International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

Empowering Women Entrepreneurs: The Role of Information and Communications Technology Usage and Financial Literacy

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Abstract

Helping women's entrepreneurship is an essential part of promoting common wealth. This paper adopts the data from the China Family Panel Survey 2020, incorporates Information and Communications Technology (ICT) usage, financial literacy and female entrepreneurship into a unified analytical framework, and employs the Probit model and the OLS model to study the effects of ICT usage, financial literacy, and the interaction of the two on female entrepreneurship from the perspectives of whether or not to start a business, the scale of entrepreneurship, and entrepreneurial income. The results of the study show that, firstly, both ICT usage and financial literacy are key factors affecting women's entrepreneurship, and the effect of ICT usage on women's entrepreneurship is more obvious than that of financial literacy. Second, ICT usage and financial literacy have there are significant substitution effects on whether women start a business, the size of the business, and the income from the business. Third, ICT usage and financial literacy have significant positive effects on rural female entrepreneurship, and insignificant effects on urban female entrepreneurship. Fourth, human capital shows positive moderating effects in the impact of ICT usage and financial literacy on female entrepreneurship. This paper provides a complementary perspective to existing theories in the field of entrepreneurship and provides a theoretical basis for the development of female entrepreneurship policies.

Keywords: ICT usage, financial literacy, women's entrepreneurship.

1. Introduction

In the context of the growing digital economy and more frequent financial activities, the impact of Information and Communications Technology (ICT) usage and financial literacy on women's entrepreneurship has become more and more significant. The Research Report on Digital Economy and Chinese Women's Employment and Entrepreneurship reveals that the digital economy has generated an impressive 57 million employment opportunities for women. Although more and more women are involved in entrepreneurship, the challenges are not to be overlooked. Compared to their counterparts, they often grapple with pronounced disadvantages in human, financial, and social capital. Literature has consistently highlighted the hurdles that women entrepreneurs encounter, ranging from discerning the quality of information to the intense competition in the “Internet+” startup landscape and a scarcity of financial resources. Recognizing these issues, the government and various societal sectors have ramped up their support for women's entrepreneurship in recent years. The establishment of the Key Definitions and General Guidelines for Women's Entrepreneurship has set a benchmark for defining and fostering women's equitable engagement in economic endeavors.

In the digital economy era, ICT usage has the potential to transcend geographical constraints on business activities, thereby democratizing entrepreneurship. This technological empowerment is particularly beneficial for

disadvantaged groups, including women, who traditionally face limitations in social networks and embeddedness. By leveraging ICT, these women can overcome spatial and temporal barriers to entrepreneurship, fully actualize their active roles, and seek a better balance between family and career responsibilities.

Moreover, entrepreneurship is inherently a venture in project investment, where financial literacy plays a pivotal role in achieving economic value through the judicious management of risk and return. Women with strong financial acumen are better positioned to understand their financial standing, plan for future expenditures, and make informed decisions about financing options. This, in turn, can lead to expanded entrepreneurial ventures and increased income.

This study utilizes data from the China Family Panel Survey 2020 to integrate ICT usage, financial literacy, and women entrepreneurship within a cohesive analytical framework. Employing both the Probit model and the Ordinary Least Squares (OLS) model, the research investigates the individual and interactive effects of ICT usage and financial literacy on the decision to engage in entrepreneurship, the scale of entrepreneurial ventures, and the income derived from these endeavors.

2. Literature Review

Although women have made inroads across various sectors, the prevalence of entrepreneurship remains disappointingly low, often hindered by issues such as inadequate access to microcredit [1]. The female entrepreneurs face a difficult situation in financing [2]. Women's entrepreneurship usually faces challenges with a particular focus on access to information, finance and networks [3]. Internet has changed entrepreneurship, it provides an access to unlimited marketplace that was monopolized by big enterprises before, and allows entrepreneurs to advertise their business worldwide and build customer engagement with lower cost, but only few people are able to make full use of these resources [4].

The digital economy era offers digital dividends' that can empower women, particularly in enhancing their entrepreneurial capabilities. ICT usage significantly propels women towards entrepreneurship, increasing the likelihood of starting businesses and encouraging opportunity-driven ventures [5,6]. The reason is that Internet has fostered a conducive environment for rural women's entrepreneurship, liberating them from traditional mindsets that may have previously constrained their entrepreneurial aspirations [7]. In addition, digital platforms have helped to expand the reach of businesses, bring them closer to the market and increase the self-efficacy of women entrepreneurs [8-10]. However, existing research suggests that the degree of Internet embeddedness is a pivotal factor in women's online entrepreneurship, yet it does not invariably lead to an improvement in their entrepreneurial skills [11]. The effectiveness of automated SMS business training showed that the training led to greater monthly revenue and financial resilience, more extensive usage of formal book-keeping and a better self-reported understanding of financial concepts [12].

The financial literacy exerts a positive influence on the entrepreneurial endeavors of rural households. The enhanced financial literacy substantially amplifies the likelihood of entrepreneurship and enables farmers to engage in more sophisticated and extensive entrepreneurial activities [13]. The reason is that financial literacy can access to external financing resources more easily [14], bolster their inclination to seek formal financial channels [15], and choose different borrowing channels [16]. In addition, this positive effect is more pronounced in households with larger family sizes and is positively moderated by the marketability of land, capital, and labor factors at the village level [17].

Despite the valuable insights provided by existing research, there are several areas where further exploration is necessary. Firstly, while there is a wealth of literature examining the determinants of entrepreneurship among farm and rural households, there is a notable absence of studies that specifically consider women as a distinct gender group. Secondly, although financial literacy has been extensively studied in the context of personal factors influencing farm entrepreneurship, there is a recognized deficiency in research that addresses the role of ICT usage in the digital economy era. Thirdly, while external factors such as financial support and the empowering potential of digital platforms have been examined in the context of women's entrepreneurship, there is a conspicuous lack of focus on the internal skill literacy that women possess. Understanding the level of skill literacy among women

entrepreneurs is crucial, as it can significantly influence their ability to leverage digital tools and financial resources effectively.

