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Environmental Protection Outlays in Industry and the Return on Assets in the Food Industry in Poland*

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Abstract

This study examined the impact of changes in fixed asset expenditures for environmental protection, on the return on assets of food enterprises sector and their selected subsectors (meat, bakery, and fruits and vegetables) in Poland from 2011 to 2021. The main reason for this analysis was the relatively limited number of studies addressing the issue of current differences at the subsector level. The study shows the differences at the subsector level and can serve as a starting point for the further research aimed at identifying the causes of the differing responses. The study involves the dynamic panel models. The model estimation was performed using the Generalized Method of Moments (GMM) with the F. Windmeijer correction. The structural parameter estimates were prepared in Gretl, using the Arellano-Bond First Difference Generalized Method of Moments (FDGMM). The research used stratified random sampling which reflects the sectoral structure of medium and large enterprises employing at least 50 employees. The research sample consisted of 193 enterprises representing 15% of the population. It revealed that investment expenditures in water and sewage management significantly impacted the profitability of food enterprises, including those in the meat, bakery, and fruit and vegetable sectors. The increase in expenditures on water and sewage management was associated with the increased profitability in the meat sector and the decreased profitability in the bakery and fruit and vegetable sectors. Additionally, the study demonstrated the varying impact in waste management expenditure value on return on assets in food industry enterprises and their subsectors. The increase in investment expenditures in the waste management was associated with the increase in the return on assets of enterprises in the food industry and the bakery sector.

Keywords: expenditures, environmental protection, return on assets, food enterprises, sectors (meat, bakery, fruits and vegatable)

JEL codes: G3, L25, L66.

Introduction

Important factors that determine whether enterprises achieve a sustainable competitive advantage include the size and efficiency of their production assets, among other things. Investment expenditures in this area determine current and future production capabilities and influence the possibility of achieving economies of scale and scope. How enterprises allocate their resources and whether they comply with trends and regulations relating to the state's economic policy are crucial because these factors influence the macroeconomic environment. In an era of growing macroeconomic uncertainty related to climate change and volatile energy prices on global markets, the effectiveness of investments in environmental protection is paramount (Durand, Paugam, Stolowy, 2019). Investment expenditures incurred in this area are, on the one hand, consistent with the current economic policies adopted by many European Union countries, and on the other hand, lead to increased energy independence for

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enterprises, increased diversification of energy sources, and economic growth (Iazzolino, Bruni, Veltri, Morea, Baldissarro, 2023). Among the many sectors operating within the economy, the food industry plays a significant role, providing food in quantities that satisfy consumer needs and of quality that positively impacts their health (Kaliszuk, 2009) (Szczepaniak, Wigier, 2019). The special role played by food industry enterprises in the economic system is also demonstrated by the results of the analysis of data relating to the structure of consumer spending on food goods. Analysis of the weights used in calculating consumer price indices in Poland revealed that the share of food and non-alcoholic beverages in the structure of household consumption expenditure was the largest of all categories of goods and services throughout the entire study period. The average share of this category of goods between 2005 and 2018 accounted for nearly 25% of household consumption expenditure (CSO, 2005-2018). This means that approximately one-quarter of Polish household expenditure during this period was related to meeting their food needs. Assessing the effectiveness of expenditures on fixed assets for environmental protection in the food industry is therefore also important in the context of assessing their current and future capacity to meet consumer food needs.

Material and Methods

The main objective of the research was to determine the strength and direction of the impact of expenditure on fixed assets for environmental protection in industry on the return on assets of food industry enterprises in Poland in the years 2011-2021[1] . The research used data from the financial statements of enterprises whose main business activity was the production of food products (C.10 PKD code according to the Central Statistical Office), which also:

- submitted financial statements for the years 2011-2021 to the National Court Register,
- in the years 2011-2021 they conducted continuous business activity and were not involved in any mergers or acquisitions,
- employed at least 50 employees.

