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FINANCIAL EFFICIENCY VS. ENVIRONMENTAL EFFICIENCY ON THE EXAMPLE OF THE MEAT AND POULTRY INDUSTRY IN POLAND

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ABSTRACT: The purpose of the article is to assess the relationship between financial efficiency and environmental efficiency in the meat and poultry industry in Poland between 2010-2020. Firstly, the assessment of financial efficiency in the area of profitability was underdone. Secondly, the environmental efficiency in the area of selected environmental policy components was assessed. Based on the results, the author built an econometric model examining the impact of binary variables on individual financial efficiency indicators in the area of profitability. The study consists of theoretical and practical parts. In the theoretical part, methods of analysis, synthesis, comparison and graphical transposition of data were used. In the practical part, quantitative methods: ratio financial analysis, ANOVA method, panel econometric modelling, and qualitative methods – case studies, were used. The study shows that for financial efficiency, the values of the net sales profitability ratio are statistically significant. The most important factor for environmental efficiency are consistently implementing transparent environmental policies. The practical implication of the study contributes to financial support for the meat and poultry industry in Poland. The social implication of the study is the urge to implement the principle of sustainable consumption.

KEYWORDS: financial efficiency, environmental efficiency, meat and poultry industry, Poland

Introduction

The food economy is one of the most important sectors of the national economy. Meat and poultry enterprises require constant continuity of good quality supplies of raw materials in order to produce food which corresponds to the changing needs and preferences of consumers and their ongoing changes in food patterns. On the other hand, the meat and poultry industry need to implement the practical aspects of the paradigm of sustainable development and balanced development at every level of food production and processing.

Poland is one of the largest meat producers in the European Union. It ranks first in poultry meat production in the EU-28, fourth in pork production (behind Germany, Spain, France), and seventh in beef production (behind France, Germany and the UK, Italy and Ireland). In 2020, the total production of pork, beef and poultry amounted to 4.782 thousand tons in hot weight, 17% higher than in 2014. During 2010-2020, beef production increased the most (29%) to 543 thousand tons and poultry meat (27.4%) to 2.374 thousand tons, while the smallest increase was in pork (3.4%) to 1.865 thousand tons. In 2020, poultry meat accounted for the highest decline in total meat production, followed by pork and beef. The share of other meat, i.e. calf, horse, mutton, goat and rabbit (including game), was 1.1% (Mroczek, 2020).

An overview of the literature

The environment, according to the Law on Environmental Protection, is the total of natural elements, including those transformed as a result of human activity, in particular the land surface, minerals, water, air, landscape, climate and other elements of biodiversity, as well as the interactions between these elements (Act, 2008). In the process of socioeconomic development, the environment has two functions. First, it is a source of resources and, at the same time, a source of assimilation of pollution. Woś (2004) emphasises that for the proper functioning of both the environment and the economy, it is necessary to respect both principles simultaneously:

- renewable natural resources should be used so that the rate of their consumption is not greater than the rate of their restoration,
- the streams of pollutants flowing into the environment must not be greater than the assimilation capacity.

The environment in Poland is threatened by factors related to agricultural activities like a way of farming, land use, the nature of livestock production, and drainage system, as well as factors unrelated to agricultural activit-

ies like emissions from enterprises' production and processing, residential buildings, waste management, sewage system, public transport, etc. (Urbaniec & Tomala, 2021). Every economic activity has certain effects on the environment, which can be more or less harmful, sometimes even irreversible. According According to Woś (2004), "the burden of environmental effects on Polish agriculture has an increasing trend, but the standards have not been exceeded". In every enterprise, environmental activities mean production that is environmentally friendly as a result of the minimisation of emitted anthropogenic loads, i.e. dust, gases, wastewater, and waste. In addition, such environmentally friendly production, f. ex., eco-production, is supplemented by waste-free technologies, recycling, eco-friendly packaging and the use of unconventional raw materials – secondary raw materials (Ejdys & Szpilko, 2022; Sikora, 2020; Yang et al., 2022; Żuchowski, 2001).

Sustainable production consists of a reduction in the amount of goods produced, an optimal product mix to be safe, economical and sustainable, clean production technologies, and appropriate attitudes and behaviour of employees based on pro-social and ethical attitudes (Godawska, 2021; Pabian, 2013; Zegar, 2012).

A greening activity is based on the principle of respect for the natural environment that takes into account the protection of the environment and the rational use of its resources with its simultaneous reproduction in the short term, preserving the potential of the environment (Jelonek & Walentek, 2022; Lavuri et al., 2021; Sukiennik et al., 2017). Any pro-environmental activity of an enterprise includes undertakings of the pre-and post-production and post-consumption phases (Lemkowska & Wiśniewska, 2022; Czyżewski et al., 2021), but due to the nature of the analyses carried out, this paper presents the actions taken during and in connection with the production process.

The terms production process and manufacturing process are not the same. A manufacturing process is understood as «an orderly sequence of activities that results in the consumer receiving products» (Kasztelan & Nowak, 2021). The manufacturing process, on the other hand, involves «the industrial transformation of factors of production into products" (Siderska & Jadaan, 2018).

