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E-Commerce Adoption and SMEs Economic Performance in the European Union: Evidence from 2019 to 2025

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Abstract

The digitalisation of small and medium-sized enterprises (SMEs) is not just a technological trend, but also a strategic path towards sustainable economic development. This study provides a comprehensive comparative analysis of SMEs digitalisation across the EU-27 during the post-pandemic period (2019–2025). The originality of this study stems from its comprehensive comparative analysis by integrating dynamic, cluster, concentration, and regression analyses, it provides updated evidence on the relationship between e-commerce adoption, enterprise turnover, and economic development, while highlighting cross-country disparities and convergence trends within the European Union. The results confirm a positive association between the adoption of e-commerce practices and enterprise economic performance, underlining the contribution of digitalisation to broader development objectives. The study provides relevant insights for policymakers seeking to strengthen digital ecosystems and support SMEs competitiveness, as well as for business managers aiming to leverage digital technologies as a source of growth and resilience. As the analysis is based on aggregated country-level data and the correlational methods, the findings should be interpreted as evidence of statistical associations rather than causal relationships and should not be directly extrapolated to individual SMEs.

Keywords: digital transformation; SMEs; economic development; European Union



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1. Introduction

In the contemporary European economic landscape, small and medium-sized Enterprises function as the primary structural pillars, constituting approximately 99% of all commercial entities and contributing nearly 60% of total value added and 50% of export volumes [1]. As the globalized economy pivots toward a data-driven paradigm, the digital transformation of these enterprises has evolved from a discretionary strategic asset into a fundamental prerequisite for organizational survival and systemic resilience [2]. This shift is catalyzed by the European Union's 2030 "Digital Decade" mandate, which targets a 75% adoption rate for advanced technologies—including cloud computing, artificial

intelligence, and big data analysis—across all corporate sectors. Achieving these benchmarks is critical for ensuring that the EU27 maintains its collective competitive edge against shifting global market dynamics [3,4]. The acceleration of digital transformation has led to changes in production systems, management practices, communication channels and market structures. In this context, the digital transformation of SMEs and its impact on the economy has attracted increasing attention from researchers and policymakers.

Most studies consistently show that digitalization contributes to the optimization of internal processes of firms, the optimization of repetitive tasks, efficient inventory management and strengthening customer relationships. In other words, the literature has focused mainly on how digital transformation impacts performance indicators at the microeconomic level and less on examining the impact on macroeconomic development. In this context, studying the economic effects of digitalization of SMEs at the level of EU member states contributes to the existing literature, using a balanced EU panel dataset (2019–2025) and contributes empirical evidence on the association of SMEs digital transformation with broader economic development outcomes.

The main objective of the research was to identify and analyze the differences between the developments of various forms of e-commerce in the EU27 states, their degrees of concentration, as well as to identify the disparities between the EU27 states from this point of view. To this end, several hypotheses were considered, including:

H1. *There are trends of concentration of various forms of e-commerce leading to changes in the relationships between them at the level of the EU27 states;*

H2. *Although e-commerce is continuously growing, the gaps between the states are deepening, leading to significant segmentations of them from this point of view;*

H3. *The gaps between the states do not depend only on the policies of SMEs but also on specific factors such as the inclination of the population towards e-commerce and digital skills.*

The paper is structured as follows: analysis of relevant literature in Section 2; presentation of the materials and methods in Section 3; discussion of the empirical results in Section 4; conclusions and future research in Section 5.

2. Literature Review

Despite the evident advantages of technological integration, the relationship between digital maturity and economic performance is characterized by significant theoretical complexity. While longitudinal evidence suggests a strong positive correlation between digital intensity and firm-level indicators such as labour productivity and turnover, scholars frequently reference a persistent “productivity paradox” [5–7]. Under one diverging hypothesis, digital maturity is conceptualized as a “slow-moving state variable” rather than an immediate catalyst for financial growth [8]. This paradox is exacerbated by a significant “digital size gap.” While digitalization offers substantial potential for all firms, its economic effect is often more pronounced in large enterprises than in SMEs [9]. Empirical analyses often find that the initial impact of digital capabilities on e-commerce turnover remains “statistically fragile” until a firm develops a requisite “absorptive capacity” to assimilate new business models and innovative workflows [10,11].

These findings highlight that the relationship between digitalization and SMEs performance remains inconclusive. While most studies report positive economic effects of digital transformation, others argue that these effects materialize only after firms develop sufficient absorptive capacity and organizational maturity. Therefore, the debate has gradually

shifted from whether digitalization improves performance to identifying the conditions under which different forms of digitalization generate measurable economic benefits.

The empirical reality of this transition is marred by a widening “digital size gap” between large enterprises and the SMEs sector. For instance, while 44% of large EU firms successfully conduct electronic sales—generating roughly 27% of their turnover—only 20% of small enterprises have achieved similar adoption levels, contributing a mere 8% to their total output [12]. This disparity is even more pronounced in advanced ICT adoption; currently, while 20.9% of large enterprises utilize machine learning for complex data analysis, the adoption rate among small firms languishes at a negligible 4.2% [13]. Furthermore, data indicate that only 7.3% of SMEs across the EU27 have integrated Artificial Intelligence into their core operations [14].

This deficit prevents smaller firms from engaging in the “business model innovation” necessary to remain competitive in data-driven markets [10,15].

The pathway to this level of maturity is frequently blocked by significant structural impediments. Research identifies a persistent “financial gap” and high upfront investment costs as primary hurdles for technology procurement [16,17]. This is compounded by human capital deficits, specifically a chronic shortage of specialized digital skills and a lack of digital literacy among leadership [17,18]. Furthermore, organizational inertia, traditional philosophies, and a risk-averse corporate culture often cause digital projects to stall, as many firms prioritize safety over the experimental nature of digital innovation [16,19,20].

Although there is broad agreement regarding the barriers that hinder SMEs digitalization, considerably less attention has been paid to the extent to which these constraints translate into different patterns of e-commerce adoption and different economic outcomes across EU member states. Consequently, existing studies provide only limited evidence on whether disparities are explained primarily by differences in firms’ digital capabilities or by differences in the digital readiness of consumers.

