Acta Simulatio - International Scientific Journal about Simulation
Volume: 9 2023 Issue: 2 Pages: 15-20 ISSN 1339-9640

https://doi.org/10.22306/asim.v9i2.95

Received: 26 Feb. 2023
Revised: 20 Mar. 2023
Accepted: 15 Apr. 2023

Power of digitalization: statistical analysis of European SMEs

Laura Lachvajderova
Technical University of Košice, Faculty of Mechanical Engineering, Department of Business Management and Environmental Engineering, Park Komenského 5, 04200, Košice, Slovak Republic, EU, laura.lachvajderova@tuke.sk (corresponding author)
Richard Duda
Technical University of Košice, Faculty of Mechanical Engineering, Department of Industrial and Digital Engineering, Park Komenského 9, 04200, Košice, Slovak Republic, EU, richard.duda@tuke.sk
Martin Trebuna
Technical University of Košice, Faculty of Mechanical Engineering, Department of Industrial and Digital Engineering, Park Komenského 9, 04200, Košice, Slovak Republic, EU, matrin.trebuna@tuke.sk
Marek Mizerak
Technical University of Košice, Faculty of Mechanical Engineering, Department of Industrial and Digital Engineering, Park Komenského 9, 04200, Košice, Slovak Republic, EU, marek.mizerak@tuke.sk

Keywords: analysis, digitalization, small and medium-sized enterprises.
Abstract: The ongoing effects of the pandemic have led to a heightened adoption of digital technologies among businesses. Acknowledging the importance of small and medium-sized enterprises (SMEs), the European Commission emphasizes the need for support in digitalization efforts. The study focuses on investigating the influence of digitalization on SME performance by analyzing data from 27 EU countries using econometric analysis. A thorough literature review explores the relationship between digitalization and SME performance. The findings of our study provide valuable insights for policymakers, suggesting the integration of digital tools into the infrastructure of SMEs, and also serve as inspiration for future research in this area.

1 Introduction

According to the European Commission, more than 98% of all businesses in the European Union (EU) are small and medium-sized enterprises (SMEs), and they account for approximately two-thirds of total employment. SMEs make a significant contribution to the EU's gross domestic product (GDP), comprising over half of the added value in the non-financial corporate economy [1]. Despite the considerable impact of the COVID-19 pandemic on SMEs throughout the EU, these businesses have demonstrated their resilience and ability to adapt to the challenges [2]. Various measures have been implemented to support them, including easing regulations, providing financial assistance, and implementing targeted programs for digitalization and innovation support. The digitalization of SMEs can have a positive effect on their value added and performance by streamlining processes and production, enhancing service quality and productivity, improving collaboration and communication within the company, and enhancing the customer experience. These improvements can contribute to increased value added and improved performance for SMEs, directly influencing their business growth and development. Furthermore, digitalization enables SMEs to better compete in the market, which is crucial for success and maintaining a competitive advantage [3].

While research on digitalization's impact on SME performance is growing, the specific effects are not yet well-established. Rigorous scientific studies are needed to systematically investigate its influence on productivity, profitability, innovation, competitiveness, and customer satisfaction. These studies should employ quantitative analysis, case studies, surveys, or experiments, collecting data on SMEs' digitalization initiatives and objectively measuring performance outcomes. Well-designed research is necessary, considering confounding factors, utilizing appropriate statistical analyses, and acknowledging contextual influences. Conducting scientific investigations into digitalization's effects on SME performance can provide valuable insights and evidence-based recommendations for SMEs, policymakers, and stakeholders to optimize digital transformation and improve business performance [4].

This study aims to examine the relationship between digitalization and business performance, specifically investigating whether digitized companies tend to be more prosperous and achieve higher performance levels. The research focused on a sample of 27 European Union member countries (EU27) and utilized a regression model for panel data over a 5-year period (2017-2021). By using the EU27 sample, the study provides a concentrated and comprehensive analysis of the EU context, facilitating comparative assessments, bolstering statistical power, and

leveraging relevant data availability. The findings of this research contribute to the existing literature by enhancing the understanding of factors influencing business digitalization and offering empirical evidence on how the integration of digital technologies impacts SME performance within the EU.

