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Challenges of the MSE sector in the digital economy in Poland and Ukraine: comparative and statistical analysis

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Abstract

Purpose – The authors aimed to examine how the level of digitalization in Poland and Ukraine affects the contribution of small and medium-sized enterprises (SMEs) to the countries' gross domestic product (GDP).
Design/methodology/approach – The study involved a comparative analysis and statistical modeling of the impact of key economic factors on the contribution of SMEs to Poland's and Ukraine's GDP in the 2010–2020 period. The authors used principles of the theory of economic growth and calculated the coefficient of digital competitiveness as a composite indicator consisting of a number of global indices.
Findings – The study revealed significant differences between both countries, which can be attributed to a higher level of digitalization in Polish SMEs. The authors used the Polish experience to recommend how to reform Ukraine's digital economy in postwar recovery.
Originality/value – The contribution of SMEs to Poland's GDP is higher than that of Ukraine's because of the higher entrepreneurship rate in the Polish micro and small enterprises (MSEs) sector. The authors found that a unit change in the integrated coefficient of digital competitiveness is related to the greatest change in the contribution of SMEs to the country's GDP when the other factors in the model equation remain fixed.

Keywords MSEs, Digital economy, Digitalization, Poland, Ukraine, GDP, Micro and small enterprises, Business, Competitiveness
Paper type Research paper

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1. Introduction

Digitalization is becoming increasingly significant in the economy, particularly with the advent of the fourth industrial revolution and plays a crucial role in increasing factor productivity. Through automation and artificial intelligence (AI), the digital economy has the potential to transform economic and business structures, leading to improved performance (Yuan *et al.*, 2021). Micro and small enterprises (MSEs) are vital for employment generation, economic growth and addressing societal needs, making them crucial for achieving the Sustainable Development Goals. Researchers have focused on various aspects of digitalization in MSEs, including digitalization barriers (Rupeika-Apoga & Petrovska, 2022); possibilities of using digital technologies during crises (Khurana, Dutta, & Ghura, 2022); business model challenges in internationalization and its impact on entrepreneurial orientation and the internationalization rate (Herve, Schmitt, & Baldegger, 2020); regional aspects of digitization of processes in MSEs (Miniesy, Shahin, & Fakhreldin, 2021; Falentina, Resosudarmo, Darmawan, & Sulistyaningrum, 2021; Kimuli, Sendawula, & Nagujja, 2021; Meher *et al.*, 2021; Malodia, Mishra, Fait, Papa, & Dezi, 2023). To the best of our knowledge, scholars have not thoroughly investigated the impact of a country's digital competitiveness (in particular that of Poland and Ukraine) on the contribution of small and micro-businesses to its gross domestic product (GDP).

Therefore, we aimed to examine how the level of digitalization in Poland and Ukraine affects the contribution of small and micro-businesses to the countries' GDP. To achieve this aim, we formulated the following objectives:

(1) Compare the digital competitiveness of Poland and Ukraine. For this purpose, we selected five worldwide rankings, i.e. World Digital Competitiveness Ranking (WDCR), Networked Readiness Index (NRI), Global Connectivity Index (GCI, Huawei), Global Innovation Index (GII) and Global E-Government Development Index (EGDI).

(2) Compare the state of the MSE sector in Poland and Ukraine using relative indicators, such as the contribution of the MSE sector to its GDP, employment in the MSE sector and the propensity of the country's population to create MSEs.

(3) Construct the coefficient of digital competitiveness and use it to compare Poland and Ukraine.

(4) Assess the relationship between the country's level of digital competitiveness and the contribution of the MSE sector to its GDP.

To fulfill the article's aim, we used statistical multivariate regression analysis to determine the relationship between the level of the country's digital competitiveness, the number of active small and medium-sized enterprises (SMEs) and the contribution of the MSE sector to its GDP. We determined the level of the country's digital competitiveness according to the integrated coefficient of digital competitiveness (ICDC) calculated as a composite indicator of a number of global indices.

The article is structured as follows. The next section will describe the theoretical background and review the literature on the digitalization's impact on economic growth and the functioning of micro and small-sized enterprises. Next, we will describe the methodological aspects. The main section will analyze the results. It will be divided into three parts: a comparison of Poland and Ukraine in terms of digital competitiveness; the presentation of results concerning the current state and the development dynamics of the Polish and Ukrainian MSE sectors; the presentation of a model used to determine the relationship between the level of a country's digitalization and the contribution of the MSE sector to its GDP. The final part will present conclusions, recommendations for both countries, study limitations and future research suggestions.

