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Integration of financial inclusion and microfinance in developing countries

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Contents

List of tables

List of figures

Introduction

Most people in the developing countries do not have access to formal financial services, and very few benefits from a savings account, loan, or convenient way to transfer money. It is the lack of access to financial services that prevents the low-income people from making everyday decisions "that most people around those dinner tables take for granted" (Helms, 2006). According to the summary of Karlan et al. (2016), the roughly 2.5 billion people in the world who live on less than $2 a day are not destined to remain in a state of chronic poverty: while every few years, somewhere between 10 and 30 percent of the world's poorest households manage to escape poverty; there is roughly an equal number of households slip below the poverty line. Karlan et al. (2016) also assume that health-related emergencies are the most common cause, but there could be many more such as crop failures, livestock deaths, farming-equipment breakdowns and so on. Without the capability to engage in market transactions, or have sources or access to saving, insurance or credit, they and their associated families might be forced into subsistence-based lives (Yunus, 2006). In 2006, the Nobel Peace Prize awarded to Muhammad Yunus benchmarked the roles of microfinance in poverty reduction as well as the recognition from scholars and world leaders in the importance of financial services and credit to enhance social and economic development. The importance of microfinance for alleviating poverty in poor country has received new vigour last year when the The Royal Swedish Academy of Sciences has decided to award the 2019 Nobel Prize in Economic Sciences to three economist, Abhijit Banerjee, Esther Duflo and Michael Kremer "for their experimental approach to alleviating global poverty". In the previous book, Abhijit Banerjee and Esther Duflo have written that microfinance is not a panacea for solving poor people lives. However, they state that a microfinance program in Bangladesh "was not miraculous, but it was working" (Banerjee & Duflo, 2012). Although financial services for the poor cannot solve all the problems caused by poverty, but they can help put resources and power into the hands of poor and low-income people themselves, letting them make those everyday decisions and chart their own paths out of poverty. Financial inclusion helps to encompass the access to credit from formal financial institutions that allow people to invest in education and business opportunities, as well as the use of formal insurance products, allowing them to better manage financial risks (Demirguc-Kunt, Klapper, & Singer, 2017).

The thesis provides a detailed theoretical and empirical discussion about financial inclusion and microfinance sector together with its benefit and how they can contribute to inclusive growth and economic development.

Chapter 1 focuses on the impact of incoming remittance on the financial inclusion which is measured by the formal account, debit card and credit card ownership. In particular, the latest World Bank Findex dataset is taken to estimate the effect of incoming remittance on the access and usage of financial products. The findings show that receiving remittances does increase the probability of account ownership as well as the debit and credit cards. However, the effect on credit cards is negligible. Besides, the extended estimation suggests incoming remittances also leads to higher saving, especially the saving for business and saving informally. Moreover, to address the heterogeneity across countries, the clustering method is applied by dividing the whole sample into country groups of similar socioeconomic settings. The result shows that the effects of incoming remittance are stronger in the lower income countries but lessens in the richer countries.

Chapter 2 focuses on the development of microfinance institutions (MFI) as the modern financial technology becomes more prevalent. In particular, it investigates the impact of female borrower, who comprise the majority of microfinance program, on the probability of MFIs owning the website at disposal and offering the mobile banking services. We use the secondary data about MFI's performance and borrowers in 2015 from MIX Market, and the self-gathered information about the availability of websites and mobile banking services of the 311 MFIs from 23 countries in Asian. This is one among the first regression-based analysis on this topic, particularly look at the relationship of female borrowers and technology in the microfinance sector. The findings suggest that women borrowing encourages the availability of website but not the mobile financial services, except for the countries in South Asia where contains a great number of microfinance hubs. Further, profit-oriented MFIs which is believed to have more freedom in financial sources and comparative advantage in infrastructure, are more likely to digitalize their microfinance services. Overall, the study tests and emphasizes the importance of maintaining a sufficient women client proportion and MFI's economic conditions to develop the ICT system.

