Mobile Technologies, Financial Inclusion and Inclusive Growth in East Indonesia

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Submission date: 05-Apr-2023 11:12AM (UTC+0800)
Submission ID: 2056243107
File name: LilikSugiahrati_Artikel109_Mobile_Technologies.pdf (635.16K)
Word count: 9955
Character count: 52087

Journal of Telecommunications and the Digital Economy

Mobile Technologies, Financial Inclusion and Inclusive Growth in East Indonesia

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Abstract: This paper examines the influence of mobile technologies on financial inclusion, and the matter of whether mobile technologies and financial inclusion have an impact on the income of individuals in East Indonesia, considering the data from the Survey on Financial Inclusion and Access (SOFIA) in 2017. A seemingly unrelated probit model and an ordinary least-squares model are used to compare both determinants of formal and informal financial services, as well as simple and smart mobile technologies. The study finds that mobile technologies and access to finance significantly increase the likelihood of higher incomes. Smart technologies and formal finance have higher effects on incomes compared to the effects of simple devices or semi-formal and informal finance. Significant gaps in financial access exist between individuals in accordance with gender, income, education, and location. Technologies account for a small difference in the broader access to financial services.

Keywords: Financial Inclusion; Mobile Technologies; Inclusive Growth; Financial institutions; Indonesia

Introduction

Financial inclusion is defined as having access to formal financial services either for saving, borrowing, or conducting financial transactions (Wang & Guan, 2017) at competitive cost (Mehrotra & Yetman, 2015). Several countries (including Indonesia) have increased their

http://doi.org/10.18080/jtde.v8n2.253

numbers of 'bankable' people since a decade ago (Demirguc-Kunt *et al.*, 2018). Nevertheless, Indonesia still has 17% of its total population financially excluded (that is, they have no bank accounts), nearly 40% excluded from savings, and almost 60% excluded from credit. Above and beyond this, critical gaps exist among individuals in Indonesia with respect to financial inclusion. Those in urban areas who are male, older and with higher education, along with those who work in non-agricultural activities and earn high incomes, are more likely than those without these advantages to be financially included.

Although financial entities in Indonesia are liquid and profitable, still a large portion of the population remains unbanked (Rosengard & Prasetyantoko, 2011). Banks face greater adverse borrower selection with implications of lower efficiency and the threat of non-performing loans (Hanh, Daly & Akhter, 2016) if they allow 'bankability' among the whole adult population, which possibly explains why lower-income people have remained unbaked (Wang & Guan, 2017). For instance, a focus on financial performance, market competition, or financial infrastructure alone may not lead to higher financial inclusion.

On the other hand, the link between bankability and mobile technology use suggests that mobile technologies support broad access to finance (Asongu & Nwachukwu, 2016) and have a positive impact on inclusive growth, while mobile users also generally have higher incomes (Asongu, 2015; Asongu, 2013). In 2017, there were nearly 174 mobile devices per 100 persons in Indonesia, although only 40% of individuals were connected to the Internet (ITU, 2018). While smartphones have gained rapid usage (Das *et al.*, 2016), still only 32% of the phones were connected to the Internet in 2017, according to the Financial Inclusion Insight Survey (2018), and only 5% of transactions were financial according to the same survey.

This study questions whether access to mobile technologies influences the likelihood of individuals in East Indonesia enjoying improved financial access, and whether technologies play a role in removing obstacles to banking, while driving banking services. This study focusses on individuals' characteristics, such as income, education, age, gender, and rural-urban location, which are likely to influence their participation in finance (Corrado & Corrado, 2015; Fungáčová & Weill, 2015). The study also investigates whether people in East Java, Indonesia (Jatim hereafter), display different attitudes towards financial services compared to people from three other provinces outside Java. East Java is the second largest province in Indonesia (with 40 million people of the total 270 million nationwide). East Java is also the gateway to East Indonesia. A further contribution to the literature arises as we investigate whether broader access to technology and better access to financial services play a role in improving the welfare of individuals in Indonesia (higher income). The effect of mobile technology on finance and the combined effects of technology and finance on income remain as empirical questions.

http://doi.org/10.18080/jtde.v8n2.253

This study uses the Survey on Financial Inclusion and Access (SOFIA) in 2017, which includes East Java, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT) and South Sulawesi, and has a total sample size of 20,000. A probit method is employed to analyse how individual characteristics – gender, age, income level, education, and location (rural/urban) – contribute to the determinants. Additionally, the model developed introduces binary data on low-tech (basic mobile phones) and high-tech devices (smartphones/Internet/PCs) to analyse the impact they have on financial inclusion. To evaluate the impact of digital technologies and finance on income level, the paper applies ordinary least-squares (OLS) regression, differentiating impacts based on the type of finance (formal, semi-formal, informal, and family), the level of technology (low or high), and income level (low, medium, and high). A seemingly unrelated regression equation (SURE) probit model is employed for robustness.

In Indonesia, financial inclusion plays a central role in the government's financial development agenda (OECD, 2018), as there is evidence that finance plays a vital role in reducing poverty and income inequality (Park & Mercado, 2015; Swamy, 2014) and that it supports inclusive growth (Sanjaya & Nursechafia, 2016). Financial inclusion is expected to allow larger expenditures, to multiply sources for borrowing, to increase the prospect of being employed (Bruhn & Love, 2014), to allow larger savings or credit for education or entrepreneurial investment (Demirgüç-Kunt & Klapper, 2012), to support the empowerment of women, to cushion against financial shocks (Han & Melecky, 2013), and to manage risk amid hard-hitting times (Dienillah & Anggraeni, 2018). This paper contributes to the literature of financial inclusion as it offers evidence of the determinants of financial inclusion based on an individual's characteristics, and analyses financial products according to formality. Additionally, this paper considers the effect of mobile technologies and financial inclusion combined, whereas earlier research has considered the effects of each only individually.

