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ROLE OF THE CIRCULAR ECONOMY IN MANAGING THE PROFITABILITY OF WINE INDUSTRY ENTERPRISES IN BULGARIA

Petar Borisov BORISOV, Georgi Dimitrov PETKOV

Agricultural University of Plovdiv, AUP, Department of Management and Marketing, 12, Mendeleev Street, 4 000, Plovdiv, Bulgaria, Phone: (+359) 32 438, E-mails: peterborisov@au-plovdiv.bg, georgidimitrov@au-plovdiv.bg

Corresponding author: peterborisov@au-plovdiv.bg

Abstract

Winemaking has long been one of Bulgaria's leading agricultural sectors, generating billions of dollars annually in a highly competitive global market. The industry operates under conditions of intense competition, which significantly limits profitability. Effective integration into the value chain and cost optimization are key factors in enhancing financial performance. This research seeks to examine how the application of circular economy practices impacts the profitability of wine production. An essential part of the methodology involves classifying wine industry businesses according to the degree to which they have adopted circular economy strategies. This classification follows the Technology Readiness Levels (TRL) approach, which evaluates enterprises according to their technological preparedness for circular economy adoption. Based on the statistical analysis of key indicators such as investments, operating income, and net sales revenue, it is evident that level 4 enterprises exhibit the highest levels of investment activity and operating expenses. These enterprises also report the highest net sales revenue. It is clear that enterprises that have integrated technologies to close the production cycle through recycling and resource reuse demonstrate high efficiency in managing cash flows derived from investment activity.

Key words**:** *circular economy, winemaking, profitability, enterprise, circular economy adoption*

INTRODUCTION

A major obstacle to the broad implementation of the circular economy at both national and international levels is the uncertainty surrounding its effect on investment profitability. This raises a central question: Does the circular economy have the potential to improve financial returns on investments?

The linear business model, which has been traditionally employed in economic systems worldwide, has demonstrated its profitability and remains the preferred approach in many countries. It has played a crucial role in the globalization of economic activities, enabling entrepreneurs to achieve their financial goals regardless of their geographic location. Furthermore, the linear model facilitates business operations without imposing additional considerations regarding the environmental footprint of the enterprise.

Winemaking has long been one of Bulgaria's leading agricultural sectors, generating billions of dollars annually in a highly competitive global market. The industry operates under conditions of intense competition, which significantly limits profitability [26]. Effective integration into the value chain and cost optimization are key factors in enhancing financial performance. As with other European industries, Bulgarian winemaking is subject to European Union (EU) policies especially Green Deal [29] and regulations. In recent years, there has been a pronounced political commitment to promoting the circular economy in agriculture and the food industry.

This research seeks to examine how the application of circular economy practices impacts the profitability of wine production. An essential part of the methodology involves classifying wine industry businesses according to the degree to which they have adopted circular economy strategies.

Conceptualizing Profitability in the Context of the Circular Economy. Profitability is a fundamental economic concept that serves as a guiding principle, an approach, and a strategic objective in business management. It is a multifaceted category influenced by numerous factors, making it difficult to quantify using a

single metric. While a comprehensive examination of the concept is beyond the scope of this study, it is essential to outline the key characteristics relevant to assessing the impact of the circular economy on profitability:

-*Efficiency*– Profitability serves as an indicator of business process excellence [4].

-*Return on Investment* – It reflects the rate at which invested resources generate income for the enterprise [4].

-*Value Recovery* – Profitability measures the ability of resources allocated to production to regain their economic value [3].

-*Equity and Distribution* – It assesses the fair distribution of income generated by business activities, determining the portion appropriated by the entrepreneur [5].

-*Decision-Making Tool* – Profitability provides an objective framework for evaluating investment alternatives and making data-driven business decisions [7].

These characteristics highlight the role of profitability in managing business models. The successful integration of circular economy principles into various economic sectors should, at a minimum, maintain existing profitability levels or, ideally, enhance financial performance [2].

