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Can ICT make small beautiful? Examining the role of ICT in affecting the credit behavior of SMEs in India

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ADBI Working Paper Series

**CAN ICT MAKE SMALL BEAUTIFUL?
EXAMINING THE ROLE OF ICT IN
AFFECTING THE CREDIT BEHAVIOR
OF SMES IN INDIA**

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Abstract

The paper explores the relationship between ICT adoption and credit behavior for small and medium enterprises in India. We use the latest round of the World Bank Enterprise Survey for India, conducted in 2021, and employ an instrumental variable estimation technique to account for any potential endogeneity between ICT adoption and credit behavior. We find that better ICT usage enhances the likelihood of obtaining credit and the size of credit for these firms. Additionally, it increases the likelihood of applying for loans and loan approvals. We also examine the result for micro firms in India and find confirmation of our findings. On exploring further, we find evidence that reduced information asymmetry, better financial awareness, innovation, and enhanced productivity are possible channels that improve access to credit for small and medium firms. The study underscores the role of ICT in reducing the credit constraints of small and medium enterprises.

Keywords: small and medium-sized enterprises, credit, information and communication technology

JEL Classification: D22, O14, H81, L86

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1. INTRODUCTION

Small and medium enterprises (SMEs) are vital contributors to growth and employment, representing 90% of businesses and 50% of jobs worldwide (World Bank 2023).¹ These enterprises play an especially important role in developing economies due to their high job creation potential. Despite their growth and employment potential, access to finance is a key constraint for SMEs. According to various World Bank Enterprise Survey (WBES) rounds, SMEs in developing economies have cited credit constraints as the second largest obstacle to business.

Beck (2007) discusses the reasons behind the differential access to credit for SMEs vis-à-vis large firms. Using the fixed transaction cost approach and the resulting agency problems as the basis for financial market frictions, Beck (2007) argues that high transaction costs, in the form of credit assessment, processing, and monitoring, which are predominantly fixed, push up the cost of borrowing and may restrict access to credit for a few consumer groups. Since SMEs' operations are relatively more opaque than those of their large counterparts, these transaction costs act as barriers to external funding. Further, SMEs are constrained by default risk since debtors have access to information related to their project but lenders may have access to only part of the information due to prohibitively high costs. This leads to information asymmetry problems, such as moral hazard and adverse selection.

Allen and Santomero (1997) focus on the risk management-based theory of financial intermediation and argue that technological adoption can reduce the information asymmetry issues for SME financing (Blancher et al. 2019). Specific technology usage to obtain data on SMEs' accounting and registration information can help to alleviate the information asymmetry. Banks' transaction costs can also be alleviated by access to the socio-economic, historical, and demographic data of the SMEs and their owners. Thus, reliance on information and communication technology (ICT) can be an effective bridge to improve credit access for SMEs. Further, reducing the information asymmetry benefits the banks as well since it facilitates an easy flow of credit, helping them and other financial intermediaries to diversify their risk (Hannig and Jahnson 2011; Albertazzi et al. 2021).

A growing body of literature focuses on the impact of ICT and access to credit on the SME sector. Pellegrina et al. (2017) find that SMEs that use ICT are more likely to have access to credit because ICT usage signals their capacity to innovate to banks. The positive impact of ICT access on credit behavior is documented by other studies as well (Mushtaq and Bruneau 2019; Maiti and Singh 2020; Agyekum et al. 2022; Bui and Do 2022). The basic argument explored in the above studies relies on ICT's potential to reduce the high cost of intermediated funds due to asymmetric information. In the absence of ICT adoption, banks bear a share of the screening and monitoring costs throughout the entire relationship term with their customers (Boot 2000). Since most of these transaction costs are fixed in nature, the burden is greater for smaller loans and hence leads to smaller firms facing higher rates of loan rejections. From the firms' perspective, investing in ICT carries the benefits of transparency, higher quality of information, and hence easier credit evaluation. Thus, ICT can reduce the information asymmetries on both the supply and the demand side of the credit market. We attempt to contribute to this literature by examining the relationship between ICT and credit behavior among SMEs in India.

¹ These numbers correspond only to formal MSMEs and significantly increase when informal enterprises are also included. Source: <https://www.worldbank.org/en/topic/sme/finance> (accessed 3 June 2024).

