Journal of Financial Literacy and Wellbeing (2025), 1–21
doi:10.1017/flw.2025.10002

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Micro-entrepreneurs towards the twin sustainable and digital transition. Does financial literacy play a role?

Alessio D'Ignazio, Daniela Marconi and Massimiliano Stacchini

Bank of Italy, Directorate General for Consumer Protection and Financial Education, Rome, Italy
Corresponding author: Daniela Marconi; Email: daniela.marconi@bancaditalia.it

(Received 22 July 2024; revised 6 June 2025; accepted 26 July 2025)

Abstract

The digital and sustainable transitions represent two strategic drivers of growth and innovation for micro-, small-, and medium-sized enterprises. This is especially relevant for micro-firms, which significantly lag behind larger firms in these areas. Financial literacy can play a key role in guiding small entrepreneurs to make sound financial choices and make the so-called twin transition successful. We exploit a survey conducted by the Bank of Italy in 2021 – involving about 2,000 non-financial firms with less than 10 employees – to investigate whether financial literacy acts as a driver for the twin transition. Through instrumental variable estimation, we find evidence of a causal link between financial literacy and both digitalisation and engagement in sustainable activities.

Keywords: financial literacy; digitalisation; sustainability; micro-firms

JEL Codes: G53

1. Introduction[1]

In 2020, the European Commission presented the "SME Strategy for a sustainable and digital Europe." The first pillar of the Strategy aims at increasing the number of SMEs engaging in sustainable business practices as well as the number of SMEs employing digital technologies (so-called twin transition). Micro SMEs – i.e. firms with less than 10 employees, Micro, small and medium enterprises (MSMEs) – will play a crucial role within the twin transition process. MSMEs are indeed very relevant in many European countries, accounting on average in the EU27 for about 20 per cent of value added and 30 per cent of employment. Italy, in particular, is one of the European countries where firms with less than 10 employees account for the largest share of value added and employment (25 per cent and 42 per cent, respectively, in 2019; Figure 1).

In the areas of digitalisation and sustainability, MSMEs are significantly lagging behind with respect to larger firms. According to the European Investment Bank (2021), only 40 per cent of European micro-firms had implemented at least one digital technology in 2020, about half of the share for large firms. The shares remained similar in 2021, with the

[1] The authors would like to thank Paolo Angelini, Giuseppe Bertola, Magda Bianco, Riccardo De Bonis, Maikel Pellens, participants to the 63rd SIE Conference (Torino, October 2022) and the 5th ZEW Conference on the Dynamics of Entrepreneurship (Mannheim, October 2023) and two anonymous referees. The usual disclaimer applies. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy.

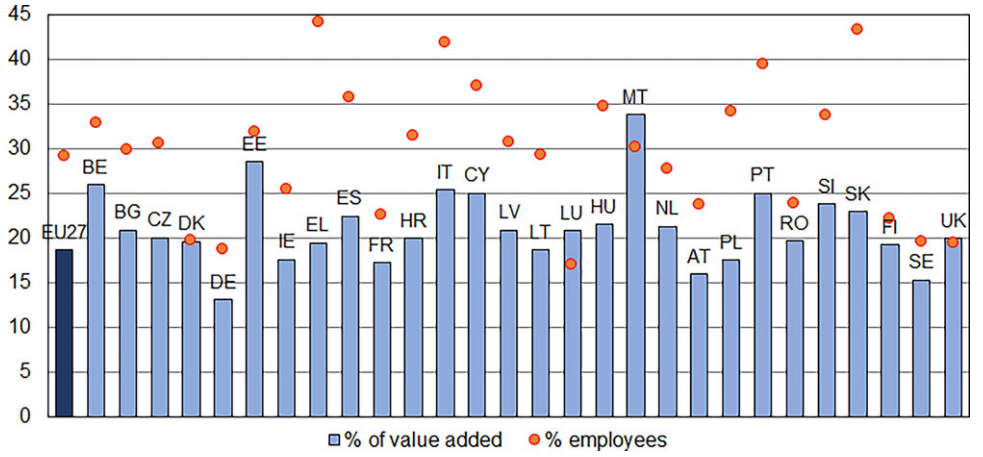

Figure 1. Share of value added and employment of MSMEs in Europe.
Notes: Source: Eurostat. Data refer to year 2019, with the exception of EU27 and UK (2018).

probability of micro-firms investing in digital technologies being significantly lower than that of SMEs (European Investment Bank, 2022). The European Commission (European Commission and Executive Agency for Small and Medium-sized Enterprises et al. 2021) shows that in the pre-COVID-19 pandemic period, about 20 per cent of MSMEs believed that there was no need to introduce any digital technologies at all (16 per cent of MSMEs and 10 per cent of medium-sized SME). The study also finds a positive association between the digital profile of firms and climate-related investment. Concerning the latter, according to European Commission and Executive Agency for Small and Medium-sized Enterprises et al. (2021), one-third of European SMEs have a sustainability strategy, while about one-fifth said that they do not have it and will not have one in the future. The share of firms concerned with sustainability issues is even lower among micro-firms, as the interest in sustainability projects is inversely related to firm size (Yook et al. 2018). Indeed, according to Istat (2020), Italian micro-firms invest significantly less in sustainability projects with respect to larger firms.

Despite the relevance of MSMEs within an economy moving towards an increase in both digitalisation and sustainability, little is known about the drivers of their choices in such areas. Investigating these drivers is indeed relevant, as such analysis can provide useful insights to support the twin transition. In this paper, we investigate whether firms' financial literacy affects MSMEs' attitudes towards both digitalisation and sustainability. On a theoretical ground, the role of financial literacy in fostering digitalisation is largely associated with the expansion of digital financial services and products (DFS). Lo Prete (2022) investigates country-level data and shows that financial literacy is positively correlated with a higher use of digital payments. On a similar ground, Yang et al. (2023) use household-level data in China and find, by means of an IV approach, that financial literacy positively affects the use of DFS. Indeed, greater financial competencies could allow entrepreneurs to evaluate better (and take advantage of) the opportunities offered by DFS.

While the relationship between financial literacy and sustainability has been investigated at the individual level (see, for instance, Gutsche et al. 2023), it is still unexplored at the firm-level. All in all, greater financial literacy arguably encourages entrepreneurs' thinking about the drivers of their firm's growth, including sustainability issues. For instance, a short-sighted approach by MSMEs on climate change-related issues could be very penalising both in terms of participation in global value chains and access to finance in the near future (Angelini, 2022). Along this line, Aristei and Gallo (2024) focus on

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the post-COVID-19 pandemic firm-level data and find that businesses adopting high-quality green management practices are less likely to face a decline in liquidity shortages.

Overall, whether financial literacy determines greater entrepreneurs' involvement in digital and sustainable activities or not is an empirical question, but there is no evidence available so far. We investigate whether such causal relationships exist by exploiting a survey conducted by the Bank of Italy in spring 2021, involving about 2,000 non-financial firms with less than 10 employees. The survey was part of a larger initiative, promoted by the G20 Italy Presidency 2021, using the OECD/INFE 2020 survey instrument to measure the financial literacy of MSMEs and involved fourteen countries (see G20/OECD-INFE, 2021).

The identification of any causal relationship between financial literacy and both digitalisation and engagement in sustainable activities is challenging, with several potential sources of endogeneity being at work. We obtain a consistent estimate of that causal relationship by means of instrumental variable estimation, where the exogenous source of variation is derived from the number of universities that offered a degree in economics near the entrepreneurs' area. As a robustness check, we also exploit an alternative source of exogenous variation given by the number of bank branches existing in the area of the entrepreneur in 1951.