Empirical Evidence on the Circular Economy and Profitability. A growing body of scientific literature supports the claim that circular economy strategies can significantly influence business model profitability [13]. Key findings from empirical studies include:

-*Reduction in Raw Material and Supply Costs* – The application of circular economy principles in the automotive industry has demonstrated cost savings in raw material procurement, leading to lower production expenses and improved profitability [10].

-*Enhanced Production Efficiency* – The optimization of resources through sustainable product design and manufacturing processes leads to reduced energy consumption, decreased operational costs, and higher profitability [10].

-*Waste Reduction and Cost Savings* – Implementing circular economy strategies minimizes waste disposal expenses, thereby decreasing operational costs and increasing financial returns [12].

-*Improved Market Competitiveness and Customer Satisfaction* – Businesses that adopt circular economy principles have reported increased competitiveness by offering more sustainable and environmentally responsible products and services, resulting in expanded market share and improved profitability [22].

-*Extended Product Lifecycle and Long-Term Revenue Generation* – Business models that prioritize durability, repairability, and reusability secure more stable market positions and generate sustained revenue streams [23].

Sector-Specific Considerations in Winemaking. The winemaking industry presents unique challenges in profitability management due to its reliance on living organisms [6]. The sector is characterized by strong seasonality, influenced by the biological cycles of plants and fermentation processes. This pronounced seasonality affects financial performance, necessitating the introduction of subsidies and financial incentives to mitigate income fluctuations. Unlike other industries, winemaking offers opportunities for synergies, wherein a single investment can generate multiple valuable outputs. For example, biomass—a byproduct of wine production—can be commercialized, contributing to diversified revenue streams and enhancing overall profitability.

Numerous studies indicate that biomass utilization remains an underexploited economic opportunity in agriculture, particularly in the wine industry [24, 27, 19, 20, 31, 29, 25, 16, 15]. Scholars suggest that the circular economy should be integrated with the ***bioeconomy***to maximize its benefits [18]. The bioeconomy is a multidisciplinary field focused on the sustainable use of biological resources to produce materials, energy, and services [30]. It encompasses diverse domains such as biology, agriculture, ecology, engineering, and economics [28]. The fundamental objective of the bioeconomy is to establish an economic system that harmonizes with nature, ensuring the sustainable utilization of biological resources without causing environmental degradation [21]. This includes developing innovative technologies for processing biomass, utilizing plants, micro-

organisms and animals for food, energy, medicine, and material production [21].

According to recent research, the bioeconomy holds significant potential for addressing critical global challenges, including climate change, biodiversity loss, and resource scarcity. Furthermore, it contributes to economic growth and fosters job creation in high-tech sectors related to biology and innovation [8].

The convergence of circular and bioeconomy approaches within agriculture offers considerable potential for fostering sustainable and competitive growth. In the context of winemaking, however, applying circular economy principles requires careful consideration of the sector's unique biological cycles and seasonal limitations. Leveraging biomass as a resource and integrating bioeconomic strategies could enhance financial returns while promoting environmental sustainability. Future research should focus on the practical application of these approaches, exploring policy frameworks and business models that support the transition toward a more resilient and profitable circular economy in winemaking.

Table 1 outlines the advantages and drawbacks associated with applying circular economy principles to the management of business model profitability. The information presented highlights the complexity of the circular economy's impact on financial outcomes, emphasizing the need for strategic planning to ensure that its benefits outweigh potential downsides.

Table 1. Impact of circular economy principles on business profitability

Principles of the circular economy	Positive impact on profitability	Negative impact on profitability
Reducing the costs of acquiring raw materials and supplies	Reducing costs, all other things being equal, creates "the opportunity to realize a higher margin" [1]	
Improved efficiency of production processes	Higher efficiency is a reason for saving materials and raw materials, which creates an "opportunity for a higher profit margin" [11]	
Waste reduction	Reducing waste by re-incorporating it into the production cycle "creates conditions for minimizing costs within the framework of the applied technology." [14]	"Additional investments are needed to move to a new technological level, which in the short term reduces profitability due to the higher investment costs" [9], required to implement the new technology. The process of implementing the new resource-saving technology requires time, which can negatively affect profitability.
Increased life cycle duration of the products offered		"A longer product life cycle can create conditions for a decrease in sales turnover, and hence sales revenue" [17]. All other things being equal, this may lead to lower profitability based on sales revenue. The consumer may quickly get bored with the product and prefer a competing one, thus reducing sales and, consequently, revenue and profitability based on sales revenue.