The main environmental problem resulting from the broadly defined production activities of enterprises include production waste, emissions of atmospheric air pollutants, wastewater discharge, use for the production of agricultural and forest land, devastation and degradation of soils, electromagnetic radiation, changes in the environment due to extraction of raw materials from deep underground, changes in the landscape and other aesthetic qualities, even the final product during its use and its packaging at the disposal and storage stage (Hadryjańska, 2015).

It should be borne in mind that taking environmental measures by a processing enterprise requires paying attention to such issues as (European Commission, 2022; European Environment Agency, 2020; Nahotko, 2002):

- if the costs of using environmental resources and services are not borne by those who generate these costs, then market prices convey false information to producers and consumers,
- preventing environmental damage is cheaper and more effective than restoring the environment to its pre-damage state after it has been destroyed,
- as much as 70% of the waste and harmful emissions produced by industry can be prevented at their very sources,
- around 20-25% reduction in emissions can be achieved without major financial outlays.

The author found current, inspiring contributions to the issue of systematisation of the financial and environmental efficiency measurement. Wasilewski and Zabadała (2012) presented changes in the efficiency of agricultural enterprises depending on the relationship between equity and debt. Filipiak and Jasińska (2018) carried out a multi-faceted classification of the concept and measurement of effectiveness. Waśniewski and Skoczylas (2004) have sorted out the fundamental categories in financial analysis.

The author found a research gap in methodology and understanding of detailed insight into profitability indicators to support management processes in the sense of investigation and quantification of relationships among profitability ratios within a financial efficiency framework (Mensch, 2008). Moreover, a second research gap consists of various attempts to quantify the assessment of environmental performance in the food sector around the world (Pawlak & Kołodziejczak, 2020; Krupanek et al., 2022).

The scientific novelty of the manuscript is the presentation, analyses and assessment of financial efficiency in terms of profitability versus environmental efficiency in the Polish meat and poultry industry. First, the financial method was used to carry profitability indicator analysis out. Second, ANOVA analysis to find only statistically significant relationships between calculated profitability indicators were used. Third, a case study on environmental efficiency in order to combine the quantitative with qualitative results of the research was used. Additionally, analysis, synthesis and comparative methods to enrichen the context of the underdone multifaced and multileveled study were used. The concurrent use of quantitative and qualitative methods deepened and broadened the underdone analyses.

The practical novelty of the manuscript is the environmental activities of meat and poultry enterprises in the area of sustainable use of raw materials and use of energy-efficient technologies.

In view of the global trend of searching for solutions to reduce the environmental impact of the food industry, the exploration of meat and poultry enterprises' financial and environmental efficiency takes on great significance. The article undertakes three research objectives: theoretical, empirical and applicative.

The theoretical-cognitive goal is:
- To systematise knowledge of the concept, role and importance of the efficiency of entrepreneurs in the food market.

The empirical goals are:
- To select and present quantitative indicators for assessing financial efficiency and qualitative measures for assessing environmental efficiency,
- To determine changes and relationships between financial efficiency and environmental efficiency of the meat and poultry industry.

The applicative goals are:
- To formulate public institutional policy objectives for improving the environmental efficiency of the meat and poultry industry in Poland,
- To support institutions and actors responsible for the development of the food sector and individual entrepreneurs by improving their efficiency in the conditions of dynamically developing exports.

In order to carry out the study, the following research questions have to be answered:
- What is the level of financial efficiency of the meat and poultry industry in Poland between 2010-2020?
- What is the level of environmental efficiency of the meat and poultry industry in Poland between 2010-2020?
- Do the financial efficiency outcomes of the meat and poultry industry coincide with its environmental efficiency?

The author undertook quantitative and qualitative research; therefore, the article has a research hypothesis and a thesis. On the basis of theoretical analysis and empirical results of the previous studies, hypothesis (H_1) was formulated: Financial efficiency in terms of profitability differentiates the examined groups of meat and poultry enterprises. The thesis (T_1) was accepted for verification: Higher the values of profitability ratios are, the higher the environmental efficiency is.

Research methods

To assess the multifaced issue of financial efficiency vs environmental efficiency variety of research methods and tools are used. Quantitative methods such as ANOVA analysis and Panel Data Modeling to evaluate financial efficiency in the area of profitability of meat and poultry industry enterprises

in Poland in 2010-2020 were used. Qualitative methods in the form of eight semi-structured interviews with respondents responsible for environmental issues in chosen meat and poultry enterprises in Poland in 2020 were carried out (Table 1).