The last chapter looks at the impact of microfinance at micro level where we measure the effect of training on microfinance women borrowers in TYM Fund – a MFI in Vietnam. Using the data

survey from a random control trial, the financial and mindset development outcomes are measured over short and long time periods. The factor analysis helps to construct the empowerment index which categorizes the empowerment into three layers: individual, household and community. Moreover, the difference in difference approach is applied to investigate the impact of training, whether the training is individual or husband-joint, on the gender development of the participants. The results show that the training overall increases the women empowerment in three levels, especially when there is presence of husband. Particularly for the husband-joint training, the sense of self-confidence and community engagement experience a considerable increase over a long-run among women participants. Notably, higher number of family members could potentially be an issue that hinder the empowerment at household level, while increases the level of self-empowerment and social involvement.

Chapter 1

The impact of remittances on financial inclusion: the formal account, debit card, and credit card ownership

Abstract

While the financial inclusion is gaining attention among the current economic development literature, its potential relation to the financial behaviour of the remittances receivers has not been fully tackled. This research aims at investigating the impact of incoming remittances on financial inclusion, as proxied by bank account, credit card and debit card ownership. The data are taken from World Bank Findex 2017 Survey regarding 144 countries worldwide. Using a probit regression model, the impact of incoming remittances on financial inclusion, controlling for clients' individual characteristics is examined. The findings show that receiving remittances positively encourages the access and usage of financial tools, leading to an increase the probability of ownership in all examined transaction accounts. Moreover, when the heterogeneity through country clustering groups is introduced, the results suggest that the impact of remittances on different financial tools are different across countries due to the different levels of socio-economic development. Finally, it is demonstrated that in saving behaviours, remittances play a higher and significant role in informal rather than formal savings, and in business use rather than older age.

1.1. Introduction

According to the latest Migration and Development Brief report (2019), annual remittances flows to low-and middle-income countries are likely to reach $550 billion, which even larger than foreign direct investment (FDI) and official development assistance (ODA) flows. In 2018, remittances flow to the developing countries reached $529 billion, an increase of 9.6 percent over 2017. A large body of literature has emerged on the effects of remittances on economic and social inclusion. For example, Acosta et al. (2008) examine the migration and remittances in Latin America and find a strong linkage to the increase of household incomes, thus reducing inequality. In El Salvador, incoming remittances are proved to increase the investment in children's education, reduce child labour especially in the recipient households (Acosta, 2011). Overall, using a global database from 71 developing countries, it is found that remittances help to reduce the level, depth, and severity of poverty (Adams Jr. & Page, 2005).

While there is extensive literature on the effects of remittances on growth, investment in microenterprises, poverty, inequality, health and education, the economic studies have ignored the impact of international remittances on financial inclusion so far (Anzoategui, Demirguc-Kunt, & Peria, 2014). Financial services can help drive development, which facilitates the poverty reduction by giving access to health, education and business investment. At its most basic level, financial inclusion is defined as the opportunity to have a deposit or transaction account at a bank or other financial institution or through a mobile money service provider, which can be used to make and receive payments and store or save money (Demirguc-Kunt, Klapper, & Singer, 2017). As it describes the access to and effective use of appropriate financial services, financial inclusion has become a subject of growing interest for not only the researchers but also policymakers and financial sector stakeholders. The new Global Findex data in 2017 reveals that globally, the share of adults owning an account is now 69 percent, an increase of 7 percentage point since 2014, with total financial inclusion rising of 18 percentage points since 2011 when account ownership was only 51 percent (Demirguc-Kunt, Klapper, & Singer, 2017).

In the resounding randomized evaluation of a microcredit program in India, Banerjee et al. (2015) find that access to credit leads to greater investment in business durables, increases the number of businesses started, and improves the profitability of existing ones. Financial services can also help

people accumulate savings and increase spending on necessities. After being provided with savings accounts, market vendors in Kenya, primarily women, saved at a higher rate and invested 60 percent more in their businesses (Jake & Voorhies, 2014). In Mexico, Bruhn and Love (2014) report from a natural experiment where over 800 bank branches opened at the same time to serve low-income clients, find that access to finance helps to increase the labour market activities by keeping clients' informal businesses open and overall income levels. Regarding household spending, in Nepal, women-headed households spent 15 percent more on nutritious foods (meat and fish) and 20 percent more on education after receiving free savings accounts (Zimmerman & Baur, 2016). In a broader perspective, Demirguc-Kunt and Levine (2009) suggest that improvement of the financial system can expand economic opportunities and reduce inequality.

