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ORIGINAL SCIENTIFIC PAPER

Enterprises' Emissions Intensity and Financial Performance in Serbia: The Case Study of Wastewater

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ABSTRACT

Untreated industrial and municipal wastewater is the key factor that leads to water pollution in Serbia. The aim of the paper is to examine the impact of environmental performance (using eco-intensity indicators) of enterprises on their profitability in the period 2011-2020 in Serbia in the area of wastewater. Apart from using the panel data technique in the paper, the Generalized Method of Moments (GMM) is also used to estimate the parameters in the model. The results demonstrate that if the eco-intensity indicator increases, the profitability of an enterprise increases significantly, whereas the profitability of an enterprise decreases with the increase in the size of an enterprise. According to the results of the evaluated model, the capital intensity variable has no influence on the profitability of an enterprise. Additionally, it has been determined that the coefficient with the eco-intensity indicator is quite large, indicating the poor eco-efficiency of Serbian enterprises in the area of wastewater.

Keywords: *eco-intensity, enterprise profitability, wastewater, GMM, Serbia*

JEL Classification: C23, L25, Q25, Q53

INTRODUCTION

The concept of eco-efficiency was first defined by Schaltegger and Sturm (1989), whereby the indicator is a mixture of economic and environmental efficiency. Eco-efficiency refers to the ability to create more products or services with fewer resources and less damage to the environment (Chen et al., 2022a). Eco-efficiency is a type of management whose task is to seek environmental improvement that brings parallel economic benefits. It focuses on business opportunities and enables enterprises to become more environmentally responsible and profitable (Revollar et al., 2021).

Daud et al. (2023) maintain that eco-efficiency can be measured in two ways. The first way is to use the economic value-added quotient and several measures of environmental impact (the higher the quotient, the more profound effect the surrounding has on the environment). Another way is the inverse relationship, also known as eco-intensity, which is a measure of the environment divided by the economic value (the lower the value of this indicator, the better eco-efficiency is).

Industrial and communal wastewater discharged directly into the watercourses, without prior treatment, is the biggest water polluter in the Republic of Serbia, bearing in mind that industrial

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wastewater can be highly dangerous due to its toxic substances (Ekologika, 2023). Approximately 50% of the pollution discharged into the rivers originates from industrial plants, and only 13% of the municipal wastewater is treated before being discharged (Zelena Zemlja, 2023). Mitrović (2021) states that industrial plants, municipal wastewater coming from settlements, and agriculture are the main sources of pollution of the rivers and other water resources in Serbia because of using artificial fertilizers and other chemical compounds. In Serbia, only 10% of wastewater is treated, while the other 90% is discharged into the rivers (Dalmacija, 2022). The public company Elektroprivreda Srbije (JP EPS) is the major generator of industrial wastewater in Serbia. According to the data of the Serbian Environmental Protection Agency, JP EPS annually discharges over 95% of the total industrial wastewater in Serbia (Ekologika, 2023). Dalmacija (2022) states that the biggest water polluters in Serbia are the three cities that do not have treatment plants: Belgrade, Novi Sad, and Niš.

The Water Act (2018) regulates the protection of water pollution in the Republic of Serbia. "Water protection, in compliance with the law, is a set of measures and activities that protect and improve the quality of surface water and groundwater, including the protection from the effects of cross-border pollution, in order to:

1) preserve the life and health of people;
2) reduce pollution and prevent further deterioration of the water condition;
3) provide harmless and unhindered use of water for various purposes;
4) protect aquatic and coastal ecosystems and achieve the environmental quality standard in accordance with the regulation governing environmental protection and environmental goals." (Water Act, 2018, Article 92).

The Water Act regulates the prevention of the deterioration of water quality and the environment, determines the physicochemical parameters and emission limit values of polluting substances, as well as the methods and conditions for discharging polluting substances and the application of emission limit values. Moreover, the law defines the water protection plan against pollution.