Recent empirical evidence based on Eurostat data for the 2019–2025 reveals starkly bifurcated trajectories for digital development across member states. Previous studies report heterogeneous patterns in the digitalisation of SMEs, highlighting both rapid catching-up processes in some emerging economies and the persistence of significant regional disparities. Thus, Longitudinal data for the proportion of SMEs engaged in B2B and B2G web sales (PBBG) show a vast regional divide, with adoption ranging from 7.01% in Romania to 34.56% in Lithuania, compared to a Union average of 13.46%. Conversely, emerging economies demonstrate exceptional catch-up potential; Greece recorded an exceptional average annual growth rate in PBBG adoption of 18.59%, while Romania followed with 12.17%. Furthermore, turnover growth from e-commerce (RRTT PCS) highlights significant imbalances: while Bulgaria (17.84%) and Romania (11.02%) show high positive growth, several member states like Ireland (−15.17%) and France (−2.36%) recorded negative growth rates in this metric during the same period. These asymmetries are further complicated by a regional divide, where Northern member states consistently lead in digital intensity while Southern and Eastern regions continue to lag [21,22].

Although there is a large body of literature on the digitalisation of SMEs, there are still several research gaps. Several studies have identified a persistent financial gap and a chronic shortage of specialized digital skills as major obstacles limiting SMEs’ ability to benefit from digital transformation [17,23–25]. The uneven distribution of these constraints across EU member states has contributed to substantial regional differences in the adoption and economic outcomes of digital technologies. Therefore, analyzing these regional disparities is particularly important, as it provides insights into the extent to which digitalisation contributes to economic convergence or divergence within the European

Union and supports the design of more effective, place-based policy interventions aimed at achieving the Digital Decade targets.

Recent studies argue that the benefits of digital transformation depend not only on technology adoption but also on the development of organizational capabilities and managerial competencies, which enable SMEs to effectively exploit digital platforms and e-commerce opportunities and show that digital orientation has a positive effect on SMEs performance through the development of dynamic capabilities rather than through technology adoption alone [26–28]. These findings are consistent with studies highlighting that digitalisation contributes to enterprise competitiveness only when supported by complementary resources and organizational readiness. At the same time, the existing literature primarily focuses on overall digital maturity or aggregated measures of digitalisation, while comparatively less attention has been paid to differences among specific e-commerce channels (EDI, B2B/B2G and B2C), their contribution to SMEs' turnover, and the extent to which disparities in digital demand—reflected by online purchasing behaviour and digital skills—explain the heterogeneous economic performance observed across EU27 member states. Addressing these issues represents the main motivation for the present research.

To address these gaps, the present study analyses six complementary indicators describing both the supply side (PBS, PEDI, PBBG and PBC) and the demand side (PIBGS and PIBDS) of digitalization. Unlike previous studies, which generally investigate individual indicators separately, this research combines concentration analysis, hierarchical clustering and econometric modelling to examine not only the diffusion of different forms of e-commerce but also their contribution to SMEs' turnover across EU27 member states during the 2019–2025 period.

Consequently, the existing literature provides conflicting expectations regarding the evolution of disparities among EU member states: while the diffusion of digital technologies should promote convergence, differences in digital capabilities, organizational maturity and consumer readiness may instead reinforce structural segmentation.

3. Materials and Methods

The main data sources used in the comparative analysis of the role of SMEs digitalisation in the economic development of the EU27 member states were e-commerce sales of enterprises by size class of enterprise (ESELS) [29] and value of e-commerce sales by size class of enterprise (EVELS) [30], individuals who have basic or above basic overall digital skills (IHBOS) [31], and individuals using the internet for buying goods or services (IUBGS) [32]. Based on these, 10 main variables were identified (Table 1).

Table 1. Economic variables and meanings of the main variables used.

Variable	Definition	Unit
PBS	Share of SMEs with e-commerce sales of at least 1% turnover	%
PEDI	Share of SMEs with EDI-type sales	%
PBBG	Share of SMEs with web sales—B2B and B2G	%
PBC	Share of SMEs with web sales—B2C	%
PIBGS	Share of individuals who used internet for buying goods or services within the last year	%
PIBDS	Share of individuals with basic or above basic overall digital skills	%
TBS	Share of SMEs' total turnover from e-commerce sales	%
TEDI	Share of SMEs' turnover from EDI-type sales	%
TBBG	Share of SMEs' turnover from web sales—B2B and B2G	%
TBC	Share of SMEs' total turnover from web sales—B2C	%

Taking into account the objective and hypotheses formulated above, the research used both methods of analyzing the dynamics of the evolution of indicators (comparative analysis of average annual rates, in first part of analysis, and a multifactorial econometric model, in the fourth part of the paper), as well as analyses of the degree of concentration and a hierarchical cluster analysis of states depending on the values of the indicators at the level of 2025. In the first part of the paper, a descriptive dynamic analysis of the evolution of the share of SMEs with e-commerce sales of at least 1% turnover (PBS), with EDI-type sales (PEDI), with web sales—B2B and B2G (PBBG) and with web sales—B2C (PBC), in the period 2019–2025 was carried out. The data series of these four indicators on SMEs with e-commerce were organized in the matrix $Y = [y_{k,i,t}]$, $k = \overline{1,4}$, $i = \overline{1,27}$, $t = \overline{0,6}$, $t_0 = 2019$ and two indicators were used, namely the average annual index $\bar{I}_{t_j/t_0}^{y_{k,i}} = \sqrt[m]{\frac{y_{t=t_j}}{y_{t=t_0}}}$, $t_j > t_0$ and average annual growth rate $\bar{R}_{t_j/t_0}^{y_{k,i}} = \bar{I}_{t_j/t_0}^{y_{k,i}} - 1$. For the period 2019–2025, for each member state $i \in U27$ and each indicator k $\bar{I}_{2025/2019}^{y_{k,i}} = \sqrt[6]{\frac{y_{k,i,2025}}{y_{k,i,2019}}}$.

In the second part of the paper for testing hypothesis H1 (there are trends of concentration of various forms of electronic trade leading to changing the relationships between them at the level of EU27 states) the degrees of concentration of PBS, PEDI, PBBG and PBC were analyzed. For this purpose, the Gini coefficient Equation (1) and Shannon entropy Equation (2) were used:

$$G = \sqrt{\sum_{i=1}^n g_i^2}, G \in \left[\sqrt{\frac{1}{n}}, 1 \right], \text{ for } n = 27, G \in \left[\sqrt{\frac{1}{27}}, 1 \right] \quad (1)$$

$$S = \sum_{i=1}^n g_i \ln \frac{1}{g_i}, S \in [0, \ln n], \text{ for } n = 27, S \in [0, \ln 27] \quad (2)$$

To test the research hypothesis H2 (although e-commerce is continuously growing, the gaps between countries are widening, leading to significant segmentations of them from this point of view) and to highlight the disparities existing in 2025, between the EU27 countries regarding the shares of the forms of e-commerce included in the analysis, hierarchical clustering analysis was used [33,34]. Clustering was performed using Squared Euclidian distance, and Ward's method in which the distance between two clusters A and B is defined as follows [35]:

$$\Delta(A, B) = \sum_{i \in A \cup B} \|x_i - m_{A \cup B}\|^2 - \sum_{i \in A} \|x_i - m_A\|^2 - \sum_{i \in B} \|x_i - m_B\|^2 - \frac{n_{A \cap B}}{n_{A \cup B}} \|m_A - m_B\|^2 \quad (3)$$

In Equation (2) x_i is an item (a cluster or an individual element, not included yet in a cluster) to include in a cluster, m_i is the centroid and n_i is the number of elements from clusters i .

