The role of digitalization in improving SMEs' access to finance

Valentina Diana Rusu[1] and Angela Roman[2]

[1]*Institute of Interdisciplinary Research, Department of Social Sciences and Humanities, Alexandru Ioan Cuza University of Iași, Iași, Romania, Alexandru Lăpușneanu Street, no. 26, valentinadiana.ig@gmail.com*
[2]*Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iași, Iași, Romania, Carol I Boulevard, No. 22, aboariu@uaic.ro*

Corresponding author: Valentina Diana Rusu, "Alexandru Ioan Cuza" University of Iași, Institute of Interdisciplinary Research, Department of Social Sciences and Humanities, *Alexandru Lăpușneanu Street, no. 26*, Iași, Romania. E-mail: valentinadiana.ig@gmail.com, valentina.rusu@uaic.ro

ABSTRACT

Due to its substantial contribution to the creation of new jobs, added value, and innovations, the small and medium-sized business (SME) sector is essential to a nation's economic and social development. However, small and medium-sized businesses encounter many barriers to financing when compared to larger companies. The global business landscape has changed dramatically in recent years due to advancements made possible by digital technologies. They also provided SMEs with new chances to enter new markets, strengthen their resilience, and remove barriers to funding. Therefore, we investigate the degree to which SMEs' access to financing would be enhanced by the use of digital technology. Furthermore, we seek to determine whether the relationship between a firm's access to financing and the use of digital technology varies depending on the size of the firm. Our investigation, which is based on statistical data for 2009–2023, applies panel data estimation techniques to a selection of European nations. Two indicators that gauge SMEs' financial accessibility serve as the dependent variable in the econometric model, while several indicators pertaining to the use of digital technologies serve as the independent variables. Overall, our findings demonstrate that by reducing financial barriers, digital technology use can have a major impact on SMEs' access to funding. Policymakers who are interested in implementing certain policies to promote SMEs' use of digital technologies to reduce barriers to obtaining outside funding sources could find our results useful.

Keywords: digitalization, access to finance, Small and Medium Enterprises (SMEs), panel data analysis

JEL classification: D83, G20, M21, O33

Introduction

In countries around the world, small and medium-sized enterprises (SMEs) are regarded as the backbone of the economy, playing a vital role in economic and social development while significantly contributing to the creation of added value, new jobs, and innovations. SMEs account for around 90% of all businesses, 60-70% of employment, and 55% of GDP in developed economies (Arnold, 2019). In 2023, in the European Union, estimates suggest that approximately 24.3 million SMEs were active, representing 99.8% of the total number of enterprises, contributing about 52% to the added value of the EU27 economy and providing nearly two-thirds of all jobs (Di Bella et al., 2023). Despite their significance, SMEs encounter several challenges in conducting their business activities, the most pressing of which is access to finance, particularly in developing countries where financiers are hesitant to extend credit to SMEs due to a lack of guarantees, as well as deficiencies related to the absence of financial data and documents required by credit providers to evaluate the creditworthiness of these companies (Beck & Demirguc-Kunt, 2006; Ayyagari et al., 2008; Aterido et al., 2011; Godke Veiga & McCahery, 2018). Several studies (e.g., Agyekum et al. 2022; Mushtaq et al., 2022; Li et al., 2023) indicate that the difficulties

encountered by SMEs in seeking financing resources it is due to information asymmetry, high transaction costs, and a lack of collateral. Compared to larger firms, many SMEs do not possess the guarantees required by capital providers, are much less transparent, making their economic and financial situation more challenging to assess, and often have no or limited credit history (European Central Bank, 2013, p. 43).

On the other hand, in recent years, the developments recorded by digital technologies have significantly transformed the international business environment and offered SMEs new opportunities to expand on the markets and increase their sales, but also to alleviate the difficulties in accessing financing. Moreover, at the international level, the COVID-19 pandemic has stimulated the adoption and use of digital technologies by enterprises, especially SMEs, to ensure their survival and the continuity of their activity. Many businesses have moved their operations online and implemented digital solutions to stay operational during lockdown periods. Different surveys show that worldwide, 70% of SMEs have intensified the use of digital technologies as a result of the manifestation of the COVID-19 crisis (OECD, 2021).

In the presented context, it is of major interest to examine to what extent the adoption of digital technologies would mitigate the financing constraints of SMEs. Thus, our study completes the literature by empirically investigating the impact of SMEs' use of Information and Communication Technologies (ICT) on their access to finance. Our analysis focuses on a sample of 12 countries from the European continent. The period considered is between 2009 and 2023. In choosing the sample and the period, we were influenced by the availability of data.

In addition, we aim to identify whether there are significant differences in the link between the use of digital technologies and firms' access to finance, depending on their size. We also want to test if the gender of the owner and/or manager influences the relationship tested initially.

Through its content, our paper contributes to the development of the literature focused on the digitalisation of SMEs, primarily by providing evidence on the impact of businesses' use of digital technologies on their access to finance. To our knowledge, a limited number of studies provide evidence of the extent to which the digitalisation of SMEs influences their access to finance.

The paper's contributions are both theoretical and practical. On the one hand, our analyses contribute to expanding the specialised literature that focuses on the relationship between the digitalisation of SMEs and their access to finance. On the practical side, our results have several implications: (i) highlighting the role played by different components of basic digitalisation in facilitating access to finance; (ii) differentiating between small and medium-sized enterprises concerning the relationship between the use of digital technologies and access to finance; (iii) providing insight into the role played by gender disparities in the management of SMEs and the allocation of funds.