Source: own interpretation.

MATERIALS AND METHODS

Defining the Scope and Limitations of the Research. Developing an objective and reliable methodology to analyze and assess the impact of circular economy principles on the profitability of enterprises in the wine industry requires clearly defining the research scope and its inherent limitations. These limitations pertain both to the availability and reliability of information related to the research object and subject, as well as to external, uncontrollable factors that may influence profitability levels in the studied enterprises.

The critical limitations identified in this study include:

-*Reliability of selected metrics* – The indicators used to assess the degree of circular economy

adoption in the studied enterprises must be robust and accurately reflect the extent of implementation.

-*Scientific validity of analytical measures* – The selected metrics must be based on established scientific methodologies and terminologies to ensure analytical rigor.

-*Measurability and interpretability* – The chosen metrics must be easily quantifiable and interpretable within the framework of scientific research.

-*Relevance of the indicators* – The chosen indicators should offer valuable understanding of how circular economy practices relate to the profitability of enterprises.

Classification of Research Objects. An important element of the study's methodology involves grouping wine industry enterprises according to the extent to which they have adopted circular economy practices. This classification follows the **Technology Readiness Levels (TRL)** approach, which evaluates enterprises according to their technological preparedness for circular economy adoption. For this purpose, a four-level classification scale is employed:

Level 1 – Enterprises that have implemented or are in the process of implementing technologies enabling them to close production cycles and recycle up to **30%** of their waste.

Level 2 – Enterprises that have integrated technologies allowing them to recycle resources, products, or waste from previous production cycles at a rate exceeding **50%**.

Level 3 – Enterprises that have adopted technologies facilitating not only recycling but also the reuse of recycled materials in subsequent production cycles at a rate exceeding **75%**.

Level 4 – Enterprises that have achieved **100% recycling and reuse**, fully closing their production cycle.

This classification enables a structured comparison of enterprises based on their circular economy adoption level, providing a foundation for further statistical analysis.

Analytical Approach and Statistical Methods. Once enterprises are classified, they will be analyzed using *multiple comparison methods* to identify statistically significant differences in profitability levels across the groups. The statistical techniques employed in this study include:

-***T-test*** – To compare profitability indicators between groups and assess significant differences in financial performance.

-***Regression analysis*** – To examine the relationship between circular economy adoption and enterprise profitability, identifying key influencing factors.

-The primary indicators used to measure profitability in the studied enterprises include [6]:

-***Cost-based profitability*** (expressed as a percentage)

-***Return on investment (ROI)*** (expressed as a percentage)

-***Profitability of sales revenue*** (expressed as a percentage)

Data Sources and Reliability. The financial data required for calculating these indicators will be obtained from the accounting records of the surveyed wine-making enterprises. All enterprises registered in the Commercial Register of the Republic of Bulgaria are legally required to publish their annual financial and accounting reports, which serve as publicly available and reliable data sources for this research.

By utilizing these financial disclosures, the study ensures data accuracy, transparency, and the validity of its findings, enabling a comprehensive assessment of how circular economy principles impact the profitability of wine industry enterprises.

Approach to Validating the Main Research Hypothesis. The primary hypothesis examined in this study asserts that the adoption of circular economy principles influences the profitability of enterprises in the wine industry. To validate this hypothesis, a hierarchical framework of research hypotheses is developed, each tested for statistical significance throughout the study. The validation process follows a structured approach comprising the following key stages of testing using the t-Test tool:

The t-test is employed to assess the relationship between circular economy implementation and various profitability indicators. The hypotheses tested include:

Hypothesis 1: Relationship Between Circular Economy Adoption and Cost-Based Profitability

-*Null Hypothesis (H_0):* There is a statistically significant relationship between the adoption of circular economy technologies and cost-based profitability.