When determining the number of clusters, it was taken into account that “an appropriate cluster solution could be defined as the solution at which the reduction in SSE slows dramatically” [36]. Thus, for a solution with n clusters, in which y_{kij} is the value of the element ij from the cluster k and $\bar{y}_{ki}$ is the average of the variable i from the cluster k , TSSE is:

$$SSE_n = \sum_{k=1}^n \sum_{i=1}^r \sum_{j=1}^{m_i} (y_{kij} - \bar{y}_{ki})^2 \quad (4)$$

To test the third research hypothesis (the gaps between countries depend not only on SMEs policies but also on specific factors such as the population's inclination towards e-commerce and digital skills) an econometric model of the form was used:

$$TESC = a_0 + a_1 \cdot PBS + a_2 \cdot PIBGS + a_3 \cdot PIBDS + \varepsilon \quad (5)$$

Relation (5) models the influence of the share of SMEs with e-commerce sales (PBS) and the characteristics of individuals who used internet for buying goods or services (PIBGS and PIBDS) on the share of SMEs' total turnover from e-commerce sales (TESC).

For testing the statistical hypotheses of the Wald tests (used to determine the statistical significance of the means of variables across clusters) and the least squares method (used to assess the robustness of model 5), a 95% confidence level (significance level $\alpha = 0.05$) was primarily used.

4. Results and Discussion

The continued expansion of internet use and e-commerce across Europe has created favourable conditions for the digital transformation of SMEs. Sustained growth in online commercial activities after the COVID-19 pandemic has increased opportunities for SMEs to access digital markets, improve competitiveness, and generate higher revenues through e-commerce. At the same time, significant differences persist among European regions regarding the intensity of digital adoption and e-commerce development, highlighting the uneven pace of SMEs digitalisation across Europe [28]. During the period 2019–2025, in the vast majority of EU27 states (Table 2), positive annual growth rates were recorded in the shares of SMEs with e-commerce sales of at least 1% turnover (R_{PBS}), the highest being recorded in Greece (16.65%), Bulgaria (11.43%) and Cyprus (9.33%), with 13.83, 8.61 and 6.51 percentage points above the EU27 average (2.82%). At the same time, in four states (Czechia, Ireland, Sweden and France) reductions in the R_{PBS} were recorded, ranging from -3.13% in Czechia and -0.02% in France.

Table 2. Average annual growth rates of the shares of SMEs with e-commerce sales (R_{PCS}), with EDI-type sales (R_{PEDI}), with web sales B2B and B2G (R_{PBBG}) and with web sales B2C (R_{PBC}), in the period 2019–2025.

Country	R_{PCS}	R_{PEDI}	R_{PBBG}	R_{PBC}	Country	R_{PCS}	R_{PEDI}	R_{PBBG}	R_{PBC}
Belgium	0.84	3.43	1.44	−1.87	Lithuania	6.99	0.50	13.26	5.25
Bulgaria	11.43	3.87	5.18	6.60	Luxembourg	2.01	−0.17	3.17	2.31
Czechia	−3.13	−10.23	−1.04	0.14	Hungary	5.63	−2.42	7.85	7.17
Denmark	2.52	2.55	2.63	4.32	Malta	5.66	2.38	5.26	10.80
Germany	2.23	−2.80	1.92	4.27	Netherlands	1.84	−0.87	0.69	1.59
Estonia	1.76	3.93	0.47	4.19	Austria	3.66	−3.79	3.25	4.95
Ireland	−1.77	−8.56	3.10	−0.36	Poland	1.11	−5.69	3.68	5.01
Greece	16.65	−2.74	18.59	15.26	Portugal	4.50	1.48	6.09	6.35
Spain	4.92	−3.32	5.09	8.86	Romania	2.91	4.64	12.17	3.92
France	−0.02	−6.35	2.69	4.06	Slovenia	3.33	5.16	0.89	4.60
Croatia	1.08	3.23	0.34	−0.53	Slovakia	4.43	0.12	2.24	5.70
Italy	6.68	4.62	8.49	8.53	Finland	4.50	3.60	3.78	4.38
Cyprus	9.33	−5.29	4.40	9.96	Sweden	−0.43	−3.62	5.97	5.14
Latvia	6.80	2.93	7.94	10.09					

Source: calculations performed by the authors based on ESELS data series.

From the point of view of SMEs with EDI-type sales ($PEDI$), in terms of the values of the average annual rates (R_{PEDI}) the differences between the countries are significant. Thus, while in 14 countries positive values of R_{PBS} were recorded ranging from 5.16% in Slovenia to 0.12% in Slovakia, in the other 13 EU27 countries negative values of R_{PBS} were recorded ranging from -0.17% in Luxembourg to -10.23% in Czechia.

On the other hand, as evidence of the higher economic efficiency by using web sales is that, in the case of SMEs with web sales B2B and B2G ($PBBG$) and with web sales B2C (PBC), with the exception of three countries (Belgium, Croatia and Slovenia), the average

annual growth rates of their share (R_{PBBG}) and/or (R_{PBC}) were higher than the average annual rates of SMEs with EDI-type (R_{PEDI}).

Thus, in the case of SMEs with web sales B2B and B2G (PBBG), the highest values of R_{PBBG} were recorded in Greece (18.59%), Lithuania (13.26%) and Romania (12.17%), with 14.66, 9.33 and 8.24 percentage points above the EU27 average (3.93%), and the lowest in Estonia (0.47%), Croatia (0.34%) and the Czech Republic (−1.04%). In the case of SMEs with web sales B2C, R_{PBC} values ranged from a minimum of −1.87%, recorded in Belgium, to a maximum of 15.26%, recorded in Greece, with 10.13 percentage points above the EU27 average (5.13%).