In light of these shortcomings, this paper investigates the impact of ICT usage, financial literacy and their interactions on female entrepreneurship. The contributions of this paper are threefold: first, it shifts the focus from the traditional subjects of farmers or rural households to the female demographic, which is gaining prominence in the digital era. This is a strategic choice, as women possess unique advantages in the digital economy and are well-positioned to leverage this moment for entrepreneurial ventures. By concentrating on this group, this research aims to contribute to the practical resolution of rural revitalization and inclusive growth. Second, the paper delves into the interplay between ICT usage and financial literacy, a topic that resonates with the contemporary digital landscape. By exploring the intrinsic skill literacy of women, this study expands upon the conventional emphasis on external factors in entrepreneurship research. Demonstrating the positive influence of ICT and financial literacy on women's entrepreneurship could further bolster their capacity for self-driven development in rural areas. Third, this research acknowledges the heterogeneity inherent in female entrepreneurship by scrutinizing how individual characteristics, such as household status and human capital, influence the effectiveness of ICT usage and financial literacy in fostering entrepreneurial activities.

3. Theoretical Analysis and Research Hypothesis

According to the theory of empowerment, femininity is better able to adapt to digital changes and access more inclusive entrepreneurial employment opportunities. In the era of digital economy, ICT usage can make better use of digital platforms to empower women themselves, provide them more time and space for women's entrepreneurship, and this flexible time space also provides help for balancing family and career, further creating conditions for women's entrepreneurial activities. Access to information is an important aspect of entrepreneurship theory. The resources provided by the digital economy are richer than those provided by the traditional economy in the past, which makes up for women's relatively small resources, and this information access is a new way of accessing resources, which is different from the traditional gender constraints, and can effectively help this group to identify entrepreneurial opportunities, break through the resource and technology barriers in the process of entrepreneurship, and enhance the performance of entrepreneurship. Existing research also suggest that women's willingness to start a business is high if they have adequate skills in ICT usage [18]. Based on the above analysis, the following hypotheses are proposed:

Hypothesis 1a: ICT usage has a positive effect on whether women start a business, the size of the business, and in terms of entrepreneurial income.

By combing the theories and literature on female entrepreneurship, entrepreneurial opportunities, business management, and entrepreneurial capital are important components of the female entrepreneurial ecosystem. Firstly, women's individual perception of value differences helps to identify entrepreneurial opportunities, and financial knowledge such as return on investment helps to effectively estimate the financial cost of resource integration and the expected benefits of opportunity development, so as to improve the identification and assessment of entrepreneurial opportunities, which is crucial to their entrepreneurial decision-making. Secondly, financial literacy in human capital directly affects the knowledge, skills, and business management capabilities that entrepreneurs need to have, and a wealth of financial knowledge, good financial awareness and behavioral skills are crucial to their entrepreneurial development. Rich financial knowledge, good financial awareness and behavioral habits help women to grasp their own financial situation, reasonably plan future expenses and prepare in advance to ensure healthy and orderly financial management of entrepreneurial projects [17]. Finally, the greatest impact of financial literacy on their entrepreneurship is that financial literacy can influence entrepreneurial financing decisions, enhance women's entrepreneurial willingness to raise funds and choose formal financial financing, and better bring financial capital to expand the initial entrepreneurial scale. bring in financial capital, expand the initial entrepreneurial scale, and enhance entrepreneurial income. The existing literature empirically demonstrated that the improvement of farmers' financial literacy significantly increased their entrepreneurial possibilities; and that the improvement of financial literacy is conducive to the development of higher-level and larger-scale entrepreneurial activities by farmers [13]. Therefore, the following hypotheses are proposed:

Hypothesis 1b: Financial literacy has a positive effect on whether women start a business, the scale of entrepreneurship, and in terms of entrepreneurial income.

The human capital is a major factor influencing women's entrepreneurship, and ICT usage and financial literacy itself, as a part of human capital, also directly affect women's entrepreneurship in terms of whether to undertake entrepreneurial activities, the scale of entrepreneurship, and entrepreneurial income [19]. There may be the interaction effect of ICT usage and financial literacy. The existing researches finds that there is a certain degree of substitutability of academic education and financial literacy, while skills training and financial literacy have some complementarity [20]. The ICT usage studied in this paper is more expressed as a kind of skill literacy in social groups, accordingly, it is proposed:

Hypothesis 2a: There are complementary effects of ICT usage and financial literacy in terms of whether women start a business, the size of the business, and the income from the business.

In entrepreneurship theory, social capital and human capital are both drivers of entrepreneurship. There is a substitution effect of human capital and social capital in women's entrepreneurial choices [21]. Whereas ICT usage and financial literacy are both components of human capital, and at the same time have an effect on female entrepreneurship, the following hypothesis is proposed by analogy based on the results of the literature:

Hypothesis 2b: There is a substitution effect of ICT usage and financial literacy in terms of whether women start a business, the size of the business, and the income from the business.

It has been shown that compared with urban women, rural women are more susceptible to traditional attitudes, entrepreneurial atmosphere and capital, etc., coupled with the differences in policies, infrastructure, culture, etc. across regions, so rural women's entrepreneurship needs more attention. The increase in the frequency of ICT use significantly increased the probability of entrepreneurship among rural women [6], because it can improve women's skills and experience accumulation, weaken the negative effects of gender discrimination, and accumulate entrepreneurial information resources and funds by expanding social networks through influencing traditional concepts, human capital, social capital and other mechanisms [22]. Based on the above theory, the following hypotheses are proposed:

Hypothesis 3a: ICT usage has a positive effect on whether rural women start a business, the scale of entrepreneurship, and in terms of entrepreneurial income.

Hypothesis 3b: Financial literacy has a positive effect on rural women in terms of whether they start a business, the size of the business, and the income from the business.