This research complements to the current literature using the latest global cross-section Findex dataset of 2017, to examine the impact of remittances from the demand side at the individual level on the financial inclusion in three dimensions: account, debit and credit card ownership. The data were collected by Gallup, Inc and based on the interviews with over 150,000 randomly selected adults in 144 countries. The data allows not only to examine the extent to which different individual characteristics are associated with financial inclusion, but also to look at the country factor to investigate how the outcomes of financial inclusion vary across macro-setting according to the specific individual-level characteristics. This is essential when linking the impact of remittances with financial access because it helps to capture the unobserved household characteristics that are considered to mainly affect remittances and financial inclusion. Moreover, the extended model provides information about the impact of remittances on saving and different saving behaviours such as different saving purposes and saving sources. The additional test where the whole sample is divided into the different country group of homogenous socio-economic situations differentiate the remittances-financial inclusion relations in four contexts based on the economic environment.

To proxy for the financial inclusion, we use the ownership of account, debit and credit cards. Account ownership and debit/ATM card, according to Allen et al. (2016), are typically comparable across countries, as mechanisms for both payment and savings. Credit card, however, is associated to maturity, interest, collateral and other requirements, thus typically being unfavourable to the

poor households. Including credit card as a proxy to measure financial inclusion, similar to Wellalage and Locke (2019), helps to shed light on the effect on the remittances on recipients.

Our results show that incoming remittances have a positive impact on financial inclusion by increasing the probability of owning account, debit and credit cards, although the effect on the credit card is not strong. Besides, there are also significant and positive associations between receiving remittances and the saving and different saving behaviours, in which remittances encourages the informal saving rather than formal saving, and saving for business rather than saving for the future. The additional test compares the impact of remittances on financial inclusion across countries and finds out that the influence is only stronger in the lower-income countries with the unstable socioeconomic environment, whereas the effect lessens in the richer countries.

This study contributes to existing literature on the relationship between remittances and financial inclusion. One of the biggest issues in this literature is potential endogeneity from reverse causality: the development of financial access in the developing country increases the amount of remittances. For example in Kenya, the M-Pesa money mobile applications smoothen the economic risks of the rural microfinance borrowers because the amount of remittance was higher during the crisis (Jack & Suri, 2014), or in Togo, better financial access increases households' ability to deal with some life emergencies especially environmental and agricultural vulnerability (Afawubo, Couchoro, Agbaglah, & Gbandi, 2020). Most of the papers in this area focus on measuring how negative shocks are smoothened out, or the *volumes* of remittances, being liquidated by different channels (see Paola and Ruiz-Arranz (2009), Jack and Suri (2014), Wellalage and Locke (2019)). Relative to these papers, the novel aspect of this study is to specifically focus on the *need* for incoming remittances in the year of 2017, catching a snap of how demand for remittances become an impetus to the financial providers to diversify the products. Intuitively, when the need for receiving remittances arises, it is safer to open a bank account to receive the transfer from abroad. On the contrary, it is less likely to for one to send money to home country just because both sides have bank accounts. Therefore, the paper should not suffer from endogeneity bias.

The rest of the chapter is study is organized as follows. Section 2 provides the literature review on the topic, section 3 describes the data, section 4 explains the empirical methodology, section 5

presents the discussion on the main results, followed by section 6 with the robustness check, while the last section includes concluding remarks.