Literature Review

In this section, there are two main points addressed: first, the relevance of financial inclusion for welfare; and, second, links between mobile technology and finance. Addressing financial inclusion is relevant as there are welfare benefits for recipients by their having broader access to financial services. A more inclusive financial system could help decrease poverty beyond urban areas (e.g., the Indian case (Burgess & Pande, 2005)), reduce unemployment (Bruhn & Love, 2014), allow individuals higher expenditures (Dupas & Robinson, 2013), raise the national saving levels (e.g., the Malawi case in Brune *et al.* (2016)), support government policies (e.g., poverty reduction programs in Beck & Demirgüç-Kunt (2008)), and help in aid transfers. Financial inclusion plays a decisive role in firm performance, through either informal financial services (Allen, Qian & Xie, 2018) or through formal finance arrangements

http://doi.org/10.18080/jtde.v8n2.253

(Chauvet & Jacolin, 2017), where it supports a competitive landscape for firms. In Indonesia, although a general deepening in financial services is on-going (Riwayati, 2017; Tambunan, 2018), significant social gaps in financial access remain, where access to savings and credit is low for younger people, the less-educated, lower-income individuals, and those out of the labour force (Demirguc-Kunt *et al.*, 2018). Besides the challenges to close social gaps, financial literacy and skills in ASEAN remain low (OECD, 2018).

Efforts to advance financial inclusion are in place (Llanto, 2015; Tambunan, 2018; Yoshino & Morgan, 2016), which will promote financial literacy, regulation, and the facility to expand services. Nevertheless, Indonesia ranks as an average country in financial inclusion, as demand for finance is limited to basic services (e.g., payments, as in Kostov, Arun & Annim (2015)), which offer only weak incentives for banks to expand. Besides, the high cost of finance, barriers, market failures, and self-exclusion remain (Cole, Sampson & Zia, 2011). Substantial evidence suggests that low financial literacy and a poor level of financial knowledge are critical to low financial inclusion (Allen *et al.*, 2012; Grohmann, Klühs & Menkhoff, 2018). Cole, Sampson & Zia (2011) provide evidence for how financial literacy and knowledge influences financial behaviour that is associated with better decision-making, broader demand for banking services, and wiser use of accounts. Technology provides a potential link to address financial literacy and knowledge, as mobile technologies contribute to more in-depth financial inclusion (Ouma, Odongo & Were, 2017), by providing information (Abor, Amidu & Issahaku, 2018), broader access to services, facilitating account management and securing transactions. Additionally, technology creates a more conducive environment for banking associated with broader access, lower cost, proximity, and less documentation, by removing barriers (Allen *et al.*, 2016).

Nevertheless, in developing countries, socio-economic gaps among individuals are wide, with technological improvements making uneven differences in the broader access to financial services, as other barriers may hinder individuals from accessing services. Gaps among individuals are observed in gender (Demirguc-Kunt & Klapper, 2012; Ghosh & Vinod, 2017; Swamy, 2014), culture, education (Zins & Weill, 2016), job status, economics (Aterido, Beck & Iacovone, 2013), or with legal-social structures (Demirguc-Kunt *et al.*, 2013). As those socio-economic gaps prevail, critical breaches remain among individuals with respect to financial inclusion. Informal financial services, as opposed to formal finance, including interpersonal borrowing, trade credit, private money houses, pawnshops, and cooperatives, are widespread in developing countries (Fungáčová & Weill, 2015; Grohmann, Klühs & Menkhoff, 2018). Allen, Qian & Xie (2018) noted that the existence of informal finance arises as informal investors have superior information and stronger networks than formal institutions that help in reducing hazards and adverse selection. Mobile technology could assist in intermediation –

http://doi.org/10.18080/jtde.v8n2.253

moral hazard and adverse selection – and deliver finance at a lower cost than conventional finance (Beck, Demirguc-Kunt & Martinez Peria, 2007), while closing the gap of low financial knowledge and bridging exclusion.

Methodology

Data

This study uses the most recent survey (that of 2017) from Indonesia's Survey on Financial Inclusion and Access (SOFIA), which covers the provinces of East Java, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT) and South Sulawesi, with a total sample size of 20,000 individuals within 93 districts and 1,250 villages. The database provides indicators on access to an array of financial services, main barriers to inclusion, motivations for saving and seeking credit, sources of credit, mobile finance, and informal finance. The micro-level data allows for individual differences in gender, age, income, education, location, and employment, and differentiates financial services by formality: account, savings or credit.

While considering the structure of the SOFIA Database (answers under a dummy structure – yes or no, one or zero), this study uses a probit regression, with a dependent variable (y_i) taking values of one or zero. The model assumes that y^* is determined by a set of exogenous variables introduced as controls in a z' vector (e.g., gender, age, income, education), so that:

$$y_i^* = z_i'\beta + u_i \quad (1)$$

$$y_i = 1 \text{ if } y_i^* > 0;\ y_i = 0 \text{ otherwise}, \quad (2)$$

where the subscript i represents individuals, the vector β contains the parameters of the model, and u is the normal distribution error term, assumed to have an average of 0 and variance of 1. The model assumes a critical threshold in y_i when y_i^* is over y_i, indicating that the individual is financially included (in either of the services tested), as noted in Martínez, Hidalgo & Tuesta (2013).

The probit model is estimated using the standard maximum likelihood approach as:

$$y_i^* = \alpha + Male_i + Age_i + Age^2{}_i + Edu_i + Inc\_low_i + Inc\_med_i + Rural_i + JATIM_i + Tech\_low_i + Tech\_high_i + u_i \quad (3)$$

where y represents the variable for financial inclusion, the sampled individual is i, and the additional independent variables are the explanatory components. As z′ parameters (β'), a set of variables are proposed in Table 1.