2 Literature review

Digital transformation varies among companies depending on the industry and is influenced by factors such as the adoption of advanced technologies, evolving customer needs, market size, and the specific business sector [5]. Boundary companies that prioritize digitalization tend to achieve higher long-term productivity and revenue compared to less digitally-oriented companies [6]. SMEs can leverage digital technologies to support their business functions, such as utilizing social media applications, open-source software, mobile security, e-commerce platforms, video conferencing, instant messaging, and shared calendars, which may be either paid or free [7]. Additionally, tools like Big Data, Blockchain, Artificial Intelligence, and the Internet of Things offer further potential for enhancing SME performance economically, socially, and environmentally [8].

Companies' digital transformation levels vary based on contextual factors and can be grouped into three categories: highly digitally mature SMEs that quickly adapt to digitalization, SMEs with liquidity issues that only digitize their sales function, and SMEs with limited digital literacy but strong social capital seeking digital partners [9]. Successful digital transformation requires investment in various dimensions, including infrastructure, IT technologies, intellectual and strategic aspects, formal and informal structures, culture, and social factors [10]. Optimal performance outcomes require significant operational changes externally and internally [11]. Overcoming obstacles and challenges involves adapting business models, knowledge, and technologies, while increasing the benefits of digital technology adoption necessitates innovative business model development [12]. Conflicting findings exist regarding the impact of digitization on SME performance. For example, a recent study (2021) suggests that digital technologies have a limited effect on innovative performance, with R&D expenditures being a more reliable predictor of innovation [13]. This study challenges the notion that digital technologies necessarily enhance innovative performance. Considering these findings and building upon the existing literature, a research question was formulated to investigate the influence of digitalization on firm performance: *'Does digitalization affect SMEs performance?'*

3 Methodology

3.1 Research measure

In this chapter, we will summarize the key indicators (variables) relevant to our research, which fall under the category of quantitative research approaches. These methods prioritize the identification of causal relationships rather than individual experiences or beliefs, enhancing objectivity. As our study utilizes publicly available data, it can be replicated. The evaluation of the study's overall quality relies on criteria such as reliability and validity. Our aim is to ensure consistent and stable results when applying the same data in future studies. To achieve this, we have relied on reliable sources, including:

- Eurostat: the statistical office of the European Union.
- European Commission: the executive branch of the EU, providing information on EU policies, programs, and activities.

The study involves conducting an econometric analysis using panel data to examine the influence of digitalization on SME performance and validate our hypotheses. The dataset comprises 135 observations gathered from 27 EU countries over a period of five years. To address the research question and assess the validity of the established hypotheses, a panel dataset spanning from 2017 to 2021 was created. The panel data method was selected for its capability to track the same individuals over time, facilitating the analysis of dynamic responses and controlling for unobserved heterogeneity within data containing both cross-sectional and time series elements [14]. Utilizing panel data offers several advantages, as highlighted by [15], including increased variability, reduced collinearity between variables, greater degrees of freedom, enhanced efficiency, and the ability to account for individual heterogeneity, resulting in more informative data. The statistical analysis was performed using EViews 12 [16]. Table 1 presents the four variables derived from the dataset that will be observed.

Table 1 Descriptive statistics variables

Dependent variable	Interpretation	Unit
Value added	Share of the total value added of EU27 SMEs	%
Independent variable		%
Integration of digital technologies	Level of implementation and use of digital technologies in EU27 SMEs	%
Control variable		%
Total investment	Percentage of GDP for each of the EU27 countries	%

The aforementioned independent variable will be used to address the research question. As discussed in [17,18], there is a reciprocal relationship between the dependent and independent variables. Higher value-added can contribute to employment growth, while increased employment can enhance productive performance, thereby fostering value-added growth. Furthermore, the integration of digital technologies across various business domains can improve operational efficiency and speed. Total investment can facilitate job creation, spur the development of new products and services, and stimulate economic growth.