-*Alternative Hypothesis (H_1):* There is no statistically significant relationship between the adoption of circular economy technologies and cost-based profitability.

Hypothesis 2: Relationship Between Circular Economy Adoption and Return on Investment (ROI)

Null Hypothesis (H_0): The use of circular economy technologies is significantly associated with variations in return on investment.

Alternative Hypothesis (H_1): The use of circular economy technologies does not have a statistically significant effect on return on investment.

Hypothesis 3: Relationship Between Circular Economy Adoption and Sales Revenue Profitability

Null Hypothesis (H_0): The implementation of circular economy technologies has a statistically significant impact on the profitability of sales revenue.

Alternative Hypothesis (H_1): The implementation of circular economy technologies does not significantly influence sales revenue profitability.

Study Organization. At this stage of the survey we point the research location and sample selection process. The Republic of Bulgaria is divided into *four wine-growing regions*—North, East, South, and South-West—and *six planning regions (NUTS 2)*—North-West, North-Central, North-East, South-East, South-Central, and South-West. For the purposes of this study, the wine-growing regions have been chosen as the basis for determining the research location. This selection ensures consistency with the specific environmental and economic conditions influencing wine production. Thus, the study encompasses all four wine-growing regions in Bulgaria.

The sample for this study was drawn from the National Chamber of Vine and Wine Register, based in Sofia. This register contains voluntarily registered wine enterprises, with a total population of 9,340 wine-producing enterprises as of December 31, 2024. The sample was formed using random selection with non-replacement, ensuring an unbiased representation of enterprises engaged in wine production.

A final sample of **94 enterprises** was selected for participation in the study. The sample size was determined based on the financial constraints of the research while ensuring a sufficient number of enterprises in each category to meet the statistical reliability criteria necessary for analysis.

Questionnaire Structure. The data collection instrument used in this study was a **structured questionnaire** comprising three sections:

General Enterprise Characteristics

This section collects information on the fundamental characteristics of the surveyed wine enterprises, including their **legal form, size, and life cycle stage**.

-Circular Economy Practices

-This section gathers information on **business practices** that align with circular economy principles.

-The responses from this section allow for an objective classification of enterprises based on the extent to which they have integrated circular economy strategies into their operations.

-Intentions and Future Adoption

The final section focuses on the **enterprises' intentions and capacity** to further implement circular economy principles in their management and production processes.

RESULTS AND DISCUSSIONS

This study primarily investigates whether adopting circular economy principles affects the profitability of wine-producing enterprises. To evaluate this hypothesis, a cost-based profitability analysis was carried out among enterprise groups categorized by the extent of their circular economy adoption (as defined in the methodology section). The primary statistical tool used for hypothesis verification is the **t-test**, which evaluates whether significant differences exist in **cost-based profitability** among the enterprise groups.

The results of the **t-test analysis** are summarized in **Table 2**. By conducting multiple comparisons across enterprise groups, the study identifies the systematic influence of circular economy principles on **profitability levels**. The findings provide empirical evidence to determine whether circular economy adoption contributes to increased profitability in the wine industry.

Table 2. Results of the application of the t-test method for comparing group averages, in this case cost-effectiveness in the studied enterprises

	Level 1	***Level 2***			***Level 1***	***Level 3***
Mean	6.570828	6.064045		Mean	10.51559	12.56074
Variance	240.0994	194.5923		Variance	613.8018	568.2404
Observations	31	31		Observations	31	31
Pearson Correlation	-0.00205			Pearson Correlation	0.394788	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	0.135198			t Stat	-0.42563	
P(T<=t) one-tail	0.446679			P(T<=t) one-tail	0.336708	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	0.893358			P(T<=t) two-tail	0.673416	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	
	Level 1	*Level 4*			*Level 2*	*Level 3*
Mean	10.51559	28.01429		Mean	6.064045	12.56074
Variance	613.8018	664.3362		Variance	194.5923	568.2404
Observations	31	31		Observations	31	31
Pearson Correlation	0.375962			Pearson Correlation	-0.18263	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	-3.44897			t Stat	-1.2164	
P(T<=t) one-tail	0.000845			P(T<=t) one-tail	0.116659	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	0.001691			P(T<=t) two-tail	0.233318	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	
	Level 2	*Level 4*			*Level 3*	*Level 4*
Mean	6.064045	28.01429		Mean	12.56074	28.01429
Variance	194.5923	664.3362		Variance	568.2404	664.3362
Observations	31	31		Observations	31	31
Pearson Correlation	0.149611			Pearson Correlation	0.175719	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	-4.45862			t Stat	-2.69851	
P(T<=t) one-tail	5.34E-05			P(T<=t) one-tail	0.005663	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	0.000107			P(T<=t) two-tail	0.011325	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	