According to data published by the Central Statistical Office, as of December 31, 2021, there were 1,303 medium and large enterprises employing at least 50 employees in the PKD (Polish Classification of Activities) section C.10 (Food Production). The significant role of medium and large enterprises in the food industry allows us to relate the research results to the entire food industry (Juszczyk, Balina, Bąk, Juszczyk, 2020). The research used stratified random sampling, reflecting the sectoral structure of the population and representing 15% of its size. The research sample consisted of 193 enterprises. Data on the number and structure of food industry enterprises by type of activity are presented in Table 1.

Table 1 The size of the research sample compared to the size and structure of the general population as of December 31, 2021.

PKD 2007	Central Statistical Office		Research sample size [pcs.].
C.10.1: Processing and preserving of meat and production of meat products	368	28%	55
C.10.2: Processing and preserving of fish, crustaceans and molluscs	52	4%	8
C.10.3: Processing and preserving fruit and vegetables	149	11%	22
C.10.4: Production of oils and fats of vegetable and animal origin	13	1%	2
C.10.5: Manufacture of dairy products	116	9%	17
C.10.6: Manufacture of cereal mill products, starches and starch products	46	4%	7
C.10.7: Production of bakery and flour products	337	26%	50

[1]Data on industry concern economic entities conducting, in accordance with the Polish Classification of Activities (PKD 2007), activities within the following sections: "Mining and quarrying", "Industrial processing", "Electricity, gas, steam, hot water and air conditioning production and supply" and "Water supply; sewage and waste management and remediation activities". cf. Industry Statistical Yearbook 2022, Central Statistical Office, Warsaw 2022.

C.10.8: Production of other food products	172	13%	25
C.10.9: Production of prepared animal feed and food	50	4%	7
C.10: Food production	1303	100%	193

Source: Own study based on Central Statistical Office data.

Due to the observed diversity of the research sample in terms of the scope of their business activities, it was assumed that, in addition to food industry enterprises, the modeling would also include sectors with a sufficiently large set of observations, namely: meat, bakery, and fruit and vegetable sectors. Due to the relatively high diversity of the scope of business activities of enterprises in the other food products sector, we decided not to attempt to build models for this sector, despite meeting the criterion relating to the number of surveyed enterprises (25). Model development began by defining the independent and dependent variables. The dependent variable was the return on assets (ROA), given by the following formula:

$$ROA = \frac{net\ income}{average\ of\ total\ assets}$$

The independent variables included the dynamics of changes in the value of expenditures on fixed assets for environmental protection in section C.10. Food production, taking into account the direction of their expenditure[2] . Due to the functional nature of investment expenditures, which is related to the time-delayed impact on the structure of revenues and costs, the modeling also used the levels of independent variables lagged by one and two years.

The independent variables included:

- dynamics of changes in the value of expenditure on fixed assets in industry y/y [%],
- dynamics of changes in the value of expenditure on fixed assets for air and climate protection in industry y/y [%],
- dynamics of changes in the value of expenditure on fixed assets for sewage management and water protection (including expenditure on municipal sewage treatment, expenditure on the sewage network discharging sewage and rainwater, and expenditure on the circulating water supply) in industry y/y [%],
- dynamics of changes in the value of expenditure on fixed assets for waste management and protection of surface and underground waters in industry y/y [%].

The research used dynamic panel models (Dańska-Borsiak, 2009):

$$y_{it} = \gamma y_{i,t-1} + x_{it}^{T}\beta + u_{it} = \gamma y_{i,t-1} + x_{it}^{T}\beta + \alpha_i + \varepsilon_{i,t},$$

$$i = 1, \dots, N, t = 1, \dots, T$$

where, $\varepsilon_{i,t} \sim N(0, \sigma_{\varepsilon}^{2})$ for all i, t, α_i - group effect, random or non-random. Whereas if α_i they are random, then $\alpha_i \sim N(0, \sigma_{\alpha}^{2})$,$[x_{kit}]_{Kx1}$ is a vector of independent variables with K coordinates, β is a vector of parameters ($Kx1$), the same for all i and t ((Dańska-Borsiak, 2009)(Arellano, M., Bond S., 1991).