Table 1. Presentation of research characteristics

Subject	Objects, Country, Time	Measurement Methods and Tools	Goal
Assessment of financial efficiency	Database on enterprises operating in meat and poultry industry in Poland in 2010-2020	Quantitative: indicator analysis, ANOVA analysis, Panel Data Modelling	A comprehensive study on financial efficiency in terms of profitability in meat and poultry industry
Assessment of environmental efficiency	Semi-structured interviews in chosen meat and poultry enterprises in Poland in 2020	Qualitative: semi-structured interviews, case-studies	A case-study on environmental efficiency in chosen meat and poultry enterprises

In the first step, the financial indicator analysis in terms of profitability ratios were used. Financial analysis is the process of using financial information to assist in investment and financial decision-making (GSU, 2022). Financial analysis helps managers with efficiency analysis and identification of problem areas within the company (Yu et al., 2021). The motivation for using financial indicator analysis in order to measure the profitability of the meat and poultry industry in Poland between 2010-2020 was the fact that it is simple, universal, and can be applicated at the industry level. Furthermore, it is characterised by a wide comparability of results over time and space. Fourthly, financial indicator analysis for individual business entities from a given sector provides a means of obtaining an overview of the economic and financial situation of the sector. As is the case with any method, financial indicator analysis is not free of flaws. Most of the limitations of this method are as follows. First, financial indicator analysis is static, which makes it difficult to take into account different dimensions of an enterprise's activities. Second, benchmarks are often tied to industry averages, not leaders. Third, balance sheets may be distorted by inflation. Fourth, ratio analysis does not give the context of an analysed enterprise or a sector (Carlson, 2022).

In the second step, the panel database in order to find and assess relationships between different profitability ratios in all four groups of meat and poultry enterprises in the Polish meat and poultry industry was created. The final panel database consisted of 38. 000 financial units of 750 enterprises in the period 2010-2020. The data processing was made with the statistical program Excel. The calculations of records for 750 enterprises in the period 2010-2020 for five profitability indicators, such as operating profitability

(OP), return on total capital (ROI), net return on sales (NRS), return on assets (ROA) and return on equity (ROE) were carried out (see Annex A). The calculated profitability ratios for all 750 enterprises in the period 2010-2020 were used to run panel data estimations with the use of the ANOVA method for only statistically significant ratios between four groups of examined meat and poultry industry enterprises with a significant level equal to 95%. Only statistically significant values were taken for further analysis, which turned out to be the values of the net return on sales (NRS) ratio. The values of the NRS ratio were calculated with the use of approx. 10 860 data observations [1 ratio × 750 enterprises × (min. 6 max. 8 years)].

In the third step, chosen components of the environmental performance of analysed meat and poultry enterprises were tested. The identification of those components followed a specific procedure to determine which of them led to significant environmental impacts. The magnitude of the impact was considered, as well as the impact of the change on other activities and processes and on the public perception of the organisation (Czakon, 2009). Once the most relevant environmental aspects of an enterprise were determined, measurable goals were formulated and implemented with specific tasks. For instance, such environmental goals include the reduction of the amount of waste generated in the production process, more efficient use of resources, minimisation of environmental pollution, and promotion of eco-actions among employees and consumers. The implementation of environmental goals required calculable indicators to measure the company's significant impact on the environment, verified and comparable over time, at best, with environmental standards (Nahotko, 2002). Unfortunately, not every examined meat and poultry enterprise was willing to present its environmental activity; environmental efficiency was achieved with a case-study method.

In the fourth step, a one-way statistical analysis of variance (ANOVA analysis) was used to examine observations that depend on one factor acting simultaneously. A one-way ANOVA compares the effects of an independent variable on multiple dependent variables. This method explains with what probability the extracted factor can cause differences between the observed groups. There are a few limitations of ANOVA analysis (Kenton, 2022). The first one is that the groups have the same, or very similar, standard deviations. The second limitation concerns its restrictive assumptions (Davies, 2022).

In the fifth step, Panel Data Models from cross-sectional temporal data, which are objects×variables×periods were built. They describe a fixed group of objects in more than one period (Baltagi, 2001). Thanks to the information about objects and their simultaneous characteristics in particular periods, panel data models allow reducing of measurement error resulting from the omission of important unobservable variables for these objects. The panel

database was created to find and assess relationships between different profitability ratios in all four groups of meat and poultry enterprises in the Polish meat and poultry industry. The final panel database consisted of 38. 000 financial units of 750 enterprises for five profitability indicators: operating profitability (OP), return on total capital (ROI), the net return on sales (NRS), return on assets (ROA), return on equity (ROE) in the period 2010-2020 in Poland (see Annex A). The data processing was made with the statistical program Excel. Three profitability ratios: ROE, NRS and OP, were statistically significant, which meant 28 455 panel data observations. [3 ratios x 750 enterprises x (min. 6 max. 8 years)]. From the exploratory analysis, dependent variables – indicators were extracted. A higher value of the profitability indicator obtains a better result, and lower values – a worse result.

In the sixth step, the results of the Panel Data Model with semi-structured interviews to assess and interpret the dichotomous dependencies between financial efficiency and environmental efficiency were juxtaposed with each other. According to Stańko (2008), qualitative research is no easier to conduct than quantitative research. They are not without methodological rigour at the stages of data collection and analysis or theory building.

Sample and Procedure

The basic criterion for a research selection sample in order to measure financial efficiency in the area of profitability were:
- subject of conducted activity according to PKD 2007 (Biznes.gov.pl, 2022)- classes 10.12 and 10.13,
- location within the country,
- keeping the financial statements for the period from 2010 to 2020,
- raw material processing volume (t/week), number of employees (full-time), and the volume of revenue (PLN/year).