Source: results of statistical data analysis with the SPSS product.

The summarized results of the analysis conducted using the t-test method are presented in Table 3. This table also indicates whether each hypothesis has been confirmed or rejected.

By applying the multiple comparison method for group means, with a statistical significance level of $\alpha = 0.05$, a statistically significant difference was identified in the mean values of the indicator "Cost Profitability" across the four groups of enterprises.

To determine statistical significance, the value of the P (two-tailed) indicator must be lower than the selected significance level α (0.05). If this condition is met, the null hypothesis can be accepted, confirming that there is a statistically significant difference between the various enterprise groups in terms of cost profitability. This conclusion provides empirical support for the hypothesis that the degree of circular economy adoption influences profitability levels in the wine industry.

Table 3. Results of statistical hypothesis testing regarding whether there is a difference between the individual groups of enterprises according to the indicator - "Cost profitability"

Comparison between→	**Level 1**	**Level 2**	**Level 1**	**Level 3**	**Level 1**	**Level 4**	**Level 2**	**Level 3**	**Level 2**	**Level 4**	**Level 3**	**Level 4**
Null hypothesis – there is a statistically significant difference	is rejected		is rejected		accepted		is rejected		accepted		is rejected	
Alternative hypothesis – there is no statistically significant difference	accepted		accepted		is rejected		accepted		is rejected		accepted	

Source: results of statistical data analysis with the SPSS product.

The results presented in Table 3 indicate a statistically significant difference in cost profitability between enterprises at Level 1 and those at Level 4 (as highlighted in the grayed-out cell of Table 2). Additionally, a significant difference is observed in the comparison between enterprises at Level 2 and those at Level 4.

The analysis suggests that enterprises implementing technologies enabling 100% closure of the production cycle—through recycling and efficient resource utilization—achieve substantially higher cost profitability than enterprises at Level 1 and Level 2.

Table 4. Results of the application of the t-test method for comparing group averages, in this case profitability of sales revenues in the studied enterprises

	Level 1	***Level 2***			***Level 1***	***Level 3***
Mean	19.59663	4.194949		Mean	19.5966328	12.02208
Variance	806.6298	119.7633		Variance	806.62979	207.1829
Observations	31	31		Observations	31	31
Pearson Correlation	0.073448			Pearson Correlation	0.33262757	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
df	30			df	30	
t Stat	2.889523			t Stat	1.54838321	
P(T<=t) one-tail	0.003551			P(T<=t) one-tail	0.06600796	
t Critical one-tail	1.697261			t Critical one-tail	1.69726089	
P(T<=t) two-tail	0.007102			P(T<=t) two-tail	0.13201592	
t Critical two-tail	2.042272			t Critical two-tail	2.04227246	
	Level 1	*Level 4*			*Level 2*	*Level 3*
Mean	19.59663	43.88442		Mean	4.19494897	12.02208
Variance	806.6298	199.8661		Variance	119.763332	207.1829
Observations	31	31		Observations	31	31
Pearson Correlation	-0.03389			Pearson Correlation	0.06363178	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
df	30			df	30	
t Stat	-4,206			t Stat	-2.48762762	
P(T<=t) one-tail	0.000108			P(T<=t) one-tail	0.00932182	
t Critical one-tail	1.697261			t Critical one-tail	1.69726089	
P(T<=t) two-tail	0.000216			P(T<=t) two-tail	0.01864364	
t Critical two-tail	2.042272			t Critical two-tail	2.04227246	
	Level 2	*Level 4*			*Level 3*	*Level 4*
Mean	4.194949	43.88442		Mean	12.022081	43.88442
Variance	119.7633	199.8661		Variance	207.182935	199.8661
Observations	31	31		Observations	31	31
Pearson Correlation	0.119056			Pearson Correlation	-0.37701083	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
df	30			df	30	
t Stat	-13.1409			t Stat	-7.49335034	
P(T<=t) one-tail	2.79E-14			P(T<=t) one-tail	1.1821E-08	
t Critical one-tail	1.697261			t Critical one-tail	1.69726089	
P(T<=t) two-tail	5.58E-14			P(T<=t) two-tail	2.3642E-08	
t Critical two-tail	2.042272			t Critical two-tail	2.04227246	