Model estimation was performed using the Generalized Method of Moments (GMM) with the F. Windmeijer correction (Windmeijer, 2005). Structural parameter estimates were estimated in Gretl using the Arellano-Bond First Difference *Generalized Method of Moments (FDGMM*) (Blundell, Bond, 1998)(Arellano, M., Bond S., 1991). The adopted methodological assumptions involved an attempt to build models for the dependent variables of food industry enterprises and their sectors. The values of the structural parameters of the models were interpreted, as were the results of statistical tests relating to first- and second-order autocorrelation , the correctness of the instrumental variables used in modeling (Sargan test), and the joint significance of the entire set of independent variables (Wald test).

[2]Based on the Statistical Yearbooks of Industry of the Central Statistical Office for 2012-2022. Data on expenditures on fixed assets for environmental protection and water management and their material effects are presented in accordance with the Polish Statistical Classification of Activities and Facilities Related to Environmental Protection, introduced by the regulation of the Council of Ministers of March 2, 1999 (Journal of Laws No. 25, item 218).

Results and Discussion

The data presented in Table 2 show that the factors that significantly influenced the return on assets of food industry enterprises in the years 2011-2021 included: the dynamics of expenditure on water and sewage management in the industry in the current year and the dynamics of expenditure on waste management in the industry in the current and previous year.

Table 2 Model describing the impact of independent variables on the return on assets (ROA) of food industry enterprises in 2011-2021.

Dynamic 2-step panel estimation					
Dependent variable (Y): return on assets (ROA) [%].					
	Factor	*Standard error*	*Z*	*p-value*	
ROA [%] (previous year)	0.0783038	0.0691088	1,133	0.2572	
Dynamics of expenditure on water and sewage management [%]. (current year)	-0.0140877	0.00810153	-1.739	0.0821	*
Dynamics of expenditure on waste management [%]. (current year)	0.0112305	0.00412024	2,726	0.0064	***
Dynamics of expenditure on waste management [%]. (in the previous year)	0.0171473	0.00542860	3,159	0.0016	***
Sum of squared residuals	390499.9	Standard error of residuals	15.01105		
AR(1) test for error: z = -2.07819 [0.0377].					
AR(2) test for error: z = 0.520409 [0.6028].					
Sargan's test for overidentification: Chi-square(44) = 55.0186 [0.1233].					
Wald test (joint): Chi-square(4) = 13.8481 [0.0078].					

Source: Own study.

The estimated value of the structural parameter of the variable representing the impact of the dynamics of expenditure on water and sewage management in the industry turned out to be negative, which means that an increase in this variable by 1 percentage point led, assuming that other factors remained constant, to a decrease in the return on assets of food industry enterprises by 0.014 percentage points. The research results also proved that the impact of the increase in the dynamics of expenditure on water and sewage management in the industry on the level of ROA of food industry enterprises was not delayed and occurred in the same year.

The research also shows that the assessments of both structural parameters representing the impact of industrial waste management expenditure dynamics on the ROA of food industry enterprises were positive. A 1 percentage point increase in the dynamics of these expenditures in industry was associated with a 0.011 percentage point increase in the return on assets of the enterprises in the same year. In turn, a slightly larger increase in ROA for the studied enterprises (by 0.017 percentage points) occurred when these expenditures increased (by 1 percentage point) in the previous year. Model tests demonstrated the absence of second-order autocorrelation, the joint significance of the entire set of independent variables, and the use of correct instrumental variables.

Table 3 Model describing the impact of independent variables on the return on assets (ROA) of meat sector enterprises in 2011-2021.

Dynamic 2-step panel estimation					
Dependent variable (Y): return on assets (ROA) [%].					
	Factor	*Standard error*	*Z*	*p-value*	
ROA [%] (in the previous year)	0.0693475	0.0984165	0.7046	0.4810	
Dynamics of expenditure on water and sewage management [%]. (current year)	0.0390056	0.0162219	2,405	0.0162	**
Dynamics of expenditure on water and sewage management [%] (two years before)	0.0343722	0.0192100	1,789	0.0736	*
AR(1) test for error: z = -2.08605 [0.0370].					
AR(2) test for error: z = 0.797955 [0.4249].					
Sargan's test for overidentification: Chi-square(43) = 47.6984 [0.2875].					
Wald test (joint): Chi-square(3) = 6.63897 [0.00843].					

