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The effect of mobile technology on self-employment in Kenya

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Abstract

This study examines the effect of mobile technologies on the choice of self-employment in Kenya. The study used the 2016 household FinAccess retail survey data, which was collected using stratified multi-stage sampling to ensure representativeness at the national, regional, and residence (urban vs rural) levels. A probit model was used to analyse the data. The study finds that mobile phones, mobile money, mobile banking, and mobile credit influence one's decision to become self-employed. Other contributing factors include age, gender, marital status, education, wealth, place of residence, and the number of dependents in the household. These findings suggest that entrepreneurship policy in Kenya will have greater impact by enhancing access to mobile technologies.

Keywords: Mobile telephony, Mobile money, Mobile banking, Mobile credit, Self-employment

Introduction

Unemployment remains a major challenge in Kenya. World Bank data[1] shows that Kenya's unemployment rate has increased from 10.2% in 1991 to 11.5% in 2015 compared to the global unemployment rate which has fallen from 5.6% in 1991 to 5.4% in 2015. This shows that the trend in unemployment in Kenya is at variance with the global trend. In addition, there are demographic and geographical disparities; the incidence of unemployment is higher among women, the youth, and in urban areas (Vuluku, Wambugu, & Moyi, 2013). High levels of unemployment have been associated with the increasing size of the informal sector, which accounts for two thirds of total employment (KNBS, 2018). Recent strategies of understanding how to address unemployment include examining how mobile technologies can be harnessed to promote self-employment[2] in developing countries (Aker & Mbiti, 2010). This is because mobile technologies provide opportunities that enable the user to either start a business or run one (Bhavnani, Won-Wai, Janakiram, & Silarszky, 2008).

[1]These statistics can be found at https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS
[2]According to Parker, 2018, the concepts "self-employment" and "entrepreneurship" are mutually inclusive. An entrepreneur is defined as a person who perceives a business opportunity and establishes a business to pursue it while a self-employed individual is a person who has no regular wage or salary but derives his/her income from profession or business on their own risk. In this study, these two concepts are used interchangeably.

This study is motivated by three main shortcomings in the literature (see "Mobile phones and self-employment" section). First, studies on mobile technologies are yet to examine the role of these telecommunication tools in occupational choice. Specifically, there is limited understanding of how mobile technologies help individuals to transition into self-employment. At the micro-level, some of the documented informational benefits of mobile telephony include lower information asymmetry, lower uncertainty, enhanced arbitrage and efficient price mechanism, and higher profits (Jensen, 2007; Abraham, 2007; Boateng, 2011; Aker, 2010). Social inclusion benefits have also been attributed to mobile phone adoption (Jack and Suri, 2014; King, 2012, Mbiti & Weil, 2011; Sife et al., 2010; Baardewijk, 2017). Donner and Escobari (2010) reviewed numerous studies analysing the use of mobile telephony by micro and small enterprises (MSEs) and found that most are focused on the benefits accruing to existing rather than new MSEs. Amegbe, Hanu, and Nuwasiima (2017) associate mobile money and mobile commerce with business growth in MSEs while Komunte (2015) concludes that mobile phones liberate women entrepreneurs from poverty and empower them with knowledge.

Secondly, there is a limited body of research on self-employment in Kenya (House, 1984; House, Ikiara, & McCormick, 1993) yet unemployment remains a pressing developmental issue in the country. There are only two studies on self-employment in Kenya (House, 1984; House et al., 1993). Unfortunately, these studies have a narrow focus, are outdated, and lag behind advances in the mobile telecommunications industry as well as the rapid technological changes (including mobile technologies[3]) experienced in the country. While focused on the urban informal sector, the study by House (1984) found that the informal sector was a seedbed for opportunity entrepreneurs despite the perception at the time that the sector was a reservoir for residual labour. Research also highlighted the disconnect between the Government of Kenya's stated policy and programme implementation (House et al., 1993).