Source: results of statistical data analysis with the SPSS product.

Specifically, these enterprises attain a cost profitability of 40.5%, demonstrating the economic benefits of a fully circular production model.

Table 4 displays the outcomes of the t-test analysis used to assess how circular economy principles affect sales revenue profitability. Through multiple comparisons across various enterprise groups, the study reveals consistent patterns in how circular practices influence revenue performance among the surveyed businesses.

Table 5. Results of statistical hypothesis testing regarding whether there is a difference between the individual groups of enterprises according to the indicator - "Profitability of sales revenue"

Comparison between→	**Level 1**	**Level 2**	**Level 1**	**Level 3**	**Level 1**	**Level 4**	**Level 2**	**Level 3**	**Level 2**	**Level 4**	**Level 3**	**Level 4**
Null hypothesis – there is a statistically significant difference	accepted		is rejected		accepted		accepted		accepted		accepted	
Alternative hypothesis - there is no statistically significant difference	is rejected		accepted		is rejected		is rejected		is rejected		is rejected	

Source: results of statistical data analysis with the SPSS product.

Table 6. Results of the application of the t-test method for comparing group averages, in this case profitability of investments in the studied enterprises

	Level 1	***Level 2***			***Level 1***	***Level 3***
Mean	-0.00704	0.019225		Mean	-0.00704	0.968775
Variance	0.011942	0.046639		Variance	0.011942	7.141467
Observations	31	31		Observations	31	31
Pearson Correlation	0.407478			Pearson Correlation	0.132074	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	-0.73717			t Stat	-2.04242	
P(T<=t) one-tail	0.233372			P(T<=t) one-tail	0.024992	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	0.466744			P(T<=t) two-tail	0.049984	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	
	Level 1	*Level 4*			*Level 2*	*Level 3*
Mean	-0.00704	1.632419		Mean	0.019225	0.968775
Variance	0.011942	0.680121		Variance	0.046639	7.141467
Observations	31	31		Observations	31	31
Pearson Correlation	0.049346			Pearson Correlation	-0.0999	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	-11.0438			t Stat	-1.9563	
P(T<=t) one-tail	2.16E-12			P(T<=t) one-tail	0.029898	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	4.31E-12			P(T<=t) two-tail	0.059796	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	
	Level 2	*Level 4*			*Level 3*	*Level 4*
Mean	0.019225	1.632419		Mean	0.968775	1.632419
Variance	0.046639	0.680121		Variance	7.141467	0.680121
Observations	31	31		Observations	31	31
Pearson Correlation	-0.07943			Pearson Correlation	-0.16007	
Hypothesized Mean Difference	0			Hypothesized Mean Difference	0	
Df	30			df	30	
t Stat	-10.3366			t Stat	-1.26536	
P(T<=t) one-tail	1.05E-11			P(T<=t) one-tail	0.107741	
t Critical one-tail	1.697261			t Critical one-tail	1.697261	
P(T<=t) two-tail	2.1E-11			P(T<=t) two-tail	0.215482	
t Critical two-tail	2.042272			t Critical two-tail	2.042272	

Source: results of statistical data analysis with the SPSS product.

The summarized results of the t-test analysis, presented in Table 5, indicate which hypotheses are confirmed (accepted).