The analysed group of 750 enterprises in the meat and poultry industry were divided into four groups: slaughterhouses, where N = 53, meat enterprises, where N = 597 (subdivided into large meat enterprises, where N = 35, medium-sized, where N = 295, and small enterprises, where N = 267), poultry meat enterprises, where N = 50, meat trading enterprises, where N = 50. Small meat enterprises employ from 10 to 49 persons, process more than 7.5 to 20 tons of slaughter material per week and obtain sales revenue of up to PLN 100 million per year. Medium-sized meat enterprises employ from 50 to 249 people, process 20 to 100 tons of slaughter material per week, and obtain sales revenue of PLN 101-499 million per year. Large meat enterprises employ over 250 people, process more than 100 tons of slaughter material per week, and obtain sales revenue exceeding 500 million PLN per year. The

research was comprehensive (full) because it covered the entire population. It means that the number of all enterprises subjected to the research was equal to the number of enterprises in the population. The study of financial efficiency met the criterion of representativeness. The basic criterion for a research selection sample to measure environmental efficiency in the area of profitability is presented in Table 2.

Table 2. Presentation of potential factors and indicators shaping environmental efficiency of food processing enterprises

Quantity	- quantity of raw materials used in the production process [t], - amount of water used in the production process [m³], - amount of sewage discharged [m³], - amount of energy used [MWh], - the amount of gas and dust emissions into the atmosphere [t], - the type of gas and dust emissions to the atmosphere, - amount of waste generated in the production process [t], - amount of waste to be recycled [t].
Quality	- installation of own sewage treatment plants, - the purchase of an efficient furnace, which reduces the consumption of mine raw materials, - installing filters to reduce gas and dust emissions into the atmosphere, - implementation of new production technology, - organizational and improvement activities consisting in the reduction of waste generated in the production process, - improvement of the company's image resulting from environmental activities.

Results of the research

Between 2010-2022, Poland is the sixth EU food producer behind Germany, France, Italy, the UK and Spain, with a value share of around 9%. The Polish food sector accounts for more than 20% of the sales value of the entire domestic industry. It is formed by some 16,000 companies employing 402,000 people, i.e. about 16% of those employed in domestic industry (GUS, 2020). The meat and poultry industry is one of the most important among dairy, fruit and- vegetable, bakery and- confectionery industries, branches of the food industry in Poland. The meat and poultry industries are characterised by relatively low levels of profitability of sales. The Polish meat and poultry industries are classified as low-profitability sectors of the food industry, although the poultry industry is characterised by average higher profitability than the meat industry (Zielińska-Chmielewska, 2020; Mroczek, 2018; 2020; 2022).

Table 3. Key financial indicators of the meat industry in Poland in 2010-2020

No.	Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	Net revenues from sales of products, goods and materials [million PLN]	31 404	32 986	41 728	44 862	44 675	46 189	49 951	57 825	54 474	59 381	59 034
2.	Net profit [million PLN]	1 029	680	891	963	1 389	1 447	1 267	1 763	1 762	1 351	2 214
3.	Return on total revenues [%]											
	- gross	3.76	2.29	2.45	2.36	3.35	3.40	2.86	3.41	3.54	2.61	4.28
	- net	3.25	1.95	2.12	2.05	2.98	3.01	2.45	3.07	3.14	2.21	3.71
	- capital accumulation*	5.31	3.80	3.74	3.69	4.69	4.80	4.21	4.71	4.83	3.87	5.58
4.	Equity	6 153	6 200	6 709	7 487	8 611	9 648	9 671	10 771	10 547	11 428	11 561
5.	Total debt	6 325	6 827	8 010	8 475	9 117	9 955	11 256	12 398	13 415	14 398	12 777
6.	Current liquidity	1.20	1.24	1.22	1.30	1.34	1.31	1.32	1.46	1.40	1.33	1.34
7.	Investment rate **	1.18	1.24	1.23	1.16	1.13	1.50	1.31	1.30	1.28	1.36	1.12
8.	Profitable companies [%] - percentage of profitable companies	86.9	77.3	81.3	84.1	87.3	89.0	82.2	85.3	87.8	83.1	88.8
	- their share in industry revenue	91.1	85.8	91.4	84.5	94.9	93.99	89.9	90.9	87.3	83.9	90.8

* net profit + amortization
** Investments in relation to depreciation

Source: author's work based on Mroczek (2018; 2020; 2022).

