THE IMPACT OF DIGITALIZATION ON THE PERFORMANCE OF COMPANIES IN THE AGRICULTURAL SECTOR

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ABSTRACT

This research examines the relationship between the level of digitalization and the returns achieved by companies operating in the agricultural sector. The study is based on a review of the available literature and aims to determine the impact of digitalization on the performance of agricultural companies. The research relies on panel data analysis and utilizes the EViews software. The dataset includes daily data for the period from 2014 to 2024. To investigate this impact, an OLS regression model was applied, revealing the relationship between independent and dependent variables. The results indicate that there is a highly systematic and complex relationship between the degree of digitalization and company performance. Although digitalization is of strategic importance, its impact on returns can be negative due to the costs associated with organizational transformation.

Introduction

Agriculture is increasingly adopting digital technologies. Global digital corporations, local startups, and state institutions are providing and supporting a wide range of solutions aimed at creating the "smart" farmer – from self-driving tractors to drones that detect soil diseases, as well as from farm management applications to milking robots. Smart agriculture is often described as a place of agricultural production that uses software-driven "smart" technologies (Bertschi, 2018) and "big data" (Protopop & Shanoyan, 2016).

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The agricultural sector is undergoing a major transformation due to digitalization. The impact of digitalization is observed not only in terms of technology but also in economic terms. The positive impact of digitalization is reflected in the efforts of economic policymakers to encourage farmers to engage more in electronic forms of trading and to be less dependent on state subsidies and state-supported pricing mechanisms (Chand, 2016).

The use of digital technology (in terms of the application of information and communication technologies) is based on digital platforms that provide the buyer with a certain degree of transparency, high speed, and transaction efficiency. Sellers also benefit from the use of markets in a much easier way, while the available information is highly detailed. All this leads to a shift in the procurement process of agricultural products from traditional oral auctions to digital methods. Digitalization affects numerous aspects of business operations, including information technology, strategy and business models, products and services, internal and external processes, organization, and company culture. In this paper, the phenomenon of digitalization particularly digital transformation—is examined from the perspective of relevant literature. The knowledge obtained comes from case studies. Finally, a synthesized conceptual framework model is presented and analyzed (Francois et al., 2014; Gavrilović et al., 2025; Liu et al., 2020).

The subject of this research is the analysis of the impact of digitalization on the financial performance of companies operating in the agricultural sector, with a particular focus on publicly listed companies. The main objective of the paper is to empirically examine whether and to what extent the level of digitalization affects the returns achieved by these companies, as well as to determine the direction and significance of this impact. In line with the stated objective, the study is based on the hypothesis that digitalization has a statistically significant effect on the returns of companies in the agricultural sector, with the assumption that this effect may be negative in the short run due to the high costs of digital transformation and the adjustment of organizational processes. The proposed hypotheses are tested using panel regression analysis, while the obtained results are thoroughly discussed and interpreted in the Results and Conclusion sections, thereby ensuring the logical and methodological consistency of the entire research. First, the introduction to the research is presented. Based on the literature, key insights are outlined. After that, the research method is discussed in the following chapter. The next chapter provides the research results, followed by the conclusion and references.

Literature Review

Questions related to the impact of digitalization on agriculture depend on whether and how it is integrated into policies, as noted by MacPherson et al. (2022). Garske et al. (2021) investigate the ecological opportunities and limitations regarding digitalization in the agricultural sector through the implementation of qualitative governance analysis. Here, agriculture is recognized as a highly important area for the application of digital advancements, including artificial intelligence. The authors examine the impact of agricultural education, staffing issues in rural areas, and the development of certain practical and promising methods. They conclude that there is a growing importance

of highly qualified education in the agricultural sector, a demand for unskilled labor, increasing automation of processes, and similar trends (Akramovich, 2022).

They also analyzed small family farms and their position during the COVID-19 pandemic. Major negative consequences were observed, such as a decline in sales due to the closure of hospitality venues, delays in the delivery of certain inputs, and so on. However, these challenges contributed to the development of digitalization in agriculture and created new opportunities (Blažková et al., 2023; Barović et al., 2025). The authors Chung et al. (2021) examine whether advertising via digital media has the potential to efficiently support and improve the work of agricultural holdings, concluding that farms located in certain rural areas benefit more from digital media advertising.