2. Literature review

2.1 Digitalization and economic growth

In economy, digitalization plays a significant role in affecting factor productivity. Moreover, it has increased over the years. By deriving benefits from automation and AI, companies in a digital economy can transform their economic and business structure and improve their performance. Digitalization can change business dynamics, institutional quality and organizational structure of economic entities (Yuan *et al.*, 2021) and accelerate the economic growth. Micro and small enterprises play a critical role in the economy by creating employment (particularly for vulnerable population groups), contributing to economic growth and addressing societal needs. (International Labor Organization, 2021). For these reasons, there is a growing body of research on the digitalization's impact and activity of MSEe on economic growth. The problem has gained special relevance in the contexts of the COVID-19 pandemic and the war in Ukraine, which have created an uncertain and unstable environment for economic entities. Now, it becomes evident that businesses need to respond flexibly to threats and challenges and that business processes of enterprises and government agencies need to be digitalized. When analyzing the impact of digitalization on economic growth, we considered general theoretical issues (Cavallo & Ghezzi, 2021; Georgescu, Androniceanu, Kinnunen, & Dragulanescu, 2021; Ivanovic-Dukic, Stevanovic, & Radenovic, 2019; Novikova, Khandii, Shamileva, & Olshanskyi, 2022) and studies in which scholars investigated this impact at the regional level (Habibi & Zabardast, 2020; Hosan, Karmaker, Rahman, Chapman, & Saha, 2022; Iddrisu & Chen, 2022; Myovella, Karacuka, & Haucap, 2020; Nguyen, 2021; Vyshnevskyi, Stashkevych, Shubna, & Barkova, 2020).

2.2 Digitalization of micro and small-sized enterprises

Digital tools bring many significant benefits to firms. They reduce transaction costs by providing better and quicker access to information and communication between staff, suppliers and networks. They can help SMEs enter global markets by reducing costs associated with transport and border operations and they significantly enhance SMEs ability to trade services. Moreover, digital tools facilitate access to resources, including finance (e.g. peer-to-peer lending), training and recruitment channels, including government services, which are increasingly available online. They also support innovation, greater access to innovation assets and enable firms to generate data and analyze their own operations in new, more effective ways (OECD, 2021). Researchers are interested in various aspects of digitalization in MSEe, such as digitalization barriers, including the lack of appropriate financing options, IT security issues, employees' insufficient digital skills, the shortage of specialists in the external labor market, internal resistance to change, managers' lack of knowledge on how to implement digital technologies (Rupeika-Apoga & Petrovska, 2022); SMEs' use of digital technologies during a crisis, which leads to the emergence of resilience as a dynamic capability at the macro or ecosystem level (Khurana *et al.*, 2022); the use of digitalization to overcome business model challenges in SME internationalization (Reim, Yli-Viitala, Arrasvuori, & Parida, 2022); digitalization as a factor in increasing the level of entrepreneurial orientation and internationalization speed (Herve *et al.*, 2020).

Several country-specific studies have explored digitalization in the MSE sector focusing on Egypt (Miniesy *et al.*, 2021), Indonesia (Falentina *et al.*, 2021), Uganda (Kimuli *et al.*, 2021) and India (Meher *et al.*, 2021; Malodia *et al.*, 2023). Fauzi and Sheng (2022) focused on digitalization undertaken by Indonesian micro, small and medium-sized enterprises (MSME) specializing in online food delivery services (Fauzi & Sheng, 2022)

Our study based on the theory of economic growth and suggests that we may see digital transformation as an example of technological changes, which occur in each economy and society. Proponents of neoclassical economic theory (Solow), endogenous

growth theory (Romer) and evolutionary growth theory (Freeman) all agree that technological change is a crucial factor in economic growth. In particular, endogenous growth theory emphasizes the role of technological change as an important driver of economic growth (Olczyk & Kuc-Czarnecka, 2022).

Based on the literature review, we hypothesized:

H1. The entrepreneurship rate in the MSE sector determines the level of a country's economic development.

H2. The level of a country's digital competitiveness significantly affects the contribution of the SME sector to its GDP.

3. Method and data

Key data for the study came from global indices, which, as it turned out, present a number of challenges. Researchers calculate different indices at different intervals, in some cases only once every two years (the Global EGDI). Moreover, indices also differ in when they started to publish their data online and how many countries they cover. For example, the GCI, Huawei dates back to 2014 and the WDCR – to 2017. To solve the problem of missing data, we created regression equations for indicators with missing values and estimated the determination coefficient.

We treated the five global indices as independent variables and combined them into a single composite indicator, i.e. the ICDC. It represents the level of a country's digital competitiveness, which we calculated according to formula (1):

$$I_{int} = \frac{1}{\sqrt[5]{I_1 * I_2 * I_3 * I_4 * I_5}} \tag{1}$$

in which:

I_1 – WDCR;

I_2 – NRI;

I_3 – GCI, Huawei;

I_4 – GII;

I_5 – Global EGDI.

We used ICDC to analyze the level of digital competitiveness of small and micro-business enterprises in Poland and Ukraine. A higher value of this indicator corresponds to a higher level of digital competitiveness.

In the last stage, we determined the relationship between the level of digital competitiveness in each country and the contribution of the MSE sector to its GDP by calculating and assessing the equation of a multivariate regression model. Noteworthy, this approach offers the possibility of applying other analytical methods, such as correlation analysis based on Pearson correlation coefficients; factor analysis to select the most significant factor; discriminant analysis of the impact of measure segmentation; analysis of classification trees for studying the tree of goals, analysis of average index values in each period and modeling to forecast future values of the indicators. Simultaneously, the multivariate regression helped us identify the most significant factors affecting the SME sector's contribution to Ukraine's GDP. Furthermore, the regression analysis results guided us in suggesting potential paths for Ukraine's economic recovery and growth after the war.