Our study is structured as follows. Section "Brief literature review" presents a literature review on the use of digital technologies by firms and the benefits of digitalisation for SMEs, including access to finance. Section "Methodology" describes the methodology used in the empirical analysis and the variables included in the model. Section "Results and discussions" is devoted to the empirical results and their discussion, and Section "Conclusions" presents the conclusions and limitations of our research.

Brief Literature Review

Using digital technologies can contribute to increasing the company's competitiveness (Skare et al., 2023) because it allows entrepreneurs to enter new markets, differentiate their offers and improve operational efficiency (Rajiani et al., 2023). Also, digital technologies can help firms (especially SMEs) to reduce their costs, improve their performance, and have better access to financial products and services (Wirdiyanti et al., 2022; Affandi et al., 2024).

The analysis of specialised literature reveals an impressive number of studies focused on the issue of SMEs' access to finance and the difficulties they face. However, the investigation of the link between the use of digital technologies and the access to financing of firms, especially SMEs, is carried out by a small number of studies and is a more recent concern of researchers.

Some studies have argued that the development of the digital economy (Huo & Wang, 2022) and the digital transformation of firms (Liao et al., 2023) can alleviate constraints in firm financing and thus help improve investment efficiency. The digital transformation of enterprises, including SMEs, has the potential to positively influence their financing by reducing financing constraints. Such an impact is empirically proven by recent research (such as Guo et al., 2023; Skare et al., 2023; Wei & Li, 2024) and can be explained by the fact that a high level of digitalisation of SMEs would allow them to innovate, increase their productivity, identify new customers and compete in the market, which would lead to improving their performance and thus increasing the availability of external financing (Skare et al., 2023).

Using data from a sample of Chinese listed firms for the period 2010-2019, the study by He et al. (2023) argues that the digital transformation of enterprises can significantly improve their financing by reducing information asymmetry and transaction costs, but also by improving their performance. Analysing certain forms of digital

technology, Agyekum et al. (2022) point out that the adoption of digital technologies by SMEs supports SMEs' access to credit and thus stimulates their financial inclusion because it increases the probability that these firms will access credit. The authors argue that the use of the Internet (website, email) by SMEs improves their access to credit because credit providers can remotely assess the creditworthiness of credit applicants.

The study by Pellegrina et al. (2017) argues that SMEs that widely use Information and Communication Technology (ICT) in their business activities can obtain better lending opportunities because banks consider ICT adoption as a signal/indication of SME desires and willingness to innovate. Given that SMEs are generally less transparent about their financial situation, ICT investments could represent a signal of a firm's quality and creditworthiness. Also, by using ICT, SMEs can prepare clear and verifiable financial statements so that banks can quickly process the information to prepare easily verifiable credit scores. Similarly, Mushtaq et al. (2022) point out that the widespread adoption and use of Information and Communication Technologies (ICT) by SMEs would improve their access to finance. The authors argue that adopting ICT reduces information asymmetry in the relationship between banks and SMEs. Therefore, banks would be more willing to grant loans to SMEs. Similarly, Chen & Yuan (2021) point out that SMEs that implement digital technologies are much more likely to receive attention from financial institutions because information asymmetry is reduced and, thus, some financing constraints are alleviated by these companies.

Analysing the literature relevant to our research, we find that a significant number of studies have focused on examining SMEs' use of certain forms of digital technologies, such as e-commerce (e.g., Moertini, 2012; Kabanda & Brown, 2017; Rahayu et al., 2018) and pointed out that its use offers several opportunities for SMEs to increase their number of customers, to enter new markets and thus increase their sales and profit. In addition, it is argued that commercial transactions conducted through e-commerce platforms are considered an important data source that can help SMEs obtain financing resources from different capital providers (Teima et al., 2022). The study by Wirdiyanti et al. (2022) argues that the adoption of e-commerce by SMEs would lead to a higher performance of these firms and, thus, would contribute to improving their financial inclusion. The authors find that the performance of SMEs would be a strong predictor of their financial inclusion, and e-commerce platforms, by ensuring users' connection with financial institutions, would reduce asymmetric information and improve access to finance for SMEs. On the other hand, it is found that some SMEs encounter certain problems in the use of e-commerce, such as the lack of knowledge of the use of digital technologies, lack of business knowledge, and the lack of knowledge of the English language (Moertini, 2012; Ulas, 2019).

From the perspective of the constraints faced by SMEs in terms of access to credit, some recent studies (such as Chaudhuri et al., 2020; De Andrés et al., 2021; Aristei & Gallo, 2022; Allison et al., 2023; Khan et al., 2024) aimed to examine whether there are differences between male and female entrepreneurs and found that businesses led by women are more likely to encounter difficulties in obtaining external financing and to be discouraged from applying for loans compared to enterprises led by males. These gender disparities would be due to prejudices and the fact that female entrepreneurs are considered less qualified and less efficient (De Andrés et al., 2021). On the other hand, Orozco Collazos & Botero (2024) showed that women ownership and having women in the ownership group are positively related to SME financial performance. Thus, although the presence of women in the management of SMEs can generate higher performance, they still face more obstacles in obtaining financing than men.