As a result of these developments, in 2025, the shares of SMEs with web sales B2B and B2G (PBBG) ranged from 7.01%, recorded in Romania (Figure 1), to 34.56%, recorded in Lithuania. High values were also recorded in Sweden (24.70%), Finland (21.05%) and Denmark (20.99%), with 11.24, 7.59 and 7.73 percentage points above the EU27 average (13.46%). At the opposite pole, alongside Romania were Slovakia (8.43%), Luxembourg (8.25%) and France (7.66%). Finally, around the EU27 average were Estonia (14.02%), Greece (13.99%), Hungary (13.82%), Germany (13.65%) and Poland (12.78%).

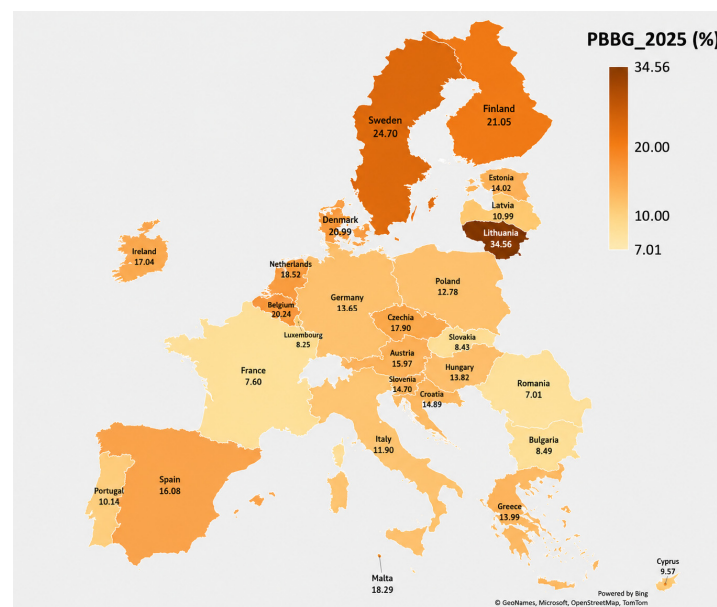


Figure 1. Geographical distribution of the shares of SMEs in the EU27 with web sales—B2B and B2G (PBBG) in 2025. Source: prepared by authors based on data series ESELS and powered by Bing.

Compared to the shares of SMEs with web sales B2B and B2G (PBBG), at the level of 2025 the shares of SMEs with web sales B2C (PBC), in 22 of the 27 EU27 countries, including at the EU27 level, PBC were higher than PBBG with values ranging between 0.01 percentage points in Finland, and 11.71 percentage points in Cyprus, at the EU27 level the difference being 3.47 percentage points. In the other five countries (the Netherlands, Croatia, Belgium, Sweden and Lithuania), the differences were negative with values ranging between −0.73 percentage points in the Netherlands and −7.75 percentage points in Lithuania.

In absolute values, the shares of SMEs with web sales B2C (PBC) ranged between 10.26%, a value recorded in Luxembourg (Figure 2) and 29.84%, a value recorded in Malta. High values were also recorded in Ireland (27.53%), Lithuania (26.81%) and Sweden (23.32%), 10.60, 9.88 and 6.39 percentage points above the EU27 average (16.93%). At the opposite pole, next to Luxembourg were Slovakia (8.43%), Luxembourg (8.25%) and France (7.66%). Finally, around the EU27 average were Romania (11.93%), Slovakia (13.39%), Bulgaria (13.60%), France (13.89%) and Croatia (14.15%).

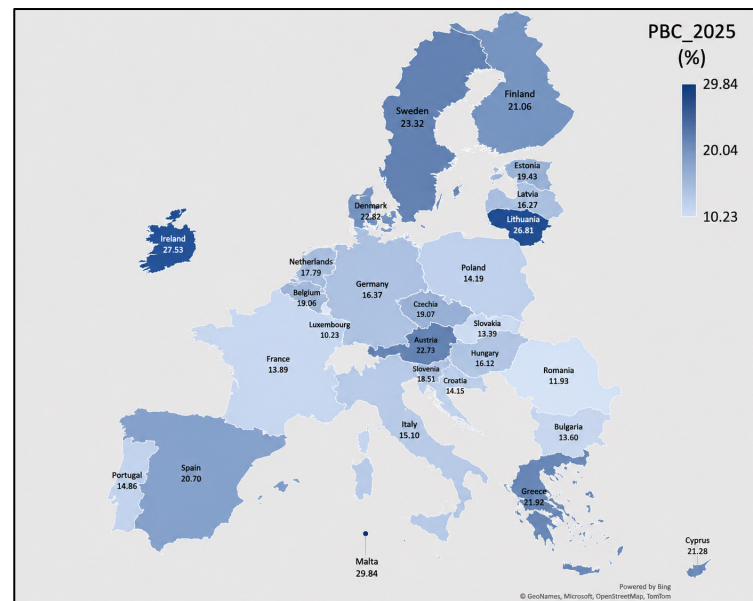


Figure 2. Geographical distribution of the shares of SMEs in the EU27 with web sales—B2C, in 2025. Source: prepared by authors based on data series ESELS and powered by Bing.

To highlight the changes that occurred between 2019 and 2025 in the use of e-commerce by SMEs, Figure 3 presents the distributions by value groups of the shares of SMEs in the four categories analyzed in 2019 and 2025.