The remainder of the paper is organised as follows. Section 2 describes the data and outlines how the indicators of financial literacy, digitalisation, and potential engagement in sustainable activities were developed. Section 3 discusses the empirical strategy and identification issues, while Section 4 presents the results. Section 5 concludes.

2. Data

The empirical analysis benefits from a new survey promoted by the G20 Italy Presidency 2021 and conducted by the Bank of Italy in 2021. The surveyed sample consists of about 2,000 non-financial Italian firms with less than 10 employees,[2] representative of the population of Italian MSMEs (consisting of 4.4 million businesses).[3]

Figure 2 displays some characteristics of the Italian MSMEs sample. About 8 per cent of the surveyed firms have 1 or 2 employees, while about 60 per cent have 3 or 4. About 30 per cent of entrepreneurs achieved university-level education, while about half of them reached a secondary school or upper school diploma at most; the share of entrepreneurs who completed primary school only or did not get any formal education at all is negligible. About 60 per cent of people were aged between 40 and 59 years, and slightly less than 30 per cent of interviewed entrepreneurs are female. Finally, and with regard to geographical localisation, about 70 per cent of micro-enterprises are located in the Centre and North, with only 30 per cent in the South and Islands. The questionnaire used for the survey was developed by OECD/INFE, with the main aim to measure the financial literacy of small firms (OECD/INFE, 2020). In 2021, the questionnaire was revised to take into account the consequences of the COVID-19 crisis on businesses and to investigate both small businesses' digitalisation and involvement in sustainable activities as well.

MSMEs' financial literacy. – In line with the existing (OECD/INFE, 2020) definition, financial literacy is measured as a combination of financial knowledge, behaviours, and attitudes (see Table A1 provided in the Supplementary Material). Each of these three

[2] More specifically, the questionnaire asks to indicate the number of (full-time equivalent) people working in the firm including the owner. With this approximation in mind, the entrepreneurs who claim to work in one-person businesses are referred as self-employed throughout the paper.

[3] For a more detailed description of the survey, see D'Ignazio et al. (2025).

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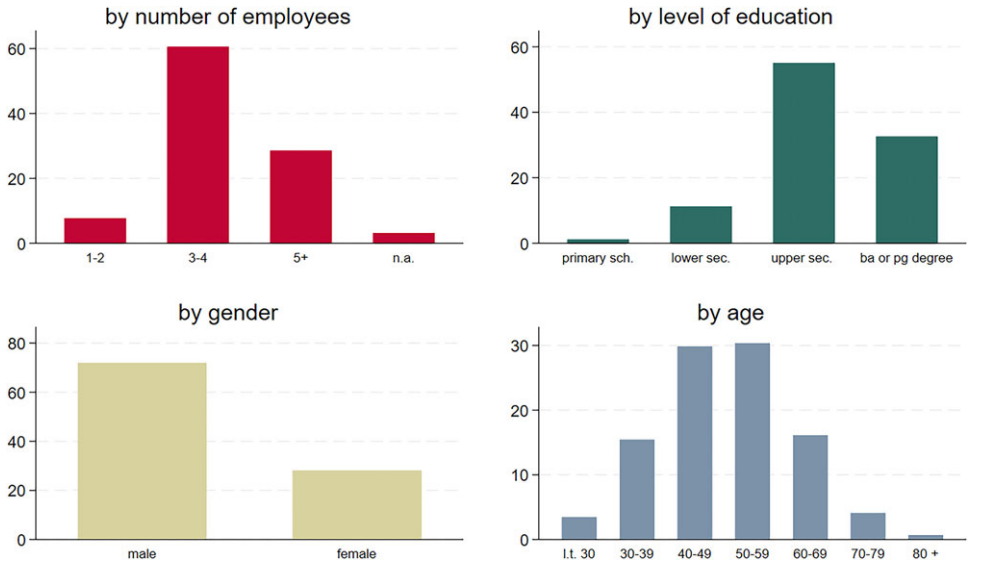

Figure 2. Sampled firms' distribution (percentage values).
Notes: Sample of non-financial Italian firms with less than 10 employees. See Table A1 provided in the Supplementary Material for the description of variables.

components is assessed by means of a score built drawing from five, nine, and three questions, respectively (see Table A2)[4] In particular, the knowledge score is computed as the number of correct answers to the financial knowledge questions, while the financial behaviour score and the financial attitude score are computed as the number of "financially savvy" behaviours and attitudes, respectively. In order to devise a financial literacy score, we aggregate the scores of the three components. Following D'Ignazio et al. (2025), we employ a weighted financial literacy score, where each of the three components (knowledge, behaviour, attitudes) is given an equal importance. In particular, we normalise each financial component's score between 0 and 1 (dividing the raw score by the number of questions), and then we sum them up. In this way, we obtain an overall financial literacy score ranging from 0 to 3. The average score of micro-entrepreneurs is equal to 2.2, and it corresponds to about 70 per cent of the maximum level (see Table A1). As pointed out by D'Ignazio et al. (2025), the share of small-business owners with an "adequate" level of financial literacy is low in Italy: less than 4 in 10 business owners reach 80 per cent of the maximum level according to the metric developed by OECD/INFE.

With regard to the knowledge component of financial literacy, the score also reaches about 70 per cent of the maximum achievable (0.73 out of 1). Micro-entrepreneurs show the highest familiarity with concepts like dividends and the risk–return trade-off, with over 80 per cent answering correctly; the share of correct responses decreases for topics such as interest on loans of different durations (62) and equity (48). The percentages of "I do not know" responses range from 9 for the question on inflation to 19 for that on equity. Regarding the scores on financial behaviour and attitudes, entrepreneurs reach 80 and 62 per cent of the maximum, respectively. It is worth noting that only 53 per cent compare offers from different providers ("shopping around") when subscribing to a financial product for their business – such as a bank account, loan, or insurance policy –

[4] Scores on behaviours and attitudes are assigned when these broadly align with those typically exhibited by rational and well-informed individuals, as defined by the OECD framework (OECD/INFE 2020).

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while just 50 have considered how they will fund their retirement. 62 per cent feel confident when dealing with banks (see Table A2).

MSMEs' digitalisation. – The micro-entrepreneurs' involvement in digital activities is measured in the survey both before and after the pandemic. Since the breakthrough of the pandemic, as a response to the crisis, several firms increased their digital activities. Such phenomenon was heterogeneous across several firm characteristics, such as size and sectors (see D'Ignazio et al. 2025); arguably, the greater digitalisation was transitory in some cases. In order to estimate the causal relationship between financial literacy and digitalisation more accurately in our analysis, we investigate the extent of MSMEs pre-pandemic digitalisation. In particular, we exploit ten questions pertaining to engagement in digital activities, reported in Table A3. Five of them require a "yes/no" answer; for them, we assign a score equal to 1 in the case of "yes" (i.e. the firm engages in the specific digital activity) and 0 otherwise. Five questions require instead the entrepreneur to claim whether the relevance of specific digital activity for the business is "very small, small, quite large, very large"; for them, we assign a score ranging from 0 ("very small") to 3 ("very large"). We sum up such scores and obtain a normalised digitalisation score, ranging from 0 to 1 (see Table A3 for more details about the construction of the score). The average digitalisation score is equal to 0.44 (Table A1). The data show that 64 per cent of micro-entrepreneurs have a website to sell products or services, and 52 have opened a bank account through online channels.