We used the multiple regression model to determine how the digitalization level in Poland and Ukraine affects the contribution of small and micro-businesses to the countries' GDP. The formula was:

$$\tilde{y}_x = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3, \quad (2)$$

in which:

x_1 – the ICDS (Variable 1);

x_2 – the number of active business entities per 10,000 people (Variable 2);

x_3 – the percentage of the country's workforce employed in SMEs (Variable 3);

y – the percentage contribution of the SME sector to the country's GDP, the effective factor, (during the calculations of the regression model using the SPSS software, this factor was designated as Variable 4);

b_o – intercept;

b_1 – partial regression coefficient on the first factor, which represents by how many units, on average, the effective factor changes when the ICDC changes by one by one point;

b_2 – partial regression coefficient on the second factor, which represents by how many units, on average, the effective factor changes when the number of active business entities per 10,000 people changes by one unit;

b_3 – partial regression coefficient on the third factor, which represents by how many units, on average, the effective factor changes when the percentage of the country's workforce employed in SMEs increases by 1%.

We sourced the data for our analysis from these global organizations and research institutions: IMD World Competitiveness Center, Portulans Institute, Huawei, World Intellectual Property Organization and the United Nation. Information about MSEe in both countries came from Statistics Poland and Ukraine's State Services of Statistics and Ministry of Finance.

The reference period for the analysis covered the decade 2010–2020, which saw significant changes in production processes at small and medium-sized enterprises and the widespread use of electronic document management.

4. Results and discussion

4.1 Comparison of Poland and Ukraine in terms of digital competitiveness

The competitiveness of a country's economies and businesses hinges on their readiness to function in uncertain conditions, confront challenges and adapt swiftly to changing business environments. The COVID-19 pandemic and the Russian Federation's war in Ukraine have shown how vulnerable supply chains can be and the impact of limited digitalization on the economy and other aspects of life. On March 9, 2021, the European Commission presented Europe's Digital Compass illustrating the significance of digitizing various aspects of public life. This compass outlines "a vision and avenues for Europe's digital transformation by 2030" (EU, 2021).

We used five global rankings to analyze Poland's and Ukraine's digitalization level, i.e. the WDCR, the Network Readiness Index (NRI), the GCI, the GII and the Global EGDI.

WDCR, NRI and GCI assess the use of digital technologies in business; GII measures the climate and infrastructure for innovation, while EGDI measures the development of e-government. We considered all these indices in the form of a composite indicator: the ICDC.

According to WDCR data shown in Figure 1, between 2014 and 2020 Poland improved its digital competitiveness in the ranking of 64 countries by seven places moving from 39th to 32nd place. When we analyzed the index in terms of its component factors (knowledge, technology and future readiness) [1], we found that we can attribute Poland's improvement to positive change with respect to the knowledge factor resulting from improvements in scientific concentration, which started in 2017. However, in 2020, Poland registered a decline in the factors of technology and future readiness (which was due to a fall by five places in terms of the business agility subfactor).

Within the same period, Ukraine's position in the WDC ranking was significantly lower. We observed the smallest gap between the two countries in 2014 when Poland was ranked 39th and Ukraine 50th. From 2015, Ukraine' digital competitiveness gradually declined, causing the gap between Poland and Ukraine to grow. The discrepancy was the biggest in 2019 (27 places) when Poland was ranked 33rd and Ukraine 60th.

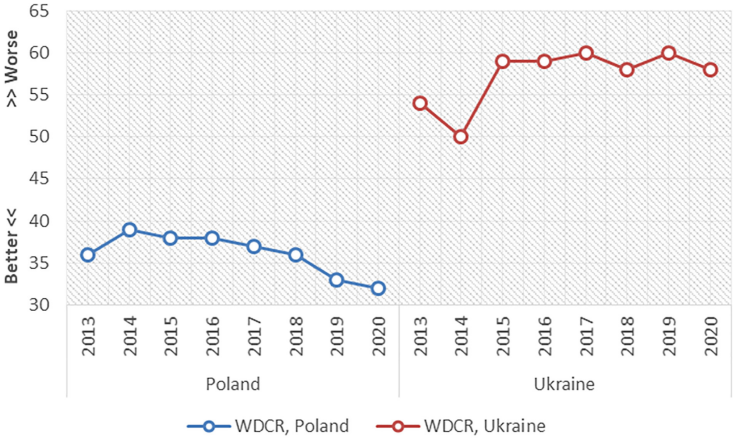
Regarding the NRI in Figure 2, we observed a positive trend for Poland and Ukraine starting from 2014. However, throughout the reference period (2010–2020), we noticed a considerable gap between both countries, which ranged from 20 to 30 places.

Furthermore, Figure 2 shows data for the GII, which indicate positive changes in both countries. While the gap between Poland and Ukraine remains, it decreased from 14 places in 2010 to seven places in 2020.

A comparison of Poland and Ukraine in terms of GII in Figure 3 indicates Poland's stable advantage regarding various indicators of the information and communication technology (ICT) infrastructure and digital transformation.