In addition, some authors were concerned with investigating whether using digital technologies could contribute to mitigating the gender gap in accessing external financing resources. For example, Khan et al. (2024) demonstrated that businesses run by women, which used e-commerce and remote work technologies under the conditions of the COVID-19 pandemic, had easier access to bank loans compared to other businesses. Such a result indicates that digital technologies could contribute to mitigating gender disparities in accessing credit, especially in periods of economic and financial crisis.

Several studies focused mainly on emerging countries have tested the role played by the use of ICT for women entrepreneurs and showed that the use of digital technologies positively influences the constraints faced by them (Motilewa et al., 2015; Sharafizad, 2016; Kamberidou, 2020). Other studies have also highlighted that company size plays an important role in companies' decisions to digitalise (Holl & Mariotti, 2021; Buer et al., 2021). This motivated us to choose to compare small and medium-sized enterprises to see if these findings are confirmed.

Through its content, our study complements specialised literature focused on the impact of the digitalisation of SMEs on their financing by providing new empirical evidence on the link between the use of digital technologies by these enterprises and their access to financial resources.

Methodology

Our empirical analysis proposes to test if SMEs' use of digital technologies could improve their access to external financial resources. In creating the database, we were conditioned by data availability. We started with all the countries in Europe, but to obtain data for all the proposed variables, we collected data only for twelve countries

in Europe (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia and Turkey). The chosen period is 2009-2023. With the specification that the data were only available for the years in which the World Bank conducted surveys, namely 2009, 2013, 2019 and 2023. The selection of the sample of countries was made by including only those countries that participated in the survey in all four years, thus having data available for all variables considered for the entire period.

To examine the link between the use of digital technologies and access to finance, we use data from the World Bank Enterprise Surveys (WBES). The firms included in the World Bank database are divided into three categories, depending on their size, namely: small firms, which are those with 5-19 full-time employees; medium-sized firms, which have between 20-99 full-time employees, and large enterprises, respectively those with over 99 full-time employees. Since our study focuses on SMEs, we only use data on small and medium-sized firms.

The WBES database provides valuable information related to the business environment in which firms operate, including information on access to finance for firms of different sizes. The WBES also collects information on firm-level technology adoption. Thus, with each questionnaire/survey conducted, enterprises are asked if they have a business website to carry out their operations and if they use email to communicate with clients and suppliers.

We use panel data regression analysis, and we divide the empirical analysis into two parts. The first part tests the link between digitalisation and access to finance, and the second includes gender as a moderator of this relationship. To realise the analysis, we use as dependent variables alternatively two indicators that measure firms' access to financing. The first indicator considers the percentage of firms that have a bank loan or a line of credit. In the case of countries with financial systems focused on banks, as is the case of the countries in our sample, the main external financing resource of SMEs is bank credit, so access to this type of loan is vital for the development of these enterprises. The significant dependence of SMEs on banks is also explained by the fact that they have a reduced number of financing options, given that many of these enterprises do not have direct access to the financial markets, and, in some countries, venture capital markets are poorly developed. Therefore, the analysis of companies that benefit from bank loans allows us to make an opinion about their access to financing. To test the robustness of the results obtained using the first variable, we propose the second dependent variable, which has an opposite meaning to the first and analyses the percentage of firms that declare access to financing as the main constraint in carrying out their activity. By using the two variables with different meanings as alternatives, we expect to obtain opposite results that will confirm the correctness of our results and validate them.

The independent variables were chosen as a proxy for the use of digital technologies by firms and referred mainly to basic indicators, such as access to the internet of firms and/or of the persons employed in firms, having a website, communicating by email with costumers and selling online. Other studies (Mushtaq et al. 2022) also have considered access to the Internet and email as an expression of the use of ICT by enterprises.

We also include two variables that express the moderator role of gender and measure the percentage of firms having female participation in ownership and the percentage of firms having a female as top manager.

Starting from the objective proposed in this study, we formulate the following hypotheses that we will further test through econometric modelling:

Hypothesis H1: The use of digital technologies by SMEs improves their access to financial resources.

Hypothesis H2: SMEs' digitalisation has a higher influence on their access to finance when the firm size increases.

Hypothesis H3: The gender of the owner and/or manager significantly influences the link between SMEs' digitalisation and their access to finance.

Following other studies in the literature, two control variables are adopted. One variable measures the annual GDP growth of the countries included in the sample. Another variable measures the level of total investments from a country as a percentage of GDP. Theoretically, we anticipate that the control variables positively influence the access to finance for SMEs. But, the expected signs may depend on the dynamism and expansion of the market and might be different from our expectations.

In Table 1 below, we describe the variables included in our empirical investigation, together with their abbreviation and also the sources for the data. In the Appendix, we have included the correlation matrix for the variables for both small and medium firms, used to look for possible multicollinearity.