The impact of the different technologies (low or high) and the effects of each sort of financial service is regressed against the income level groups employing an OLS regression model.

$$y_i = \beta_0 + \beta_1 Z_i + \beta_2 \gamma_i + \beta_3 \tau_i + X_i'\delta + \varepsilon_i \quad (4)$$

http://doi.org/10.18080/jtde.v8n2.253

where y_i represents the income of the individual (low, medium, or high), Z_i is the proxy for access to a simple mobile phone, γ_i measures access to smartphone/Internet/computer, τ_i represents access to financial services (formal, semi-formal, formal non-bank, family, informal, and credit from suppliers or business). To address the endogeneity, the Woolridge test is performed (available upon request).

Table 1 Descriptions of the Variables

Variable	Definition	Measurement
Male	Gender of the respondent	1 = male; 0 = female
Age	Age	Years
Age2	Age squared	Years Squared
Edu	Education of respondent	1= Elementary (SD/ MI/ Paket A) 2= Junior high school (SMP/ MTS/ Paket B) 3= Senior high school (SMA/ MA/ Paket C/SMK) 4= Diploma (D1, D2, D3) 5= Bachelor 6= Master/Doctoral
Inc_low	Respondent who has low income (< US$ 2 a day)	1 = if yes; 0 = otherwise
Inc_med	Respondent who has medium income (US$ 2-20 a day),	1 = if yes; 0 = otherwise
Rural	Respondent lives in rural area	1 = if yes; 0 = otherwise
Jatim	Respondent's residence in East Java	1 = if yes; 0 = otherwise
Tech_low	Respondent only uses simple mobile phone	1 = if yes; 0 = otherwise
Tech_high	Respondent uses Internet/ Smartphone/Personal Computer	1 = if yes; 0 = otherwise

Source: Author's compilation from SOFIA Dataset

Finally, a latent simultaneous model (seemingly unrelated SURE probit) is applied as a robustness test to address the endogeneity issue arising in cases where having a phone or access to finance could be attributed to higher income levels rather than the other way around. SURE addresses unobserved heterogeneity, endogeneity and correlation (Abor, Amidu & Issahaku, 2018). Intuitively, it is expected that belonging to a higher income group increases the likelihood of access to high-tech and to financial services. It may be that having a middle income makes for mobile phone ownership and high-tech device ownership. That is the natural endogeneity question that often appears in studies of this class. Due to this reason, a model simultaneously estimating the ownership of mobile phones and the income status is proposed by employing a SURE model. Mobile technologies are proxied by two different dichotomous variables proxying the two different technologies employed in this study: simple mobile phones or smart technologies. Inclusive income categorizes individuals based on low-, medium- or high-income level. Considering that both are dichotomous variables (taking values of 1 or 0), a latent simultaneous model is proposed (Greene, 2003):

$$y_{i1}^{*} = \acute{\pi}_1 x_{i1} + \acute{\varphi}_1 y_{i2}^{*} + \varepsilon_{i1},\ y_{i1} = 1; 0 \text{ otherwise} \quad (5)$$

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$$y_{i2}^{*} = \pi_2 x_{i2} + \phi_2 y_{i1}^{*} + \varepsilon_{i2},\ y_{i2} = 1 \text{ if } ; 0 \text{ otherwise} \quad (6)$$

$$\text{where } \begin{pmatrix}\varepsilon_1\\ \varepsilon_2\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}\begin{pmatrix}1 & \rho\\ \rho & 1\end{pmatrix}\right]$$

That is, the two error terms $(\varepsilon_1, \varepsilon_2)$ are simultaneously estimated with zero mean, constant variance and correlation (ρ). A ρ equal to 0 will suggest that the equations are unrelated, meaning that the equations do not need to be estimated simultaneously. The variable y_1^* represents the unobservable latent variable related to mobile phones, while y_2^* is the measured income level of the individual: y_1 will take the value of 1 if the individual owns a mobile device; y_2 will take the value of 1 if the individual belongs to the low income level; and zero otherwise. The method models the different technologies (simple and smart) and income levels (low, middle, and high) proposed in the study. The variables x_S are vectors of exogenous variables measuring socio-economic characteristics of the individuals (gender, age, education, and location); π_S' and ϕ_S are vectors of parameters.

Results

Descriptive Indicators of Financial Inclusion

The SOFIA dataset captures the fact that nearly 41% of the population have access to formal accounts, 42% have access to semi-formal or/and informal services, while 17% are financially excluded (Table 2). While nearly 57% of the population in East Indonesia have access to savings, only 24% employ formal savings. Access to credit is 41%: nevertheless, only 13% do formally access credit; 4% from non-bank sources; and 25% from semi-formal and informal sources.

Table 2 Descriptive Statistics Sample Data

Variable	Percentage (yes)	Variable	Percentage (yes)
Male	42.73%	Save Money Formal	41.93%
Income_low	50.11%	Save Money informal	76.96%
Income_med	43.05%	Banked	15.85%
Jatim	35.00%	Paid_bill	62.67%
Rural	65.41%	Mobile_money	2.36%
Tech_low	72.45%		
Tech_high	31.40%		

Source: Author's calculation from SOFIA Dataset.

In Indonesia, more males (43%) have access to formal financial services (accounts, saving, and credit) than females (39%). Nevertheless, females have greater access to informal services (10% as opposed to 6% among males) than males. Financial inclusion is predominant amongst non-farm labouring people, with higher education and higher income; and among those in

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urban areas (49% formal in urban areas vs 35% in rural). While the gap in financial inclusion has narrowed in terms of gender, the gap between less and more educated (80 percentage points) and the gap between lowest income and highest income (68 percentage points) is large.