The other significant shortcoming revealed in the comprehensive review of literature is the limited knowledge on the link between self-employment and mobile technology, yet Kenya has outperformed many developing countries in terms of digital inclusion (Villasenor, West, & Lewis, 2016). While past research has extensively explored the drivers of individual self-employment choice, the potential effect of mobile technology has remained largely neglected. Existing literature has largely focused on individual, family, personality, and human, social, and financial capital (Parker, 2018; Simoes, Crespo, & Moreira, 2016). The most weighty individual factors include age (Caputo & Dolinsky, 1998; Heintz & Pickbourn, 2012), gender (Leoni & Falk, 2010; Wu & Wu, 2015; Budig, 2006), and marital status (Lofstrom, Bates, & Parker, 2014; Parker, 2018). Family background is captured by the occupation of the parent and/or spouse (Hundley, 2006; Wu & Wu, 2015; Budig, 2006). Personality traits have been justified by the idea that

[3]In this study, mobile technology refers to mobile phone and the associated financial services including mobile money, mobile banking and mobile credit. Mobile money denotes the use of the cellular phone to convert cash into an "e-float" that can be exchanged with other mobile phone users and can be converted back into cash (Mbiti & Weil, 2011). Mobile money denotes the ability to access bank services using the cellular phone. Such services include transferring funds, verifying account balances, settling bills and obtaining customised information (Donner & Tellez, 2008). Mobile credit denotes the use of the cellular phone to remotely execute loan transactions starting from loan application to credit scoring, as well as loan approval and disbursement.

self-employment is purely a psychological response to the existence of business opportunities. Such traits include risk attitudes as well as overconfidence, overoptimism, need for achievement, and so on (Croson & Minniti, 2012; Koellinger, Minniti, & Schade, 2013; Rauch & Frese, 2007). The contribution of human, financial, and social capital has also been the focus of research based on the view that individuals with higher educational levels, longer business experience, more social networks, and greater access to financial resources have a higher chance of being self-employed (Krasniqi, 2014; Backman & Karlsson, 2016; Shavit and Yuchtman-Yaar, 2001; Parker, 2018). Similarly, the enclave hypothesis and other related theories have spawned research that analyses the role of ethnicity and exclusion of minorities in self-employment (Cueto and Rodriguez Alvarez, 2015; Shavit and Yuchtman-Yaar, 2001; Li, 2001; Vejsiu, 2011; Hout & Rosen, 2000; Le, 2000).

The main objective of this study is to examine the influence of mobile technologies on self-employment, posing the question: How does the adoption of mobile technologies affect the decision to become self-employed in Kenya?

Literature review

Mobile phones and self-employment

Mobile phones can enable the user to either start a business or run one (Bhavnani et al., 2008). In this way, the mobile phone is an enabler of job search and business start-ups by lowering information asymmetry as hypothesised by the transaction cost and distance theories (Weber, Kulkarni, & Riggins, 2012; Boateng, 2011). As a telecommunications tool, the mobile phone reduces informational frictions by increasing the amount of information circulated and or preserved thereby increasing access to and use of such information. Because it is also a technology, the mobile phone affects self-employment through three main channels (Jagun, Heeks, & Whalley, 2008). First, it enhances the speed of information flow. Second, it reduces the costs of information search. Finally, it reduces opportunistic behaviour among economic agents. Due to these facts, the mobile phone enhances the quantity and quality of information that is available to people and firms, which empowers them by reducing their propensity of making wrong decisions (Dornberger et al., 2007; Low, 2000; Abraham, 2007). Since the self-employed face more information-related constraints (absence, uncertainty, and asymmetry), they stand to benefit more from the implementation of such new technologies (Jagun et al., 2008; Moyi, 2003).