Table 1. Description of the variables included in the analysis

Variable	Abbreviation	Source
Dependent variables		
Percentage of firms with a bank loan/line of credit	BANK_LOAN	World Bank (2024)

Percentage of firms identifying access to finance as a major constraint	ACCESS_FIN	World Bank (2024)
Independent variables		
Percentage of firms having their own Web site	WEB_SITE	World Bank (2024)
Percentage of firms using e-mail to interact with clients/suppliers	EMAIL	World Bank (2024)
Percentage of firms with internet access	INTERNET	European Commission (2024)
Persons employed have access to the internet for business purposes (percentage of total employment)	PERS_INT	European Commission (2024)
Percentage of firms with e-commerce sales	ECOMM	European Commission (2024)
Variables expressing gender		
Percentage of firms with female participation in ownership	FEM_OWN	World Bank (2024)
Percentage of firms with a female top manager	FEM_MAN	World Bank (2024)
Control variables		
GDP per capita growth (annual % growth)	GDP	World Bank DataBank (2024)
Total investment (% of GDP)	TOT_INVEST	IMF (2024)

Source: processed by the authors

To test our hypotheses, we use the panel data linear regression model, and we test the following general equation. Then, we apply specific models which alternate the dependent and independent variables starting from the correlations identified in the correlation matrix. The proposed model emphasises the link between the independent and dependent variables, indicating how a change in the digitalisation of firms can impact their access to finance. The empirical analysis is carried out with the help of the Eviews 10 program.

The general equation of the regression model used is:

$$Y_{it} = c + \beta 1\, X_{it} + \beta 2\, Z_{it} + \mu_{it} \qquad (1),$$

Where:

- Y_{it} is the dependent variable for the country (i) and the time (t);
- X_{it} is the independent variable for the country (i) and the time (t);
- Z_{it} represents the control variables for the country (i) and the time (t);
- β1 and β2: are the coefficients;
- c is the constant;
- μ_{it} represents the error term for the country (i) and the time (t)
- i is for the country (each one of the twelve countries analysed)
- t is time (from 2009 to 2023).

The empirical investigation has two parts. One part tests the link between firms' digitalisation and their access to finance, comparing the results for small and medium enterprises. Based on Equation (1) and related to the fact that to ensure the robustness of our results, we considered two dependent variables, but also that we analysed the models for small and medium firms separately, the equations of our study are:

$$ACCESS\_FIN_{it} = c + \beta_1(WEB\_SITE)_{it} + \beta_2(EMAIL)_{it} + \beta_3(INTERNET)_{it} + \beta_4(PERS\_INT)_{it} + \beta_5(ECOMM)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \qquad (2)$$

$$BANK\_LOANS_{it} = c + \beta_1(WEB\_SITEL)_{it} + \beta_2(EMAIL)_{it} + \beta_3(INTERNET)_{it} + \beta_4(PERS\_INT)_{it} + \beta_5(ECOMM)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \quad (3)$$

The second part tests the moderator role of gender and wants to identify if the involvement of women in firms determines the appearance of particularities in the relationship between digitalisation and access to financing. For this, we include two variables that express the percentage of enterprises that are owned by women and the percentage of enterprises that women manage. Thereby, the tested equations become:

$$ACCESS\_FIN_{it} = c + \beta_1(WEB\_SITE*FEM\_OWN)_{it} + \beta_2(EMAIL*FEM\_OWN)_{it} + \beta_3(INTERNET*FEM\_OWN)_{it} + \beta_4(PERS\_INT*FEM\_OWN)_{it} + \beta_5(ECOMM*FEM\_OWN)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \quad (4)$$

$$BANK\_LOANS_{it} = c + \beta_1(WEB\_SITE*FEM\_OWN)_{it} + \beta_2(EMAIL*FEM\_OWN)_{it} + \beta_3(INTERNET*FEM\_OWN)_{it} + \beta_4(PERS\_INT*FEM\_OWN)_{it} + \beta_5(ECOMM*FEM\_OWN)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \quad (5)$$

$$ACCESS\_FIN_{it} = c + \beta_1(WEB\_SITE*FEM\_MAN)_{it} + \beta_2(EMAIL*FEM\_MAN)_{it} + \beta_3(INTERNET*FEM\_MAN)_{it} + \beta_4(PERS\_INT*FEM\_MAN)_{it} + \beta_5(ECOMM*FEM\_MAN)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \quad (6)$$

$$BANK\_LOANS_{it} = c + \beta_1(WEB\_SITE*FEM\_MAN)_{it} + \beta_2(EMAIL*FEM\_MAN)_{it} + \beta_3(INTERNET*FEM\_MAN)_{it} + \beta_4(PERS\_INT*FEM\_MAN)_{it} + \beta_5(ECOMM*FEM\_MAN)_{it} + \beta_6(GDP)_{it} + \beta_7(TOT\_INVEST)_{it} + \mu_{it} \quad (7)$$

Our suggested model aims to comprehend the connection between SMEs' use of digital technologies and their access to external financial resources necessary for the firm's development. Before applying panel data regression models, we tested the variables. We tested if the data were normally distributed. We ran the descriptive statistics and generated histograms. The correlation matrix was used to test possible multicollinearity (see Table A1 and Table A2 from the Appendix). We have also tested the stationarity of the variables. In the following, we run the panel data models for each dependent variable, alternating the independent variables that resulted as being strongly correlated. To avoid the problems related to heteroscedasticity or auto-correlation, we run the panel EGLS method (cross-section weights). We also test the fixed and random effects models using redundant fixed effects and the Hausman tests.

In the following, we include the variables expressing gender, and we test if, for the small and medium firms owned or managed by women, the link between digitisation and their access to financing is different.