Determinants of Financial Inclusion (Savings and Credit)

The study first looks at the main determinants of financial inclusion in East Indonesia and identifies how individual characteristics, the use of technology, and location affect the likelihood of people to be financially excluded. Table 3 displays the results. Regarding individual characteristics, males have 6.4% higher likelihood of saving within formal institutions than females; nevertheless, males have 15.5% higher likelihood of being excluded from savings (Table 3, column 1). Females have 13.4% greater likelihood of being engaged in informal savings than males (additional results on saving and credit motivations in Appendix Table 10).

Higher levels of education are associated with greater access to formal savings and credit, and to a lower share of informal finance. By contrast, lower levels of education are associated with higher use of informal savings and credit, and with higher dependence on family loans. Foreign remittances are more likely among people with lower education (common among Indonesian overseas workers).

Together with education, income accounts for the most significant determinant of financial inclusion. Individuals with low income are 23.1% significantly less likely to save; they are 27% less likely to save in a formal institution; and 5.4% more likely to save informally. High income also lowers dependency on family as a source of loans. Formal and semi-formal services overlap among high-income earners, but leave the lower-income people to the informal services. This is similar to findings for Africa (Zins & Weill, 2016) and China (Fungáčová & Weill, 2015). Individuals in rural areas have a 5.11% lower probability of saving and of being bankable for credit (4.5%) versus those in urban areas. People in rural areas save and borrow more from informal sources, borrow more from family members, and send/receive more international remittances (3.5%) than urban people.

Technology and Financial Inclusion

The use of both simple phones and higher-end mobile technologies is associated with broader access to savings and credit. Individuals with simple mobile phones are 5.5% more likely to save money than those without a device, but those with higher-tech devices are 10% more likely (twice as likely as those with simple mobile phones) to save than non-device users. High-tech devices also turn individuals 18.6% more likely to save formally, while lowering informal savings by -7.8%, informal credit (-8.6%) and family loans; but they increase formal and semi-formal savings and credit.

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Different arguments support the claim that higher access to mobile technologies increases access to formal finance. First, mobile devices support more efficient communication, associated with efficient use of time, lower cost, and complete information. Mobile phones may be associated with professional activities by enhancing work performance and making users more "bankable". The perception of high cost or no money in savings and use of bank accounts falls by 5% for simple phone users and nearly 10% for users of smart technologies (see Appendix Table 8).

Lack of knowledge as a barrier to insurance services decreases by 4% for users of mobile phones and by 8.7% when it comes to a lack of knowledge for mobile payments. Users of mobiles and smart phones employ more bank services for transactions and use less cash; they are more likely to use internet banking and mobile banking, and to use ATMs to pay bills (results on Remittances, Transfers, Bill Payments, Appendix Table 7).

Nevertheless, the most substantial barrier to broader finance is voluntary self-exclusion, meaning that users prefer to use cash, and find no need to use financial services; nor do they want to save, use accounts, or borrow money. Lack of trust in saving, borrowing and getting insurance remains a barrier even for individuals with mobile phones, meaning that more information and connection does not guarantee trust. The perception of high cost remains a barrier to finance (results on barriers to finance available, Appendix Table 8).

Technology shapes saving motivations of individuals with smart devices, as they are less directed towards consumption (-6.0%), have 2.4% higher awareness of the need to save for emergencies, and higher intention to save for business expansion. Use of credit among high-tech users decreases for consumption (-10.5%), decreases for emergencies (-1.4%, perhaps as a result of higher savings for emergencies), but increases when it comes to buying a house (2%), and starting/expanding a business (4.2%) (Appendix Table 10).

Nevertheless, this study finds a rather low use of financial services for remittances, sending/receiving money, bill payments, mobile banking, ATMs, and other banking services empowered by technology. The potential of digital services remains untapped, with barriers to finance placed in non-technology aspects.

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Table 3 Determinants of Finance (Savings, Credit, Remittances)

	Saving (1-3)				Credit (4-8)				Services (9-12)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Save ALL	**Save Formal**	**Save Informal**	**Banked**	**Semi-Formal**	**Formal non-Bank**	**Family**	**Informal**	**Paid Bill**	**Mobile Money**	**Insurance**	**Remittance Abroad**
Male	-0.155***	0.064***	-0.134***	0.045***	-0.012	0.015**	-0.028**	-0.019**	-0.017*	0.000	-0.018*	-0.029***
Age	0.009***	0.028***	-0.012***	0.023***	0.016***	0.008***	-0.024***	0.004***	0.039***	0.001***	0.007***	-0.003***
age2	-0.001***	-0.000***	0.000***	-0.00***	-0.00***	-0.00***	0.000***	-0.000**	-0.000***	-0.00***	-0.000*	0.000**
edu	0.056***	0.126***	-0.051***	0.051***	0.009**	-0.001	-0.053***	-0.012***	0.009*	0.006***	0.033***	-0.016***
inc_low	-0.231***	-0.270***	0.054***	-0.117***	-0.002	-0.017	0.115***	-0.011	-0.085***	-0.017***	-0.001	-0.014
inc_med	-0.113***	-0.106***	-0.0148	-0.056***	0.027*	0.000	0.041*	-0.003	-0.037*	-0.009***	0.069***	0.008
Jatim	-0.030***	-0.115***	0.078***	-0.000	0.024***	-0.008	0.009	0.060***	0.067***	0.009***	-0.144***	-0.003
Rural	-0.051***	-0.062***	0.048***	-0.040***	-0.010	-0.026***	0.087***	-0.026***	0.001	-0.004***	-0.035***	0.035***
tech_low	0.055***	0.082***	-0.032**	0.065***	0.023*	0.014*	-0.05***	-0.005	0.071***	0.000	-0.027**	-0.002
tech_high	0.101***	0.186***	-0.078***	0.082***	0.026**	0.023***	-0.086***	-0.025***	0.008	0.018***	0.004	0.014*
N	14160	9841	9841	9497	9497	9497	9497	9497	14159	14159	14161	7494
Log likelihood	-7872.23	-5462.99	-5007.82	-3840.73	-3634.47	-2496.53	-5165.27	-2960.50	-8536.92	-1572.37	-9263.64	-1573.01
Pseudo R2	0.0961	0.1974	0.1081	0.1671	0.0378	0.0235	0.1112	0.0406	0.0521	0.2090	0.0320	0.0682