3.2 Theoretical background

For the analysis of panel data, we employed the Least Squares Dummy Variables (LSDV) method, which is specifically tailored for this type of data. The LSDV method enables the inclusion of individual-specific effects, resulting in more accurate and reliable estimates [19]. It is worth mentioning that the assumption of homoscedasticity is crucial for obtaining dependable results using the LSDV method. To address the research question, we will utilize a linear regression model with regression equation (1), which incorporates both the dependent and independent variables. This model depicts the connection between the independent variable and the dependent variable, illustrating how changes in the independent variable can influence the dependent variable.

$$Y_{it} = \alpha + \beta X_{it} + \lambda_t + \varepsilon_{it} \qquad (1)$$

Where:

- Y_{it} represents the dependent variable for a specific observation (country) *i* at a given time *t* (year);
- X_{it} corresponds to the independent (explanatory) variable for the same observation *i* at time *t*;
- α represents the country-specific intercept;
- β denotes the coefficient associated with the independent variable X_{it};
- λ_t represents the time-fixed effect, which includes time dummy variables for the respective time period *t*;
- ε_{it} signifies the error term for observation *i* during time period *t*.

Building upon equation (1) and considering the number of dependent and independent variables, the resulting equation in our study can be formulated as follows:

$$VA_{SMEs_{it}} = \alpha + \beta_0(IntDigTech_{SMEs}) + \\ +\beta_2(\text{Total\_inv})_{it} + \lambda_t + \varepsilon_{it} \qquad (2)$$

Where:

- VA_{SMEs} is a dependent variable;
- $IntDigTech_{SMEs}$ is an independent variable;
- Total_inv is a control variable.

The purpose of regression analysis is to investigate the relationship between independent and control variables and the dependent variable. In order to determine the suitable model specification, which includes deciding whether to use pooled data or incorporate fixed effects or random effects to address heterogeneity, we conducted several tests. Fixed effects are utilized to examine whether there are distinct intercepts for each entity, which remain constant over time. This approach assumes that the relationships between explanatory and dependent variables are consistent on average and over time, with specific assumptions about the independent variable and error distribution. On the other hand, random effects aim to capture effects beyond specific values of the independent variable, eliminating the need for precise assumptions about the variables. Our proposed model aims to understand the relationship between the integration of digital technologies at the SMEs level and the value added by SMEs. To confirm the necessary effects of the model, we will conduct a series of tests on the data, including a Hausman test to determine whether to use fixed effects or random effects in our model specifications.

4 Results and discussion

To assess the spread of values in our analysis, we will present descriptive statistics of the variables used. We will include measures such as the mean, median, and standard deviation, which indicate how closely data points align with a normal distribution. When data follows a standard or Gaussian distribution, the mean and median typically have similar values. After examining Table 2, we note that all variables in the model display means and medians that are close in value, suggesting that all variables are assumed to follow a normal distribution.

Table 2 Descriptive statistics of variables

Variable	Mean	Median	Standard Deviation
Value added	58.257	58.000	8.259
IntDigTech	40.319	38.000	14.809
Total_inv	22.141	22.500	2.980

Table 3 presents the correlation matrix, which reveals that no correlation surpassing 0.7 or below -0.7 was found. Following a general guideline [20], this indicates the lack of significant correlations among the variables.

Table 3 Correlations matrix

Variable	Value added	IntDigTech	Total_inv
Value added	1		
IntDigTech	-0.424	1	
Total_inv	-0.186	0.197	1

In the next step, we will perform a Hausman test to select the suitable method for conducting regression analysis on the data. The Hausman test evaluates the following hypotheses:

- H0: The random effects model is more suitable for this study.
- H1: The fixed effects model is more suitable for this study.

Based on the information provided in Table 7, the calculated p-value is lower than the significance level of 0.05 or 5%. Thus, we reject the null hypothesis (H0) and accept the alternative hypothesis (H1), indicating that the fixed effects model is more appropriate for our study.

Table 4 Hausman test

Chi-Square Statistic	19.065
Chi-Square Statistic Probability	0.0001

The final results of the panel data regression analysis using the fixed effects model and LSDV method are displayed in Figure 1. The analysis demonstrates that the coefficient of the independent variable (IntDigTech) is statistically significant, indicated by its significant estimate at the 5% level of significance. This indicates that, on average, a one unit increase in IntDigTech is associated with a 0.0658 unit increase in value added, based on the data sample (assuming other factors remain constant).