Considering the EGDI in Figure 4, it is evident that the gap between both countries kept increasing, despite some improvements registered by Ukraine: the distance grew from nine places in 2010, when Poland was ranked 45th and Ukraine 54th, to 45 places in 2020, when Poland occupied 24th place and Ukraine – 69th place.

Poland significantly outpaced Ukraine in digital competitiveness as measured by the five indices. This advantage becomes evident when a country needs to swiftly shift business processes and depend on e-government services, as was evident during the COVID-19



Source(s): Own elaboration based on data published by imd.org (WDCR), portulansinstitute.org (NRI) and wipo.int (GII)

Figure 1.
Poland's and Ukraine's position in the WDCR: overall performance (2013–2020)

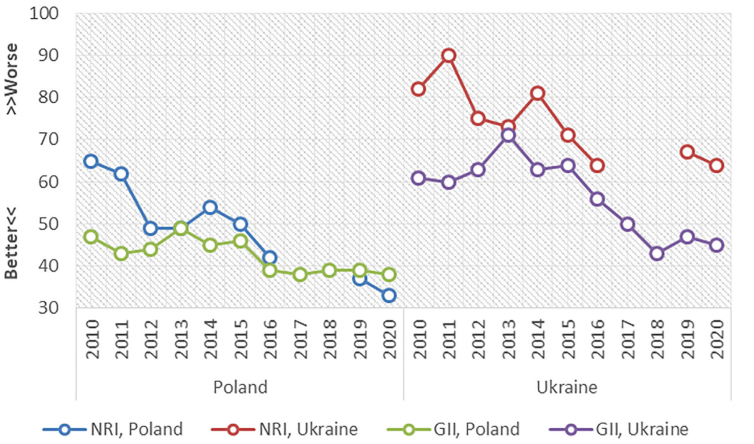


Figure 2.
Poland's and Ukraine's position according to NRI (2010–2016; 2019–2020) and GII (200–2020): overall performance

Source(s): Own elaboration based on data published by imd.org (WDCR), portulansinstitute.org (NRI) and wipo.int (GII)

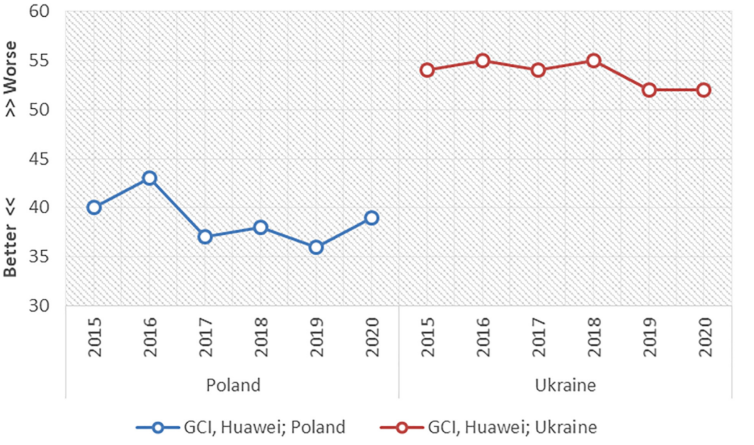


Figure 3.
Poland's and Ukraine's according to the GCI (Huawei) (2015–2020): overall performance

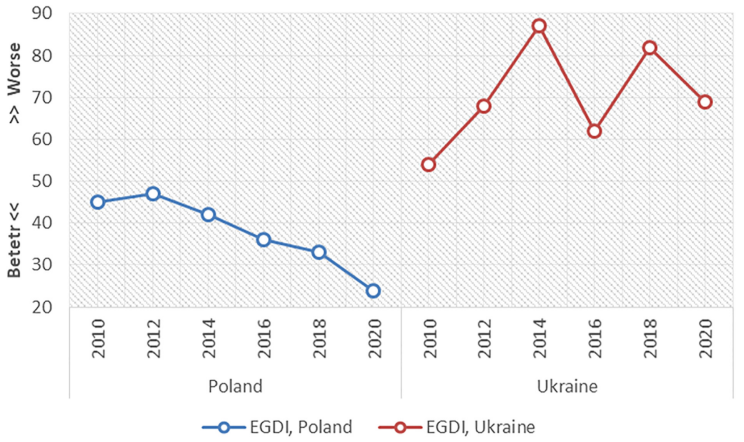
Source(s): Own elaboration based on data by huawei.com (GCI) and un.org (EGDI)

pandemic in 2019. For Ukraine, digital resources have gained strategic significance due to Russia's military aggression that began in 2022.

Because a country's economic development depends on the transparency and ease of doing business and on companies' willingness to meet the challenges of a changing and unpredictable environment, the next section will examine the impact of digital competitiveness on the development of the micro and small business sector.

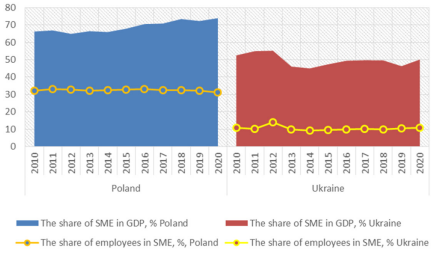
4.2 The MSE sector in Poland and Ukraine

The significance of the MSE sector for the economies of Poland and Ukraine cannot be emphasized enough Figure 5 shows the performance of this sector in the period 2010–2020.