MSMEs' engagement in sustainable activities. – The entrepreneurs' engagement in sustainable activities is measured in the survey by means of three questions only, involving the following topics: taking into account the environmental impact of the firm's real investments; taking into account the social impact of firm's real investments; encouraging actions with low environmental impact. For each of them, the entrepreneur reports whether she strongly disagrees, disagrees, agrees or strongly agrees. The survey does not measure the actual investment of firms, rather, the questions aim at measuring the awareness of small entrepreneurs with respect to the environmental and social impact of their real investments and whether they take actions with respect to the environmental impact of their providers. The questions are reported in Table A4. In order to devise a measure of sustainability engagement, we assign to each question a score ranging from 0 ("strongly disagree") to 3 ("strongly agree"). We sum up such scores and obtain a normalised score of engagement in sustainable activities, ranging from 0 to 1. At a glance, the average score level of engagement in sustainable activities is equal to 0.65. About 80 per cent declare that they pay attention to environmental issues before making investments.

MSMEs characteristics. – The survey provides a large set of firm and entrepreneur characteristics, such as size, education, sector of economic activity, gender, age, geographical area and entrepreneurial experience. The descriptive statistics are reported in Table A1, which also describes the full set of variables. Not surprisingly, MSMEs that are larger in size (in terms of number of employees) display a larger average score for both digitalisation and engagement in sustainable activities (Figure 3). Both digitalisation and engagement in sustainable activities require, indeed, some sunk costs, which can be more easily borne by larger firms. Along with firm size, the level of education of the entrepreneurs also plays a relevant role in shaping the involvement of the firm in both digital and sustainability activities (Figure 4). When firms are grouped according to their level of financial literacy, however, differences in the mean scores of both digitalisation and sustainability are even larger (Figure 5).

MSMEs' exposure to climate change risks. – The analysis of entrepreneurial engagement in sustainability transition considers the exposure of individual firms to climate change risks. The physical proximity to these risks might act as a catalyst for the individual's sensitivity toward sustainability. Such exposure is measured by means of a composite indicator that

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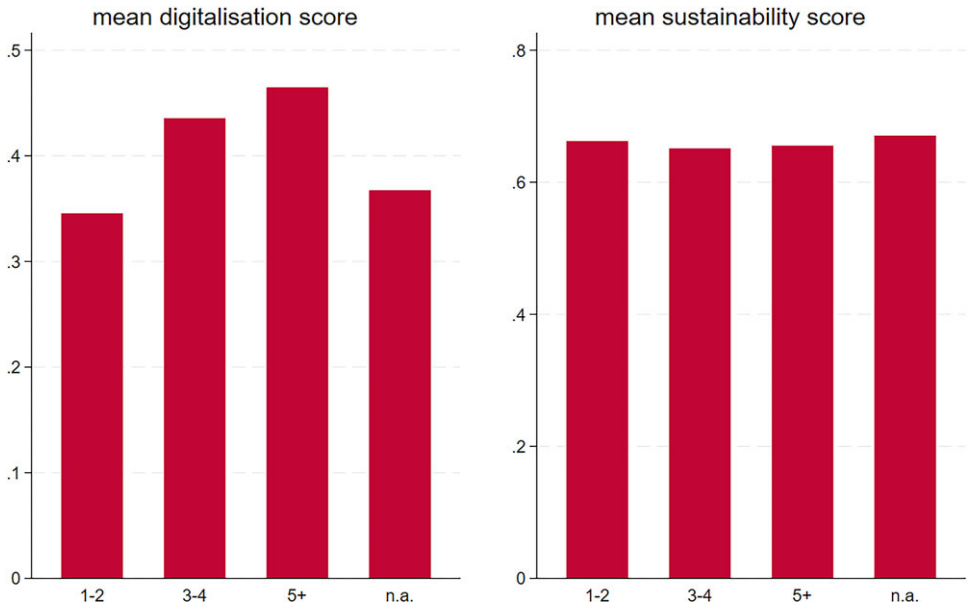

Figure 3. Digitalisation and sustainability score by number of employees.
Notes: Sample of non-financial Italian firms with less than 10 employees. Mean digitalisation score and mean sustainability score by number of employees (1–2, 3–4, 5+). See Table A1 for the description of variables.

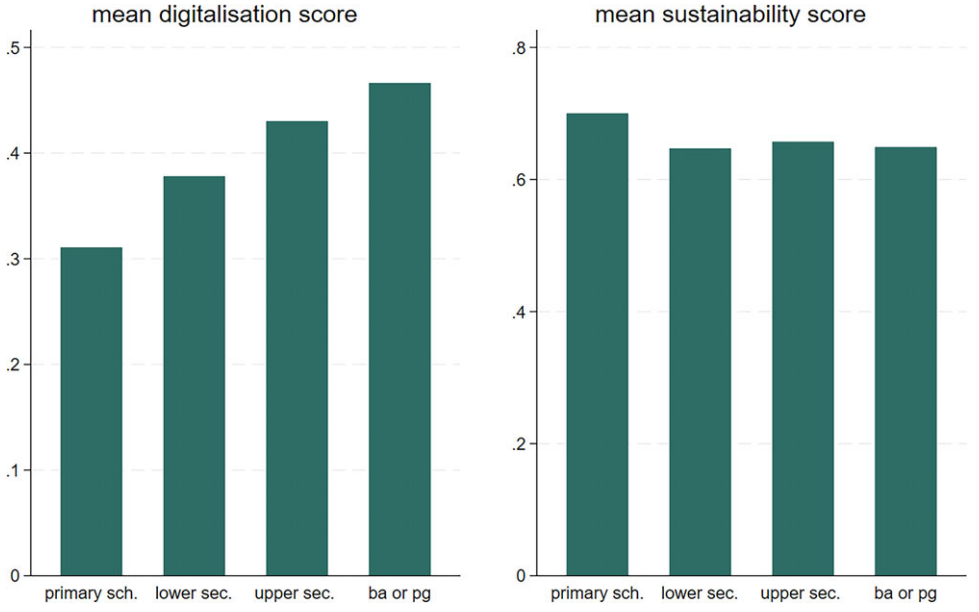

Figure 4. Digitalisation and sustainability score by entrepreneur's level of education.
Notes: Sample of non-financial Italian firms with less than 10 employees. Mean digitalisation score and mean sustainability score by entrepreneurs' level of education (primary school or no formal education at all; lower secondary school; upper secondary school; bachelor or post-graduate degree). See Table A1 for the description of variables.

