ECOEFFICIENCY AND FIRM PROFITABILITY NEXUS: THE CASE OF SERBIA

Slavica Stevanovic*, Jelena Minovic, Aida Hanic

Institute of Economic Sciences, Zmaj Jovina 12, Belgrade, Serbia

ABSTRACT

To achieve sustainable development, eco-efficiency can be used as the main tool that will enable firms to create more by using fewer resources resulting with less waste and pollution. In that aspect, this paper aims to investigate the relationship between eco-efficiency and firm profitability from 2011 to 2020 in Serbia as a high fossil fuel-reliant economy. To test the relationship between eco-efficiency and firm profitability, we used the panel technique, and we applied the Generalized Method of Moments (GMM) for estimation. The analysis showed that the highest eco-efficiency indicator in Serbia was recorded in 2015, which means that Serbia had the highest overall air emissions that year. Our main results show that the eco-efficiency variable impacts the profitability of Serbian polluting firms. Additionally, our model suggests that the size variable has a significant negative impact on firms' profitability; the investment level variable influences profitability positively, but the capital intensity variable has no impact on firms' profitability.

KEYWORDS:
Eco-efficiency, firm profitability, investment level, capital intensity, GMM, Serbia

INTRODUCTION

Economic development tendency and accelerated environmental pollution of countries worldwide resulted in a need for eco-efficiency analysis on national, regional, sectoral, firm, and many other levels. Researchers, analysts, and firms' management focused on eco-efficiency analysis to study the relationship between economic and ecological performances. "This is what eco-efficiency is all about: combining the goals of business excellence and environmental excellence and creating the link through which corporate behavior can support sustainable development" [1]. Economic decisions at the level of a firm, industry, or country are based on profits or Gross Domestic Product, paying no attention to ecological influence [2]. The researchers often discuss the environmental degradation and economic growth relationship [3], [4].

Eco-efficiency can be observed as a management strategy to facilitate implementing sustainable development on the firm's level [5] and "a management philosophy that encourages businesses to search for environmental improvements and economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible and profitable. It is a crucial business contribution to sustainable societies" [1]. Corporate polluters must try to mitigate and prevent the negative impact of their business processes on the environment and society.

The relationship between financial and environmental performance in literature was examined by observing different performance measures, countries, industries, and research results [6]. Many studies analyze eco-efficiency on a national level. Still, no research includes eco-efficiency analysis of the group of enterprises that are Serbia's most significant sources of air pollution. This paper studies the influence of eco-efficiency on the financial performances of Serbian firms from the PRTR register using panel data from 2011 to 2020. According to the paper's aim, the hypothesis of this paper is to determine the impact of eco-efficiency on firm profitability in Serbia.

MATERIALS AND METHODS

Panel analysis is based on environmental and financial data of 178 polluting firms from the national PRTR register from 2011-2020 with 1.780 observations. Environmental data refers to total air emissions from the National Register of Pollution Sources [7]. The Pollutant Release and Transfer Register, as a register of significant sources of pollution in Serbia, represents a special international agreement in the environmental field. Serbia has started the implementation of the PRTR Protocol and the E-PRTR Directive and submitting data to the European Environment Agency voluntarily [8]. Financial data used for indicators calculations were taken from firms' annual financial statements (balance sheet, income statement, and cash flow statement) disclosed in the Register of Financial Statements of the Serbian Business Registers Agency - SBRA [9].

We used five variables for our panel dynamic panel model. We use the Return on assets (ROA) indicator to measure firm profitability. The second variable in the model is eco-efficiency (EE). Eco-efficiency as a tool is crucial for assessing sustainability [2]. We employed the ratio approach to measure the eco-efficiency of Serbian firms, as Chen et al. [10] did. The EE ratio includes total air emissions over total revenues. The total emissions refer to sulfur oxides, nitrogen oxides, carbon monoxide, carbon dioxide, ammonia, particulate matter (PM10 and PM2.5), non-methane volatile organic compounds, methane, and other air pollutants emitted by Serbian PRTR plant polluters during regular plants operations. The emissions are presented in kilograms per year. The others observed variables refer to size, capital intensity, and capital expenditures. The size variable is used as a firm characteristic and one of the financial performance determinants. The indicator that shows the inverse of the turnover asset ratio is used as proxying for capital intensity as Wagner [11]. The capital expenditures (CAPEX) variable is used to measure the investment level [12].