Note. Standard errors not presented (space limitation). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Prob>Chi 0.
Source: Author's Calculation

http://doi.org/10.18080/jtde.v8n2.253

Table 4 SURE Probit Estimations for Mobile Phones (low tech) and Smartphones, the Internet, and Computers (high tech). Selected indicators displayed

	Low Income		Med Income		Low Tech		High tech		Banked		Family	
	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx
Inc_low					-0.11***	0.13	-0.49***	-0.02	-0.45	-0.10	0.30	0.10
Inc_med					-0.04	0.06	-0.20***	-0.01	-0.25	-0.06	0.13	0.04
Tech_low	-0.11***	-0.04	0.08***	0.03					0.26	0.06	-0.15	-0.05
Tech_high	-0.29***	-0.11	0.22***	0.09					0.34	0.09	-0.25	-0.09
Banked	-0.26***	-0.09	0.07***	0.03	0.23***	-0.06	0.26***	-0.01				
Semi_formal	-0.13***	-0.05	0.17***	0.07	0.12***	-0.02	0.11***	-0.01				
Formal_nbank	-0.14***	-0.05	0.11***	0.04	0.13***	-0.04	0.17***	-0.01				
Family	0.06	0.02	(-0.03)	-0.01	0.02	0.05	-0.14***	-0.01				
Informal	-0.03	-0.01	0.04***	0.02	0.06	0.06	-0.16***	-0.02				
Supplies & business	-0.42***	-0.14	0.39***	0.15	-0.17	0.01	-0.10	0.01				
Male	-0.17***	-0.06	0.07***	0.03	0.04	-0.05	0.17***	0.01	(0.21)	0.05	(-0.11)	-0.04
Young_adult	0.15***	0.06	-0.20***	-0.08	-0.08	-0.09	0.25***	0.03	(-0.29)	-0.06	(0.29)	0.10
Age	-0.05***	-0.02	0.02***	0.01	0.03***	0.02	-0.06***	-0.01	(0.08)	0.02	(-0.05)	-0.02
Edu	-0.14	-0.05	0.09***	0.04	0.07***	-0.13	0.45***	0.02	(0.22)	0.05	(-0.16)	-0.05
Jatim	0.18***	0.07	-0.12***	-0.05	-0.06***	-0.06	0.17***	0.02	(0.00)	-0.01	(0.03)	0.01
Rural	-0.16***	-0.06	0.03***	0.01	0.00	0.15	-0.47***	-0.03	(-0.19)	-0.04	(0.28)	0.11
Obs	8216				8216				8216			
Rho (ρ)	-0.99				-0.25				-0.285			
	(0.00047)				(0.02373)							
Wald	949.84				2509.2***				1316.13			
Log-Likelihood	-6988.6				-7783.56				-6042.801			
Likel. ratio test of ρ $X^2(1)$	6753.77***				105.762***				82.2522***			

Note. T-values in parentheses. ***, **, * indicates 1%, 5%, 10% significance level. Rho tests for correlation between errors, Validity model (Wald tests), and log-likelihood ratio test for correlation. dy/dx (marginal effects ~ non-linear). Marginal effects under linear estimation equal the coefficient value in percentage terms.

http://doi.org/10.18080/jtde.v8n2.253

Effects of Mobile Technologies and Financial Inclusion on Income

Table 5 displays the results of the OLS estimates for the effects of mobile technologies on income. Table 6 applies the same model relating different financial services to income. Low tech (mobile phones) and high tech (smartphones/Internet/PCs) are positively associated with higher per capita income level, significant at a 1% level. People owning a mobile phone (tech low) have a 13% probability [(exp(0.119)-1)*100] of escaping low-income status, 8.8% higher likelihood of belonging to the medium income group, and 3.36% likelihood of being among the high-income earners. Access to high-tech increases likelihood to belong to a higher income group beyond that associated with the simple mobile phone, by 5% to 7%.

Table 5 Estimates for Basic Mobile Phones and Smart Phones and Inclusive Growth (Income)

	East Indonesia			East Java (JATIM)		
	Income Low	**Income Medium**	**Income High**	**Income Low**	**Income Medium**	**Income High**
Tech_Low	-0.119***	0.0882***	0.0336***	-0.107***	0.0848***	0.0234***
Tech_High	-0.176***	0.135***	0.0340***	-0.223***	0.186***	0.0295***
N Obs	19202	19202	19202	6675	6675	6675
Log Likelihood	-12927.17	-12894.53	-4706.85	-3439.78	-3514.29	-1236.94
Pseudo R2	0.0287	0.0175	0.0167	0.0290	0.0187	0.0113

Note. Standard errors not displayed due to space limitation. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's calculation

The effects of technology on individuals in East Java are higher than for individuals outside Java, as using high-tech increases the likelihood of individuals escaping the low-income level (22.3%) and raises the likelihood of being a middle-income earner by 18.6%. This finding suggests superior technology within Java Island, versus out-of-Java areas, where access to technology results in higher empowerment. These results are in similar line with Bulman, Eden & Nguyen (2014).

Mobile technologies can influence the welfare of people who may in fact save because of more effective communication, lower transaction costs, more available information (Potnis, 2015), offering a wider variety of services, and facilitated information sharing. Mobile technology relates to gains in productivity through digitalization, allowing a broader base of users.