Table 4. Key financial indicators of the poultry industry in Poland in 2010-2020

No.	Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	Net revenues from sales of products, goods and materials [million PLN]	10 202	13 777	14 281	11 068	11 411	11 482	12 345	12 658	13 714	13807	13 198
2.	Net profit [million PLN]	193	204	180	160	314	235	280	304	455	268	81
3.	Return on total revenues [%] – gross	2.05	1.44	1.13	1.26	2.91	2.37	2.53	2.55	3.60	2.25	0.79
	– net	1.77	1.25	1.05	1.06	2.61	2.02	2.23	2.35	3.22	1.89	0.59
	– capital accumulation *	3.30	2.68	2.60	2.44	3.93	3.53	3.87	4.09	5.00	3.79	2,81
	Cash flow [%]	3.30	2.68	2.60	2.44	3.93	3.53	3.87	4,09	5.00	3.79	2,81
4.	Current liquidity	1.21	1.17	1.24	1.15	1.28	1.34	1.30	1.34	1.28	1.35	1,21
5.	Investment rate **	1.12	1.43	1.02	1.37	1.41	1.92	1.90	1.70	1.26	1.48	1,27
6.	Profitable companies [%] – percentage of profitable companies	89.4	81.3	77.6	83.1	90.7	89.3	83.6	85.5	86.1	86.7	82,8
	– their share in industry revenues	93.1	66.2	89.5	86.2	89.1	91.00	73.40	89.80	90.00	91.00	86,1

*net profit + amortization
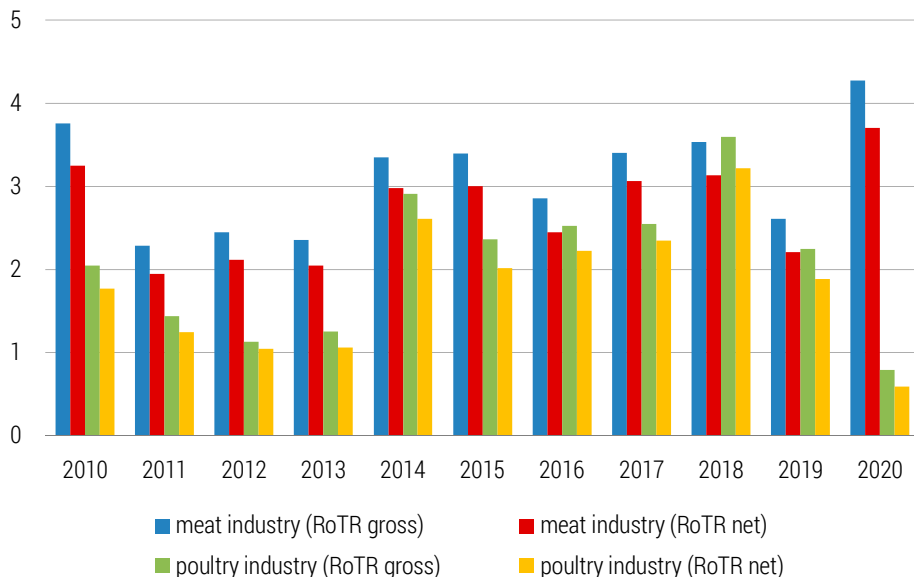** Investments in relation to depreciation

Source: author's work based on Dybowski and Pasińska (2018); Pasińska (2020; 2021).

In Poland, in 2010-2020 the economic and financial performance of the meat industry testified to a good and secure economic situation. In 2016 and 2017 meat companies generated a record net profit of more than PLN 1.75 billion, which was 39% higher than in 2016, and 42% higher than in 2010. All of the profitability ratios were marked by high values except 2019. The average ratio of the net return on sales of the meat industry rose to 3.07% and was the highest since 2011. In 2017, compared to 2010, equity increased by 42.87% to PLN 10.7 billion, and general debt increased by 10.1% (to PLN 12.4 billion), of which long-term debt increased by 30.6% (to PLN 3.6 billion). Capital expenditure reached PLN 1.2 billion and remained at the same level as in 2016. The highest value of the investment rate was equal to 1.50 in 2015, more than ensuring the replacement of production assets, as well as the upgrading and modernisation of meat enterprises. In 2020 the value of net return of total revenues was the highest in the analysed period (3.71). In the years of COVID-19 spread, current liquidity amounted to 1.34, which fully ensured the current payment of short-term liabilities. In 2010-2020 the percentage of profitable companies was at a comparable level of 84.44%, and their share in the sector's turnover was nearly 89.40% (Table 3, Figures 1, 2, 3).
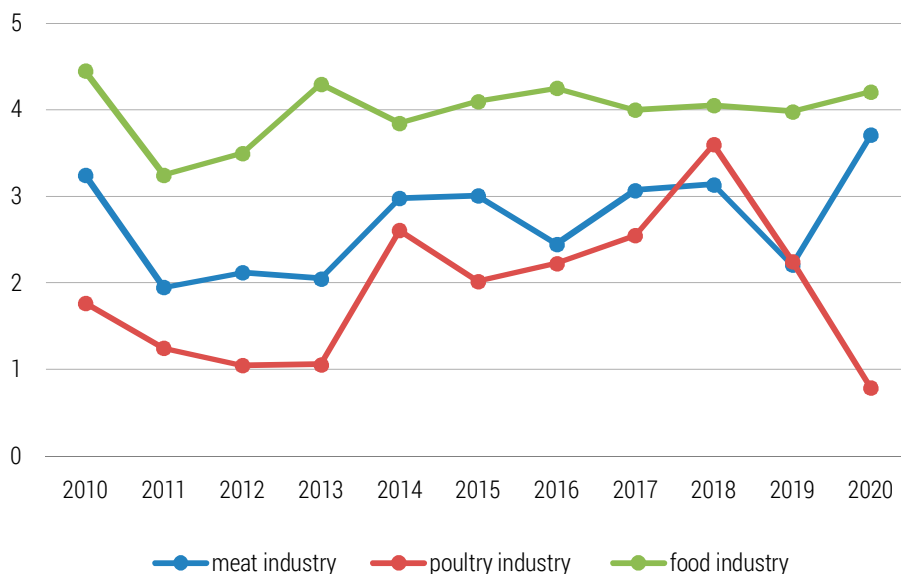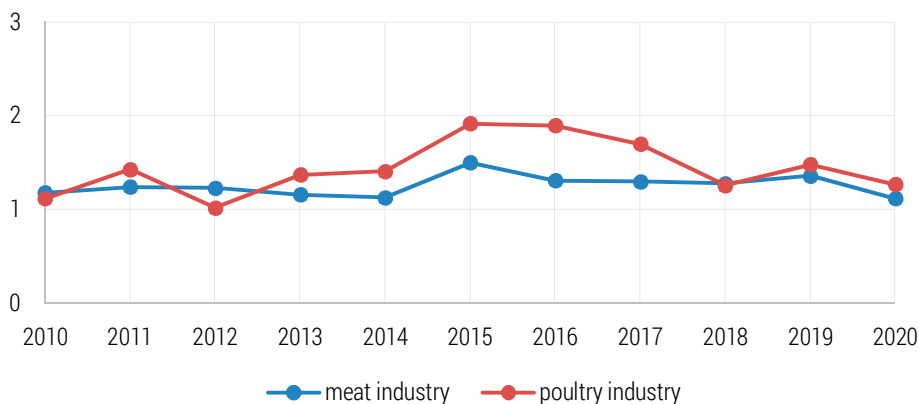