India is an interesting case study for several reasons. India has experienced exponential ICT growth since the early 2000s and is the largest exporter of ICT-related services (Maiti, Castellacci, and Melchior 2020). India has more than 1.1 billion mobile phone subscribers and more than 881 million internet users (TRAI 2023). Further, the Indian Government has launched several schemes to increase the ICT diffusion in rural areas, such as Prasar Bharat and the Universal Service Obligation Fund, which focus on providing the rural population with access to specific types of ICT. The government also uses its public sector undertakings in the telecom sector effectively by setting specific and timely targets to enhance the rural outreach. This remarkable pace of ICT diffusion paves the way for research focusing on the impact of digitalization on economic development.

Besides the ICT boom, we focus on India for reasons stemming from the pattern of SME growth in the country. Firstly, India has a dynamic SME sector that contributes significantly to business innovations and spreads across various products and services (Ghalke, Kumar, and Rao 2022). Secondly, these enterprises depend on debt financing as their primary source of capital through banks. We investigate how ICT adoption within this sector affects the credit behavior of SMEs in India. The specific patterns of ICT and SME growth in India suggest that the answer to the above question may be different from that in developed economies, which are already explored in previous studies. To highlight the unique role of ICT in the SME sector, we start with an initial comparison of the SMEs with their larger counterparts in terms of ICT adoption and credit behavior. We focus only on the SME sector for our main analysis. As an extension, we complement our analysis by studying the situation for micro-enterprises.²

We use the latest round of the World Bank Enterprise Survey (WBES) for India conducted in 2021. We employ an instrumental variable estimation methodology to reduce the potential endogeneity between the ICT adoption and the credit behavior of SMEs. Our main results indicate a positive impact of ICT adoption on credit access for SMEs. Specifically, ICT adoption improves the likelihood of obtaining a loan and the loan size for SMEs. Additionally, we find a positive impact on the likelihood of applying for loans and these loans being approved. These results highlight the positive influence of ICT adoption on deepening credit access within the SME sector in India.

We identify potential channels through which firms' ICT adoption may reduce the information asymmetry in the credit market, leading to higher credit access. We find a positive association between ICT adoption and a better capacity to adapt to online processes in other aspects of operations and formalization of business.³ We also find ICT adoption to be associated with better innovation and higher labor productivity among these firms. These factors consequently enhance credit access. Finally, we extend our main findings by testing the situation for the micro firms in India, drawing data from a parallel survey conducted by the World Bank during the same time period. We find that our results are valid for these firms as well.

² In India, the segregation of firms into large, medium, small, and micro is based on the number of employees. According to the latest revised guidelines of the Ministry of Micro, Small, and Medium Enterprises, enterprises with investment of less than Rs. 1 crore and turnover of Rs. 5 crore are categorized as micro enterprises. For small and medium enterprises, the investment limits are Rs. 1 crore to Rs. 10 crore and Rs. 10 crore to Rs. 50 crore, respectively. The corresponding turnover limits for the two categories are Rs. 50 to Rs. 100 crore and Rs. 100 crore to Rs 250 crore (source: <https://msme.gov.in/faqs/q1-what-definition-msme>). The employment correlates for these categories are as follows: micro (1–9), small (10–19), medium (20–99), and large (99+) (source: https://ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---sro-new_delhi/documents/publication/wcms_344397.pdf). The dataset that we use for our analysis also uses classifications of sizes based on employee strength. We discuss this in detail in the next section.

³ We explain the measurement of these variables in a detailed manner in future sections.

We believe that our paper contributes significantly to the literature on SME financing. The issue is particularly pertinent in the event of a crisis that, despite affecting all firms, has a stronger impact on SMEs, which are less resilient because of their smaller cash buffers and greater financial fragility. Given their already vulnerable position in terms of access to finance, it is worthwhile investigating whether financial access for these firms has narrowed even further. If so, has ICT adoption acted as a remedial tool to reduce it? An understanding of what improves SMEs' credit access is important as it can enable them to grow and at the same time increase their survival probability during crisis periods.

The rest of the paper is organized as follows. We discuss the data and the variables in Section 2. Sections 3 and 4 present the estimation methodology and the results. Section 5 concludes.