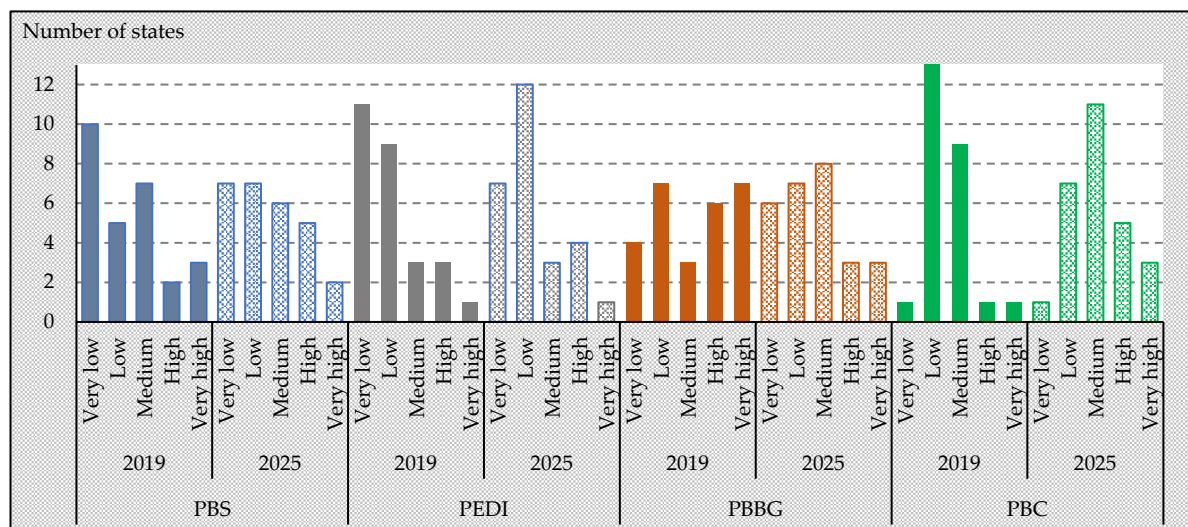


Figure 3. The distributions by value groups of the shares of SMEs with e-commerce sales weights in 2019 and 2025. Source: prepared by the authors based on ESELS data series.

In the case of SMEs with e-commerce sales of at least 1% turnover in 2019, there were three countries in the Very high values of PBS (Ireland, Denmark and Sweden) group, and two countries in the High values of PBS (Belgium and Czechia) group, representing together 18.52% of the total, and 15 countries (55.56%) in the Low and Very low values of PBS groups. In 2025, although the number of countries in the Very high values of PBS group drops to two (Denmark and Lithuania), the number of countries in the High values of PBS group reaches five (Malta, Ireland, Belgium, Sweden and Finland), representing together 25.93% of the total, while the number of countries in the Low and Very low values of PBS groups drops to 14 (51.85%), which leads to a much more balanced distribution.

A trend towards balancing the distribution of states by values groups is also recorded in the case of SMEs with web sales—B2B and B2G; however, unlike SMEs with e-commerce sales of at least 1% turnover, here the trend towards uniformity occurs by reducing the share of states in the High and Very high values of PBBG groups from 13 states (48.15%) in 2019, to six states (22.22%) in 2025, and by increasing the share of states in the Low and Very low values of PBBG groups from 11 (40.74%) in 2019, to 13 (48.15%) in 2025.

In the case of SMEs with EDI-type sales, the differences between countries regarding PEDI values remain significant. Thus, in 2019, only Ireland was in the Very high values of PEDI range, and in the High values of PEDI range there were three countries (Denmark, Sweden and Czechia) representing a total of 14.81%, and in the Low and Very low values of PEDI ranges there were 20 countries (74.07%). In 2025, only five countries were in the High and Very high values of PEDI range (Denmark in Very High, and Belgium, Finland, Sweden and Ireland in High) representing 18.52% of the total, while in the Low and Very low values of PEDI ranges there were 19 countries (70.37%). The most significant changes in the distribution of states by values groups occurred in the case of SMEs with web sales—B2C. Thus, if in 2019 the Very low and Low values of PBC group included 14 states (51.85%), and the High and Very high groups included only two states (Ireland and Belgium), representing a total of 7.41%, in 2025 the share of states included in the Low and Very low values of PBC groups decreases to 29.63% (Luxembourg in Very low, and Romania, Slovakia, Bulgaria, France, Croatia, Poland and Portugal in Low), and the share of states included in the High and Very high groups increases to 29.63% (Malta, Ireland and Lithuania in Very high, and Sweden, Denmark, Austria, Greece and Cyprus in High).

The values of the concentration coefficients recorded in 2019 and 2025 (Table 3) also highlight a reduction in the concentration of high values of the shares of SMEs with e-commerce sales in some EU27 states (values $G_{2025} < G_{2019}$, $S_{2025} > S_{2019}$) which highlights an increase in the interest of SMEs, which had lower shares of e-commerce use in 2019, towards these forms of trade.

Table 3. Concentration coefficient values of the shares of SMEs with e-commerce.

Variable	2019		2025	
	Gini	Shannon	Gini	Shannon
PBS	0.20856	3.21057	0.20247	3.24291
PEDI	0.22561	3.12412	0.22059	3.24291
PBBG	0.20737	3.21131	0.19886	3.26249
PBC	0.20392	3.23599	0.20111	3.24715

Source: values determined by the authors based on ESELS data series.

It can be seen that there are differences between the EU27 member states not only in terms of the degree of use of e-commerce, but also in terms of the digitalization model adopted by SMEs. Thus, a high level of digital maturity and advanced integration in value chains is observed in Lithuania, Denmark and Sweden, which simultaneously record high values for both sales via websites (especially B2B/B2G) and for EDI sales, while at the opposite pole are Romania, Bulgaria and Slovakia, where the adoption of integrated digital solutions remains limited.

Digital demand and its characteristics can be considered another important argument regarding the differences between countries. In countries such as Ireland, Denmark and Sweden, where a high proportion of the population uses the internet to purchase goods and services and has developed digital skills, SMEs benefit from an internal market favourable to the expansion of e-commerce. In contrast, in Romania and Bulgaria, where the level of digital skills and online shopping is lower, businesses face a more limited internal demand

for e-commerce. This highlights that the development of e-commerce depends both on the digital offer of businesses and on the degree of digitalization of consumers.

An accelerated development of the digital ecosystem can be observed in Lithuania, which recorded in 2025 the highest share of SMEs with B2B/B2G web sales (34.56%) and one of the highest shares for B2C sales (26.81%). In contrast, Romania, although it recorded one of the highest average annual growth rates for B2B/B2G web sales (12.17%), continues to occupy the last place in the EU27 in terms of the level of this indicator (7.01%). This situation highlights the fact that high growth dynamics, starting from a low initial level, are not sufficient to quickly eliminate gaps with the most digitalized economies. In terms of value of e-commerce registered by SMEs, the available data are less than in the case of shares of SMEs with e-commerce sales, for five countries (Italy, Luxembourg, Poland, Slovenia and Finland) the data series corresponding to the analyzed period being unavailable or incomplete. In these conditions, the analysis of shares of turnover of SMEs from e-commerce sales includes only 22 countries.