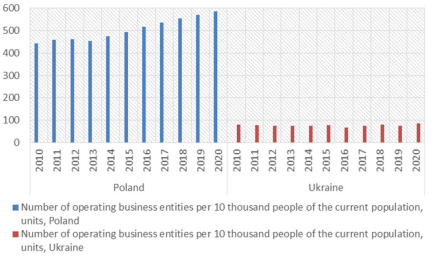
Source(s): Own elaboration based on data by huawei.com (GCI) and un.org (EGDI)

Figure 4.
Poland's and Ukraine's according to the EGDI (2010–2020): overall performance



The contribution of MSE to GDP; the share of employees working in MSEs

(a)



The number of active MSEs per 10,000 people of the population

(b)

Source(s): Own elaboration based on data published by Statistics Poland data and Ukraine's State Services of Statistics

Figure 5.
The performance of the MSE sector in Poland and Ukraine

Throughout that time, the MSE sector in Poland accounted for more than half of the country's GDP: from 66.2% in 2010, it rose to 73.9% in 2020. In contrast, the contribution of the Ukrainian MSE sector in the reference period was never above 55% and in some years it fell below 50%.

The same chart shows the employment level in the SME sector as a percentage of all employees working in each country. While it was relatively stable throughout the reference period, the share of employees working in the Polish SME sector was, on overage, higher by 20% – over 30% vs over 10% in Ukraine (with minor deviations). The 2020 decrease we observed for Poland resulted primarily from the consequences of the pandemic in 2019. According to a PricewaterhouseCoopers (PwC) study (2020), 42.5% of small enterprises in Poland dismissed employees in response to the economic shock caused by the pandemic. The considerably smaller employment in the Ukrainian MSE sectors resulted. from the much smaller number of active SMEs per 10,000 people (Figure 5b). While this indicator was never more than 100 units in Ukraine, it kept increasing in Poland from less than 450 to nearly 600 units.

4.3 The relationship between the level of the country's digitalization, the number of active SMEs and their contribution to the GDP

Data for the five global indices were not available for all years of the reference period. Thus, following Fichman Cummings' recommendations (2003) regarding the treatment of missing data, we calculated a regression line and a coefficient of determination for each of the indices, which we used to determine the position of each country in the year when index values were missing (Table 1).

To compare digital competitiveness in Poland and Ukraine, we considered the absolute values of each index and the country's place in the global ranking. Because the absolute values of different indices had different values, we used the position of each respective state in the overall ranking to determine the relative coefficient for each of the indices, i.e. I1, I2, I3, I4 and I5. We calculated the relative coefficient for each of the indices as the ratio of the country's position in a particular year for the index under study to the total number of countries covered by the ranking (total observation volume).

To account for the impact of all five indices, we plugged the relative coefficient calculated for each of the indices into formula (1) to calculate the ICDC (Table 2).

Figure 6 shows how the ICDC for Poland and Ukraine changed in the period 2010–2020. While the values of ICDC for each country were relatively close in 2010 (2.35 vs 1.92), they kept diverging in the following years. The value for Poland increased to 3.40 in 2020, i.e. by almost 45%. The corresponding value for Ukraine remained more or less at the same level reaching 1.95 in 2020 (up by less than 3%).

We used a multivariate regression model given by formula (2) to measure how the ICDC (VAR1), the number of active SMEs per 10,000 people (VAR2) and the percentage of the country's workforce employed in SMEs (VAR3) affect the contribution of the SME sector to its GDP (VAR 4). Figure 7 shows descriptive statistics of the four variables.

Figure 8 contains coefficients of correlation and determination as well as ANOVA results for each model. In both cases, values of the multivariate correlation coefficient (0.961 for Poland and 0.720 for Ukraine) indicated a high to medium degree of correlation between the three predictors and the performance indicator of the SME sector (VAR4).