2. DATA AND VARIABLES

The data for our study are based on the World Bank Enterprise Survey (WBES), a widely used database offering an expansive array of economic data on 194,000 firms in 155 countries. We use the survey performed in India, where the World Bank collected data from business owners and top managers of manufacturing and service sector firms. We employ the latest survey round conducted across 9376 firms between December 2021 and September 2022. The survey uses a stratified random sampling method whereby the sample is stratified by industry, firm size (according to employee number⁴), and geographic region (states in India). The survey data focus on large (31.88% of the total firms), medium (32.26%), and small (35.86%) firms (Table 1). These enterprises vary in their number of employees. Table 1 compares various characteristics of firms across the size categories. As expected, the average productivity varies inversely with the firm size (Table 1).

Table 1: Differences in General Attributes According to the Three Size Categories

	Large/Very Large Firms	Medium Firms	Small Firms
General information			
Number of firms	2,987	3,022	3,359
Average number of employees	125.64	39.15	17.63
Average productivity (log of sales/emp)	15.46	15.04	14.37
Credit behavior			
Percentage of firms with outstanding credit	14.51%	11.51%	9.58%
Average loan size (log of loan amt)	17.66	16.04	14.67
Percentage of firms that applied for a loan	8.50%	7.41%	6.38%
Percentage of firms that had their latest loan application approved	41.52%	33.50%	36.93%
ICT behavior			
Percentage of firms with no Internet access	2.4%	4.0%	3.9%
Percentage of firms with websites	75.66%	64.01%	43.76%
Percentage of sales through Internet transactions	26.75%	21.87%	18.52%

The WBES provides in-depth information on various aspects of financial constraints and access. For credit behavior, we use measures similar to those employed by Bui and Do (2022) and Rakshit and Bardhan (2023). The first measure is a dummy variable

⁴ Large firms have more than 100 employees, medium firms have 20 to 99 employees, and small firms have 5 to 19 employees.

indicating an open line of credit or a loan from a financial institution. As expected, the proportion of firms with outstanding credit reduces with size for the large, medium, and small firms, from approximately 14% to 9%, indicating differential credit access across size categories (Table 1). The second measure is the natural logarithm of the size of outstanding loans. As expected, the loan size is also inversely proportional to the firm size for the WBES dataset. The last two measures are indicators for loan applications in the previous financial year and the outcome of the most recent loan application. The likelihood of applying for loans and receiving approval for the most recent loan application is also lower for smaller firms. To summarize, credit access and behavior vary with firm size.

We next examine the pattern of ICT adoption across various firm size categories. Only a few questions are asked in the WBES to capture the ICT adoption of firms. According to Table 1, only 2.4% of large firms and 4% of medium and small firms in India have no access to the Internet. Since Internet access is available to a considerable share of firms in the WBES, we need to focus on the extent of ICT usage to capture ICT adoption for them. We consider whether firms have a registered website as a measure of ICT for this study.⁵

Crosato, Domenech, and Liberati (2023) provide a detailed account of how websites circumvent the information opacity that SMEs face in accessing credit. They assert that standard accountancy information fails to reduce the information asymmetry due to the large delay between their availability and the reference period. Furthermore, from the perspective of banks, predicting these measures is costly and time consuming. In contrast, data drawn from websites is free and up to date. Further, if businesses follow some basic standards in constructing their website, banks can use web structure mining and web content mining to track the behavior of potential and ongoing customers in the SME segment. Crosato, Domenech, and Liberati (2021) use online indicators, scraped from firms' websites, to predict default risks and argue that reliance on website information for SMEs as a standard accountancy-based approach is better suited to larger firms and less accurate for SMEs.

Further, website presence is a relevant indicator for India. According to a recent survey conducted by GoDaddy in 2023, 55% of small businesses in India have reported launching a website in the last 1–5 years, in contrast to 46% worldwide.⁶ Several other attributes in the survey signal India to be a leading player in the use of ICT for small businesses. For instance, 34% of small businesses in India mentioned having a website as a top activity to raise brand awareness among customers. These points make website usage a credible indicator for ICT adoption by SMEs in India.

Table 1 reports a broad pattern wherein both credit behavior and ICT access seem to be related to firm size. To test this formally, we use an econometric model containing a host of firm-level control variables. Table 2 provides the variable definitions along with their means.