Figure 1. Values of the net sales profitability ratio of meat, poultry and food industry in Poland in 2010-2020 [in % of revenues]

Source: author's own work based on Mroczek (2018; 2020; 2022).

Figure 2. Values of the ratio of return on total revenue (gross and net) in the meat, poultry and food industry in Poland in 2010-2020 [in % of revenues]

Source: author's work based on Mroczek (2018; 2020; 2022).

Figure 3. Values of the investment rate in meat, poultry and food industry in Poland in 2010-2020 (investment in relation to depreciation)

Source: author's work based on Mroczek (2018; 2020; 2022).

In Poland, between 2010-2020 the economic and financial performance of the poultry industry testified to its stable economic situation. In 2017, poultry enterprises generated a record net profit of PLN 2.35 billion, which

was 5.1% higher than in 2016, and 12.76% higher than in 2010. Due to the outbreak of the COVID-19 pandemic in 2020, the economic and financial situation of the whole poultry industry has changed dramatically. For instance, in 2020, net profit was equal to 0.79 million PLN and was 3.3 times lower than in 2019. In 2017 the average net sales profitability of the poultry industry reached the highest turnover value of 2.35%, in 2019 dropped to 1.89 and was close to its value from 2010. In 2020 the net value of return on total revenues reached the lowest value, 0.59 million PLN. In 2019, the investment rate was 1.48 ensuring the reproduction of production assets. In 2020, the current liquidity ratio was 1.21, ensuring the current repayment of current liabilities. Between 2010 and 2019, total debt was equivalent to 60% of assets. In 2010-2020, the percentage of profitable companies oscillated around 85.34%, and their share in the sector's turnover was 85.9% (Table 6, Figures 1, 2, 3).

According to the Agency for Restructuring and Modernization of Agriculture, the aftermath of the COVID-19 pandemic was a restriction on the export of livestock and poultry products to foreign trading partners. In turn, the opening of borders caused a spike in livestock prices. Livestock purchase prices were rising, and it should be remembered that raw material accounts for 60% of production costs. Food production is under strong pressure from rising production costs, i.e., the prices of agricultural raw materials, energy, services and wages; at the same time, the parity of consumers' purchasing power is falling (Mroczek, 2022).

Table 5 presents the panel data estimation results for the variable Net Return on Sales (NRS). It is proven that there is a statistically significant dependency between the value of net return on sales (NRS) with slaughterhouses and poultry processing enterprises. It means that the coefficient of slaughterhouses and poultry meat enterprises was statistically significant. Thus slaughterhouses and poultry meat enterprises had lower NRS ratios than other groups of examined enterprises. The meat industry belongs to the sections of the agro-food industry with a lower return on sales. On the contrary, the highest return on sales is observed in the production of beverages, brewery, and confectionery. Nevertheless, in the period 2010-2020, the economic and financial performance of enterprises of the red meat industry testified to a good and secure economic situation (Pasińska, 2018; Mroczek, 2018).