According to the transaction cost theory, information asymmetry exposes the self-employed to costs associated with adverse selection and moral hazard (Cordella, 2006). Adverse selection occurs when agents are more likely to make wrong decisions and choices in terms business partners, products, and customers as a result of unequal information between the buyer and seller (Dornberger et al., 2008). Moral hazard occurs when one agent in a transaction has an incentive to change his/her behaviour after signing of the contract. Usually, such behaviour causes damage to the other agent. To prevent such opportunistic behaviour and minimise moral risk exposure, the entrepreneur will incur monitoring (coordination) costs. In addition, the entrepreneur will incur bargaining costs during the signing of the contract. Entrepreneurship requires a lot of information on markets, prices, quality, inputs, skills, technologies, and so on. In

line with this fact, the informational spill-over and transaction cost hypotheses predict a positive relationship between information technologies and entrepreneurship.

Distance theory posits that monitoring costs and information asymmetry are positively correlated to the geographical distance between the contracting parties (Weber et al., 2012). Since mobile phones can bridge the distance between the buyer and seller (or the principal and agent) by transmitting more information, quickly and cheaply, they can be seen as contributors to what has been termed as "the death of distance thesis". Mobile phones have the effect of reducing the risk of making wrong decisions and in the process lowering uncertainty and increasing market efficiency (Dornberger et al., 2008).

There are many ways in which mobile phones influence entrepreneurship. Evidence emerging from micro-level studies tends to support the conjecture that mobile phones improve market efficiency (Salia, Nsowah-Nuamah, & Steel, 2011; Lee and Bellemare, 2013), leads to higher incomes for small-scale entrepreneurs (Aker, 2010; Jensen, 2007), and improves social capital (Baardewijk, 2017), quality standards for buyers, and new opportunities for financial institutions (Qiang et al., 2012). Mobile ownership has been associated with better producer prices (Lee & Bellemare, 2013). Jensen (2007) and Abraham (2007) find lower dispersion of fish prices across markets and over different periods of time for fishermen and wholesalers who used mobile phones. Evidence was also found of reduced fish wastage. Aker (2010) found lower dispersion in grain prices across markets as a result of mobile phone adoption. These results are attributed to improved access to information, which enhances arbitrage opportunities and enhances market allocative efficiency. Aminuzzaman, Baldersheim, and Jamil (2003) attribute the positive effects of mobile phone use to the reduction in transaction costs and uncertainty.

There are also financial sector implications of mobile phone ownership. Several studies indicate that mobile phones have been instrumental in promoting financial inclusion (King, 2012; Demombynes and Thegeya, 2012; Jack and Suri, 2014). King (2012) finds that mobile banking overcomes the tyranny of distance to banking infrastructure. M-Pesa users have a 32% higher likelihood to have savings (Demombynes and Thegeya, 2012) but less likely to use other informal savings (Mbiti & Weil, 2011). M-money improves the pooling of risk, which results from lower transaction costs (Jack and Suri, 2014). Despite this trend in research, Asongu (2013) suggests that there is a possible substitutability between financial sector development and mobile phone penetration.

The social benefits of mobile phones have been linked to social inclusion and poverty reduction (Anwar & Johanson, 2015; Baardewijk, 2017; Beuermann, McKelvey, & Vakis, 2012). In Peru, it was found that household real consumption increased by 11%, poverty incidence fell by 8%, and extreme poverty reduced by 5.4% due to mobile phone adoption. In Tanzania, mobile phone adoption was associated with reduced poverty incidence which was realised through wider and stronger social networks and better individual capability to respond to emergencies (Sife, Kiondo, & Lyimo-Macha, 2010). It has also been established that mobile phones not only play the role of social inclusion tools (Anwar & Johanson, 2015) but also have positive implication effects on trust (Morawczynski & Miscione, 2008).

Determinants of self-employment

The random utility model has been widely used in studies on self-employment choice. The model posits that individual labour market choices are shaped by relative expected

utilities of different occupations (Vejsiu, 2011). On this basis, rational individuals opt for self-employment because the utility derived therefrom exceeds the utility yielded from paid employment, conditional on a set of attributes (Bozzoli, Brück, & Wald, 2013). These attributes include demography (gender, age, marital status, children), family (parents, spouse), personality (risk attitude, overconfidence, overoptimism, need for achievement, need for autonomy, self-efficacy, internal locus of control, assertiveness, narcism, taste for variety, and so on), human capital (education and experience), race, and financial capital (Simoes et al., 2016). At the empirical level, predictors of self-employment are derived from a reduced form model, which links the relative indirect utilities to these attributes (Parker, 2018).