⁵ ICT adoption is measured more accurately by examining the ownership and usage of ICT devices and technologies, such as mobile phones, laptops, and other Internet-related services. In the absence of questions related to these in the WBES, we resort to an indicator for websites to measure ICT adoption. We conjecture that firms that have access to a sufficient number of ICT devices and services will use websites for their operations. Further, since most firms have reported the Internet not to be an issue in their operations, having a registered website may indicate more focused use of ICT by firms to cater to their business needs.

⁶ Source: <https://economictimes.indiatimes.com/small-biz/sme-sector/62-of-indian-smbs-use-a-website-online-store-or-e-comm-platform-as-their-main-sales-channel-report/articleshow/100589250.cms?from=mdr>.

Table 2: Descriptive Statistics of All Firms and SMEs

Variables	Measures	Mean (All Firms)	Mean (SMEs)
<i>Credit behavior variables</i>			
Outstanding credit	Dummy for any outstanding credit	0.11	0.10
Loan amount	Log (outstanding amount)	16.27	15.37
Loan application	Dummy for loan applied for in the last financial year	0.07	0.06
Loan approval	Dummy if the last loan application was approved	0.37	0.35
<i>Information and communication (ICT) variables</i>			
Website	Indicator for having a registered website	0.60	0.53
<i>Other firm-specific variables</i>			
Firm age	ln(year of survey-incorporation year)	22.41	20.54
Firm size	Predefined sizes according to employees	See Table 1	
Firm growth	Growth rate of sales in the last three years	0.07	0.06
Exports	Indicator for direct/indirect exports	0.13	0.10
Female ownership	Presence of female owners	0.05	0.07
Informal payments	Percentage of sales paid as informal payments	2.30%	1.99%
Government connection	Indicator for assistance from the government in preventing business-related problems (with suppliers)	0.44	0.42
Power loss	Percentage of revenue loss due to power outages	4.8%	5.2%
Generation	Indicator for generation of electricity (own/shared)	0.38	0.30

3. METHODOLOGY

To estimate the effect of ICT adoption on firm credit behavior, we estimate the following model:

$$Y_{ijs} = \beta_1 + \beta_2 ICT_{ijs} + \beta_3 X_{ijs} + \varepsilon_{ijs} \quad (1)$$

where Y_{ijs} are the credit behavior variables tabulated in Table 1 above (credit access, loan size, loan application, and loan approval) of the i th firm in industry j located in state s . Similarly, ICT_{ijs} and X_{ijs} are ICT adoption measures and a vector of firm-specific controls that are likely to be associated with credit behavior, respectively.

When considering the impact of ICT adoption on firms' credit behavior, it is possible that the level of ICT adoption and credit behavior may be jointly determined. For instance, firms may take out loans to expand their business (part of which may be spent on adopting or upgrading existing ICT), making ICT adoption an endogenous variable. To determine the causal impact of ICT adoption on credit behavior, we tackle the issue of endogeneity by estimating an instrumental variable estimation model. Previous studies also employ instrumental variable estimation to address the endogeneity associated with the ICT variable (Agyekum et al. 2022; Bui and Do 2022).

We use two indicators that focus on the regular supply of electricity—the share of revenue lost due to power outages and the presence of a generator to tackle power outages. The rationale for using electricity-related measures is based on ICT's reliance on electricity.

Table 3 shows that website adoption is positively associated with electricity generation and negatively associated with the share of revenues lost due to power outages. The exclusion restriction demands that the instrument affects the outcome only through the endogenous variable. In our study, power losses and electricity services will not have a direct influence on credit access for firms but will exert an indirect impact through ICT adoption.

Table 3: Association of Electricity Measures with ICT Adoption

	(1)	(2)	(3)	(4)
Dependent Variable	Website Adoption	Website Adoption	Website Adoption	Website Adoption
Power loss	-2.802*** (0.334)	-2.718*** (0.334)	-2.928*** (0.360)	-2.841*** (0.360)
Electricity generation	1.128*** (0.030)	1.059*** (0.031)	1.143*** (0.038)	1.083*** (0.038)
Small and medium dummy	N	-0.443*** (0.031)	N	-0.521*** (0.035)
State FE	N	N	Y	Y
Industry FE	N	N	Y	Y
No. of observations	9,361	9,361	9,361	9,361

Note: The dependent variable, website adoption, is a dummy variable. All the firms are used for these estimations. Models (1)–(4) show the results from a probit model. The small and medium dummy takes a value of one if the firm is small or medium and zero if it is large or very large. Standard errors are reported in parentheses. ***<0.01, **<0.05, and *<0.1.