1.2. Literature review

1.2.1. The importance of financial inclusion for development

A growing body of research reveals many potential development benefits from financial inclusion – especially from the use of digital financial services, including mobile money services, payment cards, and other financial technological applications. Access to formal financial services allows people to make financial transactions more efficiently and safely and helps poor people to climb out of poverty by making it possible to invest in education and business (Armendáriz & Morduch, 2010). By providing ways to manage income shocks like unemployment or the loss of a breadwinner, financial inclusion can also prevent people from falling into poverty in the first place, which is extremely important for people living in the poorest households (Demirguc-Kunt, Klapper, & Singer, 2017). Using survey data from 45,000 Indian households, a recent study by Churchill and Marisetty (2019) confirms that financial inclusion has a strong poverty-reducing effect, in a way that accesses to insurance has the strongest effect on poverty compared to access to bank accounts and credit. Moreover, access to insurance fosters the resilience against the income shocks, thus providing the poor with opportunities to move out of the difficulties. Besides, the influence of bank account ownership stimulates various financial engagement including saving, which helps to empower the poor households and encourages them to invest in education in the long term.

Also in the context of India, Swamy (2014) examines the significance of gender dimension in financial inclusion and finds out that there is a strong impact in terms of income development of poor women. As compared to other groups namely scheduled castes and backward classes groups, the general categories of women are largely influenced by the financial inclusion programs mostly because of their higher awareness levels and abilities to access to economic instruments. The findings also imply that women tend to use the resources to improve family wellbeing and savings, and access to financial instruments help to increase their domestic bargain power.

The benefits of advanced financial inclusion methods can be wide-ranging. For example, studies have shown that mobile money services, which allow users to stores and transfer funds through mobile phone – can help improve people's income-earning potential, thus reducing poverty. A study in Kenya country found that access to mobile money services delivered big benefits, especially for women. It enabled women-headed households to increase their savings by more than a fifth; allowed 185,000 women to leave farming and develop the business or retail activities; and helped reduce extreme poverty among women-headed households by 22 percent (Muralidharan, Niehaus, & Sukhtankar, 2016). Digital financial services can also help people manage financial risk – by making it easier for them to collect money from distant friends and relatives when times are tough. In Kenya, researchers found that when hit with an unexpected drop in income, mobile money users do not reduce household spending – while non-users and users with poor access to mobile money network reduce their purchases of food and other items by 7-10 percent (Karlan, et al., 2016).

While financial inclusion is measured by the ownership of an account at the individual level, it is also greatly influenced by macro-level indicators such as lower account costs, greater proximity to financial intermediaries, stronger legal rights, and more politically stable environment (Allen, Demirguc-Kunt, Kalpper, & Peria, 2016). Karlan et al. (2014) lay out five sets of constraints that may hinder the adoption and effective usage of particularly saving products and services, namely transaction costs, lack of trust and regulatory barriers, information and knowledge gaps, social constraints and behavioural biases. Interestingly, Grohmann et al. (2018) test a new macro variable which is the financial literacy on the financial inclusion. In this paper, regarding the "access to finance", financial infrastructure and financial literacy are mainly substitutes, however, when it comes to the "use of financial services", the effect of higher financial literacy strengthens the effect of more financial depth and the impact of financial literacy on financial inclusion holds across income level and separated subgroups within countries.

1.2.2. Remittances

Remittances, usually understood as the household income from foreign economies arising mainly from the temporary or permanent movement of people to those economies (IMF, 2009), are proved to be an effective tool to stimulate financial development. The research by Giuliano

and Ruiz-Arranz (2009) studies the remittances flows of 100 developing countries and finds out that remittances boost growth in countries with less developed financial systems by providing an alternative way to finance investment and helping overcome liquidity constraints. In the Latin America and Caribbean countries, over the year 1970-2013, the remittances has proved to bring a positive, significant and robust bidirectional impact on financial development, especially in the countries with high ratio of remittances to GDP; and made the financial sector more expanded and profound (Fromentin, 2018). Similarly, using the balance of payments data on remittances in the long period of time 1975-2007, Aggarwal et al. (2011) show the positive and significant association between remittances and bank deposits and credit which are the impetus for national financial development. In recent research, Sobiech (2019) found out that more financially developed a country is, the smaller the impact of remittances on economic growth. Remittances can foster growth, but the effect is significant only at low levels of financial development in terms of size depth and efficiency. To fuel the trans-border transaction, technology development has emerged as an effective instrument to bring down the costs, particularly for remittances that are small-scale or directed towards the least developed countries or rural areas (Rodima-Taylor & Grimes, 2019). Alternative remittance infrastructure has helped to reinforce social and kinship networks as well as various social and human intermediaries in the local connective ecologies such as indigenous knowledge and patterns of resource management, cultural monetary practices and kinship values.