It has been well documented that human capital often has a threshold effect in the entrepreneurial process. On the one hand, high human capital and strong social network investment significantly enhance entrepreneurial performance and exhibit a Matthew effect of "the stronger the strong, the weaker the weak" [23]. On the other hand, digital inclusive finance can lower the threshold of human capital required for entrepreneurship and promote women with lower education levels to engage in entrepreneurial activities [24]. Based on the above analysis, the following hypotheses are proposed:

Hypothesis 4a: ICT usage has a stronger positive effect than low human capital women on whether they start a business, the size of their business, and the income from their business.

Hypothesis 4b: Financial literacy has a stronger positive effect than low human capital women on whether they start a business, the size of their business, and the income from their business.

4. Research Design

4.1 Data sources and processing

In order to verify the hypotheses of this paper, this paper mainly adopts two levels of data from the Chinese Family Panel Survey (CFPS) 2020 conducted by the China Social Science Survey Centre of Peking University: the first level is information on individual characteristics from the adult questionnaire, including information on family members' age, marital status, and Internet use; the second part is information on family characteristics from the

household economic questionnaire and the family relationship questionnaire, which It includes information on family income status, family size, and so on. The survey data sample covers 602 counties in 30 provinces, which is highly representative. In this paper, the data at the above two levels are merged based on household coding, while using individuals as the research unit. The female samples studied in this paper are retained, invalid data such as male samples and vacancy values are excluded, and finally the CFPS data are merged with the per capita GDP data based on provinces to obtain a final valid sample of 8,534.

4.2 Definition of variables

The explanatory variable in this paper is women's entrepreneurship, which is expressed by three indicators of whether or not to start a business, entrepreneurial scale and entrepreneurial income [25-27], and the specific indicators are shown in Table 1.

Table 1 Indicators of women's entrepreneurship.

Indicators	Specific use of indicators	Description
Entrepreneurship	Whether self-employment	Both self-employment and non-farm work are assigned a value of 1, and vice versa is 0.
	Whether non-farm work	
Entrepreneurial scale	Total business assets	Total business assets in logarithms
Entrepreneurial income	Net profit from operations	Logarithm of the greater of net profit from operations and its estimated value

The key explanatory variables are ICT usage and financial literacy. ICT usage is defined as an individual's ability to adopt digital technology or through digital devices to securely and effectively access, use, communicate, manage, evaluate, create, and apply information or data. Combined with the actual digital life of Chinese residents, 19 measurement questions on ICT usage were screened from CFPS 2020, and the entropy weighting method was applied to the 19 measurement questions to measure the comprehensive score of ICT usage. The ICT usage measurement is specifically shown in Table 2.

Table 2 Indicators of ICT usage.

Dimension	Specific Measurement Question	Assignment
Digital device	Whether access to Internet by mobile device	Yes=1, No=0
	Whether access to Internet by computer	Yes=1, No=0
Digital life	Whether play e-learning every day	Daily = 2, Yes = 1, No = 0
	Whether watch short videos every day	Daily = 2, Yes = 1, No = 0
	Whether shop online	Daily = 2, Yes = 1, No = 0
	Whether play online games every day	Daily = 2, Yes = 1, No = 0
Depth of digital usage	Hours spent online by mobile devices	Original data
	Hours spent on the Internet by computer	Original data
Digital communication	Whether use WeChat	Both question items combined, almost every day = 7, 3-4 times a week = 6, 1-2 times a week = 5, 2-3 times a month = 4, 1 time in a month = 3, 1 time in a few months = 2, never = 1, no = 0
	Frequency of sharing in circle of friends	
Numerical Identity	Importance of Internet for work	Very important=5, Important=4, Average=3, Not important=2, Very unimportant=1
	Importance of Internet for study	Very important=5, Important=4, Average=3, Not important=2, Very unimportant=1
	Importance of Internet for leisure and entertainment	Very important=5, Important=4, Average=3, Not important=2, Very unimportant=1
	Importance of Internet for daily life	Very important=5, Important=4, Average=3, Not important=2, Very unimportant=1
	Importance of Internet for keeping in touch	Very important=5, Important=4, Average=3, Not important=2, Very unimportant=1

The financial literacy is measured by 3 dimensions that are financial cognition, financial application, and financial risk and 10 indicators referring to its definition and combining with the actual characteristics of rural women in China. The entropy weighting method was applied. The financial literacy measurement is shown in Table 3.

Table 3 Indicators of financial literacy.

Dimension	Specific Measurement Question	Assignment
Financial Awareness	Whether to rent land	Yes=1, No=0
	Renting out other people's land	Yes=1, No=0
	Renting out other assets	Yes=1, No=0
Financial risk	Whether holding financial products	Yes=1, No=0
	Preferred borrowing recipients	Borrowing from formal financial institutions=3, private borrowing=2, friends and relatives=1, no borrowing=0
	Commercial Insurance Expenditure	Original data taken in logarithm
Financial Applications	Total Cash and Deposits	Total Cash and Deposits and the greater of the estimated values are taken in logarithmic terms.
	Total price of financial products	Original data taken as logarithm
	Profit on Investments	Original data in logarithmic terms
	Non-mortgage financial liabilities	Original data in logarithmic terms

In order to minimise the error in model estimation, this paper controls variables at three levels: individual characteristics variables, family characteristics variables, and provincial characteristics variables that affect female entrepreneurship. In terms of individual characteristics, the square term of age (age2), spouse status (spouse), education (edu), and health (health) are controlled with reference to existing studies. For family characteristics, family size (familysize) and the number of young children (young) are controlled. The province level controls for the level of economic development of the corresponding province (lpgdp). The detailed variable measures are shown in Table 4.

Table 4 Definition of control variables.