The dynamic panel model estimation method - also known as the GMM technique - provided by Arellano and Bover [13] was employed in this investigation (similar to Brahmana and Kontesa [14], and Wang et al. [15]). GMM is described in Hansen [16]. In Serbia, we seek to investigate the dynamic relationship between eco-efficiency and firm profitability. The estimated equation is similar to Yang and Wang [17]:

$$Y_{it} = C_0 + \alpha Y_{it-1} + \beta_i X_{it} + \varepsilon_{it} \quad (1)$$

where Y_{it} is the dependent variable (ROA) of firm i at time t, Y_{it-1} entails the lagged value of the dependent variable for firm i at time $t-1$, X_{it} are the independent variables (EE, SIZE, INTENSITY, CAPEX), ε_{it} is the residual of the model.

We specifically tested the model that follows:

$$\mathrm{ROA}_{it} = \alpha_1 ROA_{it-1} + \alpha_2 \mathrm{EE}_{it} + \alpha_3 \mathrm{SIZE}_{it} + \alpha_4 \mathrm{INTENSITY}_{it} + \alpha_5 \mathrm{CAPEX}_{it} + \mathrm{C} + \xi_{it} \quad (2)$$

The ROA rate is obtained by dividing the net financial result of firm *i* for period *t* by the operating assets value of firm *i* at the end of the fiscal year t. EE variable is calculated by dividing the total air emissions of firm i for period t by the total revenues of firm i for period t, similar to Galindo-Manrique et al. [12]. SIZE variable is defined as the natural logarithm of the total assets at the end of the fiscal year t as Galindo-Manrique et al. [12], Sudha [18] and Meutia et al. [19]. INTENSITY is defined as the total assets of firm i at the end of the fiscal year t per operating revenue of firm i for period t. CAPEX variable is obtained by dividing the cash outflow of capital equipment (real estate, plant, and equipment) purchase of firm i for period t by the total revenues of firm i for period t, similar to Tatsuo [20].

RESULTS AND DISCUSSION

Eco-efficiency indicator links environmental and financial performance. Emissions of individual pollutants could be observed for environmental performance measurement but for total emissions of more pollutants too. Figure 1 shows the aggregated eco-efficiency of 178 PRTR firms in Serbia in the period 2011-2020 based on overall emissions of all recorded air pollutants.

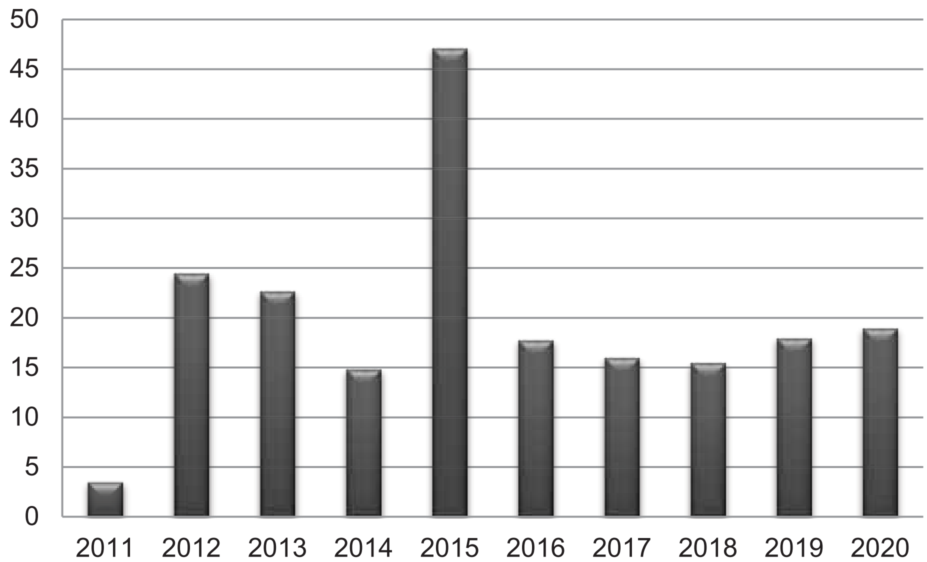

FIGURE 1
Eco-efficiency for Serbia in the period 2011-2020
Source: Authors' calculation based on SEPA [7] and SBRA [9] data