Table 1. Rankings calculated for years in which index data were missing

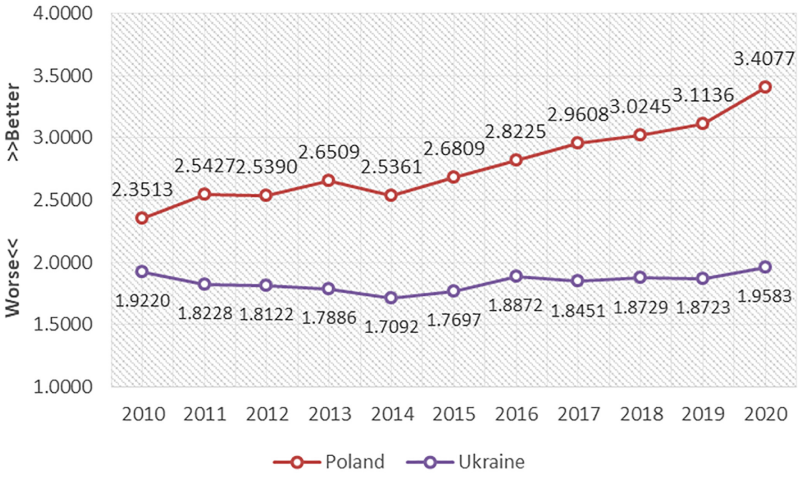
	Year with no data	Poland		Ukraine	
Index		Regression equation: Determination coefficient	Calculated rank	Regression equation: Determination coefficient	Calculated rank
WDCR	2010	$y = -0.2167x+37.75$	40	$y = 0.4167x+54.806$	54
	2011	$R^2 = 0.144$	38	$R^2 = 0.1098$	54
	2012		38		55
NRI	2017	$y = -2.8868x+64.717$	42	$y = -2.1167x+86.636$	69
	2018	$R^2 = 0.8887$	39	$R^2 = 0.7045$	67
GCI	2010	$y = -0.7143x+41.333$	44	$y = -0.2321x^2+1.1107x+53.3$	45
	2011	$R^2 = 0.2896$	43	$R^2 = 0.7115$	48
	2012		43		50
	2013		42		52
	2014		41		53
EGDI	2011	$y = -0.3117x+39.706$	37	$y = 1.9198x+43.722$	61
	2013	$R^2 = 0.1079$	36	$R^2 = 0.6157$	65
	2015		36		69
	2017		35		73
	2019		34		76

Source(s): Authors' own elaboration

Year	WDCR relative coefficient (I1)	NRI relative coefficient (I2)	GCI relative coefficient (I3)	GII relative coefficient (I4)	EGDI relative coefficient (I5)	ICDC (x_1)
			Poland			
2010	0.6177	0.4851	0.5594	0.3561	0.2332	2.3513
2011	0.5932	0.4627	0.5503	0.3258	0.1912	2.5427
2012	0.5898	0.3657	0.5413	0.3333	0.2435	2.5390
2013	0.5625	0.3657	0.5322	0.3712	0.1880	2.6509
2014	0.6094	0.4030	0.5232	0.3409	0.2176	2.5361
2015	0.5938	0.3731	0.5063	0.3485	0.1847	2.6809
2016	0.5938	0.3134	0.5443	0.2955	0.1865	2.8225
2017	0.5781	0.3106	0.4684	0.2879	0.1815	2.9608
2018	0.5625	0.2891	0.4810	0.2955	0.1710	3.0245
2019	0.5156	0.2761	0.4557	0.2955	0.1783	3.1136
2020	0.5000	0.2463	0.4937	0.2879	0.1244	3.4077
			Ukraine			
2010	0.843322	0.61194	0.571438	0.462121	0.279793	1.9220
2011	0.849833	0.671642	0.606063	0.454545	0.316063	1.8228
2012	0.856344	0.559701	0.634813	0.477273	0.352332	1.8122
2013	0.84375	0.544776	0.657686	0.537879	0.335958	1.7886
2014	0.78125	0.604478	0.674684	0.477273	0.450777	1.7092
2015	0.921875	0.529851	0.683544	0.484848	0.355852	1.7697
2016	0.921875	0.477612	0.696203	0.424242	0.321244	1.8872
2017	0.9375	0.512704	0.683544	0.378788	0.375746	1.8451
2018	0.90625	0.496908	0.696203	0.325758	0.42487	1.8729
2019	0.9375	0.5	0.658228	0.356061	0.39564	1.8723
2020	0.90625	0.477612	0.658228	0.340909	0.357513	1.9583

Source(s): Authors' own elaboration

Table 2.
The ICDC for Poland and Ukraine, 2010–2020



Source(s): Authors' own elaboration

Figure 6.
The ICDC for Poland and Ukraine, 2010–2020

The coefficient of determination (*R*-squared) for the Polish model (0.924) was higher than that for the Ukrainian model (0.519), which means that the independent variables explained a greater proportion of the variance in the dependent variable (VAR4). The ANOVA results

Descriptive Statistics

	Mean	Std. Deviation	N
VAR00004	69,0000	3,26527	11
VAR00001	2,7845	0.31361	11
VAR00002	504,5455	51,09279	11
VAR00003	32,4455	0.55202	11

Poland

Descriptive Statistics

	Mean	Std. Deviation	N
VAR00004	49,6455	3,43114	11
VAR00001	1,8418	0.07129	11
VAR00002	76,8182	4,19090	11
VAR00003	10,4545	1,22667	11

Ukraine

Figure 7.
Descriptive statistics of the four variables used in the multiple regression model for Poland and Ukraine

Note(s):
VAR1: the integrated coefficient of digital competitiveness;
VAR2: the number of active SMEs per 10,000 people;
VAR3: the percentage of the country's workforce employed in SMEs;
VAR4: the contribution of the SME sector to the country's GDP

Source(s): Own elaboration based on calculations in SPSS software (decimal commas are used in SPSS software)

showed how much the changes in the three included factors, along with unaccounted-for random factors, influenced the variance in the performance indicator.

The result of the Fisher test for the Polish model was 28.417 (higher than 4.48 – the critical value for the Fisher test), which indicated a high reliability of the regression model at the significance level of 0.05. The corresponding value for the Ukrainian model was 2.516 (less than 4.48), which we can attribute to the low decomposition of the total variance of the performance indicator and the small share of intergroup variance. This is the consequence of the high variability of Ukraine's economic indicators.