At the same time, those who are banked have nearly 25% higher likelihood of escaping the low-income level group, more than 14% probability of belonging to the medium-income class, or to climb towards a higher income (6.4%). Formal financial services have a higher impact on income than access to semi-formal and formal non-bank services and larger significant effects when compared to informal finance (e.g., family). While borrowing from family increases likeliness to exit the low-income level by 7%, an individual borrowing from family has a negative likelihood of making it to medium-high income level. Access to credit from suppliers

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or business increases the likelihood of having higher income levels, which may be in line with the findings of Chauvet & Jacolin (2017), who argue that financial inclusion and access to credit supports firm growth.

Table 6 Estimates for Financial Inclusion and Inclusive Growth (Income Groups)

	East Indonesia			East Java (JATIM)		
	Income Low	**Income Medium**	**Income High**	**Income Low**	**Income Medium**	**Income High**
Banked	-0.245***	0.141***	0.0640***	-0.282***	0.198***	0.0491***
Semi-Formal	-0.0937***	0.0888***	0.00498	-0.134***	0.129***	0.0022
Formal_Non-Bank	-0.111***	0.0973***	0.0111	-0.138***	0.135***	-0.0011
Family	0.0719***	-0.0441**	-0.0212***	0.0559**	-0.0386	-0.0134
Informal	0.00714	0.00443	-0.00800	-0.00247	0.0149	-0.0112
Suppliers & Business	-0.201***	0.140**	0.0416	-0.261***	0.206**	0.0337
N	12239	12239	12239	4365	4365	4365
Log Likelihood	-8150.84	-8280.53	-3035.00	-2262.76	-2332.70	-754.26
Pseudo R^2	0.0379	0.0169	0.0369	0.0386	0.0205	0.0357

Note. Standard errors not displayed due to space limitation. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's calculation

A combination of access to technology and access to finance offers positive effects for more inclusive growth, and brings about larger effects within East Java as opposed to out-of-Java. Access to formal services offers 60% higher effects in income inclusion versus access to semi-formal service and formal non-bank services.

The marginal effects of mobile financial services are rather small, suggesting that the potential of inclusion through technologies is still unrealized. Payments offer the largest possibility of engaging with mobile banking.

Robustness Test

A seemingly unrelated probit model (SURE) is applied for robustness to test whether technology and income, as well as finance and income, are simultaneously dependent. A latent simultaneous model (SURE) is applied to address the endogeneity issue arising in cases where having a phone or access to finance could be attributed to higher income levels rather than the other way around. The log-likelihood of the SURE model suggests that the variables are significant (1% level), meaning that both sets of variables should be jointly estimated (mobile devices and income level) as there is multi-directional causality. The estimates for rho (ρ) suggest that the unobserved factors that affect mobile-phone technology and income growth are correctly specified and have the expected negative sign (negatively correlated).

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The results in the SURE model in Table 4 are similar to those of the OLS (magnitudes) suggesting that both results properly observed the endogeneity issue, and suggesting that mobile-phone technologies and income are bi-causal, further advising simultaneous estimation. A low-income individual is 11% less likely to have a simple mobile phone, and 49% less likely to have a high-tech device than a medium-income earner. By contrast, middle-income people are only 4% unlikely not to have a phone and 20% unlikely not to own high-tech devices.

The use of technology reduces the likelihood of people belonging to a certain income level. For example, individuals employing simple mobile phones were 11% less likely to be low income. A similar individual employing high-tech devices is 30% less likely to be low income. A mobile phone is associated with 8% higher likelihood of individuals belonging to the middle-income class, and a higher-tech device is associated with 22% higher likeliness to be middle-income earners. The findings are in line with Abor, Amidu & Issahaku (2018), who estimate that ownership and use of mobile technologies in Ghana increases the probability of households to exit poverty, arguing that mobile technologies support inclusive growth. A similar relation is also presented in the case of Kenya (Suri & Jack, 2016) with mobile money having an impact in poverty reduction. Our results also support the findings of Rowntree (2018), who argues that closing the gaps (e.g., gender) in mobile-phone technologies is related to increased incomes in the emerging world, and represents a potential growth in GDP of nearly 0.7 per cent for developing countries.

A bankable individual also has lower likelihood of being low income (26%) as opposed to those who are not banked. Access to semiformal services also lowers the likelihood of individuals being low income; nevertheless, the marginal effect is nearly half of that for formal banking. Informal services play only 3% in favour of individuals to be excluded from the low-income level. Males are 17% less likely to be low income than females, and they are more likely to have simple mobile devices or higher-tech ones. Young adults are more likely to have high-tech devices (25%) than older adults; however, young adults are more likely to be low-income earners. Higher education raises likeliness to have higher income levels and to own higher-tech devices. People in rural areas are less likely to have access to high-tech devices, making it hard to introduce high-tech financial services in rural areas where tech penetration is low.

It is noticeable that young adults are left behind in most fields of financial inclusion in comparison with older adults (proxied by the variable of age), either as they have fewer opportunities (income) or because they have different priorities (e.g., less concerned about health, housing, or being elderly). Table 8 and Table 9 shows results on barriers and preferences to finance, and Table 10 displays results in saving and credit motivation.

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Nevertheless, the youth, similar to females, are more likely to employ higher technology and may have substantial potential for housing credit and entrepreneurship than older adults, in line to the findings reported in Aayog (2015).

Empowering micro financiers, rural banks, and cooperatives with more technology could help to broaden the reach of financial inclusion, so the most vulnerable ones are included (Arun & Kamath, 2015). Mobile technologies could help to lower the cost of finance and support financial education. The massive penetration of mobile phones in Indonesia could benefit the expansion of financial services (cashless transactions). Barriers to finance related to high cost, distance, and documentation, could be addressed by lower-cost products empowered by technology.