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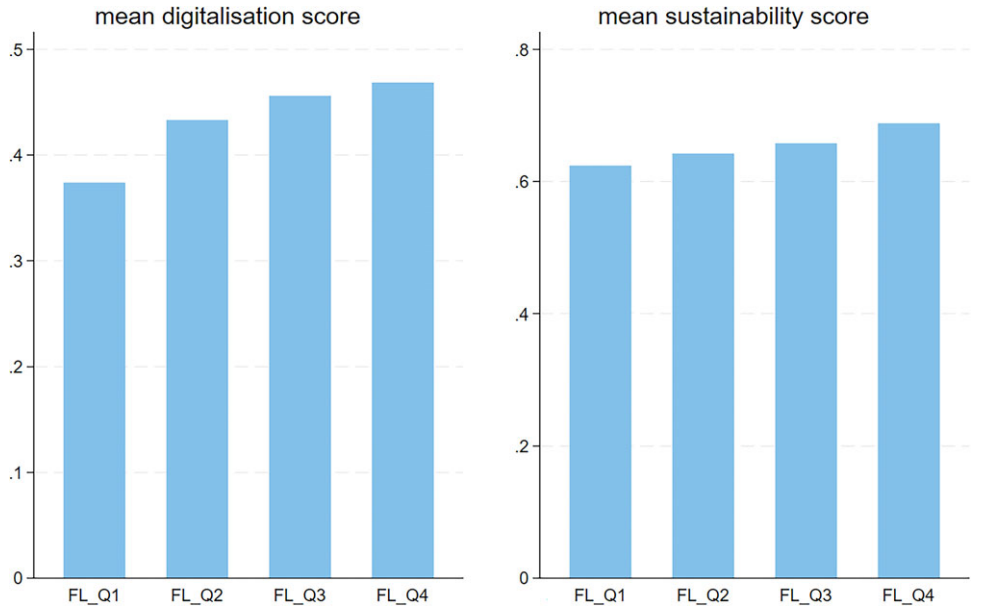

Figure 5. Digitalisation and sustainability score by entrepreneur's financial literacy.
Notes: Sample of non-financial Italian firms with less than 10 employees. Mean digitalisation score and mean sustainability score by entrepreneurs' financial literacy (quartiles). See Table A1 for the description of variables.

takes into account five indicators of landslide and flooding risks, available at municipality level: the percentage of local units at risk; the percentage of area at risk; the percentage of buildings at risk; the percentage of population at risk; and the percentage of households at risk (see Table A1). The basic indicators are retrieved from the Environmental Data Yearbook compiled by the Italian Institute for Environmental Protection and Research (ISPRA). Figure 6 illustrates the geographical distribution of floods and landslides risks over the Italian territory at the municipality level. As expected, the extent of these risks is widely heterogeneous across the country. Figure 7 shows the distribution of our sampled micro-enterprises by level of exposure to climate change risks. In particular, about one-fifth of sampled firms are located in the quartile of Italian municipalities with high climate change risk areas; a similar share characterises firms headquartered in low-risk municipalities, while about 50 per cent of firms operate in medium climate risk areas.

3. Empirical strategy and identification

The aim of the paper is to assess the impact of entrepreneur financial literacy on both digital and sustainable transition. Our baseline regressions consider the variable financial literacy measured as a combination of financial knowledge, attitudes, and behaviours, in line with the existing OECD/INFE definition of financial literacy for MSMEs and the scoring guide included in the questionnaire (OECD, 2020). We consider this measure particularly valuable for young people, adult individuals and more so for small entrepreneurs as it encompasses not only the knowledge and understanding of financial concepts, but also the skills and attitudes to apply such knowledge to make effective financial decision for the benefit of the businesses and the society. The behaviour and attitude questions considered in the toolkit give a good indication of their practical skills, including those that enable them to effectively manage and operate within a business environment and build their

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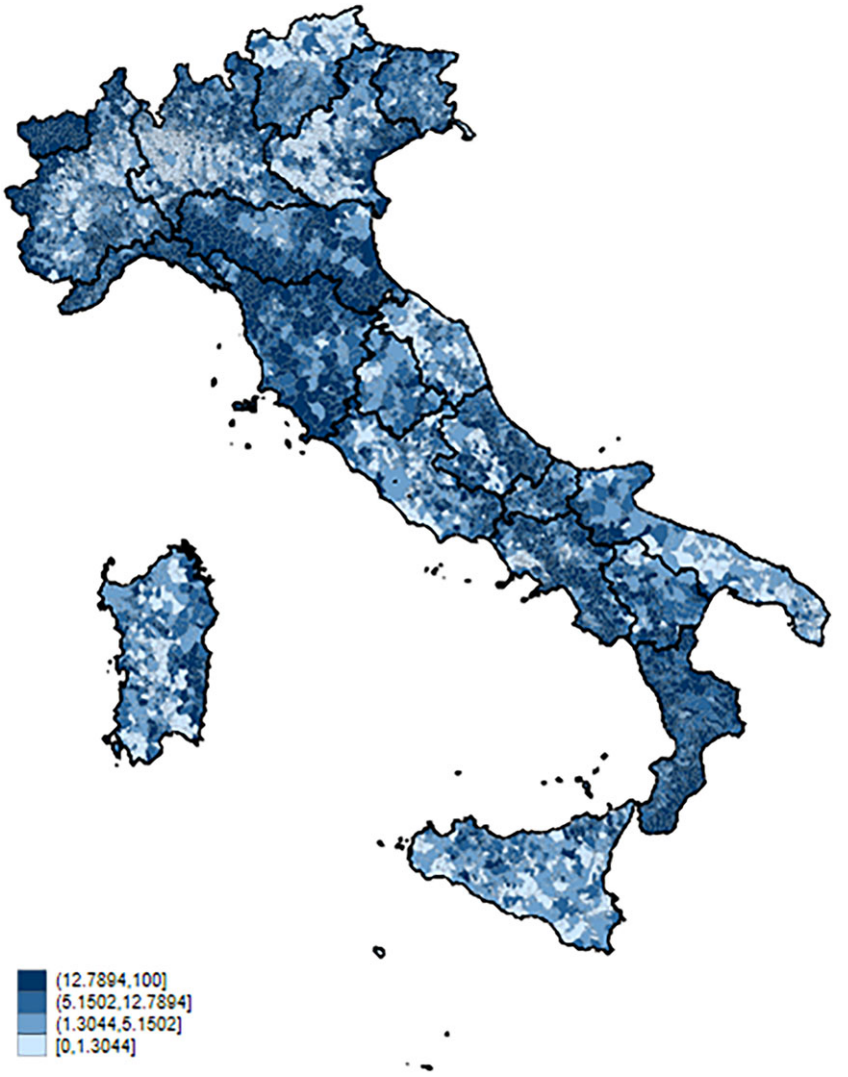

Figure 6. Flooding and landslides risk in Italian municipalities.
Notes: Floods and landslides risks of Italian municipalities. Composite risk indicator that takes into account five indicators of landslide and flooding risks, available at municipality level: percentage of local units at risk; percentage of area at risk; percentage of buildings at risks; percentage of population at risk and percentage of households at risks. The basic indicators are retrieved from the Environmental Data Yearbook compiled by the Italian Institute for Environmental Protection and Research (ISPRA). See Table A1 for the description of this variable.

own financial wellbeing (Atkinson (2017)). To take into account the fact that the three components are correlated, we also consider the three components in isolation.