Results and discussions

The descriptive statistics of the variables are presented in Table 2. The results obtained point out the heterogeneity of the sample chosen for analysis. The increased values of the standard deviation show us the diversity of the countries from the sample regarding access to financing for SMEs and digitalisation. Therefore, the independent variable with the largest standard deviation is, both for small and medium-sized enterprises, the possession of a website. The highest proportion of small firms with a website was registered in the Slovak Republic in 2013. The lowest proportion of small firms with a website was registered in Lithuania in 2019. The highest proportion of medium firms that own a website was recorded in Slovenia in 2009 and the lowest was in Lithuania in 2019.

Table 2. Descriptive statistics for all the variables included in the empirical analysis

Variable	Mean	Maximum	Minimum	Std. deviation	Observations
SMALL ENTERPRISES					
BANK_LOANS	39.197	66.400	15.500	11.343	42
ACCES_FIN	15.333	39.600	0.900	8.719	42
WEB_SITE	62.373	88.000	20.800	16.599	42
EMAIL	87.956	99.900	58.300	10.607	25
INTERNET	93.057	100.000	75.500	5.843	35
PERS_INTERNET	39.792	58.100	21.000	10.276	41
ECOMM	14.463	28.700	3.300	6.664	41
FEM_OWN	36.904	51.900	9.200	8.947	42
FEM_MAN	22.787	37.800	3.000	7.477	40
MEDIUM ENTERPRISES					
BANK_LOANS	55.866	88.800	33.800	12.002	42

ACCES_FIN	14.183	33.300	0.800	9.336	42
WEB_SITE	79.247	99.500	35.000	14.597	42
EMAIL	95.632	100.000	73.300	5.986	25
INTERNET	97.831	100.000	88.000	2.840	35
PERS_INTERNET	38.060	57.500	18.100	10.080	41
ECOMM	19.826	36.100	6.000	8.289	41
FEM_OWN	36.964	54.400	15.300	8.857	42
FEM_MAN	18.967	45.600	5.700	8.349	40
Control variables					
GDP	0.314	8.485	-14.838	5.527	42
TOT_INVEST	23.518	33.610	12.660	3.992	42

Source: authors' calculations in Eviews 10

Regarding the dependent variables, the share of small firms having bank loans was the highest in Slovenia in 2009 and the lowest share in Latvia in 2013. Similarly, the highest share of small firms that consider access to financing to be a major constraint was registered in Romania in 2009, and the lowest share in Hungary in 2019. The highest share of medium-sized enterprises having bank loans was also recorded in Slovenia in 2009, and the lowest share in Latvia in 2013. Regarding access to financing, the highest share of medium-sized enterprises mentioning it as a constraint was recorded in Romania in 2013 and the smallest in the Slovak Republic in 2019.

The results of the regression analysis (see Table 3) show that, for all the models, digitalisation might significantly influence the access to finance of small and medium firms. Therefore, four of the five variables considered for measuring small enterprises' digitalisation could play an important role in alleviating the financing constraints for these firms.

From these, the largest coefficient, and therefore the most important, is the Internet access data for enterprises, then the access of employees to the Internet, followed by email communication with clients and owning a website. When small enterprises have access to the Internet, offer it to employees, practice email communication with clients and have a website, access to financing, respectively to credits would be easier. Other studies also found that internet access plays a positive role in alleviating financing difficulties faced by small enterprises (Chen et al., 2018) because the use of ICT would show the banks that SMEs are interested in innovating (Pellegrina et al., 2017) and therefore would be a guarantee for the loans granted to them. Moreover, the use of the Internet increases the productivity and performance of SMEs (Grimes et al., 2012; Bertschek et al., 2012 Colombo et al., 2013; Nucci et al., 2023), thus increasing their credibility and the chances of obtaining easier access to external financial resources. However, the relationship between the use of ICT by SMEs and credit constraints depends on the type of financing to which SMEs apply (Charfeddine et al., 2024).

Only e-commerce sales positively affect the percentage of firms identifying access to finance as a major constraint. This happens because e-commerce sales involve a series of additional expenses on the part of enterprises, therefore additional financial resources, and do not necessarily facilitate enterprises' access to these resources.

The difference appears in the case of medium-sized enterprises, for which only the enterprises' access to the Internet and the possession of a website would improve their access to financing. For e-commerce sales, the coefficient is similar to that obtained for small enterprises.

These findings confirm our first hypothesis, showing that the use of digital technologies by SMEs reduces their financing constraints, with particularities depending on the size of the enterprise (also confirming H2).

For the second part of the model, in the case of small firms, having a website and e-commerce sales can facilitate access to bank loans because of the increased availability of information about companies, but also as the data on online commercial transactions can improve banks' ability to assess credit risk and thereby support access to bank financing for firms considered more opaque (Agyekum et al., 2022; Wiridyanti et al., 2023). Comparatively, for the variables measuring internet access for enterprises and employees and email communication with clients, we find that all the coefficients are significantly negative at the 1% level. Such a result indicates that the use by small enterprises of some forms of digital technology would not increase the use of bank financing by small enterprises. This is because access to the Internet allows obtaining information and access to finance from sources other than those offered by the traditional financial system (like microfinance services and crowdfunding) (Łasak, 2022) or different platforms that allow people to grant loans directly to entrepreneurs (Ahmed et al., 2016; Wang & Han, 2021).

For medium-sized enterprises, our empirical results indicate a positive and strongly significant correlation between the use of certain digital technologies (internet access and e-commerce sales) and the access to bank loans of these enterprises. At the same time, having a website would not be associated with easier access to bank financing. This last aspect signals that medium enterprises with a website do not necessarily have a positive image for the banks, and its possession is not seen as an element that can facilitate their access to bank loans.