Conclusions

This study uses the data from the Survey on Financial Inclusion and Access (SOFIA) in 2017, covering four provinces in East Indonesia: East Java, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT) and South Sulawesi, with a total sample size of 20,000 individuals within 93 districts and 1,250 villages. The study analyses how individual characteristics – gender, age, income level, education, and location (rural/urban) – determine the access to financial services, both based on formality and service provided (accounts, savings, credit, payments, among others). The main focus of the paper is to analyse the impact of digital technologies on financial inclusion and to analyse whether digital technologies and financial inclusion lead to higher income levels among individuals. An OLS regression tested for endogeneity is employed to differentiate impacts based on the type of services (formal, semi-formal, informal, and family), level of technology (low or high), and income levels (low, medium, high).

The results suggest that digital technologies have a positive impact on financial inclusion and on incomes in Indonesia, with higher technology driving higher demand for formal finance (saving and credit), lowering access to informal services, and raising the likelihood of employing other financial services. Use of payments, transfers, mobile banking, insurance, and other non-saving and credit services remain low, rising only slightly even when employing digital devices. Nevertheless, income level and education remain as the most significant determinants of financial inclusion; while perception of high cost, lack of money, and some self-excluding arguments (no-need, do not want) explain a large share of exclusion. Significant gaps in sources of demand, barriers, motivations, and drivers of services are identified across different genders, age, income levels, education, and locations. The province of East Java displays its own particularities in being different from other provinces. In East Java, a combination of access to technology and access to finance offers larger positive effects towards more inclusive growth than out of Java, suggesting that areas out of Java have lower gains in

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financial deepening through higher use of technology. Finally, financial access and mobile technologies are positively associated with higher incomes, allowing people in lower-income levels to climb the income ladder when employing higher technology (mobile devices, Internet, and computers) and formal financial services.

Acknowledgements

This work was supported by Universitas Airlangga, Surabaya, Indonesia, through Hibah "Riset Mandat 2020".

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Appendix

Table 7 Channels of Remittances, Transfers, Bill Payments (Probit Estimations)

	How People receive Remittances (1-2)		Most Frequent way to send money (3-4)		How people pay Bills (6-10)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)
	Bank	Cash	Bank	Cash	Cash	Internet Banking	Mobile Banking	ATM	Voucher
Male	-0.112***	0.110***	0.0119**	0.0106	-0.0104	0.000476	0.000136	0.00102	0.0152
Age	-0.00930***	0.00978***	0.00689***	0.0150***	0.000132	0.0000	0.000	0.000	-0.000
Age2	0.00011***	-0.0001***	-0.00006***	-0.0001***	0.0000	-0.000	-0.000	-0.000005*	-0.0000
Edu	0.0381***	-0.0178***	0.0311***	0.00236	-0.0106**	0.0003	0.0013***	0.001***	0.002
Inc_low	-0.0924***	0.0373*	-0.096***	-0.154***	-0.036*	-0.000	-0.002	-0.004**	0.042*
Inc_med	0.0119	-0.043**	-0.042***	-0.052***	-0.014	-0.000	-0.0017	-0.002*	0.029
Jatim	-0.0431***	0.0454***	-0.055***	0.138***	-0.024**	0.0005	0.001	-0.0009	-0.0070
Rural	0.0064	-0.019	-0.028***	-0.009	-0.028**	-0.0004	0.0002	-0.004***	0.020*
Tech_low	0.0434**	-0.0298*	0.0162**	0.0431***	0.0277**	-0.0003	-0.000	0.0011	-0.010
Tech_high	0.104***	-0.075***	0.058***	0.010	0.028**	0.0013*	0.003***	0.006***	-0.036***
N	7494	7494	14161	14161	9448	9448	9448	9448	9448
Log likelihood	-4139.8716	-3913.3619	-4081.9116	-8561.0633	-4486.4974	-207.26256	-283.65077	-558.97621	-4927.853
Pseudo R^2	0.0606	0.0428	0.1693	0.0355	0.0177	0.2306	0.1605	0.2328	0.0135

Note. Standard errors not displayed due to space limitation. * p < 0.05, ** p < 0.01, *** p < 0.001

http://doi.org/10.18080/jtde.v8n2.253

Table 8 Selected Indicators on Barriers to Finance (Probit Estimations)

	M21 Saving Barriers (1-3)			Barriers to Use of Bank Accounts (4-11)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	No Money	No Need	Other	No Money	Don't Know	Lack of Doc	Prefer Cash	Cost	Far	No Trust	Other
Male	0.141***	0.0118***	0.00833**	-0.00771	-0.00660	0.000822	0.00311	0.00145	0.00351	0.00244	0.00124
Age	-0.00911***	-0.000789*	0.00144*	0.00197	-0.00273***	-0.00065**	-0.00257	0.00200***	0.00134	0.000628	0.00139*
age2	0.0001***	0.00001**	-0.00001*	-0.0000	0.00002***	0.0000	0.00003**	-0.00002***	-0.00001*	-0.0000	-0.00001*
Edu	-0.0559***	-0.00000254	0.00478***	-0.0221***	-0.0167***	0.0000357	0.0198***	0.00402***	0.00356	-0.000372	0.00350*
inc_low	0.248***	-0.0155***	-0.0172**	0.220***	-0.0338***	-0.00415	-0.0893***	-0.00998*	-0.0244**	-0.00779*	-0.0205**
inc_med	0.130***	-0.0133**	-0.0100*	0.117***	-0.0222*	-0.00109	-0.0444**	-0.00323	-0.00667	-0.00666*	-0.0127*
Jatim	0.0289***	0.000106	-0.00196	-0.0265*	-0.00736	-0.00319*	0.0567***	-0.000961	-0.00699	0.00408*	-0.0168***
Rural	0.0520***	-0.00307	-0.00458	0.0301**	-0.00792	-0.0048***	-0.00640	-0.00380	0.00970*	-0.00262	-0.00820*
tech_low	-0.0528***	0.00593	-0.00401	-0.0150	-0.00366	0.000597	0.0186*	0.00499	-0.00663	0.00210	0.000800
tech_high	-0.106***	0.0101***	0.00893**	-0.103***	0.00783	0.00346*	0.0442***	0.00724**	0.00693	0.00484*	0.0144***
N	14157	4242	4315	6997	6997	6997	6997	6997	6997	6997	6997
Log likelihood	-7744.081	-281.00	-328.989	-3669.978	-1187.635	-263.897	-2359.440	-477.236	-922.268	-286.089	-710.931
Pseudo R^2	0.0974	0.1200	0.1113	0.0377	0.0237	0.0960	0.0387	0.0667	0.0292	0.0521	0.0538