Formally, we estimate such causal relationships by means of the following linear regression model

$$y_i = \alpha + \beta FL_i + X_i\gamma + P_i\delta + \mu e_{mi} + \varepsilon_i \quad (1)$$

where y is a measure of digitalisation or of the extent of involvement into sustainability for firm i; FL_i is a measure of financial literacy of firm i; X_i is a set of firm-specific controls, including sector, area and size (measured by the number of employees); P_i is a set of

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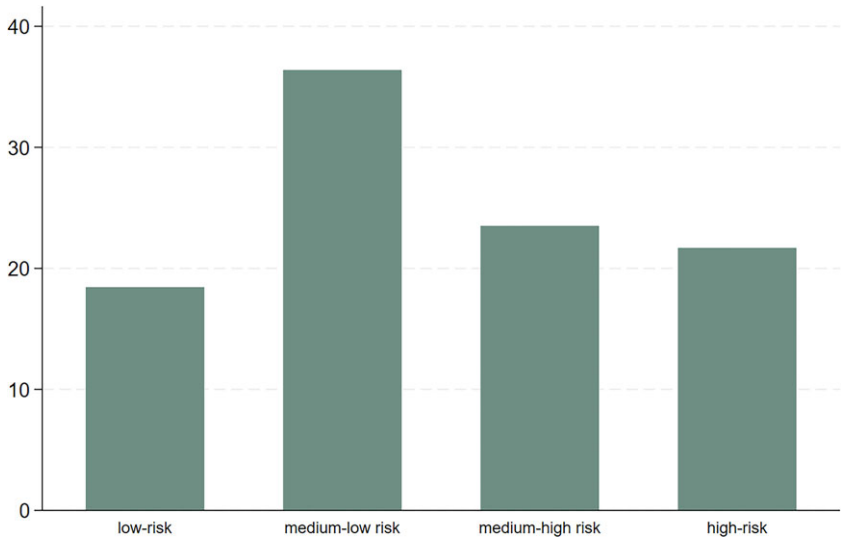

Figure 7. Sample firms' distribution by quartile of flooding and landslide risks.
Notes: Sample of non-financial Italian firms with less than 10 employees. See Table A1 for the description of this variable.

entrepreneur-specific controls, including level of education, gender, age cohorts, acquaintance with finance and economics (measured by being parented by an entrepreneur); e_{mi} is the exposure to climate change related physical risks: this variable is employed in the model that investigates the relationship between involvement into sustainability and financial literacy. Standard errors are clustered at the municipality level.

Ordinary least squares (OLS) estimates of equation (1) arguably suffer from three sources of bias and hence cannot be intended in a causal fashion. Firstly, although a large set of firm- and entrepreneur-level controls are employed in the regression, there still could be unobserved firm characteristics, such as firm productivity, affecting both the dependent variables and the financial literacy. In this case, OLS estimates would be upward-biased, since productivity is arguably positively correlated with both financial literacy and the two dependent variables. A similar bias could arise if unobservable components that are specific to the entrepreneur, such as their innate abilities, correlate with both entrepreneur's literacy and digitalisation skills and sustainability involvement. A second source of bias could stem from potential reverse causality issues, when greater digitalisation or sustainable investments might call for greater investments in financial knowledge, leading to inflated OLS coefficients. Finally, measurement error of the independent variable of interest (i.e. financial literacy) would lead to biased OLS estimates (attenuation bias).

We tackle these challenges and reach causal identification by means of instrumental variable (IV) estimation. To devise our IV, we exploit a source of exogeneity operating at the municipality level, represented by the number of universities that offered a degree in economics near the entrepreneurs' area, similarly to Klapper et al. (2013). Differently from Klapper et al. (2013), who focus on the total number of universities in each region, we consider only those universities offering degrees in economics; moreover, we use more granular municipality-level data to identify universities that are close enough to the entrepreneur. To this aim, we exploited 2015 data provided by Istat.

The presence of courses in economics offered by nearby universities is arguably correlated to the financial literacy of both the entrepreneurs and their peers, who were

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exogenously exposed to a different amount of information and economic knowledge according to their closeness to such universities. To devise our instrumental variable, we first computed, for each firm, the driving time distances between the municipality where firm is headquartered and any other Italian municipality. Then, we selected those municipalities reachable within a driving time of at most 30 minutes. Finally, we summed up the number of faculties offering economics degrees in those municipalities, including the one where the firm is headquartered.

4. Results

The baseline results of the econometric analysis about the effect of financial literacy on digitalisation are displayed in Table 1. The OLS estimates show that financial literacy positively correlates with the extent of digitalisation. As expected, entrepreneurs holding at least a secondary school diploma display a greater use of digital activities; on the other hand, smaller firms are characterised by a lower degree of digitalisation.[5]

IV estimates (columns 4–5) provide evidence for a causal relationship between financial literacy and entrepreneurs' engagement in digitalisation. As far as the first-stage regression is concerned, the estimates document the significance of our instrument in shaping entrepreneurs' financial skills; they also show that financial literacy is higher among owners with a secondary school diploma and those who have an entrepreneur as a parent, while it decreases among businesses located in the South and the Islands. The second stage shows that the coefficient of the financial literacy is positive, statistically significant and sizeable: a one standard deviation increase in the financial literacy score leads to an improvement of the engagement in digitalisation equal to about 70 per cent [$= (0.51 * 0.59)/0.44$] of the average digitalisation level. Moreover, the IV estimates confirm the important role played by age when exploring the digital transition, as early-career entrepreneurs engage in digital activities more than late-career ones. The first-stage F-statistic is well above the conventional threshold for weak instruments. The downward bias observed in OLS results aligns with findings from Lusardi and Mitchell (2014), who show that the impact of financial literacy on financial decision-making estimated through IV models tends to be larger compared to those estimated through OLS in many cases, pointing to a possible underestimation of the true effect by OLS estimates.

The results show no gender gap among micro-entrepreneurs in terms of digitalisation and financial literacy.

Table 3 investigates the relationship between financial literacy and entrepreneurs' engagement in sustainable activities. OLS results show that financial literacy positively correlates with efforts towards sustainability. On the other hand, the level of education, which is significantly linked to entrepreneur's financial skills, does not show any correlation with engagement in sustainability. OLS findings are strengthened by IV regression results (columns 4-5), showing a causal relationship between financial literacy and entrepreneurs' interest into sustainability issues: in particular, a one standard deviation increase in the financial literacy score leads to an increase of the engagement into sustainable activities by about 32 per cent [$= (0.41 * 0.51)/0.65$] of the average level.

Interestingly, women entrepreneurs appear more willing to engage in sustainable activities than men, while age does not play a role in this case. Finally, firms located in municipalities characterised by higher climate-related physical risks are more likely to engage in sustainable activities. This result suggests that the proximity of the businesses to these risks might enhance awareness and sensitivity to sustainability issues. As in the

[5] Heterogeneities at the economic sector level are also highlighted by (unreported and available upon request) economic sector level dummies.

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Table 1. Financial literacy and digitalisation

	OLS			IV	
Variables	Baseline	Sector	Full ctrls	First-stage	Second-stage
FL score	0.0827***	0.0842***	0.0771***		0.597***
	(0.0118)	(0.0121)	(0.0125)		(0.197)
South & Islands		−0.00917	−0.00925	−0.0602**	0.0369
		(0.0126)	(0.0126)	(0.0273)	(0.0248)
Small			−0.0769***	−0.298***	0.0796
			(0.0251)	(0.0509)	(0.0678)
Diploma			0.0422**	0.220***	−0.0740
			(0.0199)	(0.0390)	(0.0523)
Woman			0.0154	−0.0247	0.0290
			(0.0121)	(0.0257)	(0.0189)
Parents entrepreneurs			0.00365	0.0613***	−0.0253
			(0.0121)	(0.0237)	(0.0198)
30–49 years old			0.00412	0.152**	−0.0733
			(0.0368)	(0.0616)	(0.0595)
50–69 years old			−0.0391	0.250***	−0.168**
			(0.0363)	(0.0616)	(0.0724)
70+ years old			−0.0628	0.237***	−0.185**
			(0.0454)	(0.0886)	(0.0775)
Instr. variable				0.192***	
				(0.0518)	
Firm sector	No	Yes	Yes	Yes	Yes
Constant	0.253***	0.349***	0.358***	1.703***	−0.546
	(0.0274)	(0.0346)	(0.0509)	(0.0884)	(0.343)
Observations	1,762	1,762	1,762	1,762	1,762
R-squared	0.030	0.045	0.068		
First-stage F					13.70

Notes: OLS and IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the digitalisation score (see Table A1 provided in the Supplementary Material for the definition of the variables). The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid.

previous set of results, the first stage confirms the significance of the link between financial skills and our instrument, and the value of the F test statistics is reassuring with regard to the strength of our IV strategy.