Control Variable	Description	Variable Description
age2	Age squared	Actual age squared by year of survey/100
spouse	Spouse status	Assign a value of 1 to married, cohabiting, and 0 otherwise.
edu	Educational attainment	Assign a value of 2 to college and above, 1 to primary school and below, and 0 to never attended school or illiterate.
health	Health status	Very unhealthy-1-2-3-4-5-very healthy familyysize The size of the family.
familysize	The size of the family	Total household size
young	Number of children	Current number of children in the household
lpgdp	GDP per capita	Logarithm of GDP per capita by province in 2020

4.3 Model construction

Since the empirical analysis of this paper includes three explanatory variables of whether women start a business, entrepreneurial scale and entrepreneurial income, whether to start a business and entrepreneurial scale and entrepreneurial income belong to different types of variables. Therefore, this paper chooses Probit model and OLS model to carry out regression respectively. Among them, the Probit model mainly focuses on whether women engage in entrepreneurship, and its value type belongs to binary variables, while the OLS model mainly focuses on women's entrepreneurial scale and entrepreneurial income, and its value type belongs to continuous variables. Considering that the problem of heteroskedasticity in the cross-sectional data may lead to biased parameter estimation, robust standard errors are used in all the empirical analyses. The specific form is as follows:

$$\mathrm{Prob}(\mathrm{RE_i}=1)=\alpha+\beta_1\mathrm{ICT_i}+\beta_2\mathrm{FL_i}+\sum_{j=3}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (1)$$

$$\mathrm{RE\_scale_i}=\alpha+\beta_1\mathrm{ICT_i}+\beta_2\mathrm{FL_i}+\sum_{j=3}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (2)$$

$$\mathrm{RE\_income_i}=\alpha+\beta_1\mathrm{ICT_i}+\beta_2\mathrm{FL_i}+\sum_{j=3}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (3)$$

$$\mathrm{Prob}(\mathrm{RE_i}=1)=\alpha+\beta_1\mathrm{ICT_i}+\beta_2\mathrm{FL_i}+\beta_3\mathrm{ICT_iFL_i}+\sum_{j=4}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (4)$$

$$\mathrm{RE\_scale_i}=\alpha+\beta_1\mathrm{ICT_i}+\beta_2\mathrm{FL_i}+\beta_3\mathrm{ICT_{i_i}FL_i}+\sum_{j=4}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (5)$$

$$\mathrm{RE\_income_i}=\alpha+\beta_1\mathrm{ICT_{i_i}}+\beta_2\mathrm{FL_i}+\beta_3\mathrm{ICT_iFL_i}+\sum_{j=4}^{m+1}\beta_j\mathrm{control_{ji}}+\mu_i \quad (6)$$

In the above model, RE_i denotes whether women start their own business or not, $RE_i = 1$ means yes, $RE_i = 0$ means no; RE_scale denotes the scale of women's entrepreneurship; RE_income denotes women's entrepreneurial income; ICT_i denotes ICT usage; FL_i denotes financial literacy; ICT_iFL_i denotes the interaction term between ICT usage and financial literacy; i denotes an individual woman; β_1 and β_2 and β_3 are the coefficients to be estimated, where, if β_3 is significantly greater than 0, it means that there is a significant complementary relationship between the two, and if β_3 significantly less than 0, it means that there is a substitution relationship between the two; $control_i$ denotes the control variable, and μ_i denotes the random error term.

4.4 Descriptive statistics

The descriptive statistics of the main variables in this paper are shown in Table 5. From Table 5, it can be seen that 9.94 per cent of women chose to start their own business. The mean value of female entrepreneurial size is 2.1462, which indicates that the average total entrepreneurial assets of women is about 85,500 yuan. The mean value of female entrepreneurial income was 10.7068, the mean value of the factor score for ICT usage was 0.3967 with a standard deviation of 0.3205, and the mean value of the factor score for financial literacy was 1.0016 with a standard deviation of 0.5062. the average age of females was about 47, and the average level of education was less than primary school. about 85 per cent of the females had a spouse, and the average health status was average, and the average household size is 4, with 1 or 2 young children. The mean GDP per capita is 11.0004 with a standard deviation of 0.3657.

Table 5 Results of descriptive statistics.

Variable type	Variable name	Mean	Standard deviation	Minimum	Maximum
Explanatory variable	Whether to start a business	0.0994	0.2992	0	1
	Size of entrepreneurship	2.1462	1.6112	-2.3026	6.9078
	Entrepreneurial income	10.7068	1.1899	5.7038	14.4033
Explanatory variables	ICT usage	0.3967	0.3205	0	0.9511
	Financial literacy	1.0016	0.5062	-1.0351	2.4000
Control variables	Age squared	22.1660	13.3716	2.25	73.9600
	Spouse status	0.8497	0.3574	0	1
	Education level	0.6309	0.7517	0	2
	Health status	3.0026	1.1823	1	5
	Family size	4.3008	2.0461	1	15
	Number of children and adolescents	1.4288	0.9399	0	9
	GDP per capita	11.0004	0.3657	10.4911	12.0130

5. Empirical analyses

5.1 Benchmark regression analysis

The results of the benchmark regression of the impact of ICT usage and financial literacy and the interaction term of the two on female entrepreneurship are shown in Table 6. The result analysis of the impact of ICT usage and financial literacy on female entrepreneurship is based on the model without interaction term of column (1)-column (3), and the result analysis of the impact of the interaction effect of the two is based on the model with interaction term of column (4)-column (6). As can be seen from the regression results of column (1)-column (3) in Table 6, the estimated coefficients of ICT usage are 0.6468, 0.6860, and 0.6306, respectively, which are all significant at the 1% level. This indicates that ICT usage has a significant enhancing effect on female entrepreneurship, and ICT usage can not only increase the probability of female entrepreneurship, but also expand the scale of female entrepreneurship as well as increase female entrepreneurial income, and Hypothesis 1a is confirmed. This result is in line with the existing ones that have also concluded that Internet use has a significant effect on increasing the probability of female entrepreneurship [5,6]. The use of the Internet is particularly important for the enhancement of ICT usage, so ICT usage can increase the probability of female entrepreneurship. The estimated coefficients of financial literacy are 0.2591, 0.7456 and 0.5285 respectively, all of which are significant at 1% level. It can be seen that financial literacy has the same significant enhancing effect on whether women choose to start a business, the size of the business and the income from the business, and hypothesis 1b of this paper is valid. From the regression results in columns (4)-(6) of Table 6, it can be seen that the estimated coefficients of the interaction