Table 5.   Panel data estimation results for the variable Net Return on Sales (NRS) –
general least squares method (GLSM)

Model 1: panel data estimation – 750 observations Time series length: minimum 5, maximum 8 Robust standard errors (robust HAC)				
Variables	*Coefficient*	*Standared error*	*Z*	*Critical signifance level*
Const	5.059239	1.119018	4.52	< 0.000
Slaughterhouses	-2.782779	1.351669	-2.06	< 0.040
Meat enterprises	-0.6000481	1.156463	-0.52	< 0.604
Poultry meat enterprises	-2.752528	1.37098	-2.01	< 0.045
Wald Chi-Squared Test (2) = 13.09, *critical signififance level* = 0.0044				
Interpretation of the model	The value of the net return on sales ratio (NRS) was significantly lower by 2.782 (critical level of significance = 0.040) in slaughterhouses, and by 2.752 (critical level of significance = 0.045) in poultry processing enterprises than in meat enterprises and trade and service meat enterprises			
Conclusions	There are statistically significant differences in the level of obtained value of the net sales profitability ratio in slaughetrhouses and poultry meat enetrprises			
Hypothesis H_1	Each type of tested profitability differentiates financial efficiency			
Decision on H_1	Do not reject H_1			
Summary	Profitability measured by the value of net sales profitability ratio (NRS) differentiates the group of meat enterprises. The obtained estimation results confirm hypothesis H_1, because the value of NRS ratio significantly differentiates both slaughterhouses and poultry meat enterprises			

Table 6.   Examined components of the environmental performance of Delikatesy Mięsne
Gzella sp. z o.o. and Zakłady Mięsne Mróz S.A.

No.	Delikatesy Mięsne Gzella sp. z o.o.	Zakłady Mięsne Mróz S.A.
1.	**Continuous control and improvement of raw material quality**, which enables the delivery of high-quality and healthy products to customers. Quality control of each stage of production is among the important tasks of the Quality Control Department.	**Continuous control and improvement of raw material quality** provides customers with tasty, healthy, high quality, products. Mróz Meat Plant has its own pig and cattle farms, which facilitates direct quality control of each stage of production.
2.	Delikatesy Mięsne Gzella **implements the company's code of values**, which states that human potential is the most important factor in development. In the hierarchy of the code, the most important place is occupied by: a) ensuring the highest quality of raw materials and products, b) partnership of all entities working together, which determines the effectiveness of their actions, c) care for the environment, which sets the framework for the functioning of all Gzella employees and those bound by contracts with Gzella Sp. z o.o.	Zakłady Mięsne Mróz SA **pursues the policy of**: a) ensuring the highest quality of raw material and products, b) partnership of all entities working together, which determines the efficiency of their operations, c) promotion of in-house utilization, d) innovative development directions of the Polish biogas usage – an opportunity to increase the profitability of biogas plants, e) development of the idea of a closed-loop bioeconomy.

No.	Delikatesy Mięsne Gzella sp. z o.o.	Zakłady Mięsne Mróz S.A.
3.	Implementation of a transparent environmental policy: a) 3% annual reduction in water consumption, b) 3% annual reduction in electricity consumption, c) 5% annual reduction in municipal waste, d) 2% annual improvement in the quality of raw materials.	**Full information on the implementation of environmental policy and the construction of biogas plants:** a) reducing the cost of managing slaughterhouse waste, b) reduction of the nuisance of piggery operations by eliminating the fetor, c) constant and inexpensive source of substrates (mainly manure) from own farm, d) use of the heat generated to heat the biogas plant's fermenters, e) self-financing of the biogas plant, f) obtaining blue certificates.
4.	**Gzella company introduced innovations in food packaging** designed to increase barrier properties and extend shelf life of perishable products. It is important to reduce losses at the stage of industrial food production.	**Innovations in food packaging** by production optimization which allows to minimize the amount of unsold products, the only form of return of which is to undertake the „complaint process".
5.	**Stakeholders relations** builds and nurtures long-term relationships with its trading partners by establishing long-term contracts and negotiating mutually important terms and conditions.	**Stakeholders relations** continues long-term relationships with its trading partners, establishes long-term contracts, realizes vertical integration.

Delikatesy Mięsne Gzella sp. z o.o.

Delikatesy Mięsne Gzella sp. z o.o. priority activity is to reduce the enterprise's negative impact on the environment and strictly comply with the regulations in force in Poland regarding its protection. The scope of the company's activities is related to production processes that could have a negative impact on natural resources such as water, air, and land. Therefore, a key role is played by specialised teams for Environmental Monitoring and Analysis and systematic work on the introduction of safer production and storage technologies. Expenses related to the protection of nature and the environment of Delikatesy Mięsne Gzella sp. z o.o. can be divided into:

- expenses for pro-environmental investments, e.g., a modern plant that does not emit harmful exhaust fumes, a modern vehicle fleet, waste segregation, optimal use of bulk packaging, the introduction of paper bags and cloth bags instead of plastic bags throughout the Gzella Meat Delicatessen chain,
- fixed costs incurred by the company for the use of the environment, incurring monitoring and research costs,
- waste management fees.

Environmental efficiency expressed in the cultivation of stakeholder relations consists of the reduction of manufacturing raw materials, contributing to the operational cost reduction indirectly affecting the financial efficiency.