So far, we have examined the propensity for digitalisation and engagement in sustainable activities in relation to a comprehensive indicator of financial literacy, which includes scores on knowledge, behaviours and attitudes, as defined by the OECD. We now take a step further by isolating the role of financial knowledge in influencing the twin transition of small businesses. The analysis considers the empirical model (1), modified by

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Table 2. Financial knowledge and digitalisation

	OLS			IV	
Variables	Baseline	Sector	Full ctrls	First-stage	Second-stage
FK score	0.0960***	0.0970***	0.0870***		1.982**
	(0.0245)	(0.0246)	(0.0247)		(0.995)
South & Islands		−0.0158	−0.0147	−0.0079	−0.0166
		(0.0127)	(0.0127)	(0.0146)	(0.0340)
Small			−0.0920***	−0.0928***	0.0855
			(0.0252)	(0.0271)	(0.110)
Diploma			0.0516**	0.0890***	−0.119
			(0.0201)	(0.0206)	(0.0924)
Woman			0.0137	−0.0021	0.0185
			(0.0123)	(0.0137)	(0.0287)
Parents entrepreneurs			0.00381	0.0491***	−0.0859
			(0.0121)	(0.0131)	(0.0545)
30–49 years old			0.00925	0.0658*	−0.113
			(0.0372)	(0.0348)	(0.0992)
50–69 years old			−0.0303	0.118***	−0.253*
			(0.0366)	(0.0346)	(0.137)
70+ years old			−0.0583	0.158***	−0.356**
			(0.0467)	(0.0447)	(0.178)
Instr. variable				0.0578**	
				(0.0291)	
Firm sector	No	Yes	Yes	Yes	Yes
Constant	0.364***	0.458***	0.447***	0.507***	−0.533
	(0.0198)	(0.0301)	(0.0480)	(0.0479)	(0.533)
Observations	1,762	1,762	1,762	1,762	1,762
R-squared	0.010	0.026	0.052		
First-stage F					3.949

Notes: OLS and IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the digitalisation score (see Table A1 for the definition of the variables). The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid.

replacing the overall financial literacy indicator (FL score) with the score on financial knowledge (FK score). Also, for this set of regressions, the financial knowledge score is subsequently instrumented using the number of nearby universities (within a 30-minute drive) offering economics degrees.

As far as the digital drive is concerned, the results are reported in Table 2. The propensity to digitalise business activities positively correlates with the score on financial knowledge in the OLS analysis. Moreover, it is higher among more educated individuals and entrepreneurs leading relatively larger firms (columns 1–3). The IV analysis confirms the positive link between financial knowledge and the digitalisation (columns 3–4). Specifically, a one

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Table 3. Financial literacy and sustainability

	OLS			IV	
Variables	Baseline	Sector	Full ctrls	First-stage	Second-stage
FL score	0.0485***	0.0517***	0.0536***		0.410***
	(0.00949)	(0.00953)	(0.00987)		(0.136)
South & Islands		0.0293***	0.0314***	−0.0595**	0.0631***
		(0.0105)	(0.0104)	(0.0274)	(0.0181)
Small			0.0207	−0.298***	0.128**
			(0.0174)	(0.0509)	(0.0506)
Diploma			−0.0105	0.220***	−0.0901***
			(0.0131)	(0.0390)	(0.0348)
Woman			0.0153	−0.0249	0.0244*
			(0.00953)	(0.0257)	(0.0132)
Parents entrepreneurs			−0.00187	0.0613***	−0.0218
			(0.00917)	(0.0237)	(0.0138)
Climate change risk			−0.0067**	0.00191	0.0079*
			(0.0033)	(0.00741)	(0.0043)
30–49 years old			0.00543	0.152**	−0.0475
			(0.0214)	(0.0616)	(0.0350)
50–69 years old			0.0239	0.250***	−0.0641
			(0.0212)	(0.0616)	(0.0424)
70+ years old			0.00112	0.237***	−0.0827
			(0.0297)	(0.0887)	(0.0515)
Instr. variable				0.195***	
				(0.0529)	
Firm sector	No	Yes	Yes	Yes	Yes
Constant	0.547***	0.537***	0.508***	1.699***	−0.113
	(0.0223)	(0.0255)	(0.0340)	(0.0891)	(0.245)
Observations	1,762	1,762	1,762	1,762	1,762
R-squared	0.017	0.026	0.034		
First-stage F					13.70

Notes: OLS and IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the sustainability score (see Table A1 for the definition of the variables). The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid.

standard deviation increase in financial knowledge associates with an increase of small-business digitalisation by 59 per cent of the average level [= (1.982 * 0.26)/0.435]. The model also shows that the digitalisation is higher among younger micro-entrepreneurs. With regard to the first-stage regression, the estimates confirm the relevance of the instrumental variable; they also show that financial knowledge is higher among entrepreneurs having a higher educational attainment, those who run larger businesses, and with greater experience – either due to age or because they come from families with an entrepreneurial

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Table 4. Financial knowledge and sustainability

	OLS			IV	
Variables	Baseline	Sector	Full ctrls	First-stage	Second-stage
FK score	0.0179	0.0203	0.0177		1.365*
	(0.0164)	(0.0164)	(0.0166)		(0.797)
South & Islands		0.0243**	0.0269**	−0.00774	0.0492*
		(0.0105)	(0.0105)	(0.0146)	(0.0257)
Small			0.00617	−0.0928***	0.132
			(0.0168)	(0.0271)	(0.0856)
Diploma			−0.000138	0.0890***	−0.121
			(0.0130)	(0.0206)	(0.0752)
Woman			0.0140	−0.00217	0.0172
			(0.00970)	(0.0137)	(0.0206)
Parents entrepreneurs			0.000290	0.0491***	−0.0636
			(0.00923)	(0.0131)	(0.0438)
Climate change risk			0.0066**	0.0005	0.0081
			(0.0033)	(0.0039	(0.0066)
30–49 years old			0.0123	0.0658*	−0.0750
			(0.0217)	(0.0348)	(0.0708)
50–69 years old			0.0351	0.118***	−0.123
			(0.0215)	(0.0346)	(0.103)
70+ years old			0.0110	0.158***	−0.200
			(0.0303)	(0.0447)	(0.136)
Instr. Variable				0.0586**	
				(0.0298)	
Firm sector	No	Yes	Yes	Yes	Yes
Constant	0.641***	0.632***	0.593***	0.506***	−0.107
	(0.0127)	(0.0190)	(0.0301)	(0.0487)	(0.424)
Observations	1,762	1,762	1,762	1,762	1,762
R-squared	0.001	0.008	0.015		
First-stage F					3.949

Notes: OLS and IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the sustainability score (see Table A1 for the definition of the variables). The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid.

background. The analysis further reveals an absence of statistically significant gender differences in financial knowledge among micro-entrepreneurs.