Figure 9 contains further coefficients of both models.

In the case of Poland, we calculated the effect of digitalization on the contribution of SMEs to its GDP as follows (2):

$$\tilde{y}_x = 30.658 + 1.308x_1 + 0.055x_2 + 0.218x_3 \quad (2)$$

Multiple regression coefficients show how the contribution of SMEs to the country's GDP changes when a specific factor changes per unit of measurement, with all other factors in the model equation remaining constant. Thus:

(1) When ICDC improved by one point, the contribution of SMEs to Poland's GDP increased by 1.308%;

(2) When the number of SMEs per 10,000 of population rose by one entity, the contribution of SMEs to Poland's GDP increased by 0.055%;

(3) When the share of the country's workforce employed in SMEs increased by 1%, the contribution of SMEs to Poland's GDP increased by 0.218%.

In the case of Ukraine, we calculated the effect of digitalization on the contribution of SMEs to its GDP as follows (3):

$$\tilde{y}_x = 8.617 + 11.763x_1 + 0.011x_2 + 1.771x_3 \quad (3)$$

The multivariate regression coefficients in this model had the following values:

(1) When ICDC improved by one point, the contribution of SMEs to Ukraine's GDP increased by 11.763%;

(2) When the number of SMEs per 10,000 of population rose by one entity, the contribution of SMEs to Ukraine's GDP increased by 0.011%;

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.961[a]	0.924	0.892	1,07506	2,287

a. Predictors: (Constant), VAR00003, VAR00002, VAR00001

b. Dependent Variable: VAR00004

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	98,530	3	32,843	28,417	0.000[b]
	Residual	8,090	7	1,156		
	Total	106,620	10			

a. Dependent Variable: VAR00004

b. Predictors: (Constant), VAR00003, VAR00002, VAR00001

Poland

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.720[a]	0.519	0.313	2,84479	0.519	2,516	3	7	0.142

a. Predictors: (Constant), VAR00003, VAR00002, VAR00001

b. Dependent Variable: VAR00004

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61,077	3	20,359	2,516	0.142[b]
	Residual	56,650	7	8,093		
	Total	117,727	10			

a. Dependent Variable: VAR00004

b. Predictors: (Constant), VAR00003, VAR00002, VAR00001

Ukraine

Source(s): Own elaboration based on calculations in SPSS software (decimal commas are used in SPSS software)

Figure 8.
Model parameters and ANOVA results for Poland and Ukraine, 2010–2020

(3) When the share of the country's workforce employed in SMEs increases by 1%, the contribution of SMEs to Ukraine's GDP increased by 1.771%.

In both cases, we observed the greatest change in the contribution of SMEs to the countries' GDP as a result of improvements in the digitalization level, as measured by the ICDC.

Table 3 summarizes the results of for both multivariate regression models.

Apart from analyzing values of the individual coefficients, we found it necessary to determine how each factor contributes to the final result: in other words, how much of the variance in the contribution of SMEs to the country's GDP we can attribute to each factor. Table 4 presents the results.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations		
		B	Std. Error	Beta	*t*	Sig.	Zero-order	Partial	Part
1	(Constant)	30,658	28,477		1,077	0.317			
	VAR00001	1,308	4,886	0.126	0.268	0.797	0,932	0.101	0.028
	VAR00002	0.055	0.028	0.857	1,971	0.089	0.961	0.597	0.205
	VAR00003	0.218	0.822	0.037	0.265	0.799	−0.440	0.100	0.028

a. Dependent Variable: VAR00004

Poland

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations		
		B	Std. Error	Beta	*t*	Sig.	Zero-order	Partial	Part
1	(Constant)	8,617	24,863		0.347	0.739			
	VAR00001	11,763	13,786	0.244	0.853	0.422	0.359	0,307	0.224
	VAR00002	0.011	0.233	0.013	0.047	0.964	0.190	0.018	0.012
	VAR00003	1,771	0.746	0.633	2,373	0.049	0.677	0.668	0.622

a. Dependent Variable: VAR00004

Ukraine

Figure 9.
Coefficients of the multivariate regression models used to assess how the level of digitalization in Poland and Ukraine affects the contribution of SMEs to the countries' GDP, 2010–2020

Source(s): Own elaboration based on calculations in SPSS software (decimal commas are used in SPSS software)

Indicator	y	x_1	x_2	x_3	y	x_1	x_2	x_3
	Poland				Ukraine			
Multiple regression coefficients (b_i)	30.658	1.308	0.055	0.218	8.617	11.763	0.011	1.771
Average values	69	2.7845	504.5455	32.4455	49.6455	1.8418	76.8182	10.4545
Partial correlation coefficients (r_{yxi})	–	0.932	0.961	0.44	–	0.359	0.190	0.677
Standard deviation (σ_i)	3.2653	0.3136	51.0928	0.552	3.4311	0.0713	4.1909	1.2267
β coefficients (β_i)	–	0.126	0.857	0.037	–	0.244	0.013	0.633
Multiple correlation coefficient (R)			0.961				0.720	