TABLE 1
Corellation matrix

	ROA	EE	SIZE	INTENSITY	CAPEX
ROA	1				
EE	0.007	1			
	(0.297)				
SIZE	-0.001	0.138***	1		
	(-0.029)	(5.864)			
INTENSITY	-0.005	-0.003	0.011	1	
	(-0.198)	(-0.139)	(0.467)		
CAPEX	0.003	-0.003	0.029	-0.004	1
	(0.119)	(-0.120)	(1.230)	(-0.160)	

Notes: ***p<1%. In parentheses are presented the values of t-statistics.
Source: Authors' estimation

Analysing total emissions and total revenues as eco-efficiency drivers and their volatility, we can conclude that the aggregated EE indicator is more defined by emissions than by revenues. The standard deviation for revenues is lower than the standard deviation of emissions during the observed period. The strongest eco-efficiency was recorded in 2011 and 2014. Data on pollutant emissions and waste generation became available in 2011 when EE indicator and total pollutants emissions had the lowest level. It could be the result of a number of polluting firms that prepared and delivered data to the SEPA in 2011 and in the following years. The highest value of the EE indicator was in 2015, showing a poor eco-efficiency compared to the years before and after because this indicator shows the amount of emitted polluters over total revenues value. The reason for it is the higher level of total emissions and lower total revenues than the other years. The decrease of the EE indicator after 2015 indicates a good trend of eco-efficiency of the group of analyzed firms until 2019 when the EE indicator is going to increase. Although it is expected that some polluters worked with reduced capacity in 2020, total emissions and the EE indicator this year are higher than emissions in 2016-2019.

Before assessing our model, where one or more regressors are endogenous, we looked at heteroscedasticity. Utilizing the Breusch and Pagan [21] test, homoscedasticity is tested as the null hypothesis. When ROA is the dependent variable and EE, SIZE, INTENSITY, and CAPEX are the independent variables, we employed pooled OLS with robust standard errors to estimate the equation (similar to Wang et al. [15]). The Breusch-Pagan Lagrange multiplier test is then performed. The value of the Breusch-Pagan Lagrange multiplier test is $\chi^2 = 0.967$ (0.325), which shows homoscedasticity. As Zhou et al. [22] mentioned, GMM techniques can solve endogenous and consistency issues better than OLS.

To test for multicollinearity issues between independent variables, we provided a correlation matrix in Table 1. Table 1's findings demonstrate that there is no mainly statistically significant correlation between the various independent variables. The exception is the correlation between EE and SIZE, which is statistically significant at the 1% confidence level; however, its value is relatively small, i.e., less than 0.3. As a result, it is reasonable to conclude that multicollinearity among variables is not an issue.

We utilize the Pesaran [23] Cross-Section Dependence (CSD) Test because, in our instance, the cross-sectional dimension (N) is bigger than the time dimension (T); N>T, as indicated by De Hoyos and Sarafidis [24]. When ROA is the dependent variable, we hypothesized there would be no cross-sectional dependency (correlation) in the model's residuals. The value of Pesaran's [23] CSD test is 2.126 (0.034). The null hypothesis that there is no cross-sectional dependence can be rejected because the p-values in this instance are significant at 5%. This issue implies that the disturbances are dependent on various cross-sections. According to Hayakawa [25], the system GMM estimator is still the most widely used estimator in empirical investigations for models that may have a cross-sectional dependence.

Panel regression analysis with Return on Assets (ROA) as the dependent variable is shown in Table 2. The validity and tools of the dynamic model were assessed using Hansen's [26] test. We can determine that the stated model is accurate because the J-statistic is small enough, and the p-value of this statistic is insignificant. For the first and second differenced residuals, we utilized the Arellano and Bond [27] specification test to check for the lack of autocorrelation. These m-statistics for the Arellano and Bond [27] specification test were insignificant, which showed no serial correlation in the calculated model's residuals, as we discovered.