Zakłady Mięsne Mróz SA

In 2013, Zakłady Mięsne Mróz in Borzęciczki, Wielkopolska, built a biogas plant for waste disposal. The operation of the biogas plant is part of the activities of the environmental policy of Zakłady Mięsne Mróz SA, the area of influence of which relates to activities in the economic and environmental dimensions. The effective management of slaughterhouse waste by external companies is cost-intensive because the disposal of 1 ton is 350 PLN. An in-house biogas plant offsets the problem of slaughter waste disposal. Residues from agri-food processing are treated as agricultural waste. The construction of a biogas plant after July 1, 2016, using substrate from agri-food processing, has a guaranteed reference price of 550 PLN for the production of 1 MW of "green energy" (Energianews, 2011). The environmental efficiency expressed in the construction of the biogas plant contributes to a decrease in the cost of waste disposal and a reduction in the operating costs and can lead to an increase in profitability (financial efficiency). Residents of Borzęciczki in Wielkopolska participated in study tours to other biogas plants inland and in Germany before the biogas plant was constructed to convince themselves of the absence of unpleasant odour. Introducing sustainable development principles in the food sector can not be done without the acceptance of a local community as beneficial of a biogas plant. The GV4+3 declaration fits in with the ongoing Europe 2020 strategy and EC's recommended closed-loop economy (Chyłek, 2016).

Expenditures related to the protection of nature and the environment of Mróz Meat Plants SA can be divided into:

- expenditures on environmentally friendly investments, e.g., a modern plant with no harmful emissions, modern vehicle fleet, waste segregation, optimal use of bulk packaging, segregation and disposal of slaughter raw materials,
- costs of exploitation and renovation of environmentally friendly installations, fixed costs incurred by the company for the use of the environment,
- incurring monitoring and research costs.

Conclusions

The results of the research contribute to the discussion on the reduction of air and water pollution by introducing the national program "Technological Foresight of Industry InSight 2030". The recognition of the development of environmental efficiency in the Polish food industry shall contribute to the accuracy of public institutional policies and financial support for this industry.

The article's results made it possible to draw conclusions about the assessment of financial efficiency in terms of profitability and environmental efficiency on the example of the meat and poultry industry in Poland in 2010-2020. The values of the Net Return on Sales ratio for meat and poultry enterprises turned out to be statistically significant. To counteract the existing threats of the meat and poultry industry are pro-environment expenses which are leading to the reduction of raw materials losses, contributing to the reduction of operational costs indirectly affecting the financial efficiency.

The conclusions from the research can be presented in three ways.

In the context of the literature review:

- introduction of the concepts and definitions of efficiencies,
- systematisation of the greening process, eco-efficiency within the paradigm of sustainable development.

From the scientific point of view:

- on a hypothesis level (H_1): Financial efficiency in terms of profitability differentiates the examined groups of meat and poultry enterprises. H_1 has been positively confirmed,
- on a thesis level (T_1): The higher values of profitability ratios are, the higher environmental efficiency is. T_1 has been positively stated.

From the practical point of view:

- on a source basis: rationalisation of raw material use, reducing the amount of non-renewable raw materials, increasing the use of renewable raw materials, use of recycled raw materials,
- on a production process basis: implementation of new technological solutions and new production methods.

The limitations set a potential direction for future research. Firstly, the results can be distorted due to global challenges regarding the spread of the COVID-19 pandemic. Secondly, a systemic improvement in data collection can contribute to a more comprehensive assessment of environmental efficiency.

Acknowledgements

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Annex A

Table A1. Characteristics of financial efficiency indicators in the area of profitability

No.	Name of the ratio	Explanation of the profitability's ratio	Average values in the sector
1.	Operating profitability (OP) = (operating profit) / (sales revenue + other operating revenue)	The operating profitability ratio measures the relationship between profit (loss) on total operations and sales in value terms. The ratio takes into account other operating activities in the assessment of profitability, thus increasing or decreasing the profitability of the core business by a partial result achieved on other operating activities.	9.82
2.	Return on total capital (ROI) = Operating profit after tax / total capital ×100%	The return on investment ratio measures the effectiveness of a company's operations, as it estimates how much profit a company can count on by investing one monetary unit. Due to its versatility and ease of calculation, the ratio is often used to compare the profitability of several investments and can be expressed as a percentage or value.	The higher, the better
3.	Net return on sales (NRS) = net profit /(net revenue from sales of products, goods and materials + other operating revenue + financial revenue + extraordinary profits) ×100%	The return on sales ratio shows how much net profit remains in the company from sales. This means that thanks to the ratio, one can find out what profit is earned on each 1 monetary unit acquired from sales. The amount of the ratio depends to a large extent on the industry of the company and the length of the turnover cycle and the company's sales volume.	3.87%
4.	Return on assets (ROA) = net profit/total assets ×100%	The return on assets ratio, also called the return on assets ratio, informs about the company's ability to generate profits and the efficiency of asset management.	8.79%
5.	Return on equity (ROE) = net profit / equity ×100%	The return on equity ratio, also called the return on equity ratio, shows how much profit a company generates from the contributed equity.	14.85%

Source: author's work based on Bień (2011); Bragg (2010); Jaki (2012).