In the Republic of Serbia, not all planning documents in terms of water management have been adopted, indicating that not all activities have been undertaken to conduct effective wastewater management planning. "The Water Council has not been established and the National Water Conference in the revised period has not undertaken any activities to monitor the implementation of the Water Management Strategy and has not made any proposals for improving public participation in the process of planning, decision-making, and controlling the process of implementation" (Ekologika, 2023). The main problem is that a large number of cities in Serbia do not have wastewater treatment systems (Mitrović, 2021). Mitrović (2021) states that Serbia has taken on the obligation of building all municipal wastewater treatment plants for settlements with more than two thousand inhabitants by 2040.

The paper analyses the link between eco-intensity and the profitability of enterprises, taking into account that eco-intensity is based on the total emissions released into the waters in Serbia. The data are collected on an annual basis, and the period analyzed is from 2011 to 2020. The methodology which is used is the econometric technique (data panel technique), and the method for evaluating the parameters is the Generalised Method of Moments (GMM). The eco-intensity indicator is calculated as the quotient of the total water emissions and total revenues of enterprises, while Return on Assets (ROA) is used to measure their profitability. To the best of the author's knowledge, this research can be considered a pioneering one because, so far, no similar research has ever been done in the field of wastewater for Serbia.

The hypotheses on which the research is based are as follows:

1. The eco-intensity indicator has a significant impact on a company's profitability in the field of wastewater in Serbia.

2. The size of a company significantly affects a company's profitability.

In addition to the introduction, the paper presents an overview of the literature (Section 2). In Section 3, the data and methodology used are described. Section 4 includes results and discussion, while Section 5 provides concluding remarks.

THEORETICAL BACKGROUND

Most of the literature refers to wastewater-based eco-efficiency research in China (Zhu et al., 2022; Zhou et al., 2020; Yu et al., 2016; Wang and Peng, 2021; Wang et al., 2022 ; Shi et al., 2021; Liu et al., 2022; Li et al., 2020; Huang et al., 2021; Hou et al., 2019; Chen et al., 2022b, etc.). There are few studies that analyze this indicator for some other countries. For example, Cecchini et al. (2023) consider the eco-efficiency of the beef cattle sector in Italy, Aoki-Suzuki et al. (2023) evaluate the eco-efficiency of the materials produced in Japan, while Chappin et al. (2007) analyze the eco-efficiency in the case of wastewater treatment, waste and energy efficiency in the Dutch paper and board industry. Furthermore, achieving eco-efficiency for the 10 most polluted countries using green technology and natural resource rents is studied by Chen et al. (2022a). Gómez et al. (2018) and Molinos-Senante et al. (2016) measure the eco-efficiency of the wastewater treatment plants in Spain. The evaluation of the eco-efficiency of the wastewater in Spain is examined by Mocholi-Arce et al. (2020). Maziotis et al. (2023) study the dynamic eco-efficiency of the water utilities in Chile. Sala-Garrido et al. (2021) assess the eco-efficiency of the water companies in England and Wales.

Chakraborty and Mukhopadhyay (2012) research water pollution in India using Input-Output Analysis, while Gani and Scrimgeour (2014) explore the impact of the governance of the water pollution levels for all industrial activities in OECD countries. Hernández-Chover et al. (2018) consider the efficiency of the wastewater treatment plants for 217 regions of Valencia.

Hou et al. (2019) state that there is literature examining the eco-efficiency of urbanization, agricultural production, wastewater treatment plants, biogas production, national economic sectors, energy use, etc.

Daud et al. (2023) claim that several studies have analyzed the relationship between eco-efficiency and financial performance in the last two decades and got varied results. Some of these studies have shown that better financial performance is achieved when companies integrate environmental efficiency into their business operations.

In the literature examining this area, two methodologies are predominantly used: parametric (econometric) and non-parametric (linear programming) techniques. Sala-Garrido et al. (2021) and Hou et al. (2019) emphasize that the most common model for evaluating the efficiency of various production activities is, in particular, the non-parametric technique, the Data Envelopment Analysis (DEA).