All independent variables in the model have statistically significant coefficients at the 1% level, except for the eco-efficiency coefficient, which is statistically significant at the 5% level. The paper model cannot reject the hypothesis that eco-efficiency impacts firm profitability of Serbian polluters with a significance at a 5% level. The model shows that if the EE indicator increases by 1%, ROA decreases by 1.4%. Our research result that includes a significant effect of eco-efficiency on ROA is consistent with the results of Meutia et al. [19], who observe Indonesian manufacturing firms, also in line with Sudha's [18] study referring to Indian S&P 500 companies. Our results are partially in line with Tatsuo [20], who found a significant relationship for Japanese companies but in the chemical and food industry. The results of Galindo-Manrique et al. [12] are partially in line with ours but include stock returns volatility instead of ROA. Contrary to mentioned results, Kamande and Lokina [28] show that eco-efficiency has no significant impact on the firm profitability using the fixed effects model.

The most crucial variable in our model is SIZE, although it has a negative coefficient. We discovered that when SIZE increases by 1%, ROA decreases by 26.9%. Our result coincides with Guenster et al. [29], who found a significant negative impact of firm size on profitability, then with Sudha (2020) but applying the random effects model. This contrasts with Wagner [11] and Galindo-Manrique et al. [12], who found no significant firm size effects on economic performance. Unlike EE and SIZE, the CAPEX variable has a positive coefficient in our model. The model shows that if the CAPEX increases by 1%, ROA increases by 0.3%. Tatsuo (2009) [20] also found a significant positive relationship between investment ratio and ROA, but only for companies in the electrical equipment industry. Wagner's study [11] shows different effects of environmental performance on profitability depending on the used model, environmental and profitability measures. Our results suggest no impact of INTENSITY on firms' profitability.

CONCLUSION

This research aims to describe the relationship between eco-efficiency and polluter firm profitability in Serbia in the period 2011-2020. We used panel analysis based on environmental and financial data of 178 polluting firms from the national PRTR register. A total of five variables were used in our panel dynamic panel model: ROA, EE, SIZE, INTENSITY, and CAPEX. These variables were selected as mostly used in similar research. To investigate the dynamic relationship between eco-efficiency and profitability of analysed Serbian firms, we applied the Generalized Method of Moments.

The results show that the highest eco-efficiency indicator in Serbia was recorded in 2015, which means that Serbia had the highest overall air emissions that year. After 2015, the EE indicator decreased, which presents a good trend of eco-efficiency of the group of analysed firms until 2019, when the EE indicator is going to increase. Although it is expected that some polluters worked with reduced capacity in 2020, total emissions and the EE indicator this year are higher than emissions in 2016-2019. Our main results show that the eco-efficiency variable impacts the profitability of Serbian polluting firms. Also, our model suggests that the size variable has a significant negative impact on firms' profitability because when SIZE increases by 1%, ROA decreases by 26.9%. Additionally, the investment level variable influences profitability positively, but the capital intensity variable has no impact on firms' profitability. In other words, if the CAPEX increases by 1%, ROA increases by 0.3%.

This paper aims to promote creating companies' effective environmental policies and encourage firm management to improve environmental and financial performances. It adds to the improvement of the current literature on eco-efficiency by providing a fresh viewpoint. But just like every research, this one also has its limitations. The main remarks focus only on the Serbian firms from the PRTR register in the observed period and the air pollutant emissions. Future research can include the examination of eco-efficiency and firm profitability relationship based on water and waste polluters in Serbia and other countries.

TABLE 2
Panel Regression Results with GMM: Dependent variable is ROA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-0.012***	0.000	-70.466	0.000
EE	-1.367**	0.564	-2.423	0.016
SIZE	-26.923***	0.825	-32.646	0.000
INTENSITY	0.000***	0.000	-3.992	0.000
CAPEX	0.332***	0.026	12.738	0.000
Hansen's test	J-statistic			Prob(J-statistic)
	42.931			0.168
Arellano-Bond	m-Statistic			Prob.
AR(1)	-1.058			0.290
AR(2)	-1.465			0.143

Notes: ***p<1%, **p<5%, *p<10%.
Source: Authors' estimation.

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CORRESPONDING AUTHOR

Slavica Stevanovic
Institute of Economic Sciences
Zmaj Jovina 12
Belgrade 11000 – Serbia

e-mail: slavica.stevanovic@ien.bg.ac.rs