terms of ICT usage and financial literacy are both negative but statistically insignificant on whether or not to start a business as well as on entrepreneurial income, while the estimated coefficient of the interaction term of ICT usage and financial literacy on the scale of women's entrepreneurship is -0.8194 which is statistically significant at the 5 per cent level. This indicates that there is a significant substitution relationship between ICT usage and financial literacy on the effect of female entrepreneurship size, and there is a substitution relationship but not significant on whether or not women start their own business and entrepreneurial income. Thus, Hypothesis 2a is rejected and Hypothesis 2b is accepted. ICT usage and financial literacy show a certain degree of substitution for the women's entrepreneurship. The possible reason for this phenomenon is that entrepreneurship is no longer limited to a fixed place and time, and women with a certain degree of ICT usage are able to use smartphones and other devices to start a business without time and space constraints, and the choice of entrepreneurial methods is diversified, which gives the group of women with ICT usage more opportunities to start a business and expand the scale of the business, and breaks the traditional entrepreneurial methods of starting a business that must be carried out in a fixed place and time, and requires a certain degree of financial literacy. This breaks the strict constraints of traditional entrepreneurial methods, which require a fixed location and time, as well as a certain level of financial literacy.

Table 6 Benchmark regression results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Whether to start a business	Entrepreneurial size	Entrepreneurial income	Whether to start a business	Entrepreneurial size	Entrepreneurial income
	Probit model	OLS model	OLS model	Probit model	OLS model	OLS model
ICT usage	0.6468***	0.6860***	0.6306***	0.6662***	1.7396***	0.9350**
	(0.0864)	(0.2335)	(0.1734)	(0.1601)	(0.5348)	(0.3745)
Financial Literacy	0.2591***	0.7456***	0.5285***	0.2675***	1.1347***	0.6363***
	(0.0411)	(0.1010)	(0.0756)	(0.0726)	(0.2022)	(0.1432)
ICT usage * Financial Literacy				-0.0186	-0.8194**	-0.2376
				(0.1325)	(0.3479)	(0.2467)
Age Squared	-0.0024	0.0119	0.0172**	-0.0024	0.0133	0.0177**
	(0.0026)	(0.0083)	(0.0065)	(0.0026)	(0.0083)	(0.0065)
Spouse	0.3099***	-0.0079	0.3286**	0.3105***	-0.0005	0.3315**
	(0.0644)	(0.1886)	(0.1438)	(0.0647)	(0.1873)	(0.1437)
Education Level	-0.1525***	0.1987	0.2607***	-0.1520***	0.2108*	0.2654***
	(0.0366)	(0.1128)	(0.0838)	(0.0370)	(0.1125)	(0.0841)
Health	-0.0103	-0.0067	0.0315	-0.0103	-0.0126	0.0307
	(0.0171)	(0.0500)	(0.0336)	(0.0171)	(0.0497)	(0.0336)
Family Size	-0.0136	0.0744**	0.0393**	-0.0137	0.0755**	0.0395**
	(0.0105)	(0.0293)	(0.0192)	(0.0105)	(0.0292)	(0.0193)
Number of children	0.0534**	0.0020	-0.0394	0.0535**	0.0016	-0.0387
	(0.0229)	(0.0651)	(0.0498)	(0.0229)	(0.0648)	(0.0498)
GDP per capita	0.0563	0.5200***	0.6567***	0.0565	0.5131***	0.6543***
	(0.0503)	(0.1583)	(0.1209)	(0.0503)	(0.1588)	(0.1209)
R^2	0.0369	0.1121	0.1675	0.0369	0.1185	0.1686
N	8448	857	824	8448	857	824

Notes: 1. ***, ** and * denote significant at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

2. Marginal effects are reported in the tables, with robust standard errors in parentheses.

From the regression results of the control variables in columns (1) - (3) of Table 6, it can be seen that age is negatively related to whether women start a business or not, and is positively related to the size of the business, entrepreneurial income and is significant at the 5 per cent level with respect to entrepreneurial income, due to the fact that young people have a higher tolerance for risk, coupled with facing a more severe employment situation, which increases the probability of their entrepreneurial activity, whereas the income and the size of the business need to be accumulation of entrepreneurship over a long period of time. Spouse status is significantly positively correlated with whether women start a business and entrepreneurial income at the 1% and 5% levels, respectively, and negatively correlated with the scale of entrepreneurship, which may be due to the fact that living with a spouse creates more living, education, medical and other expenditures, and the financial needs expand, coupled with the fact that having a spouse makes it possible for women to make use of the ICT usage of their spouses to enhance their own ICT usage, which in turn raises the level of entrepreneurial income. The effect of education level on

whether women start a business is significantly negative at the 1% level, the effect on the scale of female entrepreneurship is positive and the effect on entrepreneurial income is significantly positive at the 1% level. This is due to the fact that women with higher education level can get employment opportunities and high salary level more easily in the job market, which reduces the possibility of this group of people to choose entrepreneurship, while in the women who have already chosen to start their own business, the high level of education makes them have higher cognition and literacy, and higher human capital, which will increase the scale of entrepreneurship and income.

5.2 Endogeneity discussion

Both studies on ICT usage and financial literacy cannot avoid the problem of endogeneity due to possible bidirectional causality between them and women's entrepreneurship, and severe endogeneity can lead to biased and non-consistent model estimates. In order to solve the endogeneity problem caused by bidirectional causality and omitted variables, this paper uses “importance of the Internet for information access” and “importance of mobile phone text messaging for information access” as an instrumental variable for ICT usage based on the existing studies [28,29]. This paper also uses the net worth of the family as an instrumental variable for financial literacy [30,31]. Theoretically, information access channel importance represents the level of ICT usage to a certain extent, and financial literacy can significantly increase household net worth, while information access channel importance and household net worth are not directly related to entrepreneurship, which meets the requirements of correlation and exogeneity.

Table 7 Results of endogeneity test.