The first stage of the instrumental variable estimation model is

$$ICT_{ijs} = \alpha_1 + \alpha_2 IV_{ijs} + \alpha_3 X_{ijs} + \epsilon_{ijs} \quad (2)$$

where IV_{ijs} represents the instrumental variables. In the next stage, we use the estimated values of ICT from equation (2) in equation (1). The mean values of our measures are compiled in Table 2.

4. RESULTS

4.1 Main Findings

Table 4 contains three panels: Panel I presents the results of regressing the credit behavior variables on ICT adoption along with other factors. The results in column (1) of Panel I confirm that ICT adoption positively and significantly affects SMEs' likelihood of having a loan in India. Further, ICT adoption enhances the loan size, highlighting the deepening of the credit market. Column (4) indicates that ICT usage increases the likelihood of loan applications. Finally, column (5) reports that firms using ICT are more likely to have their loans approved. Thus, ICT adoption seems to be associated with better access to credit.

Panel I also controls for other factors that may determine credit access in the SME sector. We find that exporting firms, those with high informal payments, and firms owned by men have better access to credit.⁷ Further, we control for the regional unobserved effects. Specifically, we consider six regions (north, south, east, west, center, and north east) in India and categorize the states according to their location. We also control for unobserved industry effects by including dummy variables at the two-digit National Industrial Classification level. These results provide evidence of the positive association between ICT adoption and credit behavior. However, it must be

⁷ The control variables do not show a consistent pattern across the various model specifications since each dependent variable captures a certain aspect of credit behavior generated by the firm. While all of them are measures of credit access, each focuses on a specific dimension, and they may not be substitutable in a strict sense.

noted that these coefficients may be affected by endogeneity and that our OLS models do not account for this.

Table 4: Impact of ICT Adoption on the Credit Behavior of SMEs

	(1) Outstanding Credit	(2) Loan Amount	(3) Loan Application	(4) Loan Approval
Panel I—OLS/probit models				
ICT adoption	0.361*** (0.052)	0.525*** (0.162)	0.453*** (0.058)	0.442** (0.066)
Growth	-0.417*** (0.089)	0.275 (0.279)	-0.121 (0.097)	-0.002 (0.112)
Age	0.002 (0.001)	0.011** (0.005)	0.001 (0.001)	0.001 (0.002)
Female owner indicator	-0.109*** (0.036)	-0.698*** (0.217)	-0.037 (0.051)	-0.135* (0.081)
Export decision	0.559*** (0.068)	0.037 (0.172)	0.219*** (0.080)	0.002 (0.112)
Informal payments	0.770*** (0.218)	-1.558** (0.644)	0.615*** (0.239)	-1.060*** (0.303)
Region FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	5,936	520	5,908	2,173
Panel II—IV models				
ICT adoption	0.647*** (0.149)	0.651 (0.654)	1.234*** (0.125)	0.580*** (0.213)
Other controls	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	6,169	576	6,140	2,271
<i>First stage:</i>				
First-stage F-stat	283.87	14.67	278.78	99.35
Instrument 1: percentage loss of annual sales due to power outages	-0.550*** (0.150)	-1.719*** (0.436)	-0.452*** (0.147)	-0.881*** (0.180)
Instrument 2: indicator for generating electricity	0.317*** (0.013)	0.153*** (0.038)	0.315*** (0.013)	0.271*** (0.019)
Panel III—IV models				
ICT adoption	0.943*** (0.169)	0.838 (0.648)	1.690*** (0.106)	0.539* (0.301)
Other controls	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	5,980	576	6,140	2,271
<i>First stage:</i>				
First-stage F-stat	209.01	13.82	202.88	58.09
Instrument 1: percentage loss of annual sales due to power outages	-0.582*** (0.144)	-2.153*** (0.428)	-0.381*** (0.136)	-0.747*** (0.173)
Instrument 2: indicator for generating electricity	0.301*** (0.014)	0.079* (0.042)	0.286*** (0.014)	0.228*** (0.021)

Note: All the dependent variables are dummy variables (except column (2)). Panel I presents the results from a simple OLS/probit model. Panels II and III contain the results from an instrumental variable estimation model in which the first-stage F-stat and the coefficients of the instruments are reported in the respective panels themselves. Panels I and II control for unobserved effects only in the broad regional categories (south, west, center, east, north, and north east). Panel III controls for unobserved effects at the state level. Standard errors are reported in parentheses. ***<0.01, **<0.05, and *<0.1.