However, the effect of remittances on financial development is mixed. Chowdhury (2016) argues that financial development neither works as a substitute nor a complement for the remittance-growth nexus, but confirms the positive association between remittances and economic growth for the top-remittance-recipient developing countries. Besides, the study by Bang et al. (2016) suggests a relationship between remittances and income inequality, when they test the impact of remittances on household expenditures in Kenya. The results indicate that while remittances increase household spending, the impact is unambiguous for the poorest group.

Consideration of the concept of financial inclusion is appropriate rather than direct inferences from the economic migrant remittances stream of research (Wellalage & Locke, 2019). The remittances promote financial inclusion of an individual in several ways. First, remittances increase the exposure of financial services of remittances participants, increasing awareness of financial

services (Aga & Peria, 2014). Second, remittances may provide excess cash for households, leading to increases in demand for saving instruments, which eventually gives rise to access to other financial services such as credit and insurances (Ambrosius & Cuecuecha, 2016). Third, remittances might increase the household's likelihood of obtaining a loan, processing remittances flows provides financial institutions with information on the income of recipient households which might make financial institutions better willing and able to extend a loan to otherwise opaque borrowers. And on the other hand, since remittances might help relax households' financing constraints, the demand for credit might fall as remittances increase (Anzoategui, Demirguc-Kunt, & Peria, 2014). From the banks' perspective, remittances may increase the creditworthiness of borrowers (Wellalage & Locke, 2019), since firstly, remittances reduce "default risk" of borrowers, because continuous remittances receipt provides additional insurance for the lender; and secondly, continuous remittances receivables help develop a financial history for remittances receivers, which may act positively in loan application processes (Ambrosius & Cuecuecha, 2016). At the macro level, Demirguc-Kunt et al. (2011) find that in Mexico, municipalities, where a higher proportion of households receive remittances have a higher number of bank branches and accounts per capita, and larger shares of deposits to GDP.

The recent study by Wellalage and Locke (2019) focuses on the case of refugee's remittances in Syria and indicate that overall remittances increase the refugee's financial inclusion. In particular, the average ATM card ownership, debit card and insurance of individuals engaging remittances is respectively, 29%, 20% and 15% higher than their counterparts, who do not engage with remittances. In Nigeria, one of the largest recipient of remittances in the world, incoming remittances is seen to increase the probability of using formal financial services such as deposit accounts and Internet/mobile banking (Ajefu & Ogebe, 2019). It is suggested that reducing barriers and costs to remittances inflows can improve the access to and use of formal financial services in Nigeria, which can lead to an increase in funds for investments and economic growth for the country.

1.3.   Data

Data is taken from Global Findex 2017 which is conducted in collaboration with Gallup, Inc., and funding from the Bill & Melina Gates Foundation, including 144 countries and over 150,000 adults age 15 and above, on how people save, borrow, make payments and manage risk (2018). The initial survey was implemented in 2011, followed by a second one in 2014. In this study the third survey carried out in 2017 is used. All the countries involved in the 2017 survey are listed in Appendix Table A.1. Financial inclusion indicators are proxied by four indicators: account ownership, debit/ATM card, credit card, and saving. The variable of interest is the probability of receiving remittances. Overall, the descriptive statistics are reported in Table 1.1, while Table 1.2 provides the remittances and other demographic characteristics of the population with and without financial instruments.