Variables	(1)	(2)	(3)
	Whether or not to start a business	Size of business	Entrepreneurial income
	IV Probit model	2SLS model	2SLS model
ICT usage	3.3607*** (0.6647)	30.6395*** (8.2912)	14.1453*** (5.1629)
Financial Literacy	2.0986*** (0.3426)	18.4816*** (4.0679)	9.8850*** (2.3926)
ICT usage * financial literacy	-2.8537*** (0.5631)	-25.2396*** (6.1321)	-12.4225*** (3.7453)
Control variable	Control	Control	Control
First stage F-statistic	ICT: 2588.59 (0.0000)	ICT: 414.98 (0.0000)	ICT: 396.45 (0.0000)
	FL: 730.82 (0.0000)	FL: 61.48 (0.0000)	FL: 55.86 (0.0000)
N	7513	805	741

Note: 1. ***, ** and * denote significant at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

2. Marginal effects are reported in the tables, with robust standard errors in parentheses.

3. P-values are in parentheses for Stage 1 F-statistics.

Considering the possible reverse causality between ICT usage and financial literacy and female entrepreneurship as well as the endogeneity problem caused by omission of key explanatory variables may make the benchmark regression results unreliable. Therefore, based on the instrumental variables selected in the previous section, endogeneity is discussed using the instrumental variable method and the regression results are shown in Table 7. As can be seen from Table 7, the estimated coefficients of ICT usage on whether women start a business, the size of the business and the income from the business are 3.3607, 30.6395 and 14.1453 respectively, all significant at the 1% level, and the estimated coefficients of financial literacy on whether women start a business, the size of the business and the income from the business are 2.0986, 18.4816 and 9.8850 respectively, all significant at the 1% level. The estimated coefficients of the interaction terms of ICT usage and financial literacy on whether women start a business, the size of their business and their entrepreneurial income are -2.8537, -25.2396 and -12.4225 respectively, all of which are significant at the 1 per cent level. The above results indicate that the regression results still support the baseline regression results after considering the endogeneity issue. Meanwhile, the null hypothesis of the first stage F-test is that the instrumental variables are under-identified, and if the null hypothesis is rejected, the instrumental variables are justified. The results show that the p-values of the F-statistics

in the first stage are all 0.0000, indicating that the instrumental variables selected in this paper are reasonable. In summary, after re-estimation using the instrumental variable method, the empirical findings remain consistent and further prove that there are significant substitution effects of ICT usage and financial literacy in terms of whether women are entrepreneurial, entrepreneurial scale and entrepreneurial income, and that the enhancement effect of ICT usage on women's entrepreneurship is more pronounced than that of financial literacy, and that the core conclusions of this paper continue to hold.

5.3 Robustness test

To ensure the robustness of the previous benchmark regression results, this paper uses a robustness test by changing the measure of the core explanatory variables. The measure of ICT usage and financial literacy is changed to the topsis method to obtain the ICT usage and financial literacy scores of each woman. The regression is re-run according to the topsis indicator, and the regression results are shown in Table 8, and the test results are consistent with the baseline regression results. Therefore, the empirical results of this paper are robust.

Table 8 Results of robustness test.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Whether or not to start a business		Size of business		Entrepreneurial income	
	Probit model	IV Probit model	OLS model	2SLS model	OLS model	2SLS model
ICT usage	1.2120*** (0.1917)	9.3012*** (1.2898)	2.2749*** (0.6985)	57.5097*** (18.9469)	1.6841*** (0.4923)	30.3856*** (11.8281)
Financial Literacy	0.7536*** (0.2553)	20.6966*** (3.6400)	3.8376*** (0.8746)	105.6001*** (36.8624)	2.3407*** (0.6370)	64.1308*** (22.757)
ICT usage x Financial Literacy	-2.0392** (0.8321)	-57.8419*** (9.4008)	-4.9172* (2.8605)	-298.7234*** (101.4256)	-2.3709 (2.0986)	-174.4587*** (63.3306)
Control Variables	Control	Control	Control	Control	Control	Control
R^2	0.0233		0.0992		0.1501	
N	8427	7513	856	805	822	741

Note: 1. ***, ** and * denote significant at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

2. Marginal effects are reported in the tables, with robust standard errors in parentheses.

5.4 Heterogeneity analysis

In order to test hypotheses 3a and 3b, this paper divides the explanatory variables into rural female entrepreneurship and urban female entrepreneurship, and the results of the instrumental variable regression analyses based on hukou status are shown in Table 9.

None of the regression coefficients for urban female entrepreneurship are significant, so ICT usage and financial literacy have no significant effect on urban female entrepreneurship. For the rural female group, the estimated coefficients of ICT usage on whether they start a business, the size of their business and their entrepreneurial income are all positive and significant at the 1 per cent, 1 per cent, and 5 per cent levels, respectively. The estimated coefficients of financial literacy on whether they start a business, the size of their business and their entrepreneurial income are all positive and significant at the 1 per cent level. The estimated coefficients of the interaction terms of ICT usage and financial literacy on whether they start a business, the size of their business and their entrepreneurial income are both negative and significant at the 1 per cent level, suggesting that ICT usage and financial literacy have substitution effects on whether to start a business, the size of the business and entrepreneurial income in rural female entrepreneurship. This shows that rural women's entrepreneurship is more influenced by their ICT usage and financial literacy compared to urban women. This result confirms the existing conclusion that an increase in the frequency of Internet use can significantly increase the probability of entrepreneurship among rural women from the empirical study based on CGSS 2017 [6], and the finding that there is a significant promotion of financial literacy on the entrepreneurship of agricultural households, and that there is a long-term effect of the above effects from the empirical study based on CFPS 2014-2018 [17]. Therefore, hypotheses 3a and 3b are verified, while the verification of hypothesis 2b is strengthened.