As discussed in Section 3, there is a possibility that the ICT variable is not exogenous; hence, the coefficients obtained above may not capture the effect of ICT on firms' credit behavior. To account for endogeneity, we estimate the instrumental variable models using loss due to power outages and use of a generator as instruments for the ICT adoption variable. All our dependent variables, except the loan amount, are dichotomous, so we use the instrumental variable probit (IV probit) model for these outcome variables, whereas we use the instrumental variable two-stage least squares method when the outcome variable is loan size. Panel II presents the results of the instrumental variable estimation models. We only report the coefficients of ICT adoption from the second stage of this model.⁸ We find that the coefficient is positive and significant across all our models. In the first-stage regression, the F-statistic is higher than 10, suggesting that our instrument is relevant. The instruments are also positive and significant across all the models. In terms of the firm-specific variables, we find that size, sales growth, and export decision have a positive association with credit access. All the models control for region- and industry-level unobserved effects. Panel II confirms that ICT adoption improves SMEs' credit behavior by not only improving credit access but also increasing the likelihood of applying for loans and gaining loan approvals. It is noteworthy that ICT adoption does not appear to be related to loan size. The findings are broadly in line with the theoretical underpinnings suggesting that ICT adoption, in the form of having a registered website, may help to reduce the information asymmetry between the borrower and the lender by providing information about the SMEs and, at the same time, can reduce the transaction costs incurred by the creditor due to the ease of accessing SME-related information through the website.

To test the robustness of our relationship, we re-estimate our instrumental variable models by including state-level (instead of regional) dummy variables to control for spatial unobserved factors. We compile the results of these models in Panel III of Table 4.⁹ The results confirm our earlier findings, highlighting that the vital role of ICT in influencing firms' credit behavior is robust to the inclusion of unobserved geographical variation at the state level.

To contrast the findings for the SME sector with those for large enterprises, we re-estimate our effects using the entire sample of large firms and SMEs in the WBES dataset. We then interact the website indicator with the SME dummy. We present the results in Table 5.

In Table 5, the coefficient for the website indicator is positive, significant, and of a higher magnitude than that in Panel II of Table 4. Further, the interaction term between SME sector and website is negative and significant, indicating that the positive impact of ICT on credit access is larger for larger firms. This highlights the role of pre-existing factors in determining how ICT adoption may affect the credit behavior of firms. It underscores the fact that pre-existing organizational structure can moderate the benefits of ICT, and ICT itself is not sufficient to bridge the gap between large firms and SMEs in developing economies. This can be attributed to the higher information

⁸ The model controls for all the other variables used in the OLS model. The detailed results can be made available on request.

⁹ Since we are using a cross-sectional dataset, state-level fixed effects will capture the state of the financial sector (bank branches, ATMs, and credit availability) across states within India. To explore the role of the financial sector and other supply-side characteristics, we also try interacting the state and industry dummies in the IV models. This approach is relevant in India's case due to the policy emphasis on priority sector lending by banks in some sectors. We find that ICT adoption continues to have a positive impact on the likelihood of obtaining credit and the likelihood of applying for a loan. The results can be made available upon request.

asymmetry in the credit market for SMEs as opposed to larger firms. Given the differential influence of ICT on credit behavior, in this study we solely focus on SMEs.

