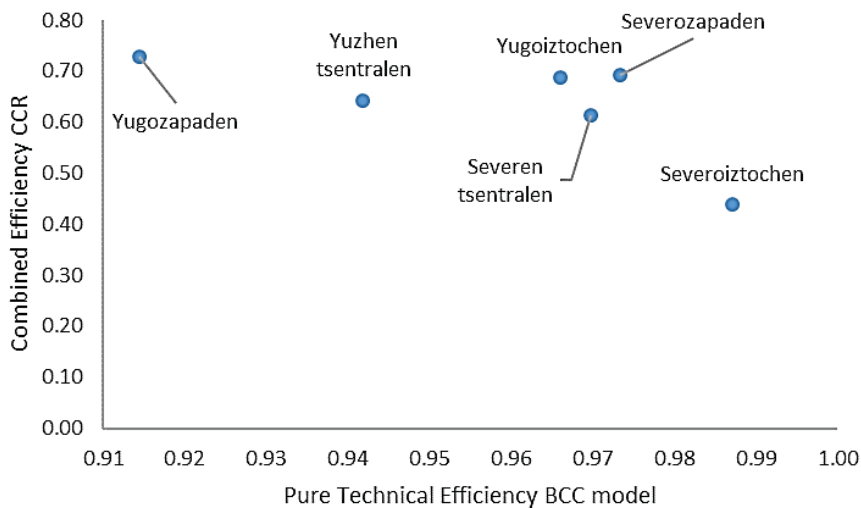


Figure 2: Efficiency scores estimated with model (1)

The graph shows that all regions have a high average efficiency. The Yugozapaden region has high combined efficiency but low pure technical efficiency. This means that companies there pay staff due to the large scale of production. At the same time, the quality of labour resources is not used to a sufficient extent. Wage costs are covered by the size of enterprises, their relative share in local industry and their larger number. At the opposite end is a Severoiztochen region. There the scale is smaller and the ratio of labour resources, number of enterprises and relative weight in the region is better. These

enterprises have a small scale. They get the best out of their resources. Severozapaden region is with better scale efficiency – 0.71 scores according to model (2), than Severen tsentralen – 0.63.

In the current research was found that the only statistically significant factor for gaining efficiency is the level of personnel costs. Estimated influence is 0.03 increment of scores of the Efficiency Θ after each EUR spent for wages (Table 1). This means that the enterprises can achieve efficiency on wages if they spend more. Otherwise they underpaid their employees.

Table 1: Regression results for CCR as dependent and Wages for independent variable, $\alpha=0.05$, $R^2=0.75$

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.35	0.10	3.61	0.02
Wages	0.03	0.01	3.42	0.03

The change in efficiencies over time presents the ability of the regions to achieve

efficiency and the way they adapt to the economic environment. It is shown in Fig.3.

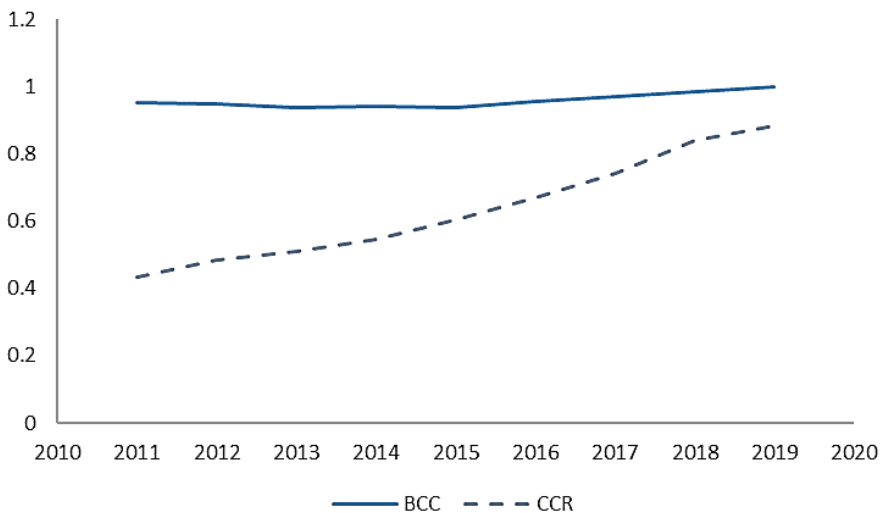


Figure 3: Efficiency changes during the period of research

The figure reveals that over the years the forest industry has developed a scale of production. There was no emphasis on the development of productivity and quality of the workforce. It can be said that this is extensive

growth. In some of the regions in 2019 full economic efficiency has been achieved. Yugoiztochen and Yugozapaden are fully effective – scale and pure technically in 2019. This is an interesting result, which shows that

the sector is adapting to the economic environment within 10 years. Hiring staff is a leading source of increasing production capabilities.

CONCLUSIONS

Bulgaria's forest industry needs to improve the quality of human resources. Manufacturers rely on creating a scale of production that allows for larger production volumes. In the regions of Bulgaria, the most effective is the Yugozapaden, followed by the Severozapaden. The most inefficient is the Northeast. In regions with high efficiency, the main production strategy is to increase human resources. The most significant factor in improving the employment-wage ratio is wage costs. Businesses should invest in human resources to improve net technical efficiency. The positive trend in combined efficiency is a positive sign that the scale is getting more and more optimal and planning is bettering. Optimality in scale reveals improved capabilities of Bulgarian forest based manufacturing to be resilient in time of crisis and inflation.

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