Table 3. The link between digitalisation and access to finance of firms, by size of the firm

Variables	Dependent variable: Access to finance as a major constraint						Dependent variable: Firms with a bank loans/line of credit					
	(1) Small	(2) Small	(3) Small	(4) Medium	(5) Medium	(6) Medium	(1) Small	(2) Small	(3) Small	(4) Medium	(5) Medium	(6) Medium
WEB_SITE	-0.078** (0.031)	-	-0.076*** (0.049)	-0.067*** (0.045)	-0.089*** (0.022)	-0.092** (0.048)	0.279*** (0.036)	-	0.257*** (0.063)	-0.063* (0.033)	0.291 (0.041)	-0.015 (0.247)
EMAIL	-	-0.484*** (0.052)	-	-	-0.010 (0.399)	-0.224 (0.259)	-	-0.174** (0.068)	-	-	0.567 (0.245)	0.434 (0.491)
INTERNET	-0.993*** (0.121)	-	-	-1.047*** (0.207)	-	-	-0.339* (0.198)	-	-	0.517*** (0.106)	-	-
PERS_INT	-	-	-0.499*** (0.065)	-	-	-0.204 (0.636)	-	-	-0.109*** (0.171)	-	-	0.151 (0.242)
ECOMM	0.037*** (0.045)	0.332* (0.172)	0.303*** (0.002)	-	0.081*** (0.019)	-	0.164 (0.276)	0.537*** (0.166)	0.234 (0.360)	-	0.373*** (0.042)	-
GDP	-0.403* (0.205)	-0.356*** (0.046)	-0.483** (0.196)	-0.439** (0.187)	-0.471*** (0.005)	-0.217* (0.131)	-0.309* (0.153)	-0.453*** (0.134)	-0.486** (0.196)	-0.851*** (0.121)	-0.595*** (0.043)	-0.924*** (0.051)
TOT_INVEST	-0.272 (0.226)	-0.139 (0.255)	-0.035 (0.332)	-0.447* (0.235)	-0.206*** (0.064)	-0.602*** (0.080)	0.076 (0.122)	0.785*** (0.077)	0.351 (0.353)	0.317 (0.260)	0.204 (0.448)	0.386 (0.729)
Constant	4.485*** (1.523)	5.615*** (1.092)	6.570*** (1.683)	6.062*** (1.993)	4.192*** (2.031)	5.843** (2.202)	4.665*** (1.123)	1.836 (1.883)	5.837 (1.969)	1.440 (1.354)	7.724** (1.824)	1.968 (1.175)
Observations	35	41	24	35	24	24	35	24	41	35	24	24
R-squared	0.405	0.343	0.422	0.224	0.305	0.186	0.543	0.454	0.525	0.391	0.217	0.191
R-squared adjusted	0.355	0.316	0.393	0.211	0.291	0.155	0.499	0.393	0.457	0.310	0.201	0.178
F-statistic	4.747***	10.883***	5.116***	2.173***	1.583***	1.823***	6.905***	3.981***	5.553***	4.829***	2.002***	1.852***

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: authors' calculations in Eviews 10

Table 4. The link between digitalisation and access to finance of firms by size of the firm moderated by gender

Variables	Dependent variable: Access to finance as a major constraint				Dependent variable: Firms with a bank loans/line of credit			
	(1) Small	(2) Small	(3) Medium	(4) Medium	(1) Small	(2) Small	(3) Medium	(4) Medium
	Moderator: Percent of firms with female participation in ownership				Moderator: Percent of firms with female participation in ownership			
WEB_SITE*FEM_OWN	-0.002*** (0.001)	-	-0.004*** (0.001)	-	0.005*** (0.004)	-	0.001* (0.001)	-
EMAIL* FEM_OWN	-	0.005*** (0.001)	-	0.002** (0.003)	-	-0.003* (0.001)	-	0.002*** (0.001)
INTERNET* FEM_OWN	0.004** (0.003)	-	0.005*** (0.005)	-	-0.002 (0.002)	-	0.003 (0.001)	-
PERS_INT* FEM_OWN	-0.016 (0.002)	-0.011*** (0.001)	-0.013*** (0.001)	-0.008*** (0.002)	-0.003 (0.003)	0.007* (0.004)	0.006 (0.004)	0.002 (0.002)
ECOMM* FEM_OWN	0.001 (0.003)	0.004 (0.002)	0.006* (0.001)	0.009*** (0.002)	0.013* (0.007)	0.025*** (0.006)	0.006 (0.006)	0.018*** (0.002)
GDP	-0.362*** (0.0.062)	-0.307*** (0.077)	-0.169*** (0.060)	-0.286 (0.178)	-0.440* (0.234)	-0.299 (0.254)	-1.058*** (0.027)	-1.088*** (0.109)
TOT_INVEST	0.045 (0.140)	-0.010 (0.124)	-0.414*** (0.103)	-0.267 (0.214)	0.593*** (0.209)	0.720*** (0.160)	0.335 (0.300)	0.916*** (0.222)
Constant	2.310*** (1.115)	1.249*** (2.256)	1.496** (1.195)	1.979*** (1.898)	1.495*** (1.874)	1.996 (8.365)	2.157*** (1.739)	3.425** (1.060)
Observations	35	24	23	24	35	24	34	24
R-squared	0.745	0.586	0.568	0.262	0.397	0.566	0.464	0.548
R-squared adjusted	0.691	0.499	0.517	0.199	0.367	0.446	0.388	0.522
F-statistic	13.694***	4.018***	3.823***	2.280***	3.072***	4.709***	3.908***	4.366***
	Moderator: Percent of firms with a female top manager				Moderator: Percent of firms with a female top manager			
WEB_SITE*FEM_MAN	-0.004** (0.001)	-	-0.007 (0.005)	-	0.005*** (0.001)	-	0.004* (0.002)	-
EMAIL* FEM_MAN	-	0.002*** (0.001)	-	0.008*** (0.007)	-	-0.016*** (0.001)	-	0.006 (0.006)
INTERNET* FEM_MAN	0.002*** (0.002)	-	0.001 (0.027)	-	-0.012*** (0.003)	-	0.001 (0.001)	-
PERS_INT* FEM_MAN	-0.007*** (0.002)	-0.005*** (0.001)	-0.035*** (0.001)	-0.025*** (0.004)	0.011*** (0.003)	0.028*** (0.002)	-0.021 (0.013)	-0.027 (0.023)