Table 5: Impact of ICT Adoption on All Firms (SMEs vs. Large Firms)

	(1) Outstanding Credit	(2) Loan Amount	(3) Loan Application	(4) Loan Approval
Website indicator	1.170*** (0.201)	2.545*** (0.549)	1.183*** (0.099)	1.029*** (0.154)
Website*SME dummy	-0.480*** (0.234)	-1.839*** (0.192)	0.109 (0.069)	-0.280*** (0.077)
Controls	Y	Y	Y	Y
# of observations	9,085	959	9,030	3,625

Note: All the dependent variables are dummy variables (except column (2)). These models are instrumental variable estimation results and include all the firms (large and SME). The SME dummy takes the value one if the firm belongs to the SME sector and zero otherwise. Standard errors are reported in parentheses. ***<0.01, **<0.05, and *<0.1.

4.2 Potential Channels

One of the ways in which ICT may improve credit behavior is by reducing information asymmetry for the creditor. To test this channel, we consider using audited accounts as a measure. The accounts variable takes the value one if the firm maintains accounts that are audited by an external auditor and zero otherwise. Column (1) of Table 6 indicates that access to ICT is positively related to SMEs having their accounts audited by an external auditor. The presence of audited accounts reduces the information asymmetry, and this in turn can improve credit access.

Table 6: Potential Channels That Drive Our Main Results

	(1) External Audit	(2) Innovation Indicator	(3) Labor Productivity
Panel I—OLS			
ICT adoption	0.441*** (0.040)	0.611*** (0.084)	0.461*** (0.029)
Other controls	Y	Y	Y
Region FE	Y	Y	Y
Industry FE	Y	Y	Y
Observations	6,200	5,985	6,217
Panel II—IV estimation			
ICT adoption	0.893*** (0.151)	1.163*** (0.235)	0.966*** (0.123)
Other controls	Y	Y	Y
Region FE	Y	Y	Y
Industry FE	Y	Y	Y
Observations	6,195	5,979	6,212

Note: All the dependent variables are mentioned in the first row of the table. Column (1) uses an indicator variable that takes the value one for firms that have their accounts externally audited and zero otherwise. Column (2) uses an indicator variable that takes the value one for firms that innovate and zero otherwise. Column (3) uses labor productivity, which is measured as the natural log transformation of the ratio of sales to employees. Standard errors are reported in parentheses. ***<0.01, **<0.05, and *<0.1.

Finally, to capture the augmenting effect of ICT on operations, we use an innovation indicator and labor productivity within the firms. We find that ICT adoption is complementary to technology upgrading and higher labor productivity. Hence, higher innovation and productivity of SMEs associated with ICT adoption sends a signal to the creditor regarding their growth potential. The positive signaling effect can be one of the reasons for improved credit access. This finding resembles that of Pellegrina et al. (2017).¹⁰

4.3 An Extension

In addition to SMEs in India, micro firms with fewer than 10 employees are important and assume significance from the point of view of job creation. These enterprises are widespread and larger in number than the entire SME sector of India.¹¹ We extend our analysis by examining the relationship between ICT adoption and credit behavior for micro firms in India. Our data for micro firms (97% of which have fewer than five employees) are obtained from a companion survey conducted by the World Bank in India, the Enterprise Survey of Micro Firms (ESM), across nine cities between December 2021 and March 2022. This survey also uses a stratified random sampling method but with two levels of stratification: region (cities) and industry (manufacturing/services). Despite the WBES and ESM being conducted during the same period in India, we cannot combine the two survey datasets because their sampling strategies are different and not comparable. Additionally, while the WBES is a more comprehensive survey containing many questions, the broad topics in the ESM correspond to the WBES in spirit.¹² The ICT variable for micro firms is defined as a dummy variable that takes a unit value if the firm uses the phone/Internet and computers for buying inputs, tracking shipments, and communicating with customers. The dependent variable is the same as in our main analysis above. Further, in this specification, we use two instruments, namely access to electricity and access to the Internet, for our ICT adoption variable.¹³ These instruments are used in past studies on firms' ICT and credit access (Agyekum et al. 2022; Bui and Do 2022). We re-estimate our models for micro firms and present them in Table 7. Like the findings for SMEs, we observe that micro firms' ICT adoption is positively related to credit access and loan applications.

Table 8 contains some underlying mechanisms that may drive the positive impact of ICT on micro firms' credit behavior. Since the nature, organization, and structure of micro firms are very different from those of SMEs, the questions asked in the survey are different from those in the WBES survey and are well suited to capturing financial awareness among micro firms. We find that micro firms that adopt ICT are more likely to prepare a formal profit and loss statement at least once a year and maintain a separate account for the establishment (columns (1)–(2)). This suggests that ICT

¹⁰ Panel I of Table 6 presents the association of ICT adoption with these variables, and Panel II presents the IV results; hence, they are causal in nature.