Gender is one of the most studied predictors of self-employment. Overwhelming evidence suggests that women are less likely than men to enter into self-employment (Backman & Karlsson, 2016; Blanchflower, 2000; Koellinger et al., 2013; Leoni & Falk, 2010). This has been attributed to several factors. First, theories of discrimination posit that labour market discriminatory practices that disfavour women force them into self-employment (Simoes et al., 2016). Second, female workers are risk averse since they prefer less risky occupations compared to males (Croson & Gneezy, 2009; Dohmen et al., 2011; Parker, 2018). Finally, men belong to more diversified work-centred networks compared to women (Koellinger et al., 2013). These dense networks act as a conduit for providing men with more information on the labour market, but women are disadvantaged because they have sparse work-related networks. Financial as well as human capital theories posit that people who are married have a higher propensity of self-employment because marriage pools the networks, capital, risks, skills, and knowledge of the couple (Parker, 2018; Taniguchi, 2002; Wu & Wu, 2015). Family business theory predicts a higher propensity for a person to get into business when the spouse is in business (Simoes et al., 2016).

Most studies hypothesise concave correlations between age and the decision to become self-employed (Vejsiu, 2011). According to these studies, the relationship between these two variables is significantly positive but there exists a threshold beyond which the impact of age on self-employment is reversed. These effects are explained by the fact that people's stock of human, financial, and social capital tends to accumulate with age. However, the negative effect after the threshold is attributed to higher risk aversion among older people and the less time that is required for such people to recoup their start-up investment (Hintermaier & Steinberger, 2005). According to Krasniqi (2014), the negative effect after the threshold is attributed to the waning of the individual's aspirations, entrepreneurial dreams, and dynamism due to old age and failing health.

Capital constraints (human, social, and financial) have been hypothesised to determine self-employment (Krasniqi, 2014; Backman & Karlsson, 2016; Shavit and Yuchtman-Yaar, 2001; Park, 2018). Individuals with more education and job experience have better prospects in the wage sector, have better management skills, and have a higher capacity to perceive self-employment opportunities. This makes the relationship between education and experience, on the one hand, and self-employment, on the other hand, ambiguous. More financial wealth means the availability of own capital to start business as well as more collateral which enhances access to bank finance. Social capital which is measured by the size and diversity of professional and family networks provides resources and support mechanisms that propel individuals into self-employment (Backman & Karlsson, 2016).

Intergenerational transfers, social capital, and discrimination against minorities have been hypothesised to contribute to a higher self-employment propensity (Le, 2000; Uusitalo, 2001; Dvouletý, Mühlböck, Warmuth, & Kittel, 2018). According to Simoes et al. (2016), intergenerational transfers flow through three main channels. First, they flow through role modelling. Older persons (e.g. parents) have a bigger demonstration effect on younger ones (e.g. their children). Second, intergenerational transfers occur through inheritance of the parent's business. Finally, they flow via transfers of human, social, and financial capital. Middlemen minority theory, discrimination hypothesis, and enclave hypothesis have been used to examine the drivers of occupational choice among immigrants (Li, 2001; Cueto and Alvarez, 2015). The discrimination hypothesis posits that immigrants opt for self-employment to escape from marginalisation in labour, credit, and product markets. The minority theory sees immigrants as sojourners with a future dream to return home and therefore engage in business ventures that accumulate wealth rapidly thereby shortening the foreign residence period. Enclave hypothesis argues that the ethnic concentration of individuals in a geographical area creates business opportunities that can be exploited by co-ethnics.