The first row of Table 1.2 compares the probability of incoming remittances of those who use or do not use a bank account, debit and credit card, or saving. Those receiving remittances are indeed more likely to use the account than those who do not, with a gap of about 0.1. There are larger differences when measured against the standard deviation of the remittances, which is about 0.4. Though the number of women using financial instruments is slightly less than men in the case of account ownership, the average number of women who engage in various types of financial instruments is higher than those who do not. Among other differences, those who are involved in any type of finance tools, tend to have higher level of education, be employed and older. Due to the data limitation which is presented as being cross-sectional, it is possible to only interpret these results as significant correlations between individual characteristics and measures of financial inclusion and not as causal relationships.

Before presenting the model on the determinants of financial inclusion, it is important to give a detailed definition of the variables (account, debit and credit cards ownership, accounts to save) and that will be used to measure financial inclusion and the remittances variable that we use as the main determinant of financial inclusion. All of these variable where taken from World Bank Findex 2017 survey according to the question answered by adult respondents in 144 countries. In explaining the variables, we also present the heterogeneity of the answers to financial inclusion questions according to the income classification of the country's respondents.

1.3.1. Account ownership

The number of account ownership is drawn from the answers to the survey question: "*Do you, either by yourself or together with someone else, currently have an account at a bank or any type of formal financial institution? An account can be used to save money, to make or receive payments, or to receive wages and remittances*". On average, 63% of adults in the sample report having an account. Not surprisingly, there is enormous variation in the use of financial services between high-income and developing economies: account penetration is close to the universe (94%) in high-income economies, while 64.0 % of adults in the upper-middle-income economies, 44.9 % in the lower-middle-income economies, and only 36.8 % in the low-income economies. From Figure 1.1, the account ownership, on average, increases sharply with economic development with the percentage of adults having an account from upper middle-income countries is almost three times as likely to have an account as adults in the low-income countries.

Figure 1. 1: Account ownership and the use of the formal account (%). Source: Global Findex, 2017
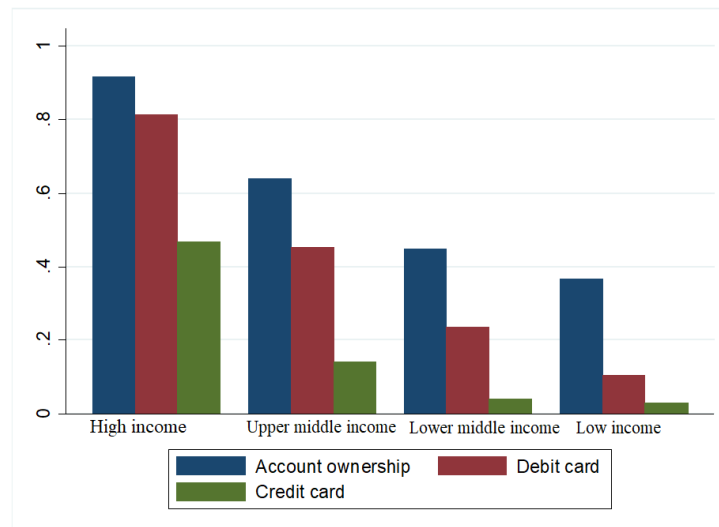
In addition to strong differences in account penetration across countries, there are also important disparities in account use by individual characteristics. For example, among high-income countries, those in the highest within-country income quintile is approximately 1.6 times higher to have an account than those in lowest income quintile. The disparities are more severe in the lower-income country group, namely 2.2, 2.6, and 3.8 times when it comes to upper-middle, lower-middle and countries. There are also significant disparities in the prevalence of accounts along

gender lines: in the upper half of higher income countries, there are more male adults reported having an account at a formal financial institution, but the gap is very small. However, in the lower-middle and low-income countries, female adults tend to own an account more than the male counterpart, at 50.6% and 56.4% respectively. In developed and developing economies, respondents with employment are, on average, more than twice as likely to have an account as those who do not, however, in the least developed economies, the disparity is nearly quadruple.