The results on the relationship between financial knowledge and involvement in sustainable activities are presented in Table 4. In columns 1–3, the coefficients of the variable capturing the financial knowledge score are consistently positive, although not statistically significant. As already noted, OLS estimates of the impacts of financial literacy

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Table 5. Financial behaviour-attitudes and digitalisation-sustainability

Variables	OLS	IV		OLS	IV
Panel (a): dependent variable = digitalisation score					
FB score	0.270***	1.784***	FA score	0.0737***	1.642**
	(0.0384)	(0.641)		(0.0199)	(0.828)
Sector	Yes	Yes	Sector	Yes	Yes
Ctrls	Yes	Yes	Ctrls	Yes	Yes
Observations	1,762	1,762	Observations	1,762	1,762
First-stage F		13.98	First-stage F		4.77
Panel (b): dependent variable = sustainability score					
FB score	0.310***	1.165***	FA score	0.0483***	1.178**
	(0.0358)	(0.359)		(0.0153)	(0.567)
Sector	Yes	Yes	Sector	Yes	Yes
Ctrls	Yes	Yes	Ctrls	Yes	Yes
Observations	1,762	1,762	Observations	1,762	1,762
First-stage F		15.475	First-stage F		4.296

Notes: OLS and IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The control variables are those described in Section 3 and used in Table 1 and the subsequent ones. The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid.

on individual outcomes are generally affected by attenuation bias, which stems from measurement error; therefore, we expect the IV analysis to yield coefficients of greater magnitude. The results confirm this pattern (columns 4–5). The coefficient for the score in financial literacy is positive and statistically significant at the 10 per cent probability level; in terms of magnitude, a one standard deviation increase in financial knowledge associates with an increase in the engagement in sustainable activities by about 55 per cent of the average level [$= (1.365 * 0.26)/0.65$].

To deepen the link between financial literacy and small-business engagement in digitalisation and sustainability, we isolated the behaviour and attitude components of the financial literacy index (Table 5). The results confirm that both the behaviour and attitude scores are positively and statistically significantly associated with the propensity toward digitalisation (panel a) as well as with engagement in sustainable activities (panel b). They also reinforce the evidence that OLS estimates tend to underestimate the true effects compared to the IV results.

4.1. Robustness checks

In this section, we perform a battery of robustness exercises to assess the relationship between financial literacy and engagement in digitalisation or sustainable activities (Table 6, panel *a* and panel *b*, respectively).

As a first robustness check (column 1), we estimate model (1) by including additional firm-level controls. In particular, we introduce more granular education level dummies (moving from one dummy to three dummies) and add firms' legal entity type. Second (column 2), we employ five macro-regions (North West, North East, Centre,

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Table 6. Financial literacy and twin transition: robustness

Variables	Add ctrls (1)	Area Dummies	Binary Depvar (2)	Binary FL (3)	Alter. IV (4)
Panel a: Financial literacy and digitalisation					
FL score	0.707**	0.532**	0.751**		0.496***
	(0.350)	(0.212)	(0.339)		(0.135)
Binary FL score				0.589***	
				(0.194)	
Sector	Yes	Yes	Yes	Yes	Yes
Firm level ctrls	Yes	Yes	Yes	Yes	Yes
Additional ctrls	Yes	No	No	No	No
5 Area dummies	No	Yes	No	No	No
Observations	1,762	1,762	1,762	1,762	1,762
First-stage F	5.325	9.740	13.70	14.49	30.91
Panel b: Financial literacy and sustainability					
FL score	0.545**	0.241*	0.893***		0.244***
	(0.270)	(0.140)	(0.313)		(0.0921)
Binary FL score				0.393***	
				(0.130)	
Sector	Yes	Yes	Yes	Yes	Yes
Firm level ctrls	Yes	Yes	Yes	Yes	Yes
Additional ctrls	Yes	No	No	No	No
5 area dummies	No	Yes	No	No	No
Observations	1,762	1,762	1,762	1,762	1,762
First-stage F	5.325	9.752	13.57	15.45	30.49

Notes: IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Instrumental variable estimates. The dependent variable is the digitalisation score in panel a and the sustainability score in panel b (see Table A1 for the definition of the variables). - (1) Additional controls include: legal entity type, age-group dummies, level of education dummies. The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid. - (2) The dependent variable is a dummy taking value 1 if the digitalisation score or sustainability score is above the mean and 0 otherwise. - (3) FL dummy is a binary variable taking value 1 if the FL score of the entrepreneur is above the mean, and 0 otherwise. - (4) The instrumental variable is the density of bank branches at the municipal level in 1951.

South, Islands) rather than just two (Centre & North vs South and Islands). Third (column 3), we employ a dependent variable as a dummy taking the value one if the digitalisation or sustainability score is above the mean level and 0 otherwise. In column 4, we consider a dichotomous measure of financial literacy rather than a continuous one. To this aim, we devise a binary variable taking value 1 for micro-entrepreneurs with a FL score above the median and 0 otherwise. Results strengthen our findings on baseline estimates, with the estimated coefficient of interest – i.e. that associated with the Financial literacy score – being always statistically significant and similar in size with that of our previous findings across the alternative specifications of model (1, see columns 1, 2 and 3).

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Table 7. Financial literacy and digitalisation: channels

	Online	Digital	Website	Social	Online payments
Variables	Current acc.	Finan. serv.	Advert.	Network	From customers
FL score	0.719**	0.339	1.471***	0.273	0.325
	(0.363)	(0.223)	(0.447)	(0.238)	(0.234)
South & Islands	0.0677	0.0281	0.0657	0.0400	−0.00802
	(0.0444)	(0.0269)	(0.0592)	(0.0264)	(0.0297)
Small	0.148	0.0346	0.238	0.0256	0.0193
	(0.123)	(0.0700)	(0.161)	(0.0741)	(0.0796)
Diploma	−0.0694	−0.0442	−0.209*	−0.0446	0.0303
	(0.0918)	(0.0585)	(0.116)	(0.0578)	(0.0559)
Woman	0.0148	−0.00478	0.0717	0.0497**	0.0732***
	(0.0307)	(0.0193)	(0.0446)	(0.0211)	(0.0224)
Parents entrepreneurs	−0.00400	−0.00460	−0.0601	−0.0193	−0.0129
	(0.0332)	(0.0216)	(0.0457)	(0.0231)	(0.0251)
30–49 years old	−0.140	−0.0860	−0.0287	−0.00353	−0.0251
	(0.1000)	(0.0656)	(0.133)	(0.0665)	(0.0627)
50–69 years old	−0.240*	−0.129	−0.201	−0.142*	−0.0363
	(0.123)	(0.0799)	(0.165)	(0.0813)	(0.0776)
70+ years old	−0.289**	−0.0786	−0.186	−0.251***	−0.0423
	(0.132)	(0.0831)	(0.177)	(0.0839)	(0.0813)
Firm sector	Yes	Yes	Yes	Yes	Yes
Constant	−0.823	−0.399	−2.102***	0.00827	−0.546
	(0.640)	(0.383)	(0.788)	(0.415)	(0.417)
Observations	1,762	1,762	1,762	1,762	1,762
First-stage F	13.70 *(for all models)*				

Notes: IV estimates on firm-level data. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The instrumental variable is the number of universities offering economics degrees within 30 minutes of driving time from the municipality centroid. See Table A1 for the definition of the variables. - (1) The dependent variable is a dummy equal to 1 if the entrepreneur has opened a bank account completely online and 0 otherwise see Table A3). - (2) The dependent variable is a dummy equal to 1 if the entrepreneur has signed a financing or insurance contract completely online and 0 otherwise (see Table A3). - (3) The dependent variable is a dummy equal to 1 if the entrepreneur has a dedicated website to showcase their products or services and 0 otherwise (see Table A3). - (4) The dependent variable is a dummy equal to 1 if the entrepreneur uses social networks for advertising or networking (see Table A3). - (5) The dependent variable is a dummy equal to 1 if the share of online payments from customers is very relevant and 0 otherwise.