Self-employment is riskier compared to wage employment (Bozzoli et al., 2013). This fact has spawned studies that seek to understand psychological and personality traits such as overconfidence, need for achievement, and need for autonomy that propel some people into risky ventures whereas others remain on the fringes (Croson & Minniti, 2012; Koellinger et al., 2013; Rauch & Frese, 2007; Simoes et al., 2016).

Methods

The research design is based on Kenya's National Sample Survey and Evaluation Programme (NASSEP) household sampling frame, which was developed by the Kenya National Bureau of Statistics in 2012 using the country's 2009 national census. It was designed to provide estimates at the national, regional, and residence (rural versus urban) levels. Using all the 47 counties as the basis in creating clusters of households, NASSEP is a national household master sampling frame that ensures national representativeness of generated samples. To ensure national, regional, and residence representativeness, the data was weighted using the 2009 population weights.

Since this was a nationwide survey, stratified multi-stage cluster sampling was applied (see Fig. 1). At the first stage of stratification, the country was divided into 47 counties. Kenya is administered through 1 national government and 47 county governments. The second stage of stratification involved generating urban and rural strata. This process yielded 92 sampling strata (47 urban and 45 rural strata). The third stage applied cluster sampling to generate 710 clusters. About 308 clusters were derived from the 47 urban strata while 402 were derived from the 45 rural strata. Each cluster was designed to have on average 100 households. At the fourth stage, random sampling was used to select 14 households from each cluster using a roster of households in the cluster by applying systematic random sampling. At the last stage, the interviewers selected the individual within the household to be interviewed using an inbuilt Computer-Aided Personal Interview (CAPI) KISH grid. The KISH grid was designed to ensure that the enumerator records the age and gender of every household member before the start of the interview. Thereafter, the enumerator was required to exclude those household members whose age was below 16 years. The enumerator then used the random

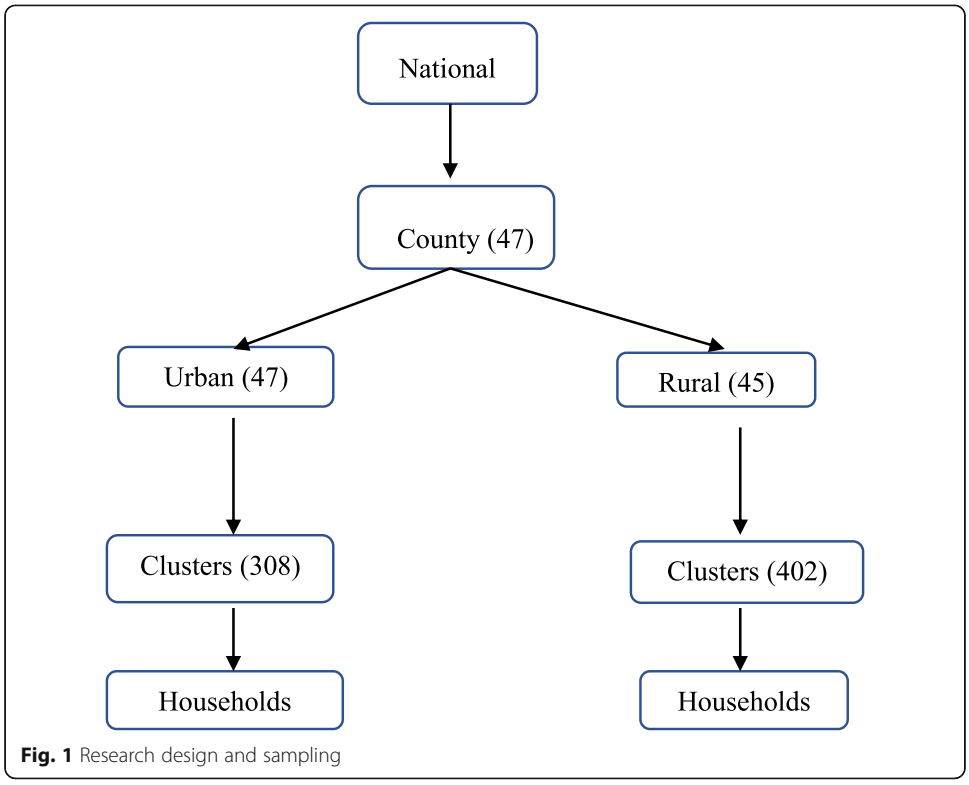

Fig. 1 Research design and sampling

number in the grid to choose the household member to be interviewed. In total, 8665 interviews were conducted between August and October 2015.