Chen et al. (2022b), Shi et al. (2021), Sala-Garrido et al. (2021), Gómez et al. (2018), Li et al. (2020), and Molinos-Senante et al. (2016) have used the DEA model in their analyses, while the econometric model GMM has been used in the following studies: Hou et al. (2019), Zhu et al. (2022); Zhou et al. (2020); Wang and Peng (2021), Brahmana and Kontesa (2021), Ahmad et al. (2021), etc.

Radonjić and Ostojić (2023) state that the situation in Serbia regarding wastewater management is terrible. Moreover, the Draft Law on Amendments to the Law on Fees for the Use of Public Goods is in the parliamentary procedure. According to this draft, Article 78, the fee for the discharge of insufficiently purified wastewater is reduced by 1000 times.

DATA AND METHODOLOGY

The data used in the paper are the environmental data from the national PRTR register (SEPA, 2022), having analyzed the total water emissions for 96 companies in Serbia. The financial data for these 96 companies are for the period 2011-2020. Therefore, there are a total of 960 observations. The financial data are taken from the annual financial statements of the companies published in the Register of Financial Statements of the Serbian Business Registers Agency (SBRA).

Four variables are used in the paper: the eco-intensity indicator (EI), the indicator that measures a company's profitability, i.e., Return on Assets (ROA); and the other two variables are the size of an enterprise (SIZE) and capital intensity (CI). The eco-intensity indicator is calculated as the quotient of total water emissions and total revenues for each company. The profitability indicator of a company or ROA is calculated as the quotient of a company's net financial result and the value of a company's business assets. The variable SIZE is defined as the natural logarithm of the total assets, while the variable CI is calculated as the quotient of the total assets of a company and the operating revenue of a company (Table 1).

Table 1. Description of the variables

Variable	Abbreviation	Calculation
Eco-intensity	EI	Total water emissions/Total revenues
Return on Assets	ROA	Net financial result/Operating assets value
Size of an enterprise	SIZE	ln(SIZE)
Capital intensity	CI	Total assets/Operating revenue

Source: Authors' own elaboration based on SEPA and SBRA data

Dynamic panel regression and Generalized Method of Moments (GMM) are used for the analysis, similar to Stevanović et al. (2023). However, Stevanović et al. (2023) consider total air emissions, unlike this paper, which takes into account water emissions. The difference is also in the number of the sample and the structure of companies, and in the number of variables as well. The following model is evaluated:

$$\mathrm{ROA}_{it} = \mathrm{C} + \lambda_1 ROA_{it-1} + \lambda_2 \mathrm{EI}_{it} + \lambda_3 \mathrm{SIZE}_{it} + \lambda_4 \mathrm{CI}_{it} + \varepsilon_{it} \quad (1)$$

where *i* refers to an enterprise, and *t* to the period, while ε represents the error term, and $\lambda_1,\ldots,\lambda_4$ are the parameters along with the described variables that need to be evaluated, and C is a constant.

RESULTS AND DISCUSSION

The heteroscedasticity test was conducted using Breusch and Pagan (1980) (Table 2). We start from the null hypothesis that there is homoscedasticity in residuals. The value of the Breusch-Pagan LM test is 7346.907 (0.000), which can be interpreted as the presence of heteroscedasticity. However, the GMM method is preferred when this kind of problem arises. As the number of companies (N=96) in our case is greater than the analyzed period (T=10), it is necessary to perform the Pesaran (2004) test to examine Cross-Section Dependence (Table 2). The null hypothesis in this case is that there is no cross-section dependence (correlation). According to the data for the p-value, which is about 6% for the Pesaran CSD test, it is possible to conclude that the disturbances have no cross-sectional dependence. It is also necessary to mention the fact that the GMM estimator is consistent under the null hypothesis of cross-sectional independence.

Table 2. Heteroscedasticity and Cross-Section Dependence tests

ROA	Statistics	Probability
Breusch-Pagan LM test	7346.907	0.000
Pesaran CSD test	1.886	0.059

Source: Authors' calculation

Table 3 presents the results of correlation analysis to test the problem of multicollinearity between the independent variables. All correlation coefficients between the variables are statistically insignificant, and it is possible to draw the conclusion that there is no problem with multicollinearity among the variables.