The authors Xu et al. (2024) investigate the resilience of rural households to risks and how these risks impact their long-term strength. They determine that the resilience index of rural households in China is influenced by the digital economy through employment effects, income structure, and the safety of household members. Additionally, Wang et al. (2024) analyze how the implementation of internet technology in rural development has contributed to the improvement and modernization of agriculture. The findings indicate that internet access improves the participation of farmers in professional cooperatives.

The authors Fang et al. (2020) emphasize the importance of enhancing digital skills among farmers and using functional platforms, along with improving innovative mechanisms through the connection between companies and farmers, as well as the crucial role of policy-makers. Competitive advantage in the economy is based on knowledge and digitalization, which cannot be achieved without the application of modern technological solutions, organizational efficiency, and the functioning of production and social processes (Kučera & Látečková, 2006).

In their study, Benner and Ranganathan (2017) refer to the work of several other authors who investigated the relationship between market value of stocks and the disclosure of digitalization-related information, concluding that awareness of digital activities increases a company's value. From this, the assumption follows that investments in digital technologies influence a company's success in the stock market. Given the favorable relationship between market value and digital investments, it is expected that publicly traded companies have a high level of digital activity.

However, the authors were not able to confirm this assumption. Namely, 53% of the surveyed organizations had insufficient implementation of digitalization, 34% of the sample did not possess digital tools or advanced digital technologies, and only 13% of publicly traded Italian firms had fully integrated and used tools such as business intelligence, analytics, and big data (Truant et al., 2021).

Broccardo et al (2023) further investigated companies listed on the Italian stock exchange in 2021. The focus of the study was to examine how digitalization affects financial performance, as well as how sustainability is integrated into business strategy. The research revealed a surprising correlation between digitalization, sustainability,

and profitability in Italian public companies. The paper emphasizes the importance of integrating sustainability into business strategy and the likely impact of digitalization on the implementation and efficiency of sustainable practices.

Similar results were presented by Ionașcu et al (2022). Their research, within the framework of the European Green Deal, deals with the digital transformation of companies listed on EU stock exchanges. The aim of the study was to examine the relationship between digitalization, financial performance, and sustainability. Based on 986 observations (companies over different years), the authors created a digitalization index using quantitative analysis of annual reports from 2018 to 2020. The results showed, particularly in terms of environmental protection, a positive relationship between digitalization projects and corporate social responsibility. Moreover, the study demonstrated a positive link between digital transformation efforts and market performance, indicating that companies that have made significant progress in digital transformation are more valuable to investors. These results have implications for both EU policymakers and the strategies of large publicly traded companies in Europe.

Although much research has been conducted on digitalization, relatively few studies explore the link between digitalization and company performance. Particularly significant in this context is the study by Truant et al. (2021), which uses a sample of Italian publicly traded companies from different sectors to examine the effect of digitalization on business performance. Although the adoption of digital technologies to support everyday business activities is still in its early stages, the results indicate that digitalization has a clear impact on company performance.

The Impact of Digitalization on Company Operations

One of the key processes transforming society and business—drawing considerable attention from both the academic community and practitioners—is digitalization. Although it is currently at the forefront of attention, related terms are often used interchangeably without clearly established and unified definitions. The rapid development of information and communication technologies has enabled the introduction of digital capabilities into products that were previously exclusively physical (Hirsch-Kreinsen, 2016).

One definition of digitalization refers to the transformation of analog content into digital form. Digitized data can be transmitted accurately, quickly, and economically. However, digitalization alone does not alter value-creating activities (Verhoef et al., 2021).

Thanks to this technological shift, it is now possible to develop digital technologies such as the Internet of Things, cloud services and mobile applications, artificial intelligence, big data, analytics, social networks, and embedded devices. All of these technologies can profoundly transform industries and societies (Mihardjo et al., 2019).

Digitalization explains changes in existing systems, corporate structures, and revenue streams resulting from the application of digital technologies. It is most commonly implemented through projects and digital initiatives that modify specific business processes (Bloomberg, 2022).

The application of digital technologies can be found in various areas of business. Digitalization helps improve customer experience, streamline operations, and transform entire business models (Nyagadza, 2022).