This study uses the 2016 household FinAccess retail survey data. This survey is the fifth in a series of surveys measuring access to and demand for financial services among adults aged 16 years and above. Data collection was undertaken by the Kenya National Bureau of Statistics in partnership with the Central Bank of Kenya and Financial Sector Deepening Trust (FSD-Kenya).

To examine the relationship between mobile technologies and self-employment in Kenya, a probit model was estimated. The dependent variable was coded as 1 if the respondent was self-employed and 0 if otherwise. This probit model took the form:

$$\Pr(\text{semp}_i = 1|x) = \Phi(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \varepsilon_i) \quad (1)$$

The dependent variable *semp* is self-employment, which is captured by a dummy variable that is coded 1 if a respondent indicated that self-employment was the main source of income and 0 if otherwise. *Mobile technology* (x_1) is captured by including four variables *m-phone*, *m-money*, *m-banking*, and *m-credit*. All variables are defined in the Table 1.

Results and discussion

Regression results are presented in Table 2. Diagnostic statistics show that the four models are statistically significant. This is evident from the Wald χ^2 statistic and the respective probability values (prob < 0.01) for all four models, which indicate that the null

Table 1 Description of variables

Variable	Description	Sources
Self-employment	1 = the respondent indicated that self-employment was the main source of income, 0 = otherwise	Parker (2018)
Independent variables		
x_1 = Mobile technology	*M-phone* measures the ownership of a mobile phone. It is captured by a dummy variable (1 = owns mobile phone, 0 = otherwise). *M-money* is a dummy variable which takes the value of 1 if the respondent is a registered mobile money user and 0 if otherwise. *M-banking* takes a value of 1 if the respondent has ever used the financial service and 0 if otherwise. *M-credit* is coded 1 if the respondent has ever received credit from either M-Shwari or KCB M-PESA and 0 otherwise.	Bhavnani et al. (2008), Jagun et al. (2008), Amegbe et al. (2017), Komunte (2015)
x_2 = Age	Age of respondent in years	Simoes et al. (2016), Vejsiu (2011), Hintermaier and Steinberger (2005), Krasniqi (2014)
x_3 = Age squared	Age squared	
x_4 = Male	1 = respondent is male; 0 = respondent is divorced, separated, or widowed	Blanchflower (2000), Koellinger et al. (2013)
x_5 = Married	1 = respondent is married or living with partner; 0 = otherwise	Wu and Wu (2015), Parker (2018)
x_6 = Education	1 = respondent completed either primary, secondary, or tertiary schooling; 0 = otherwise	Brown et al. (2011), Parker (2018)
x_7 = Wealth	A composite wealth index was computed using the first principal component of a vector of assets (durable goods, housing characteristics and access to utilities)	Parker (2018)
x_8 = Rural	1 = household belongs to a rural cluster; 0 = otherwise	Heintz and Pickbourn (2012), Leoni and Falk (2010)
x_9 = Dependency	Ratio of children under 16 years to the total number of people in the household	Parker (2018)

hypothesis (H_0: all the coefficients associated with independent variables are simultaneously equal to 0) is rejected at the 1% level.