In the period 2019–2025 of the 22 countries included in the analysis, the average annual rates of share of total turnover of SMEs from e-commerce sales (TECS) in 15 of the 22 countries included in the analysis recorded positive values of R_{TECS} (Table 4), and in seven countries recorded negative values. The highest positive R_{TECS} values were recorded in Bulgaria (17.84%), Greece (14.37%), Latvia (12.37%) and Romania (11.02%), with 15.91, 12.44, 10.44 and 9.08 percentage points above the EU27 average (1.93%). At the same time, in six countries (Estonia, Hungary, Portugal, Sweden, Spain, Czech Republic and France) negative R_{TECS} values were recorded, ranging from -0.70% (Estonia) to -2.36% (France), and in the seventh (Ireland) an R_{TECS} value of -15.17% was recorded.

Table 4. Average annual rates of share of SMEs' total turnover from e-commerce sales (R_{TECS}), SMEs' turnover from EDI-type sales (R_{TEDI}), SMEs' turnover from sales B2B and B2G (R_{TBGG}) and from web sales B2C (R_{TBC}), in the period 2019–2025.

Country	R_{TECS}	R_{TEDI}	R_{TBGG}	R_{TBC}	Country	R_{TECS}	R_{TEDI}	R_{TBGG}	R_{TBC}
Belgium	5.70	6.28	3.67	8.19	Cyprus	7.29	1.30	25.45	-1.19
Bulgaria	17.84	-4.01	36.70	26.27	Latvia	12.37	9.43	12.66	18.96
Czechia	-1.71	-3.27	-3.85	8.33	Lithuania	5.23	-3.93	16.55	-1.26
Denmark	4.39	7.63	-3.12	4.20	Hungary	-0.70	-1.75	3.32	-4.18
Germany	2.23	-2.84	5.29	10.03	Malta	9.76	9.28	6.34	11.55
Estonia	0.78	1.08	-1.13	11.40	Netherlands	6.42	10.23	6.99	-0.87
Ireland	-15.17	-16.34	-12.31	-14.10	Austria	5.54	1.30	10.40	9.94
Greece	14.37	6.48	16.29	16.90	Portugal	-0.89	-1.20	-4.20	3.24
Spain	-1.67	-6.27	-3.58	12.17	Romania	11.02	5.31	9.59	20.87
France	-2.36	-4.84	-4.68	7.67	Slovakia	3.44	1.11	-1.52	22.42
Croatia	4.37	7.01	0.44	6.43	Sweden	-1.55	-7.32	6.70	0.74

Source: calculations performed by the authors based on EVELS data series.

A relatively similar situation is also encountered in terms of SMEs' turnover from EDI-type sales ($TEDI$), with average annual rates (R_{TEDI}) having positive values in 12 countries (ranging from 10.23% in the Netherlands to 1.08% in Estonia) and negative values in 10 countries (ranging from -1.20% in Portugal to -16.34% in Ireland).

As for SMEs' turnover from web sales—B2B and B2G ($TBBG$) and SMEs' turnover from web sales—B2C (TBC), the number of countries with negative values of average annual indices and average annual rates is much smaller. In the case of R_{TBGG} , negative values were recorded in eight countries, ranging from -1.13% in Estonia to -12.31% in Ireland, and in the case of R_{TBC} , negative values were recorded in only four countries, ranging from -0.87% in the Netherlands to -14.09% in Ireland. On the other hand, the

highest values of the average annual rates recorded at the EU27 level were recorded here, of 7.28% in the case of R_{TBC} and 2.76% in the case of R_{TBBG} .

Although the differences between the countries included in the analysis in terms of the share of turnover of e-commerce sales registered in SMEs remain significant throughout the 2019–2025 period, the degrees of concentration of high values of the four indicators analyzed from this point of view in a small number of states is lower in 2025 compared to 2019 (Table 5), a fact highlighted, as in the case of shares of SMEs with e-commerce sales, by the values $G_{2025} < G_{2019}$ and $S_{2025} > S_{2019}$.

Table 5. Concentration coefficient values of the shares of SMEs with e-commerce.

Variable	2019		2025	
	Gini	Shannon	Gini	Shannon
TECS	0.23930	2.96655	0.22311	3.04430
TEDI	0.25735	2.88306	0.24427	2.94008
TBBG	0.23690	2.96360	0.23317	3.00187
TBC	0.23945	2.96272	0.22288	3.04732

Source: values determined by the authors based on EVELS data series.

In 2019, the highest degree of concentration was recorded at TEDI ($G_{2019}^{TEDI} = 0.25735$), and the lowest at TBBG ($G_{2019}^{TBBG} = 0.23690$). In 2025, the highest degree of concentration was also recorded at TEDI ($G_{2025}^{TEDI} = 0.24427$), and the lowest at TBC ($G_{2025}^{TBC} = 0.22288$). Graphically, the differences between the extreme values are also highlighted by the corresponding Lorenz curves (Figure 4).

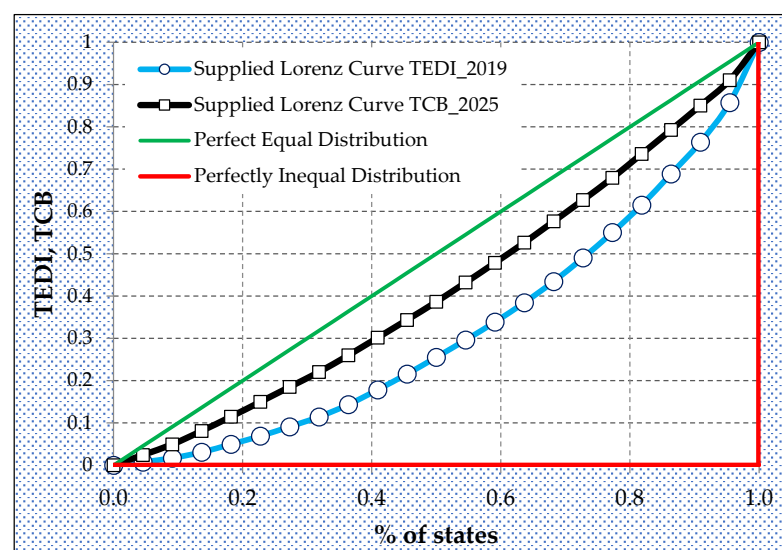


Figure 4. Lorenz curves corresponding to the concentration degrees of $TEDI_{2019}$ and $TEDI_{2025}$. Source: developed by the authors based on the EVELS data series.