¹¹ As of 21 July 2022, there were a total of 9,714,279 MSMEs registered on Udyam, including 9,282,256 micro enterprises, 393,824 small enterprises, and 38,199 medium-sized enterprises. Source: <https://www.india-briefing.com/news/micro-small-medium-enterprises-india-explainer-17887.html/#:~:text=As%20of%20July%2021%2C%202022,and%2038%2C199%20medium%2D-sized%20enterprises.>

¹² However, some questions in the WBES may not directly apply to the ESM and hence may be posed differently. For instance, unlike the ESM, the number of employees and nature of their composition in the WBES span many aspects.

¹³ In the WBES main survey, used for the SME analysis, there is no specific question on the availability of an electricity supply. Further, only 3% of SMEs have reported Internet availability to be an obstacle to their operations (Table 1).

adoption is associated with better information access, even for micro firms. Further, the micro firms that use ICT are more likely to be financially included, as indicated by the likelihood of having a savings bank account. Being financially included may increase their awareness of and willingness to take out credit.

Table 7: Impact of ICT on Micro Firms

	(1) Outstanding Credit	(2) Loan Application	(3) Loan Approval
ICT adoption	1.461*** (0.349)	1.277*** (0.462)	0.607 (0.804)
Other controls	Y	Y	Y
Region FE	Y	Y	Y
Industry FE	Y	Y	Y
Observations	793	889	88
First-stage F-stat	23.09	22.96	7.90
Sargan's statistic	0.805 (0.326)	2.234 (0.135)	0.039 (0.844)
<i>Instruments</i>			
Electricity as an obstacle	0.005 (0.051)	0.004 (0.051)	-0.013 (0.157)
Use computers and cell phones	0.219*** (0.032)	0.218*** (0.032)	0.428*** (0.107)

Note: The dependent variables are defined in the same way as for the WBES firms. The instruments used here are firms that have reported electricity to be a major obstacle to their operations and firms that use computers and cell phones.

Table 8: Possible Channels for Micro Firms

	(1) P&L Statement	(2) Separate Account	(3) Savings Account
ICT adoption	0.554*** (0.110)	0.257*** (0.113)	0.598** (0.117)
Other controls	Y	Y	Y
Region FE	Y	Y	Y
Industry FE	Y	Y	Y
Observations	775	888	891

Note: Columns (1)–(3) use dependent variables that are binary outcomes for an establishment using a checking/savings account, an establishment preparing a P&L statement at least once a year, an owner using separate accounts for the establishment and the household, and firms using microfinance institutions or banks as the financial source for day-to-day operations, respectively. Standard errors are reported in parentheses. ***<0.01, **<0.05, and *<0.1.

5. CONCLUSION

Using a recent and rich dataset on SMEs in India, this paper documents the positive effect of ICT adoption on credit behavior. We also explore the channels that highlight how ICT adoption may reduce information barriers between borrowers and lenders, consequently reducing credit constraints. This study's findings also support the firm resource-based view by considering ICT adoption as a valuable resource for firms' access to credit. Thus, the paper advocates promoting policies that will boost the ICT infrastructure in India. The findings are also confirmed for micro firms in India. However, it is worth noting that, even though ICT improves credit access, a large

proportion of firms with an open line of credit have personal loans. Personal loans are credit products that are unsecured and have high-interest rates. The effect of ICT adoption on the type of credit instruments used by SMEs remains an area for future research.

Overall, the study underscores a relevant issue in the post-pandemic era since there was widespread concern that many viable but illiquid SMEs would face burgeoning losses or shut down without sufficient policy support. Several direct policy actions are essential to expand credit lending to the MSME sector as a cushion. Our analysis emphasizes the critical role of ICT infrastructure and support in improving access to credit for these enterprises. These can be viewed as a complementary tool along with direct measures like subsidized interest on loans, collateral-free loans, tax holidays, and other policy actions. The study paves way for research related to ICT adoption and credit access for SMEs, especially in developing economies. Cross-country studies may also be undertaken to explore the contrasting patterns in developed and developing economies.

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