Results presented in Table 2 (model 1) show that the estimated marginal effect of *m-phone* is positive and statistically significant at 1% level of significance. This means that individuals who use mobile phones have 11% points higher probability of being self-employed relative to those who do not use this form of mobile technology. Model 2 shows that the marginal effect of *m-money* is 0.12, which is significant at 1% level. This implies that users of mobile money have a 12% higher chance of being self-employed compared to non-users. In model 3, the marginal effect on *m-banking* is 0.09 and statistically significant at 1% level. Hence, the likelihood of self-employment is, on average, 9% higher for mobile money users than for non-users. Users of mobile credit have a 10% higher chance of being self-employed compared to non-users.

The results in Table 2 confirm the existence of a strong and robust positive correlation between mobile technologies and the propensity of self-employment. These findings are consistent with previous studies (Aker, 2010; Amegbe et al., 2017; Jagun et al., 2008; Jensen, 2007). Amegbe et al. (2017) found that the use of mobile money and

Table 2 Marginal effects from probit model of self-employment

	Model 1	Model 2	Model 3	Model 4
M-phone	0.11*** (0.014)			
M-money		0.12*** (0.014)		
M-banking			0.09*** (0.014)	
M-credit				0.10*** (0.019)
Age	0.02*** (0.002)	0.02*** (0.002)	0.02*** (0.002)	0.02*** (0.002)
Age squared	− 0.00*** (0.000)	− 0.00*** (0.000)	− 0.00*** (0.000)	− 0.00*** (0.000)
Male	− 0.07*** (0.012)	− 0.07*** (0.012)	− 0.07*** (0.012)	− 0.07*** (0.012)
Married	0.03**(0.013)	0.03** (0.013)	0.03** (0.013)	0.03** (0.013)
Education	0.04** (0.016)	0.02 (0.017)	0.05*** (0.016)	0.05*** (0.016)
Wealth	0.04*** (0.007)	0.04*** (0.007)	0.05*** (0.007)	0.05*** (0.007)
Rural	− 0.03** (0.013)	− 0.03** (0.013)	− 0.03** (0.013)	− 0.03** (0.013)
Dependency	0.02* (0.010)	0.01 (0.010)	0.02* (0.010)	0.02* (0.010)
No of obs.	6,400	6,400	6,400	6400
Wald's χ^2	397	410	372	370
Prob. value	0.000	0.000	0.000	0.000
Pseudo R2	0.063	0.064	0.059	0.058
Pseudo LL	− 3516	− 3514	− 3532	3534

Robust standard errors are in parentheses
*Statistical significance at 10%
**Statistical significance at 5%
***Statistical significance at 1%

mobile commerce enhances the growth prospects of MSEs. Aker (2010), Jagun et al. (2008), and Jensen (2007) found that mobile phones improved the sales and marketing function by enhancing access to information and getting more customers. Past evidence attributes these effects to improved access to information, which enhances arbitrage opportunities and market allocative efficiency, while also enabling the reduction of transaction costs and uncertainty.

Further analysis of the results in Table 2 indicates that the strongest effect of mobile phone technologies on self-employment comes via the use of mobile phones and mobile money. This is explained by the fact both technologies are complementary and therefore highly correlated, i.e. almost every mobile phone user in Kenya is also registered for the respective network's mobile money service. The impact of mobile credit on self-employment is relatively higher than mobile banking because the former is exceedingly popular among low-income individuals.

The marginal effect of the male variable is negative and statistically significant, which implies that males are less likely to be self-employed compared to females. This finding reinforces the assertion by Komunte (2015) that mobile phones liberate women entrepreneurs from poverty and empower them with knowledge. According to the study, males are 7% less likely to be self-employed compared to females. Although this result confirms findings by Heintz and Pickbourn (2012), the result is surprising given the common conclusion in previous studies (Backman & Karlsson, 2016; Blanchflower, 2000; Cueto and Alvarez, 2015) that self-employment is more male-dominated. In Kenya, out of the 2273 individuals who indicated that they were self-employed, 1483 or approximately 65% were women. These findings suggest that entrepreneurship in Kenya is not only gendered but

also digitalised. Mobile phone technologies are emerging as a key driver of transition into self-employment, particularly for women.