The analysis demonstrates that in all intergroup comparisons—except for the comparison between enterprises at Level 1 and Level 3—there is a statistically significant difference in the average value of the "Profitability of Sales Revenue" indicator.

These findings suggest that enterprises implementing technologies enabling over 75% reuse of recycled resources in subsequent production and technological cycles achieve significantly higher profitability of sales revenue compared to enterprises at Level 1.

In these enterprises, the profitability of net sales revenue reaches 14.4%, further emphasizing the economic advantages of integrating circular economy principles in the wine industry.

The comparison of enterprise groups was further conducted concerning the "Return on Investment (ROI)" indicator. Table 6 presents the t-test results, illustrating the systematic impact of circular economy principles on the profitability of sales revenues in the analyzed enterprises.

Using the multiple comparison method of group averages at a statistical error level of ά = 0.05, a statistically significant difference was observed between the average ROI values when comparing the four enterprise groups. To confirm the Null Hypothesis, the P (two-tail) value must be lower than the statistical indicator ά, indicating a significant difference between the enterprise levels with respect to Return on Investment.

These results support the strong link between greater adoption of circular economy practices and enhanced investment returns within the wine industry.

Table 7 displays the results of testing the working hypotheses.

The findings indicate that there is a statistically significant difference in the average values of the "Return on Investment" (ROI) indicator across all comparisons, except for the comparisons between enterprises at level 2 versus level 3, and between level 3 versus level 4. It can be concluded that, in the majority of the comparisons, a significant difference in investment profitability is observed.

This indicates that a more widespread adoption of circular economy principles within the examined enterprises is associated with higher investment profitability, highlighting the positive impact of circular economy practices on investment returns.

Table 7. Results of statistical hypothesis testing regarding whether there is a difference between the individual groups of enterprises according to the indicator - "Return on investment"

Comparison between:	**Level 1**	**Level 2**	**Level 1**	**Level 3**	**Level 1**	**Level 4**	**Level 2**	**Level 3**	**Level 2**	**Level 4**	**Level 3**	**Level 4**
Null hypothesis - there is a statistically significant difference	accepted		accepted		accepted		is rejected		accepted		is rejected	
Alternative hypothesis - there is no statistically significant difference	is rejected		is rejected		is rejected		accepted		is rejected		accepted	

Source: results of statistical data analysis with the SPSS product.

CONCLUSIONS

The statistical analysis of the data generated from the survey and financial accounting documents of the enterprises reveals several important conclusions regarding the impact of the circular economy principles on the profitability of wine-making enterprises:

-*Investment Activity and Efficiency*. Based on the statistical analysis of key indicators such as investments, operating income, and net sales revenue, it is evident that level 4 enterprises exhibit the highest levels of investment activity and operating expenses. These enterprises also report the highest net sales revenue. It is clear that enterprises that have integrated

technologies to close the production cycle through recycling and resource reuse demonstrate high efficiency in managing cash flows derived from investment activity.

-*Profitability Trends Based on Circular Economy Implementation*. Other factors being constant, enterprises that have made the most progress in implementing the principles of the circular economy achieve the highest profitability in terms of investments, revenues, and expenses.

-*Cost Profitability*. Enterprises that have adopted technologies allowing them to achieve 100% closure of the production cycle via recycling and reuse of resources exhibit significantly higher cost profitability compared to enterprises at level 1 and level 2. In these enterprises, the profitability of operating costs reaches 40.5%.

-*Sales Revenue Profitability*. Enterprises that have introduced technologies enabling them to recycle and reuse over 75% of resources in the next production cycle show significantly higher profitability in terms of sales revenue when compared to level 1 enterprises. In these enterprises, the profitability of net sales revenues reaches 14.4%.

-*Investment Profitability*. In the majority of the comparisons made between the surveyed enterprises, a significant difference in investment profitability is observed. The more circular economy principles are implemented, the higher the profitability of investments in the enterprises.

- The combined data, analyses, and findings indicate that the sector presents favorable conditions for the adoption of circular economy principles. Specifically, the wine industry holds promise as a model for other sectors, showcasing the advantages of implementing circular economy practices.

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