Note. Standard errors not displayed due to space limitation. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

http://doi.org/10.18080/jtde.v8n2.253

Table 9 Why people do not borrow, do not use mobile payments and do not get insurance (Selected Indicators, Probit Estimations)

	Why People do not Borrow (1-3)			Why people do not use mobile payments services (4-9)						Why people do not have Insurance (10-15)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	No Need	Not Want	Have Debt	No Phone	Don't Know	Don't Need	Not Easy	No Docs	No Trust	NO Need	High Price	No Money	Don't Know	No Trust
Male	-0.0475***	-0.030*	0.038***	-0.034***	-0.0001	0.00811	-0.0028	-0.0015	0.0067*	-0.0143	0.0103*	0.0178*	-0.0079	0.0082*
Age	-0.0175***	-0.0059*	0.0202***	-0.0012	0.0007	0.0016	0.008***	-0.0008	0.0009	-0.007***	0.006***	0.006***	-0.007***	0.0054***
age2	0.0001***	0.0000**	-0.000***	0.000***	0.0000	-0.000**	-0.000***	0.0000	-0.000	0.00***	-0.000**	-0.000***	0.000**	-0.000***
Edu	-0.0180***	-0.0496***	0.020***	-0.033***	-0.05***	0.046***	-0.017***	-0.002**	0.009***	0.029***	0.014***	-0.008*	-0.08***	0.0145***
Inc_low	0.0196	0.229***	-0.041**	0.057***	0.110***	-0.043**	-0.08***	-0.013**	-0.012*	-0.11***	0.0215*	0.148***	0.0314	-0.0311***
Inc_med	-0.0125	0.126***	0.0205	0.0260*	0.070***	-0.0202	-0.052**	-0.0038	-0.0058	-0.06***	0.0195	0.098***	0.0085	-0.0167**
Jatim	0.0559***	-0.0973***	-0.04***	-0.06***	-0.03***	0.072***	0.066***	-0.029***	0.017***	0.068***	0.024***	0.037***	-0.13***	0.0155***
Rural	0.0001	-0.0072	-0.0015	0.0077	0.053***	-0.04***	-0.0238*	-0.0039	-0.01***	-0.04***	-0.02***	-0.04***	0.111***	-0.015***
Tech_low	-0.0330**	-0.0291	0.0314**	-0.25***	0.054***	0.073***	0.166***	0.022***	0.012**	-0.0127	0.020**	0.034**	-0.04***	0.0105*
Tech_high	-0.0204	-0.0700***	0.0224*	-0.15***	-0.08***	0.056***	0.077***	0.0058*	0.019***	0.0226*	0.0109	-0.03***	-0.04***	0.0292***
N	5501	5501	5501	13711	13711	13711	13711	13711	13711	12817	12817	12817	12817	12817
Log likelihood	-2118.90	-3515.50	-1850.7	-4480.8	-7082.1	-7704.0	-9296.5	-1635.2	-2172.6	-7889.5	-3752.4	-8473.8	-7844.8	-2502.7
Pseudo R^2	0.0587	0.0549	0.1057	0.2900	0.0660	0.0475	0.0218	0.0529	0.0611	0.0199	0.0244	0.0119	0.0718	0.1108

Note. Standard errors not displayed due to space limitation. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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Table 10 Saving and Credit Motivations (Selected Indicators, Probit Estimations)

	Saving Motivation (1-3)			Credit Motivation (4-8)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Consumption	Emergency	Expand Business	Consumption	Emergency	Access	Buy House	Business
Male	-0.0165	0.00267	0.0254***	-0.0663***	-0.00779	0.0182***	0.0141**	0.0405***
Age	-0.0151***	-0.00806***	0.00499***	-0.0218***	-0.000913	0.00300*	0.00646***	0.0170***
age2	0.000168***	0.000113***	-0.000054***	0.000185***	0.0000131	-0.0000365**	-0.0000610***	-0.000169***
Edu	-0.0202***	0.0164***	-0.000705	-0.0384***	-0.00297	0.00578**	0.0180***	-0.00728*
inc_low	0.121***	0.0212	-0.0308***	0.196***	0.0450***	-0.0178*	-0.0400***	-0.126***
inc_med	0.0806***	0.0408**	-0.0343***	0.139***	0.0450***	0.00396	-0.00444	-0.113***
Jatim	-0.0448***	0.0296***	-0.00336	0.0257*	0.0379***	0.0196***	-0.00618	0.00924
Rural	0.0410***	-0.0277**	-0.00323	0.0239*	0.00253	-0.0172***	-0.00414	-0.0173*
Tech_low	-0.0249*	0.0252*	0.00108	-0.0355**	-0.00223	0.0299***	0.00567	0.0487***
Tech_high	-0.0696***	0.0241*	0.0113*	-0.105***	-0.0139*	0.0328***	0.0206***	0.0420***
N	9737	9737	9737	9497	9497	9497	9497	9497
Log likelihood	-5341.2079	-4890.0717	-1859.144	-6026.3526	-2766.4766	-2133.3543	-2442.2028	-4303.8389
Pseudo R^2	0.0348	0.0164	0.0310	0.0590	0.0142	0.0489	0.0647	0.0382

Note. Standard errors not displayed due to space limitation. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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