Source: Own study.

The results of the model presented in Table 3 confirmed the significant role of the dynamics of expenditures on water and sewage management in the industry in shaping the financial efficiency of meat sector enterprises, measured by the level of ROA. The research indicates that a 1 percentage point increase in expenditures on water and sewage management in the industry in the current year was associated with an increase in the return on total assets of meat sector enterprises by an average of approximately 0.039 percentage points over the same period. In turn, a 1 percentage point increase in expenditures on water and sewage management in the industry increased the ROA of these enterprises after two years by an average of 0.034 percentage points. The research indicates that expenditures on water and sewage management have a positive impact on the return on assets of meat sector enterprises. This may indicate that water and sewage management constitute a source of significant costs for enterprises operating in this sector , which, when reduced, contribute to an increase in return on assets. The test results indicate the correct construction of the model and the appropriate selection of independent variables. They prove that the correct instrumental variables were used and also indicate the lack of second-order autocorrelation and the joint significance of the entire set of independent variables.

Table 4 Model describing the impact of independent variables on the return on assets (ROA) of fruit and vegetable sector enterprises in 2011-2021.

Dynamic 2-step panel estimation					
Dependent variable (Y): return on assets (ROA) [%].					
	Factor	*Standard error*	*Z*	*p-value*	
ROA [%] in the previous year	0.0685935	0.238050	0.2881	0.7732	
Dynamics of expenditure on water and sewage management [%]. (in the previous year)	-0.0143938	0.00664592	-2.166	0.0303	**
Dynamics of expenditure on waste management [%]. (in the previous year)	0.0124076	0.00654790	1,895	0.0581	*
AR(1) test for error: z = -1.31487 [0.1886].					
AR(2) test for error: z = 0.354231 [0.7232].					
Sargan's test for overidentification: Chi-square (44) = 18.5597 [0.9997].					
Wald test (joint): Chi-square(3) = 11.9762 [0.0075].					

Source: Own study.

The data presented in Table 4 indicate that, among the studied variables, the following had a significant impact on the return on assets of enterprises in the fruit and vegetable sector between 2011 and 2022: the dynamics of expenditures on water and sewage management and the dynamics of expenditures on waste management in industry. It is noteworthy that although both variables affected financial efficiency with the same one-year lag, they differed in terms of the direction of their impact. A 1 percentage point increase in the dynamics of expenditures on water and sewage management in industry in the previous year was associated with a 0.014 percentage point decrease in the return on assets of enterprises in the fruit and vegetable sector. In turn, a 1 percentage point increase in the dynamics of expenditures on waste management in industry in the previous year was associated with a 0.012 percentage point increase in the ROA of enterprises in this sector. The test results for this model indicate its positive features, i.e., the use of correct instrumental variables, the lack of first- and second-order autocorrelation, and the joint significance of the entire set of independent variables.

Table 5 Model describing the impact of independent variables on the return on assets (ROA) of bakery sector enterprises in 2011-2021.

Dynamic 2-step panel estimation					
Dependent variable (Y): return on assets (ROA) [%].					
	Factor	*Standard error*	*Z*	*p-value*	
ROA [%] (previous year)	0.100789	0.0556242	1,812	0.0700	*
Dynamics of expenditure on water and sewage management [%]. (current year)	-0.0872044	0.0322339	-2.705	0.0068	***
Dynamics of expenditure on waste management [%]. (current year)	0.0409998	0.0148741	2,756	0.0058	***
Dynamics of expenditure on waste management [%]. (in the previous year)	0.0460185	0.0248600	1,851	0.0642	*
AR(1) test for error: z = -1.35767 [0.1746].					
AR(2) test for error: z = 0.961986 [0.3361].					
Sargan's test for overidentification: Chi-square(44) = 49.6835 [0.2572].					
Wald test (joint): Chi-square(4) = 34.2696 [0.0000].					

Source: Own study.