Table 3. The Correlation Matrix

	ROA	**EI**	**SIZE**	**CI**
ROA	1.000			
EI	0.001 [0.029] (0.977)	1.000		
SIZE	0.009 [0.281] (0.779)	0.036 [1.103] (0.270)	1.000	
CI	-0.004 [-0.125] (0.900)	-0.004 [-0.113] (0.910)	0.007 [0.207] (0.836)	1.000

Note: t-Statistics (in brackets); Probabilities (in parenthesis)

Source: Authors' calculation.

From Table 4, it can be concluded that all the independent variables in the model are statistically significant at the 1% confidence level. Moreover, when the EI variable increases, there is a significant increase in the ROA variable as well. This result matches the result of Sudha (2020), unlike the result of Kamande and Lokina (2013), who cannot find a relationship between eco-efficiency and profitability. The first hypothesis of this paper is confirmed due to the result that the eco-intensity indicator has a significant impact on the profitability of an enterprise in the field of wastewater in Serbia.

Nevertheless, when the SIZE variable increases, the ROA variable decreases. This result coincides with the result obtained by Guenster et al. (2011), whereas it contradicts the result of Galindo-Manrique et al. (2021) who found no relationship between SIZE and profitability. Since the result shows that SIZE has a significant effect on the profitability of an enterprise, the second hypothesis of this paper has been confirmed.

Daud et al. (2023) state that the lower the value of EI, the better eco-efficiency is. However, Table 4 displays a particularly high value, indicating the poor eco-efficiency of the Serbian companies in the area of wastewater.

Table 4. Regression analysis: Dependent variable is ROA

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ROA(-1)	0.021	6.44E-05	-328.721	0.000
EI	461.091	1.883	244.828	0.000
SIZE	-31.053	0.501	-61.931	0.000
CI	0.000	3.98E-05	5.850	0.000
J-statistic	41.822			0.199
AR(1)	-1.068214			0.2854

Note: Panel Generalized Method of Moments has been used.

Source: Authors' calculation

Hansen's test or J-statistics is not statistically significant according to the results in Table 4, and it can be concluded that the model is correctly evaluated. Additionally, the value for the Arellano and Bond (1991) test for first-order autocorrelation in the residuals is also not statistically significant, meaning that there is no serial correlation in the residuals of the estimated model.

CONCLUSION

The paper studies the relationship between eco-intensity and the profitability of the enterprises in Serbia for the period 2011-2020. Eco-intensity is based on the total emissions released into the waters, and this indicator is calculated as the quotient of the total emissions into the waters and the total revenues of the enterprises. Return on Assets (ROA) was used to measure the profitability of the enterprises. A panel data technique was used to examine the relationship between eco-intensity and the profitability of the enterprises in Serbia, and the Generalized Method of Moments (GMM) was used to estimate the parameters.

Our results indicate that in the examined regression equation, all the coefficients of the independent variables of the model are statistically significant at the 1% confidence level. Additionally, if the eco-intensity indicator increases, then the profitability of an enterprise increases significantly, while the profitability of an enterprise decreases with the increase in the size of an enterprise. According to the results of the evaluated model, the CI variable has no influence on the company's profitability (ROA). It is impossible to reject both hypotheses presented in the paper. The results of the paper coincide with the results of Sudha (2020) and Guenster et al. (2011), while they contradict the results of Kamande and Lokina (2013) and Galindo-Manrique et al. (2021).

The main limitations of this paper are that the analysis is based only on the Serbian companies that are polluters from the PRTR register during the analyzed period and that the paper considers their emission of polluting substances into the water. On the other hand, the paper is a pioneering work since it examines the wastewater in Serbia, and to the best of the authors' knowledge, there have been no similar studies so far.

Future research could include a different time period, sectorial analysis and other econometric methodology, whereby the EI indicator could be measured based on the emissions of pollutants into the air, water, soil or other measures of the quality of the natural resources in Serbia. Future research could also include the relationship between eco-intensity and the profitability of an enterprise based on wastewater in other countries or the relationship between eco-intensity and revenue of selected Balkan countries.

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