Table 3.
Indicators of multiple correlations for the correlation-regression model of the performance of SME sector in Poland and Ukraine, 2010–2020

Source(s): Authors' own elaboration

No	Factor x_i	Partial correlation coefficients r_{yxi}	β-coefficients β_i	Multiplication % r_{yxi} *β_i*100%	Partial correlation coefficients r_{yxi}	β-coefficients β_i	Multiplication. % r_{yxi} *βi*100%
		Poland				Ukraine	
1	x_1	0.932	0.126	11.7	0.359	0.244	24.4
2	x_2	0.961	0.857	82.4	0.19	0.013	1.3
3	x_3	0.44	0.037	1.6	0.677	0.633	63.3
Total	–	–	–	95.7			890

Table 4.
Decomposition of total variance in the contribution of SMEs to the country's GDP due to the three factors characterizing the SME sector in Poland and Ukraine

Source(s): Authors' own elaboration

In the case of the model for Poland, three factors can explain 95.7% of the total variance in the contribution of SMEs to the country's GDP – with ICDC explaining 11.7% of the variance, the number of SMEs per 10,000 of population – 82.4% and the share of the country's workforce employed in SMEs – 1.6%. In the model for Ukraine, also three factors explain 89.0% of the total variance in the contribution of SMEs to the country's GDP can be explained by the three factors, with ICDC responsible for 24.4%, the number of SMEs per 10,000 of population – 1.3% and the share of the country's workforce employed in SMEs – 63.3%.

Unlike Poland, where SMEs' contribution to the country's GDP mainly relied on the number of SMEs per 10,000 of the population, Ukraine's situation showed that the proportion of the country's workforce engaged in SMEs was the most significant factor. Nevertheless, in both cases, the ICDC remained the second most influential factor, highlighting the significance of digitalization for economic growth.

5. Conclusions

The study results confirmed the research hypothesis that the entrepreneurship rate in the MSE sector of the population impacts this sector's the contribution to the country's GDP. Data for the period 2010–2020 indicated that the number of active MSEs per 10,000 people in Poland was four–six times higher than in in Ukraine. Consequently, the contribution of the Polish MSE sector to the country's GDP (64.6%) was higher than in the case of Ukraine (42.9%).

We also confirmed the second hypothesis about the significant impact of the level of a country's digital competitiveness on the contribution of the SME sector to its GDP. After analyzing the values of the coefficients of the multivariate regression model, we found that a unit change in the ICDC was associated with the greatest change in the contribution of SMEs to the country's GDP when the other factors in the model equation remained fixed.

In the context of the war in Ukraine, further research should concentrate on measures and tools used by Ukrainian war refugees to improve their digital skills of and factors that encourage them to set up businesses in host countries. These findings should inform Ukraine's policy aimed at encouraging war refugees to return and use their experiences after the war to accelerate the country's economic recovery.

Our study had certain limitations. We based the analysis on data for Ukraine and Poland, thus, scholars should exercise caution when concluding about other countries. Moreover, additional data from earlier or later periods may have produced different results. Finally, we calculated the ICDC using five global indices: WDCR, NRI, GCI, GII and EGDI. Utilizing different indices or introducing extra factors might potentially alter the study's conclusions.

Despite these limitations, our findings offer valuable insights to policymakers, businesses and local communities regarding the key factors influencing small and micro-business contributions to the GDP of the studied countries. This information could be helpful in enhancing digital skills in the population, integrate people from Ukraine displaced by the war into the Polish business environment and boost their entrepreneurial endeavors and promote the digitalization of business processes in SMEs, which could contribute to the growth of the economies in these countries.

6. Policy recommendations

Based on the results, we prepared the following economic policy recommendations:

(1) For Poland, to sustain and potentially boost economic growth, align with the EU's digitalization policy, considering the substantial number of Ukrainian emigrants:

- Stimulate the digitalization of business processes in the MSE sector;

- Improve the digital skills of the Polish population.
- Develop a strategy for the digitalization of business processes in the MSE sector, including accounting procedures, taking into account factors such as financial constraints, the need for a quick return on investment in digital solutions, ease of use, etc.;
- Integrate Ukrainian war refugees into the Polish business environment and intensify their entrepreneurial activities. This will help to (1) accelerate job creation by immigrant entrepreneurs and stimulate the country's economic growth; (2) accelerate knowledge transfer, increase innovation and creativity and identify untapped market opportunities in the EU; (3) strengthen Poland's international trade relations: immigrant entrepreneurs could help promote Polish goods and services in Ukraine;

(2) For Ukraine, to develop an effective policy of economic recovery after the war ends, to promote digitalization and encourage war refugees to return to Ukraine:

- Create a proper institutional environment by simplifying taxation and developing an effective system of providing loans on favorable terms;
- Ensure quick and transparent tax and customs reporting, as well as unconditional protection of property rights;
- Stimulate the population to create MSEe and do business;
- Develop a strategy for the digitalization of various economic sectors, especially, the digitalization of business processes in the MSME sector and improve the population's digital skills.

Note

1. The WDC ranking's methodology defines digital competitiveness based on three primary factors: knowledge, technology, and future readiness.

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