Table 9 Results of heterogeneity test between rural and urban.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Whether or not to start a business		Size of business		Entrepreneurship income	
	Rural	Urban	Rural	Urban	Rural	Urban
ICT usage	3.5761*** (0.8366)	2.8457 (3.2188)	20.3959*** (6.2828)	22.2554 (24.7650)	10.6693** (4.4045)	9.4996 (14.0012)
Financial literacy	2.2605*** (0.3752)	3.2472 (2.1574)	13.3076*** (2.6250)	17.4012 (16.6442)	7.8890*** (1.7357)	8.9577 (8.8352)
ICT usage * financial literacy	-3.0916*** (0.6714)	-3.5046 (3.0524)	-17.6267*** (4.3017)	-18.8799 (19.8818)	-9.6410*** (2.9986)	-8.5857 (10.7492)
Control Variables	Control	Control	Control	Control	Control	Control
N	5561	808	555	103	515	93

In order to test hypotheses 4a and 4b, this paper divides the sample with an education level lower than the average education level of the corresponding survey year into a sub-sample with low human capital, and higher than the average education level of the corresponding survey year into a sub-sample with high human capital, and the sub-sample is subjected to regression with the same instrumental variable estimation.

Columns (1), (3), and (5) of Table 10 show the regression results for low human capital, and the regression coefficients of the core explanatory variables are all significant except for the regression coefficient of ICT usage on entrepreneurial income, which is insignificant, and the probable reason for this is that ICT usage is contingent on high human capital in the process of enhancing female entrepreneurial income. Columns (2), (4), and (6) of Table 10 show the regression results for high human capital with significant regression coefficients. As shown in Table 10, the regression coefficients of ICT usage, financial literacy and their interaction terms on whether or not to start a business are 2.9568, 1.6625, and -2.5083, respectively, for low human capital, whereas the regression coefficients of ICT usage, financial literacy, and their interaction terms on whether or not to start a business are 10.8162, 7.6393, and -10.4445, respectively, for high human capital, which indicates that high human capital , ICT usage and financial literacy have stronger positive effects and their substitution effects on whether women start a business or not, and show the same characteristics in terms of entrepreneurial scale and entrepreneurial income. As a result, hypotheses 4a and 4b are accepted, while hypothesis 2a is proved to be not accepted and hypothesis 2b is accepted.

Table 10 Results of heterogeneity test between low and high human capital.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Whether or not to start a business		Size of business		Entrepreneurship income	
	Low human capital	High human capital	Low human capital	High human capital	Low human capital	High human capital
ICT usage	2.9568*** (1.0281)	10.8162*** (3.5185)	20.2270** (8.0925)	104.5617** (52.4220)	6.0059 (4.9602)	63.6181* (35.6476)
Financial literacy	1.6625*** (0.3224)	7.6393*** (2.26228)	11.2630*** (2.7993)	57.9964** (26.4636)	5.7898*** (1.5698)	35.5884** (18.0714)
ICT usage * financial literacy	-2.5083*** (0.8317)	-10.4445*** (3.3085)	-16.5145*** (5.6874)	-80.2999** (38.0681)	-5.8219* (3.4507)	-49.2004* (26.0872)
Control Variables	Control	Control	Control	Control	Control	Control
N	4011	3502	344	461	322	419

6. Conclusions and Policy Recommendations

Based on the data from the CFPS 2020, this paper empirically analyses the effects of ICT usage, financial literacy, and the interaction term of the two on women's entrepreneurship using the Probit model and the OLS model. The results of the study show that both ICT usage and financial literacy are key factors affecting female entrepreneurship, and the enhancement effect of ICT usage on female entrepreneurship is more obvious than the enhancement effect of financial literacy. Moreover, ICT usage and financial literacy have significant substitution effects on whether women start a business, the size of the business, and the income from the business. It is worth noting that there is heterogeneity in the impact of ICT usage and financial literacy on women's entrepreneurship. The effect is more significant for rural women and those with high human capital.

The continuous development of the digital economy has profoundly changed the traditional entrepreneurial environment and brought digital dividends to women's entrepreneurship. At the same time, the application of digital finance makes up for the shortcomings of traditional finance in terms of information, time and space, greatly improves the financial environment for entrepreneurship, and provides more comprehensive financial services in the process of female entrepreneurship. Based on the above research conclusions, the following policy recommendations are put forward:

First, accelerate the construction of a system to cultivate women's ICT usage and financial literacy in all regions, focus on ICT usage training, follow the trend of the digital economy, and cultivate high-quality female groups. Increase investment in digital equipment, and adopt live broadcasting, recording, e-documentation and other learning means to carry out digital learning. Broaden the cultivation channels for ICT usage and financial literacy, forming a new and efficient pattern of government assistance and industrial training together.

Second, innovate financial literacy training courses to increase women's participation in digital financial products and improve the financial service system for women's entrepreneurship. It is necessary to innovate and improve digital financial products according to the practical needs of women's entrepreneurship, so that women can learn by using them and use them in learning, and improve women's financial literacy in all aspects.

Third, focus on rural women's groups, accelerate the construction of the digital economy in rural areas, sink the centre of gravity of digital financial services, further enhance the level of inclusive development of finance, and develop appropriate training mechanisms for rural women's groups in terms of ICT usage and financial literacy, and provide them with appropriate products and services in the process of entrepreneurship.

Fourth, promote the enhancement of women's human capital, improve the female education system, and raise the overall education level of women. The government should focus on helping female groups when providing universal education, improve higher education, and enhance women's human capital from various angles, so as to alleviate digital and financial inequality and comprehensively assist women's entrepreneurship.

Funding

This study was supported by Jiangxi Social Science Fund No. 20YJ12, Jiangxi Graduate Innovation Fund No. YC2023-S287 and Jiangxi Graduate Education Reform Fund No. JXYJG-2022-051.

References

[1] Dana Leo-Paul, Chhabra Meghna, Agarwal Monika. A two-decade history of women's entrepreneurship research trajectories in developing economies context: perspectives from India. Journal of Management History,2024,30(01):6-28.

[2] Tejeiro Koller, Manuel, Molina Lopez, Manuel Maria, Garcia Villalobos, Juan Carlos. Digital female entrepreneurship for social and economic development: Characteristics and barriers in Spain. Revesco-revista de Estudios Cooperativos,2021,138(04):111-124.

[3] Elisa Ughetto, Mariacristina Rossi, David Audretsch, Erik E. Lehmann. Female entrepreneurship in the digital era. Small Business Economics,2020,55(08): 305-312.