1.3.2. Debit card ownership

The information on the ownership of a debit card is achieved through the question "*Do you, personally, have an ATM/debit card?*". On average, 45.1% of adults in the sample report having the debit card. The percentage of ATM/debit card possession in developing and least developed countries are low, between 6.2% and 1.5% respectively. And the disparity looks even more severe when looking at a gender level: there are 40% of females reporting having a debit card in the developed countries, as compared to only 6% in the low-income economies.

1.3.3. Credit card ownership

Regarding the ownership of credit card, all respondents were asked: "*Do you have a credit card?*". Globally, there are only around 19.4% of respondents answering for credit card possession. The ownership proportion is greatly different across the level of economic development. In the second half of lower developed countries, the percentage of credit card ownership ranging from 0.43% to 1.04%, with more than 24% of female in the developed countries as compared to only 1.7-2.1% of female in the developing countries having so. Within countries, while there are 5.2% of the adults in the poorest group in the wealthy countries that report having a credit card, only around 0.2 - 0.3% of those in the developing countries report could access to credibility. The discrepancy is even more substantial when comparing the richest groups between the economies. For example, there are only 1.2-1.7% respondents belonging to the richest families in the developing countries, the percentage is up to 14.5% in the developed nations that hold the credit cards.

1.3.4. The use of accounts to save

The information on saving activity is provided in the answers to the question: "In the past 12 months, have you saved or set aside any money?". If the respondent answered yes, a follow-up question asked, "In the past 12 months, have you saved or set aside money by A) Using an account at a bank, credit union, microfinance institution, or another financial institution; or B) Using an informal savings group/club or a person outside the family". Around 50.6% of respondents report having saved, in which there are roughly 48.2% adults having saved at the formal institution and only 28.3% adults saved at the informal group/club or giving to others. However, this result differs across country groups, for example, there are only 6% of adults in the high-income countries that report saving at informal source, whereas up to 24% of people from the low-income country choose decided to do so.
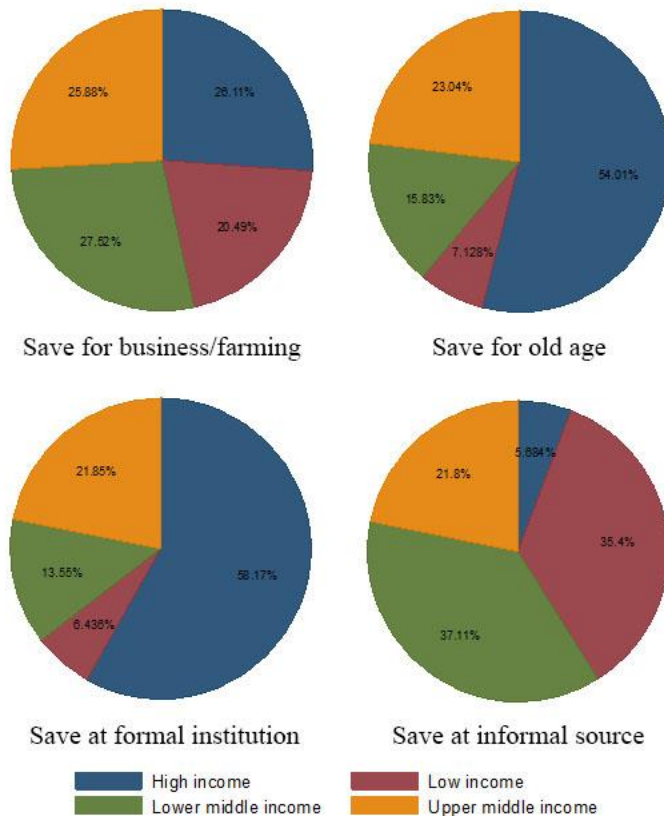
Figure 1. 2: Saving activities (%). Source: Global Findex, 2017

In terms of saving purpose, there two questions: "In the past 12 months, have you saved or saved or set aside any money to start, operate or grow a business or farm?" and "In the past 12 months, have you, personally, saved or set aside any money for old age?". In the developed countries, the choice to save for business is generally higher, around 40% of the respondents. However, the choice to save for old age is more preferred in the developing countries, between 15% and 20% in the lower-middle-income and low-income countries, while there are only around 10% of those who save in high-income countries that are toward future security.