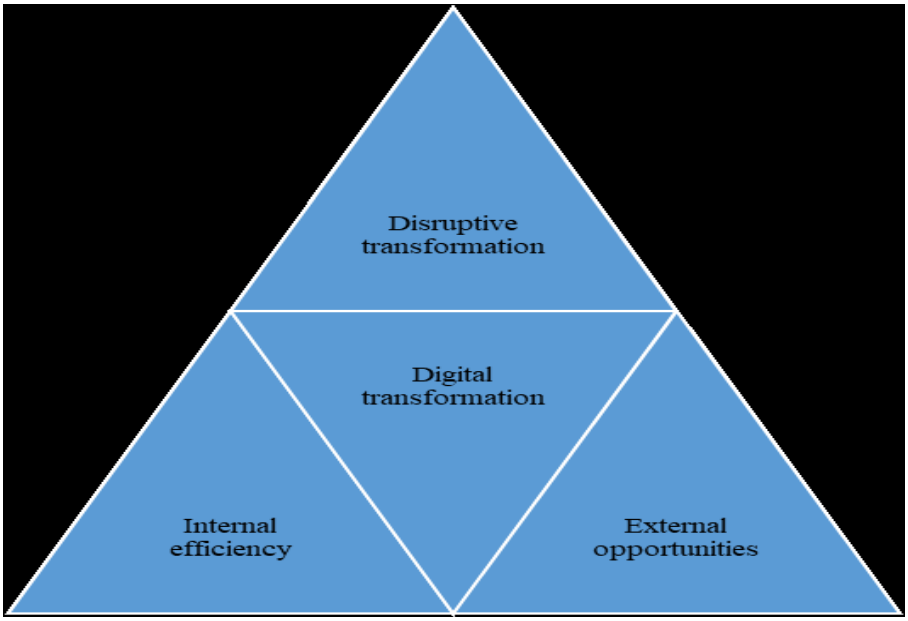
As already noted, digitalization is reshaping how companies function and their overall business environment. Ignoring digitalization carries the risk of losing position in highly competitive markets. Digitalization can impact the internal operations and the overall operational environment of a company. It can also lead to the discontinuation of existing business models, alter the roles of participants in the value chain, and create new business opportunities. For instance, digitalization can eliminate traditional intermediaries in the supply chain and introduce new ones, as a result of direct consumer access and the growing use of mobile devices.

Therefore, three distinct perspectives help in understanding the effects and objectives of digitalization for a company:

1. **Internal efficiency** – involves improving work processes through the use of digital tools and reorganizing internal procedures;
2. **External potential** – involves leveraging new business opportunities within the existing industry (new services, new clients, etc.);
3. **Disruptive transformation** – implies that digitalization fundamentally changes roles and relationships in business operations.

These three perspectives on the impact of digitalization can be illustrated in Figure 1.

Figure 1. Three Perspectives on the Impact of Digitalization



Source: Tagscherer, F., & Carbon (2023)

Data and method

The analysis of the impact of digitalization on return performance is conducted using daily data for the period 2014–2024, obtained from the Stooq stock exchange and the financial statements of the companies. In order to determine the level of digitalization of each company, computer-assisted text analysis is applied to the annual reports of each company (Drechsler et al., 2023).The territorial scope of the research includes publicly listed companies from the agricultural sector operating on the international market, with data obtained from the Stooq platform. The analyzed sample consists of companies registered in different countries and regions, which positions the study at a global level rather than being limited to a single national economy. Although the sample includes a relatively small number of companies (five), its representativeness is reflected in the fact that the selected firms are publicly listed, have been active over a long period (2014–2024), and provide high-frequency (daily) data, resulting in a large number of observations. Such a panel dataset enables the derivation of statistically relevant conclusions regarding the relationship between digitalization and company returns in the agricultural sector, while acknowledging certain limitations related to the sample size, which are considered in the interpretation of the results.