ECOMM* FEM_MAN	-0.008 (0.006)	-0.001 (0.005)	0.022 (0.010)	0.020*** (0.002)	-0.005 (0.005)	-0.015*** (0.001)	0.022 (0.013)	0.048* (0.024)
GDP	-0.473*** (0.077)	-0.432*** (0.005)	-0.372** (0.010)	-0.201 (0.123)	-0.454** (0.201)	-0.073*** (0.045)	-0.862*** (0.037)	-0.995*** (0.486)
TOT_INVEST	-0.114 (0.185)	-0.199 (0.306)	-0.293*** (0.058)	-0.582*** (0.018)	-0.007 (0.201)	0.408*** (0.001)	-0.120 (0.355)	0.039 (0.486)
Constant	1.732*** (1.632)	2.778*** (1.914)	1.490*** (2.361)	2.513*** (0.970)	2.787*** (1.822)	2.719*** (1.669)	3.154 (1.383)	3.770*** (1.563)
Observations	34	23	34	23	34	23	34	23
R-squared	0.657	0.741	0.457	0.477	0.558	0.881	0.353	0.390
R-squared adjusted	0.590	0.729	0.403	0.424	0.490	0.847	0.309	0.310
F-statistic	8.625***	3.533***	3.795***	3.110***	5.699***	4.366***	3.461***	3.175***
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1								

Source: authors' calculations in Eviews 10

Therefore, bank loans held by enterprises are stimulated by e-commerce sales for both small and medium-sized enterprises. SMEs that sell online will increasingly use bank loans to finance their activity. But there are also differences. Small businesses with a website will have easier access to bank loans. For medium-sized enterprises, it is enough to have access to the Internet to increase the number of bank loans they have. Small enterprises that have a website offer greater transparency on their activities, and banks can assess credit risk more easily, thus facilitating the obtaining of a bank loan. Medium enterprises face fewer obstacles in obtaining a bank loan comparing to small ones. If they have access to the Internet, they can obtain the necessary information to access a bank loan more easily, without physically going to the bank, prepare the file as completely as possible, and increase the chances of obtaining a bank loan. Therefore, the level of adoption of ICT influences access to bank loans differently, depending on the size of the enterprises.

When we take gender into account and use the percentage of firms with female participation in ownership as a moderator (see Table 4), only the possession of a website and the share of employed people who have access to the Internet could ease the financing constraints felt by both small and medium enterprises. Email communication with clients, Internet access of enterprises, and e-commerce sales (only for medium-sized enterprises) do not ease the financing constraints. At the same time, having a website (for small enterprises) and access to the internet (for medium enterprises), as well as e-commerce sales for both categories of enterprises in which females participate in ownership, will lead to an increase in the number of bank loans contracted by firms. Therefore, the regression relationships tested with female participation in ownership as a moderator show that the access to financing, especially to bank loans, of small and medium-sized enterprises is improved when these companies have a website, offer internet access to the employed staff but also when selling online (this last aspect being significant with precedence for access to bank loans).

When we consider the variable measuring the percentage of enterprises with a female top manager as a moderator, the results are different. Having a website and offering access to the internet to persons employed are the predictors of reducing financing constraints for small enterprises. For medium enterprises, reducing financing constraints is determined only by offering access to the Internet to persons employed. Also, SMEs with a female top manager having a website will have easier access to bank loans, while small enterprises offering access to the internet to persons employed and medium enterprises selling online will contract more bank loans. The findings for this part of the study confirm the third hypothesis of our study, pointing out that when SMEs are owned or managed by a woman, the relationship between digitalisation and access to finance has a series of peculiarities.

These differences appear concerning the fact that when women decide to enter entrepreneurship, they are driven by varying social needs and motivations, including peer approval, family obligations, and status (Monolova et al., 2007; Allen & Curington, 2014). Furthermore, women tend to be less daring business owners and less risk-taking, and they are impacted by their own psychological and emotional aspects (Jafari-Sadeghi, 2020). Usually, enterprises owned by women are small compared to those owned by men (Coleman, 2007) and the stereotypes and the lack of female role models in business affect, to a certain extent, the confidence of women in creating and managing a business (Achim et al., 2019). Analysing the role of gender in the relationship between enterprise digitalisation and access to finance is limited in the literature.