The data presented in Table 5 show that the independent variables that significantly influenced the return on assets in the bakery sector during the research period were: return on assets in the previous year, dynamics of expenditures on water and sewage management in the current year and the dynamics of expenditures on waste management in the current and previous year. The increase in the dynamics of expenditures on water and sewage management in industry was associated with a decline in the financial efficiency of enterprises in the bakery sector. In turn, the increase in the return on assets in the previous year and the dynamics of expenditures on waste management in the previous and current years were associated with an increase in financial efficiency in the bakery sector. The test results for this model indicate its positive features, i.e. the use of correct instrumental variables, the lack of autocorrelation, and the joint significance of the entire set of independent variables.

Conclusion

Research shows that the impact of expenditures on fixed assets for environmental protection in industry on the return on assets of enterprises in individual sectors of the food industry varied in terms of direction and strength between 2011 and 2021. Investment expenditures in water and sewage management in industry significantly determined the profitability of enterprises in the food industry as a whole, as well as in the meat, bakery, and fruit and vegetable sectors. The increase in the value of expenditures on water and sewage management in industry was associated with an increase in the profitability of enterprises in the meat sector, while it had a negative impact on the profitability of enterprises in the bakery and fruit and vegetable sectors. In the case of enterprises in the

bakery and fruit and vegetable sectors, it was also found that the impact of the dynamics of changes in the value of expenditures was not delayed and was associated with an increase in the return on assets of these enterprises, most often within the same period in which they were incurred.

This may indicate that the negative values of the structural parameter estimates for the models in the bakery and fruit and vegetable sectors, which occurred for non-lagged variables, could have resulted from the relatively early stage of investment, when enterprises generally experience greater pressure from transaction costs. The increase in investment expenditures in industry had the strongest impact on the return on assets of enterprises operating within the bakery sector. A 1 percentage point increase in the dynamics of investment expenditures in industry was associated with a 0.09 percentage point decrease in the return on assets of enterprises in the bakery sector during the same period, assuming other factors remain constant.

The research also demonstrated the varied impact of the dynamics of changes in the value of industrial waste management expenditures on the ROA level in food industry enterprises and its sectors. An increase in this category of industrial investment expenditures was associated with an increase in the return on assets of enterprises in the food industry as a whole and in the bakery sector. The study found that the values of the structural parameters of non-lagged variables were lower than those of variables lagged by one period (food industry as a whole, bakery sector). The increase in this category of investment expenditures had the strongest impact on the return on assets of enterprises in the bakery sector. A 1 percentage point increase in industrial waste management expenditures was associated with a 0.046 percentage point increase in the return on assets of enterprises in the bakery sector, assuming other factors remained constant.

The fundamental determinants of the observed variation in the impact of changes in the value of the studied expenditure categories on the financial efficiency of the surveyed enterprises' assets include the specific nature of investment projects (determining the volume and timing of incurred expenditures), as well as differences within key processes (supply, production, and sales), which are reflected in the implemented capital management strategies. Consequently, the implementation of investments aimed at improving the natural environment affects the value and structure of the balance sheet and income statement of industrial enterprises. These investments contributed to the modernization of the infrastructure constituting their production base, improving the quality of assets and extending the total time of their engagement in production processes. Improving production assets in industry also generally led to increased economies of scale through increased efficiency and reduced unit production costs. Capital expenditures on water, sewage, and waste management in industry were also incurred as part of the optimization of production processes, aimed at reducing material and energy consumption, achieving economies of scope, or reducing the volume of fines and fees paid to institutions responsible for environmental protection and water management. The degree of flexibility of enterprises in terms of their ability to adjust their pricing policy to the structure and volume of incurred costs is also important in assessing the impact of expenditures for environmental assessment in industry on the profitability of food industry enterprises.

The utilitarian research results resulting from the adopted methodology include a positive assessment of the approach of examining food industry enterprises within relatively homogeneous sectors. Recognizing the strength and direction of the impact of specific types of environmental protection expenditures on the financial efficiency of food industry enterprises and their sectors can be used in designing policy assumptions and tasks supporting the achievement of environmental goals, particularly at the stage of selecting target groups or implementing support instruments. Taking into account the research findings, it was concluded that to better align policy assumptions supporting investments related to the construction or modernization of water and sewage infrastructure in industry, it is worth considering the use of non-repayable or preferential financial instruments that support profitability during the initial investment period.

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