Dependent Variable: VALUE_ADDED
Method: Panel Least Squares
Date: 06/20/23 Time: 14:25
Sample: 2017 2021
Periods included: 5
Cross-sections included: 27
Total panel (balanced) observations: 135

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	50.59168	9.143313	5.533189	0.0000
INT_DIG_TECH	0.065883	0.040637	1.621252	0.1079
TOTAL_INV	0.226230	0.427006	0.529805	0.5974

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.834939	Mean dependent var	58.25704
Adjusted R-squared	0.791338	S.D. dependent var	8.258921
S.E. of regression	3.772639	Akaike info criterion	5.681220
Sum squared resid	1508.677	Schwarz criterion	6.305316
Log likelihood	-354.4824	Hannan-Quinn criter.	5.934835
F-statistic	19.14951	Durbin-Watson stat	1.624245
Prob(F-statistic)	0.000000		

Figure 1 Panel data regression results

The results indicate the statistical significance of the independent variables, as evident from the R-Squared and Adjusted R-Squared values. The regression model's R-Squared value is 0.834939, indicating the proportion of variability in the dependent variable explained by the independent variable. This value ranges from 0 to 1, where 0 implies that the independent variable has no explanatory power for the dependent variable, while 1 suggests that the independent variable (IntDigTech) perfectly explains the dependent variable (Value added). The obtained R-Squared value in our case is relatively high, indicating a strong relationship between the variables and underscoring the statistical significance of the regression model. Consequently, we can infer that the model supports a positive causal relationship between the variables.

In this study, ensuring measurement validity (construct validity) was of utmost importance as it sought to obtain accurate measurements that align with the concept under investigation. Quantitative research inherently faces the challenge of potential inaccuracies in variable measurement. To tackle this issue, we incorporated control variables that have a robust theoretical and empirical association with the topic.

The integration of digital technologies by SMEs presents opportunities to develop unique resources, enhance efficiency, and increase productivity, thereby gaining a competitive advantage in a highly competitive market. Additionally, digitalization enables SMEs to acquire new competencies, skills, and knowledge, empowering them to introduce innovative processes and products. However, SMEs often face challenges when adopting digital technologies due to limited financial and human resources. While financial constraints are a significant factor, our study's main focus is not on the influence of the control variable related to finances on the overall outcome. We carefully selected control variables based on their impact on the dependent variables, although it is important to acknowledge that these variables share their influence with numerous other indicators. Despite the limited financial resources of SMEs, the selected control variables remain relevant within the context of our study.

With confidence in the validity of our results, we can assert that the independent variable (IntDigTech), which represents the degree of digitalization in EU27 SMEs, exerts a significant and substantial impact on the dependent variable (value added). The value added serves as an indicator of SME performance in EU27. This confirmation establishes a reciprocal causal relationship between these variables, effectively answering our research question.

5 Conclusions

Our study aimed to investigate the influence of digitalization on business performance, specifically focusing on SMEs in the EU27 from 2017 to 2021. We collected datasets for both the dependent variable, representing business performance, and the independent variable, representing the level of digitalization among SMEs in the EU27 during the specified timeframe. To conduct our analysis, we transformed the individual variable datasets into panel data, which was crucial for regression analysis. The statistical software EViews 12

was chosen for the analysis based on the data nature, applicable tests, and study objectives.

The results of the panel data analysis indicate that the extent of digitalization within SMEs can contribute to an increase in value added and have a significant impact on their overall performance in the EU27. However, it is important to note that the study period encompassed the effects of the COVID-19 pandemic, which imposed certain limitations on traditional business development and accelerated the adoption of digital solutions. We believe that our research findings can inspire future studies and provide valuable insights for researchers and policymakers, emphasizing the substantial role of digitalization in enhancing SME performance. One of the main limitations of our research was the availability of data for indicators measuring SME performance. In future research, expanding the sample to a global scale would be beneficial, allowing access to a wider range of variables measuring both digitalization and business performance.

Acknowledgements
This paper was developed within the implementation of the projects VEGA 1-0340-2021 The im-pact of a pandemic and the subsequent economic crisis on the development of digitization of en-terprises and society in Slovakia, VEGA 1/0508/22 Innovative and digital technologies in manufacturing and logistics processes and systems, VEGA 1/0438/20 Interaction of digital technologies to support software and hardware communication of the advanced production system platform, KEGA 020TUKE-4/2023 Systematic development of the competence profile of students of industrial and digital engineering in the process of higher education, APVV-17-0258 Digital engineering elements application in innovation and optimization of production flows and APVV-19-0418 Intelligent solutions to enhance business innovation capability in the process of transforming them into smart businesses.

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Review process
Single-blind peer review process.