The analysis observes the dependent variable, represented by the daily return of each company, while the independent variable is digitalization. Thus, the impact of digitalization on each company's return will be examined. Following the approach of Kádárová et al. (2023), the following formula is proposed:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it}$$

where is:

Y_{it} - dependent variable for company *i* at time *t;*

X_{it} – independent variable for observations *i* at time *t;*

α – const;

ε_{it} – error term for company *i* at time *t*.

that is:

$$Return_{it} = \beta_0 + \beta_1 DigiTech_{it} + \varepsilon_{it}$$

where is:

$Return_{it}$ – return of company *i* at time *t;*

$DigiTech_{it}$ – digitalization level of company *i* at time *t;*

β_0 - const;

ε_{it} – error term for company *i* at time *t*.

Research Results

Based on the collected data, the descriptive statistics of the research results will first be presented (Table 1).

Table 1. Descriptive Analysis of the Observed Variables

	Mean	Median	Maximum	Minimum	Std Dev	Skewness	Kurtosis	Jarque Bera
Gobarto SA	-0.017458	0.000000	9.691001	-17.60913	1.345383	0.547140	20.51911	32377.94
KSG AGRO SA	-0.025198	0.000000	16.71364	-35.47149	2.355366	-2.355123	50.42477	238675.3
Agroton Group of Companies	0.007353	0.000000	12.62449	-22.14142	1.927115	0.185955	15.36243	16074.39
Agroliga Group PLC	-0.007043	0.000000	9.569633	-32.22193	1.702555	-2.514282	57.53855	315222.7
Deere & Co	0.028411	0.029354	5.497167	-6.586570	0.792098	-0.294823	11.45101	7541.539

Source: Authors' calculations

In Table 1, a descriptive statistical analysis is presented, indicating that there are significant differences in the average values among the observed companies. The average values of the observed variables suggest that most companies, on average, recorded either negative or very slightly positive performance indicators during the observed period. As shown, Deere & Co is the only company among those analyzed that recorded a positive average value (0.0284), while on the other hand, Gobarto SA, KSG AGRO SA, and Agroliga Group PLC had negative average values. Additionally, Agroton Group showed a slightly positive average value (0.0073). Furthermore, the medians of the observed companies were all zero.

In addition, KSG AGRO SA had the highest standard deviation (2.36), which may suggest that returns for this company are unstable and highly volatile. Conversely, Deere & Co had the lowest standard deviation (0.79), indicating relatively stable business performance.

In terms of skewness, significant negative skewness was observed in KSG AGRO SA and Agroliga Group, which may indicate that negative values occurred more frequently and were more pronounced. However, Gobarto SA and Agroton Group exhibited slight positive skewness, while Deere & Co showed an almost symmetric distribution.

The high kurtosis values observed across all companies suggest the presence of "fat tails" and a greater frequency of extreme values compared to a normal distribution. The most extreme case is Agroliga Group PLC, which had a kurtosis value as high as 57.5, while other companies also displayed significantly elevated values.

To examine the impact of digitalization—and whether such an effect exists—a panel regression analysis was conducted using the Panel Least Squares method. This analysis included a sample of five companies observed over the period from 2014 to 2024. The conducted research is directly related to the agroindustrial sector, as all analyzed companies operate within agriculture or agroindustry, including agricultural production, agro-processing, and the development of agricultural machinery and technologies.

Therefore, the observed effects of digitalization on company performance should be interpreted within the specific characteristics of the agricultural sector, such as high capital intensity, seasonal production, and significant implementation costs. The obtained results are consistent with findings from similar international studies, which indicate that digitalization in agriculture may have a negative or limited impact on financial performance in the short term, primarily due to the costs of digital transformation, while remaining essential for long-term competitiveness and sustainability.

The following table presents the results of the panel regression analysis – OLS model (Table 2).

Table 2. Results of the Panel Regression Analysis – OLS Model

Variable	Coef	Std error	t-statistic	p-value
Const (C)	19,279.52	1,100.44	17.52	0.0000
DigiTech	-3,419.95	708.18	-4.83	0.0000
Indicator	**Value**			
R^2	0.0017			
Adjusted R^2	0.0016			
Std error of the Regression	80,835.83			
Number of Observations	13,818			
Number of Companies (cross-sections)	5			
Durbin-Watson Statistic	1,833			
F-Statistic	23.32			
p-value (F)	0.0000			

Source: Authors' calculations

The results of the regression analysis indicate that the level of digitalization exerts a negative and statistically significant impact on company returns**.** The estimated coefficient suggests that an increase in the degree of digitalization within a firm is associated with a decline in its return, with this effect being statistically significant at the 1% confidence level**.** This finding may be interpreted as evidence that investments in digital technologies, although potentially enhancing efficiency and competitiveness in the long run, often impose substantial costs in the short term.