Conclusions

Recent developments and challenges faced by enterprises in the last decade have amplified the need for digitalisation. Especially in the context of the COVID-19 pandemic, survived mainly those enterprises that were able to adapt and had at least a basic level of digitalisation or managed to obtain it in a short time.

This study investigates the link between the digitalisation of firms and their access to finance, providing an answer to the question of whether the use of digital technologies can increase and facilitate access to financial resources for small and medium-sized firms. In addition, we test the moderating role of gender, and we point out that when firms are owned or managed by females, the link between digitalisation and access to finance of firms might be different.

The paper's main findings emphasise that the use of basic digital technologies by small and medium enterprises might significantly affect their access to external financial resources needed for their development. Thus, our results show, in general, that the digitalisation of SMEs plays a significant role in alleviating financing constraints and facilitating access to bank financing, seen as a main source of traditional financing of SMEs. Digitalisation can improve access to finance for SMEs and thus support their financial inclusion. Lowering the financial risk of SMEs through digital transformation might increase funds allocation.

We also find that the gender of the owner or manager of SMEs is a significant moderator of the link between digitalisation and their access to financing. Owning a website, providing internet access to employees, and online sales are the main factors that lead to an improvement in access to financing and bank loans for SMEs owned or managed by women.

This paper contributes to expanding the literature concerned with analysing the relationship between digitalisation and access to finance, being among the few existing papers analysing it. But the contribution is not limited to this. Our findings have several practical implications by highlighting the role played by different components of basic digitalisation in facilitating access to finance by types of firms depending on their size. It also provides an insight into the role played by gender disparities in the management of SMEs and funds allocation.

The limitations of the study come from the reduced availability of data. Further research could extend the analysis by considering a bigger sample of countries, using more indicators for measuring digitalisation and access to finance. For this aspect, we depend on the availability of data. Also, we could group the countries in the sample by clusters according to their level of development.

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Appendix

Table A1. Correlation matrix of the variables for small firms

	ACCESS_FIN_SMALL	BANK_LOAN_SMALL	WEB_SITE_SMALL	EMAIL_SMALL	INTERNET_SMALL	PERS_INT_SMALL	ECOM_SMALL	GDP	TOT_INVEST
ACCESS_FIN_SMALL	1.000000								

BANK_LOAN_SMALL	0.024788	1.000000							
	0.9106	-----							
WEB_SITE_SMALL	-0.405753	0.335602	1.000000						
	0.0547	0.1175	-----						
EMAIL_SMALL	-0.502115	0.170303	0.758140	1.000000					
	0.0146	0.4372	0.0000	-----					
INTERNET_SMALL	-0.543089	0.209691	0.588640	0.794826	1.000000				
	0.0074	0.3369	0.0031	0.0000	-----				
PERS_INT_SMALL	-0.518396	0.293413	0.620437	0.749966	0.856461	1.000000			
	0.0113	0.1742	0.0016	0.0000	0.0000	-----			
ECOM_SMALL	-0.073768	0.267602	0.406875	0.455447	0.544321	0.474595	1.000000		
	0.7380	0.2170	0.0540	0.0290	0.0072	0.0221	-----		
GDP	-0.155846	-0.134889	0.131321	-0.015824	0.098413	0.146427	0.213673	1.000000	
	0.4777	0.5395	0.5503	0.9429	0.6551	0.5050	0.3276	-----	
TOT_INVEST	0.066742	0.071267	-0.203907	-0.344499	-0.427163	-0.317384	-0.197028	0.316602	1.000000
	0.7622	0.7466	0.3507	0.1075	0.0421	0.1400	0.3675	0.1411	-----

Source: authors' calculations in Eviews 10

Table A2. Correlation matrix of the variables for medium firms

	ACCESS_FIN_MED	BANK_LOAN_MED	WEB_SITE_MED	EMAIL_MED	INTERNET_MED	PERS_INT_MED	ECOM_MED	GDP	TOT_INVEST
ACCESS_FIN_MED	1.000000								

BANK_LOAN_MED	0.289448	1.000000							
	0.1804	-----							
WEB_SITE_MED	-0.254789	0.106865	1.000000						
	0.2407	0.6275	-----						
EMAIL_MED	-0.214694	0.181253	0.544794	1.000000					
	0.3252	0.4079	0.0072	-----					
INTERNET_MED	-0.315906	0.170226	0.517325	0.627082	1.000000				
	0.1420	0.4374	0.0115	0.0014	-----				
PERS_INT_MED	-0.296611	0.054711	0.448769	0.452514	0.639572	1.000000			
	0.1693	0.8042	0.0317	0.0302	0.0010	-----			
ECOM_MED	-0.043486	0.188550	0.286705	0.368065	0.609104	0.660459	1.000000		
	0.8438	0.3889	0.1847	0.0840	0.0020	0.0006	-----		
GDP	-0.178265	-0.317513	-0.044137	-0.013495	-0.049476	0.122245	0.105828	1.000000	
	0.4158	0.1399	0.8415	0.9513	0.8226	0.5784	0.6308	-----	
TOT_INVEST	-0.125310	-0.062771	-0.219236	-0.353727	-0.379555	-0.295452	-0.247310	0.316602	1.000000
	0.5689	0.7760	0.3149	0.0978	0.0740	0.1711	0.2552	0.1411	-----

Source: authors' calculations in Eviews 10