[4] Ria Manurung, Rizabuana Ismail, Hadriana Marhaeni Munthe. Analysis of Entrepreneurship Potential in Batak Women for Developing Toba Lake Tourism. International Summit on Science Technology and Humanity,2019,(12):348-354.

[5] Ma Jiqian, Chen Hong, Wang Zhanguo. The Impact of Internet Use on Female Entrepreneurship - An Empirical Analysis Based on CFPS Data. East China Economic Management,2020,34(05): 96-104.

[6] Mao Fei, Qian Yanting, Zhao Zejin, Qin Zhiran, Kong Xiangzhi. The impact of internet usage frequency on rural women's entrepreneurship-an empirical analysis based on CGSS(2017). Rural Finance Research,2021,(04):14-23.

[7] Ye Ting, Chen Liqin. Digital Economy and Rural Women's Entrepreneurship: A Qualitative Analysis Based on NVivo. Journal of Shandong Women's College,2021,(06):65-73.

[8] Arenius, P., & De Clercq, D. A network-based approach on opportunity recognition. Small Business Economics, 2005,24(03): 249-265.

[9] World Bank and World Trade Organization. Women and Trade: The Role of Trade in Promoting Gender Equality. Washington, DC: World Bank, 2020.114-145.

[10] Victoria L. Crittenden, William F. Crittenden, Haya Ajjan. Empowering women micro-entrepreneurs in emerging economies: The role of information communications technology. Journal of Business Research, 2019,98(02): 191-203.
[11] Xiao Wei, Li Chengyan, Luo Jinlian. Empowerment: The impact of double embeddedness of the Internet on women's entrepreneurial ability. Science and Technology Progress and Countermeasures,2019,36(14):18-24.
[12] Feliciia Siegrist. Supporting Women Entrepreneurs in Developing Countries: What Works?. Women Entrepreneurs Finance Initiative,2022.49-57.
[13] Li Jinglei, Yu Yiqi, Zhang Ziqian. The Impact of Financial Literacy on Entrepreneurial Decision Making of Farmers and Heterogeneity Analysis: An Empirical Study Based on Chun'an County, Zhejiang. China Market, 2023,(10):58-63.
[14] Marco Trombetta. Accounting and finance literacy and entrepreneurship: An exploratory study. Journal of Accounting and Public Policy,2023,42(02): 107078.
[15] Dr.Ratnavalli Bhagavatula, P.Bhuvaneswari, S.Harsha Vardhan, K. Sai Srinivas Chowdary, P.Sunil Kumar. The determinants of financial literacy and the effect on Indian women entrepreneurs' a financial behavior. Journal of Northeastern University,2022,25(04):3013-3017.
[16] Liu Jiankun. What Makes Farmers' Entrepreneurship Successful? --An empirical study based on the dual perspective of human capital and social capital. Sociological Review,2020,8(03):105-117.
[17] Xiang Zhilve, Zhang Deyuan, Wang Yali. The impact of financial literacy on farmers' entrepreneurship and its heterogeneity analysis - the moderating effect based on the level of factor marketisation. Journal of Hunan Agricultural University (Social Science Edition),2020,21(04):36-44.
[18] Anuja Shukla, Priyanka Kushwah, Eti Jain, Shiv Kumar Sharma. Role of ICT in emancipation of digital entrepreneurship among new generation women. Journal of Enterprising Communities: People and Places in the Global Economy,2021,15(01): 137-154.
[19] Cheng Jianqing, Luo Jinlian, Du Yunzhou, Liu Qiuchen. What kind of entrepreneurial ecosystem generates high female entrepreneurial activity?. Research in Science,2021,39(04):695-702.
[20] Xiang zhilve, Zhang Deyuan, Wang Yali, Human Capital and Farmers' Entrepreneurship: Is "Intelligence Quotient" or "Financial Quotient" More Important?. Journal of Jiangsu University(Social Science Edition),2021,23(01):61-74.
[21] Li Xinchun, Ye Wenping, Zhu Hang. Social capital and female entrepreneurship(1)-a cross-country(regional) comparative study based on GEM data. Journal of Management Science,2017,20(08):112-126.
[22] Wu Lei, Liu Jiujiu, Wen Haiyang. Does rural women's entrepreneurship have "digital dividend"? --An empirical analysis based on CGSS2015 data. World Agriculture, 2021,(08):53-68+119-120.
[23] Li Xinchun, Ma Jun, He Xuan. Institutional evolution, entrepreneurial human capital and social capital contribution rate. Research Management,2019,40(12):51-61.
[24] Qiang Guoling, Teng Fei. Digital Inclusive Finance and Female Entrepreneurship. Statistics and Information Forum, 2022,37(04): 120-128.
[25] He Jing, Li QingHai. Digital Financial Usage and Farmers' Entrepreneurial Behaviour. China Rural Economy,2019,(01):112-126.
[26] Zhang Longyao, Li Chaowei, Wang Rui. Financial Knowledge and Farmers' Digital Financial Behaviour Response-Micro Evidence from a Survey of Farmers in Four Provinces. China Rural Economy,2021,(05):83-101.
[27] Wen Tao, Liu Yuanbo. Digital literacy, financial knowledge and digital financial behaviour response of farm households. Research on Financial Issues,2023,(02):50-64.
[28] Li Degang. Digital literacy: A new direction for media literacy education in the context of the new digital divide. Thought Theory Education,2012,(19):9-13.
[29] Wang Youmei, Yang Xiaolan, Hu Wei, Wang Juan. From Digital literacy to Digital Competence: Conceptual Flux, Components and Integration Models. Journal of Distance Education,2013,31(3): 24-29.
[30] Lian Zekai. The impact of financial literacy on household financial assets and liabilities. Financial Development Review,2019,(10):78-91.
[31] Li Rui, Liu Yongwen, Liu Wentao, Tian Weishuang. Research on the impact of rural digital financial development on household financial risk. Financial Theory and Practice, 2023,(12):92-104.