The analysis of the degree of concentration of e-commerce revenues highlights a trend towards a more balanced distribution of these revenues across the EU27 member states. The reduction in the Gini coefficients and the increase in the Shannon indices for all four forms of e-commerce show that e-commerce revenues are no longer concentrated in a small number of highly digitalised economies, but are increasingly generated by countries that, in 2019, recorded low levels of these indicators. However, the pace of this process differs depending on the form of e-commerce. While revenues generated through web sales, especially in the B2C segment, record the sharpest reduction in concentration, revenues from EDI transactions remain the most concentrated, reflecting the fact that the use of

these systems requires a higher level of digital maturity and deeper integration into supply chains. These results highlight the change in the relative importance of different forms of e-commerce within European economies and confirm hypothesis H1, according to which the concentration trends of different forms of e-commerce lead to changing ratios between them at the level of EU27 member states.

The existence of significant disparities between EU27 member states regarding the share of SMEs with e-commerce sales of at least 1% turnover (PBS), with EDI-type sales (PEDI), with web sales—B2B and B2G (PBBG) and with web sales—B2C (PBC) was also analyzed using the hierarchical clustering methodology. For a more comprehensive perspective, in addition to the four indicators regarding SMEs, two more indicators were used to highlight the characteristics of individuals who used the internet for purchasing goods or services: the share of individuals who used the internet for buying goods or services within the last year (PIBGS) and share of individuals with basic or above basic overall digital skills (PIBDS).

Based on these six indicators and taking into account that an appropriate cluster solution could be defined as the solution at which the reduction in SSE slows dramatically [33], a structure with six clusters resulted (Table 6), the most numerous being cluster C which includes eight states, and the least numerous being clusters B and F which include only two states each. The dendrogram of cluster generation is presented in Figure 5.

Table 6. Cluster structure for 2025.

Cluster	Cluster Structure
A	Belgium, Denmark, Ireland, Finland, Aweden
B	Lithuania, Malta
C	Czechia, Germany, Estonia, Spain, Croatia, Netherland, Austria, Portugal
D	Greece, Italy, Cyprus, Latvia, Hungary, Poland, Slovenia
E	France, Luxembourg, Slovachia
F	Bulgaria, Romania

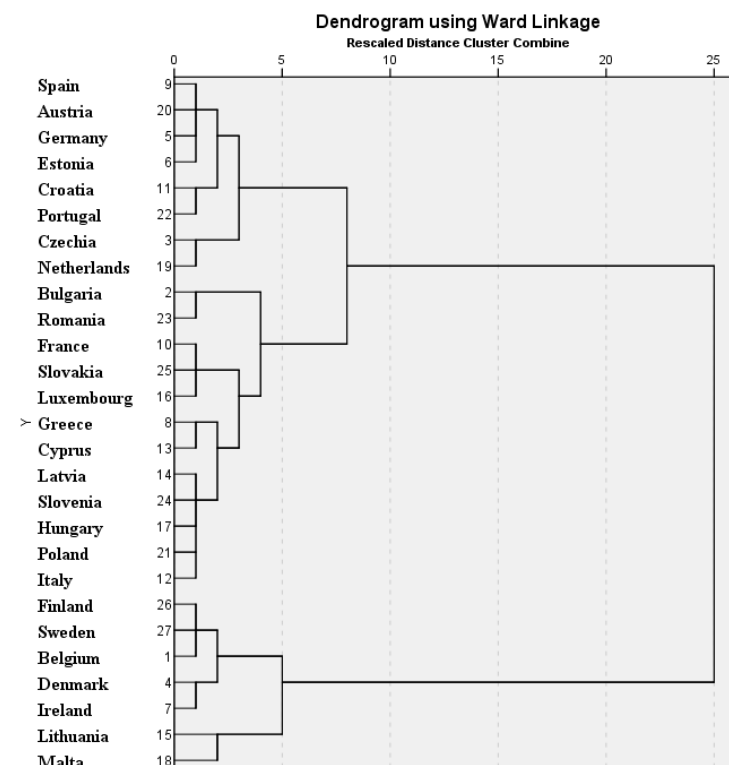


Figure 5. Dendrogram of cluster generation.

The statistical significance of differences in the mean values of the variables across the identified clusters was assessed using the Welch test (Robust Test of Equality of Means) under the null hypothesis that the mean values are statistically insignificant (do not differ significantly from zero). The results obtained (Table 7) highlight the fact that, for all six variables the significance values (Sig.) were lower than the significance level ($\alpha = 0.05$). Therefore, the null hypothesis is rejected and, consequently, the values of the six variables are statistically significant.

Table 7. Welch (Robust Test of Equality of Means).

Variable	Statistic ^a	df1	df2	Sig.
PBS	47,490	5	5.780	0.000
PEDI	12,112	5	6.021	0.004
PBBG	23,543	5	4.923	0.002
PBC	15,599	5	5.585	0.003
PIBGS	7841	5	4.619	0.025
PIBDS	14,360	5	5.934	0.003

^a. Asymptotically F distributed.

The cluster characteristics (Table 8) also highlight the disparities between EU27 member states regarding the share of SMEs with e-commerce and the characteristics of individuals who used the internet for buying goods or services. These findings also highlighted by the results obtained above regarding the increase in concentration degrees.

Table 8. Characteristics of the clusters in 2025.

Cluster	Variable					
	PBS	PEDI	PBBG	PBC	PIBGS	PIBDS
A	31.67	11.37	20.80	22.76	76.39	88.20
B	33.89	5.61	26.43	28.33	64.92	73.20
C	22.14	6.07	15.15	18.14	71.18	79.40
D	18.04	3.28	12.54	17.63	56.67	71.47
E	13.30	3.74	8.09	12.50	63.36	82.77
F	13.72	2.41	7.75	12.77	39.12	60.29

In the last two decades, e-commerce has expanded in most member states, but this development has not been sufficient to eliminate the structural differences between economies, as can also be seen from the cluster analysis. The existence of six distinct clusters, from the leading group formed by Belgium, Denmark, Ireland, Finland and Sweden to the Bulgaria–Romania cluster, shows that countries continue to evolve at different levels of digital maturity.

Analyzing the differences for the six variables taken into account, we will see that they are significant. For example, the share of SMEs using e-commerce (PBS) is 33.89% in cluster B, compared to only 13.72% in cluster F, and the proportion of people with basic or above-basic digital skills (PIBDS) varies between 88.20% in cluster A and 60.29% in cluster F. These differences suggest that the performance of e-commerce is closely linked to the level of digitalisation of the population and the economy.

Therefore, although e-commerce has developed and continues to develop at EU27 level, member states remain segmented into relatively homogeneous groups from the perspective of e-commerce and digital skills development, which confirms hypothesis H2. This segmentation reinforces the conclusions formulated for H1, demonstrating that the evolution of different forms of e-commerce is not uniform and leads to changes in the relationships between them within the European Union.