4.2. Further robustness checks: alternative IV

As a further robustness check, we devise a second instrumental variable, exploiting as a source of exogeneity an exogenous shock on the offer of banking services. In particular, the source of exogeneity comes from the 1936 banking law, which introduced a reform to protect the banking system from instability:[6] it significantly constrained the growth of

[6] The 1936 banking law, passed to address the crisis following the Great Depression, separated between short- and long-term credit and between banking and industry. Credit institutions were grouped into four categories, facing different constraints on the territory where they could open branches (city, province or region, depending on the type of bank) accordingly.

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banks in Italy over the following 50 years (Guiso et al. 2004) and led to a segmented banking system until the 1980s (Angelini and Cetorelli, 2003; De Bonis et al. 2011; De Bonis et al. 2023). Even though the reform reduced competition in the Italian banking system for many years, what we are exploring here is the effect of the shock on the availability of banking services. This may have influenced the development of different abilities across the Italian territory to handle financial issues and become familiar with various financial services.

More in detail, our second IV is grounded on three streams of research, showing: (i) that individuals' financial literacy is influenced by that of peers or that of reference groups (Bucher-Koenen and Lusardi, 2011; Fornero and Monticone, 2011; Klapper et al. 2013); (ii) the causal effect of financial experience on financial literacy (Frijns et al. 2014); (iii) the existence of a relationship between exposure to banks and customers' financial literacy (Brown et al. 2019; Fort et al. 2016). Building on the above research, we claim the (exogenous) offer of banking services across municipalities in 1951 affected the financial literacy of individuals living in such territories who, in turn, passed these competences to their peers. Hence, as an instrumental variable, we use the number of bank branches per square km in 1951 (the earliest available year), at the municipality level.

The exclusion restriction assumption requires that, conditional on the controls used in the regressions (including area and firm sector dummies), the instrumental variable affects our two independent variables only indirectly, by means of the entrepreneur's financial literacy. A possible threat to the exclusion restriction assumptions would arise in the case that the density of bank branches in 1951 at the municipality level reflects pre-existing (historical) local differences in the economic and financial landscape, thereby shaping current entrepreneurial engagement as well as levels of financial knowledge.

While the exclusion restriction assumption is not testable, we run some estimates to assess a number of potential threats to identification. In particular, we exploit 1951 municipality data available from Istat census and estimate the correlation between our instrumental variable and some relevant economic activity indicators (labour market participation and the unemployment rate, the only ones available for that year) and the illiteracy rate. As reported in Table A5, columns 1, 2 and 3, the estimated coefficient of interest is not statistically significant, suggesting that our instrument is not correlated with local economic performance in 1951.

The IV estimates obtained with the alternative instrument described above, reported in Table 6 (column 5), confirm our baseline findings about the causal relationship between financial literacy and both digitalisation and sustainability.

4.3. Financial literacy and digitalisation: a look at the channels

Financial literacy might positively affect digitalisation through several possible mechanisms. We argued before that a first mechanism involves the role of financial literacy in enhancing the access to digital financial activities, and, in this way, fostering further digitalisation. A second possible mechanism involves the role of financial literacy in making the entrepreneur aware of the potential benefits stemming from more digital commercial activities.

With respect to this second mechanism, at least two channels are at work. Firstly, higher financial literacy might lead to a greater awareness of the importance of technological upgrade to improve the productivity through, for instance, online selling platforms and a more digitalised business organisation. Secondly, higher financial literacy might lead to higher propensity of small firms to digitise their businesses because this could allow them to improve their access to finance. In fact, in the current fast-expanding digital financial landscape, innovative financial service providers make intensive use of data analytics stemming from financial and commercial digital activities to assess small

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businesses' creditworthiness (International Financial Corporation and SME Finance Forum, 2023).

In order to investigate whether some of the above outlined mechanisms are at work, we run some additional estimates of our IV model, considering, in turn, different outcome variables. First, in order to investigate whether the link going through the access to digital finance plays a role, we employ as dependent variable a dummy equal to one if the entrepreneur has opened a current account completely online and zero otherwise, and a dummy equal to one if the entrepreneur has signed a financial or insurance contract completely online and zero otherwise. Second, in order to investigate whether financial literacy plays a role for the business via purely non-financial channels, we employ as dependent variable a dummy equal to one if the firm has a website to advertise its products or services, and zero otherwise, or whether it uses social media to promote the business. We also examine the relationship between entrepreneurs' FL and the relevance of online payments received from their customers. In this case, since entrepreneurs have limited capability to influence access to digital instruments of their customers, we do not expect any statistical significant relationship between entrepreneurs' FL and their customers' payment habits.

Results are displayed in Table 7. Concerning the relationship between financial literacy and access to digital financial instruments, column 1 supports our claim, hinting at a direct relationship, as FL positively influences the access to online current account. The estimates also provide support to the claim that higher financial literacy might lead to a greater awareness of the importance of technology to improve the productivity, for instance, by means of digital platforms to showcase their products or services. We do not find, however, a relationship between FL and usage of social networks for advertising purposes. This result suggests that the use of social media, even in a business environment, is mostly related to personal attitudes, not FL-mediated, and experience with such instruments. Finally, we do not detect any relationship between the entrepreneurs' FL and a high relevance of online payments received from their customers.

5. Concluding remarks

Despite the relevance of MSMEs to the European economy, in terms of both value added and employment, the drivers of their strategies about digitalisation and sustainability – which are now key in Europe – are largely unknown. Investigating such drivers can provide useful insights to support the twin transition.

In this paper, we investigate – for the first time, to the best of our knowledge – whether financial literacy affects MSMEs strategies about digitalisation and sustainability. On a theoretical ground, financial literacy could encourage digitalisation through the availability of DFS. In particular, financially competent entrepreneurs could decide to invest in digitalisation to exploit the opportunities offered by DFS. More generally, financial skills can stimulate economic awareness and a proper assessment of the benefits of digitalisation, for instance in terms of efficiency, competitiveness and ability to preserve business continuity during crises. Concerning the relationship between financial literacy and sustainability, greater financial literacy might lead to larger efforts by small firms to adopt sustainable-friendly practices to mitigate the transition risks and to improve their access to sustainable finance as well.

By using an instrumental variable estimation strategy, we find evidence of a causal link between financial literacy and both digitalisation and engagement in sustainable activities for entrepreneurs. With respect to the impact of financial literacy on digitalisation, our findings suggest that financial literacy fosters digitalisation through at least two mechanisms: (i) the usage of DFS and (ii) a greater awareness of the importance of a digitalised business organisation, which might eventually improve both productivity and access to finance.

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These findings suggest that policy-makers should keep promoting financial education initiatives devoted to MSMEs, as they will both lead to an improvement of their financial decisions and favour greater digitalisation and involvement in environmental and social sustainable activities.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/flw.2025.10002

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Cite this article: D'Ignazio, Alessio, Daniela Marconi, & Massimiliano Stacchini (2025). Micro-entrepreneurs towards the twin sustainable and digital transition. Does financial literacy play a role? *Journal of Financial Literacy and Wellbeing*. https://doi.org/10.1017/flw.2025.10002