In capital-intensive sectors such as agriculture, digitalization and automation frequently require considerable upfront investments and involve significant adjustment costs, which can adversely affect short-term financial performance (Acemoglu & Restrepo, 2020). The process of digital transformation typically entails the acquisition of new equipment and software, extensive employee training, and the restructuring of organizational processes, all of which may exert downward pressure on current firm performance.

Moreover, it is plausible that some firms intensify their digitalization efforts during periods of weak performance, implying that digital transformation may represent a strategic response to existing challenges rather than the primary cause of declining returns. Importantly, digitalization does not inherently guarantee positive financial outcomes; its effectiveness depends critically on the quality of implementation, organizational readiness, and the specific characteristics of the sector in which the firm operates. In this regard, the findings align with Bloom et al. (2012), who emphasize the central role of managerial quality and organizational capabilities in realizing the potential benefits of digital technologies.

Furthermore, the estimated Durbin–Watson statistic amounts to 1.833**,** indicating the absence of significant autocorrelation and confirming that the error terms in the model are independent. This result supports the overall validity and reliability of the regression estimates.

The observed negative short-term effect of digitalization on company returns is also consistent with the findings of Brynjolfsson & Hitt (2000), who argue that digital investments require complementary organizational changes and sufficient time before generating measurable financial gains.

Overall, the obtained results suggest the existence of a complex and potentially paradoxical relationship between digitalization and firm financial performance. While digital transformation is undeniably crucial for long-term growth and competitiveness, its immediate impact on returns may be negative due to the substantial costs of transformation and various implementation challenges. These findings underscore the need for further research incorporating a broader set of control variables, as well as explicitly accounting for time lags between digital investments and the realization of positive business outcomes. The results are also consistent with the study conducted by Chen et al. (2024).

Conclusion

The obtained results indicate the existence of a complex and potentially paradoxical relationship between digitalization and the financial performance of the observed companies. Although digitalization is recognized as a key factor in long-term development, competitiveness, and adaptation to modern market demands, the regression analysis results show that its immediate impact on company returns can be negative. This effect can be explained by the fact that the process of digital transformation involves significant investments in technology, employee training, and the reorganization of business processes, which in the short term may impose a burden on a company's financial operations.

Furthermore, the results suggest the possibility that certain companies tend to invest more intensively in digitalization during periods of weaker business performance, meaning that digitalization acts not as a cause, but as a consequence of recovery efforts and adaptation to change. The success of digitalization does not depend solely on

the level of investment, but also on the quality of implementation, the organization's readiness to embrace change, and sector-specific characteristics.

In addition, the results indicate that the model does not suffer from autocorrelation of residuals, as confirmed by the Durbin-Watson statistic of 1.833, which further supports the reliability of the conclusions. However, given the low explanatory power (R^2), the findings should be interpreted with caution, and it should be acknowledged that digitalization is not the only factor influencing company returns.

Therefore, it is recommended that future research include a broader set of control variables, such as company size, industry sector, investment in research and development, and stages of digital maturity. It is also advisable to analyze the time lag between investment in digitalization and the realization of positive financial effects. Such an approach would allow for a deeper understanding of the dynamics of digital transformation and its long-term impact on company performance.

This study is subject to several limitations. First, the analysis is based on a relatively small sample of publicly listed companies, which may limit the generalizability of the results to the broader agricultural sector, particularly to small and medium-sized farms and privately held firms. Second, the level of digitalization is measured using computer-assisted text analysis of annual reports, which may not fully capture the actual depth, quality, or effectiveness of digital technology implementation. Third, although the panel dataset includes a large number of observations due to the use of daily data, the model does not incorporate additional control variables such as firm size, market conditions, or macroeconomic factors, which could influence company returns. Finally, the analysis does not explicitly account for time lags between digital investments and their potential long-term financial effects, which should be addressed in future research.

Conflict of interests

The authors declare no conflict of interest.

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