Apart from the significant effects of mobile technologies, Table 2 also highlights other factors that strongly influence self-employment. These include age, marital status, education, wealth, dependency ratio, and place of residence (rural). A higher age increases the propensity of self-employment until 45 years, when this relationship is reversed. This implies that very young people (closer to 16 years) and very old people (closer to 100 years) are less likely to be self-employed compared to those around 45 years. This finding is consistent with Leoni and Falk (2010), Vejsiu (2011), Wu and Wu (2015), and Shavit and Yutchman-Yaar (2001). The age effect below 45 years is explained by the fact that as individuals get older, they accumulate human, financial, and social capital which are necessary for transition into self-employment. After 45 years, the age effect of self-employment is reversed because risk aversion tends to rise (Hintermaier & Steinberger, 2005). Similarly, the time required for people over 45 years to recoup their investment is much shorter. Another explanation for the reversal of the age effect is the fact that older people's aspirations, dreams, and dynamism tend to erode with age. The increase in probability of self-employment for a one-unit change in the wealth index is between 2 and 3%. This corroborates the findings by Lofstrom et al. (2014) who established that household net worth rises with increases in self-employment up to a certain point, when this relationship is reversed. Residing in a rural area rather than an urban setting lowers the propensity of self-employment by 2%, which is consistent with findings by Heintz and Pickbourn (2012). Leoni and Falk (2010) found that residing in an urban area rather than a rural one lowers the propensity of self-employment among men, but this effect was not statistically significant for women. As expected, education increases the likelihood of self-employment. According to the study, the predicted probability of self-employment is, on average, around 0.03 higher for educated individuals than for the non-educated. Brown, Dietrich, Ortiz-Nuñez, and Taylor (2011) found that the incidence of self-employment was higher among educated individuals.

Conclusion

This study sought to examine the effect of mobile phones, mobile money, mobile banking, and mobile credit on self-employment in Kenya. The findings suggest that these mobile phone technologies stimulate self-employment. Mobile phones reduce information frictions by increasing the amount of information available to prospective entrepreneurs. Other factors that influence self-employment include age, gender, marital status, education, wealth, place of residence, and the number of dependents in the household.

These findings have wide implications for policy and further research. Based on the evidence that mobile technologies have a significantly positive effect on self-employment, policy should aim to buttress mobile phone-based interventions. Creators of mobile phone applications should be incentivised by public authorities because such mobile-based applications can boost service delivery among previously excluded communities. Since mobile phones have a wide coverage especially at the "bottom of the pyramid", they have been known to promote socio-economic inclusion.

The finding that the effect of age on self-employment is curvilinear suggests that those who are very young (close to 16 years) and those who are very old (close to 100 years) are less likely to be employed than are those that are around 45 years old. Given

the focus on youth empowerment in Kenya, more technical and financial resources should be targeted at programmes for this demographic to open pathways to self-employment. The study finds that wealth is a predictor of the propensity to be self-employed. It follows that poverty-reduction measures including the empowerment of marginalised groups and communities (particularly those residing in arid and semi-arid zones, people living with disabilities, and the youth) have a potentially far-reaching effect on entrepreneurship.

Further research should seek to unravel the factors explaining the gender factor in self-employment. Given that entrepreneurship is historically male-dominated in many countries around the world, the high proportion of Kenyan women in self-employment is unconventional. Similarly, theory seems to suggest that females are more risk averse compared to men since the former prefer less risky occupations.

Abbreviations

FSD-Kenya: Financial Sector Deepening Trust, Kenya; KCB: Kenya Commercial Bank; KNBS: Kenya National Bureau of Statistics; MSE: Micro and small enterprise; NASSEP: National Sample Survey and Evaluation Programme

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Authors' contributions

EDM solely conceptualised the study, analysed and interpreted the data, drafted the manuscript, and read and approved the final manuscript.

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Availability of data and materials

The datasets used in this study are available from the corresponding author on reasonable request.

Competing interests

The author declares that he/she has no competing interests.

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