The evolution of the value of e-commerce sales registered in SMEs during 2019–2025 highlights the importance of this type of trade in increasing the efficiency of SMEs activities, as well as the positive results of the increase in the shares of SMEs with e-commerce sales. In order to verify the impact of each category of SMEs with e-commerce sales on their turnover from e-commerce, correlation coefficients were determined.

The values of the correlation coefficients between shares of SMEs with e-commerce sales and share of SMEs' turnover from e-commerce sales (Table 9) highlight the existence of significant correlations between the four pairs of indicators.

Table 9. Correlation coefficients and significance tests between e-commerce adoption and turnover indicators.

Observations	161	$F_{0.05;1;159}$	3.90061
Variables	Value	F_{calc}	Sig.F
$r_{TECS/PBS}$	0.715441	166.722843	1.52436×10^{-26}
$r_{TEDI/PEDI}$	0.819798	325.861468	2.45477×10^{-40}
$r_{TBBG/PBBG}$	0.736692	188.703419	8.24115×10^{-29}
$r_{TBC/PBC}$	0.627451	103.244078	5.28308×10^{-19}

Source: values determined by the authors based on the ESELS and EVELS data series.

The obtained values being positive, it results that an increase in the shares of SMEs with e-commerce sales lead to an increase in the shares of SMEs' turnover from e-commerce sales. Taking into account the coefficient values, it results that between PEDI and TEDI there is a very strong positive correlation, between PEB and TECS, as well as between PBBG and TBBG there is a strong positive correlation and between PBC and TBC there is a moderately strong positive correlation.

The turnover volumes obtained by SMEs through the use of different forms of e-commerce depend, in addition to the share of their implementation and use, on a series of other factors that lead to differentiated developments between EU27 countries. To highlight this aspect, the influence of the share of SMEs with e-commerce sales (PBS) and the characteristics of individuals who used the internet for buying goods or services (PIBGS and PIBDS) on the share of SMEs' total turnover from e-commerce sales (TESC) was analyzed using the model of the form:

$$TBS = a_0 + a_1 \cdot PBS + a_2 \cdot PIBGS + a_3 \cdot PIBDS$$

Based on the available time-series data covering only the 2021–2025 period and only for 22 of the 27 EU member states (as data for Italy, Luxembourg, Poland, Slovenia and Finland were unavailable or only partially available) the following model was estimated:

$$\widehat{TBS} = -4.802 + 0.320 \cdot PBS + 0.184 \cdot PIBGS + 0.056 \cdot PIBDS \quad (6)$$

The model characteristics (Table 10) highlight the fact that the estimated model is statistically significant and explains approximately 58% of the variation in the TBS variable. Of the four coefficients, the first (the intercept) although not economically significant, is statistically significant for a confidence coefficient of 95%, PBS and PIBGS are statistically significant for a confidence coefficient of 99%, and the fourth (PIBDS) only for 90%. However, taking into account the relatively short time series available due to the aspect highlighted above, the inclusion of PIBDS in the model was considered appropriate despite its lower level of statistical significance.

Table 10. Characteristics of the estimated model of the relationship between TESC, PBS, PIBGS and PIBDS.

Observations = 115	R ² = 0.579	Adjusted R ² = 0.568	F = 50.911	p < 0.001
Variables	Value	t Stat	p-Value	
Intercept	−4.802	−2.571	0.011	
PBS	0.320	7.063	<0.001	
PIBGS	0.184	5.366	<0.001	
PIBDS	0.054	1.733	0.086 *	

* Significant for 90% ($\alpha = 0.10$). Source: values determined by the authors based on the EVELS, IHBGS and IHBOS data series.

Also, the results of testing the Ordinary Least Squares (OLS) hypotheses, presented in Table 11, highlight that the model is robust and can be taken into account in formulating conclusions.

Table 11. Testing the hypotheses of the least squares method.

Hypothesis	Test	Value	p-Value
Normality	Shapiro–Wilk	W = 0.988	0.412
Homoscedasticity	F	F = 2.683	0.104
	White	LM = 10.253	0.330
Statistics VIF			
Multicollinearity	PBS	PIBGS	PIBDS
	1.543	2.097	2.443
Autocorrelation	Durbin–Watson	DW = 1.945	No autocorrelation

Source: values determined by the authors based on the EVELS, IHBGS and IHBOS data series.

An analysis of the results obtained, namely the contributions of the share of individuals who used internet for buying goods or services within the last year (PIGBS) and the share of individuals with basic or above basic overall digital skills (PIBDS) to the increase in the share of SMEs' total turnover from e-commerce sales (TBS), correlated with their values recorded at the cluster level (Table 8), indicates that the disparities between states such as Bulgaria and Romania, on the one hand, and Belgium, Denmark, Ireland or Sweden, on the other, are largely explained by the substantial differences between their shares, 1.95 times lower in the case of PIBGS, and 1.46 times lower in the case of PIBDS.

5. Conclusions

Although there is a general trend towards increasing e-commerce use, there is still a digital divide between the EU27 economies. The Nordic and Baltic countries have higher values than the south-eastern European countries in terms of the share of SMEs using B2B/B2G (PBBG) and B2C (PBC) online sales. However, the acceleration of the digitalisation and convergence process can be confirmed for the period analyzed (2019–2025) by the increase in the number of countries in the medium and high categories of SMEs participation in e-commerce.

The analysis of e-commerce revenues shows that they differ by channel. Thus, even if revenues from web sales to consumers (B2C) are more evenly distributed in the EU, they generate a lower economic effect than those from B2B/B2G relationships and the use of EDI. Countries where SMEs use EDI tend to achieve a higher share of turnover through this channel ($R^2 = 0.672$) compared to simple B2C online sales ($R^2 = 0.394$). The competitive advantages generated by EDI are concentrated in more digitally advanced economies. Consequently, the economic impact differs significantly depending on the type of digital integration achieved by SMEs.

The limitations of the paper lie firstly in the fact that the study is based on aggregated country-level data for the EU27, limiting the possibility of capturing firm-level heterogeneity among SMEs, and secondly, the regression models examined bivariate relationships between the adoption of e-commerce channels and turnover generated by these channels without taking into account other factors such as economic development or digital infrastructure. These limitations could be addressed through future research that identifies the determinants and economic effects of SMEs digitalization using firm-level panel data and multivariate econometric models.

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