1.4. Remittances

15

The information on receiving remittances is taken from the answers to the question "In the past 12 months, have you, personally, received money from a relative or friend living in a different city or area inside [country], including any money you received in person?". Globally, there are 22.9% respondents confirming previous year incoming remittances Figure 1.3 shows the proportion of incoming remittances of different household income quintile (from 1 to 5 as poorest to more wealthy households) between the high- and low-income countries. Generally, the probability of incoming remittances is significantly higher in less developed countries. While the incoming remittances frequency seems to be flat across household income quintile within the high-income countries, the probability of remittances received increases as the families become wealthier in low-income countries. It is noticeable that the pattern of incoming remittances across the household quintile seems to be opposite to the pattern of account or card ownership in the developing economies.
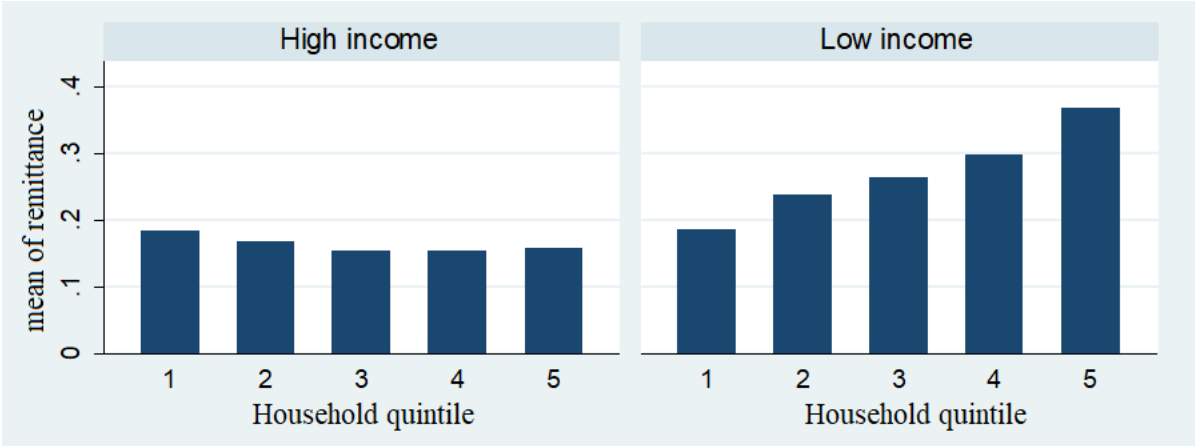
Figure 1. 3: Incoming remittances (%) according to household income quintile in high-income and low-income countries. Source: Global Findex, 2017

Besides, Table 1.2 compares the probability of remittances between groups of people who possess different financial products and those who do not. For example, there are about 29.9 percentage of remittance recipient in our sample that has the bank account, in relative to only 16.9 percentage of those that do not have. The difference mean in the groups of those who have and do not have the bank account, debit card, credit card and savings are all positive, which means that intuitively, those who receive remittances tend to be more financially included.

1.4. Methodology

Various modelling techniques have been applied to measure financial inclusion, ranging from logistic regression models (Ambrosius, 2016; Ambrosius & Cuecuecha, 2016) to probit models (Allen, Demirguc-Kunt, Kalpper, & Peria, 2016; Wellalage & Locke, 2019). While some others use linear probability model (Anzoategui, Demirguc-Kunt, & Peria, 2014) or simple OLS (Grohmann, Klühs, & Menkhoff, 2018) and SEM (Wang & Guan, Financial inclusion: measurement, spatial effects and influencing factors, 2017). Regardless of different types of modelling techniques, previous studies focusing on the impact of remittances recipient have generally used the probability to access different financial tools such as ATM/debit account, or credit as dependent variable, with a range of household characteristics such as age, education, and family size as independent variables. Logistic and probit models are very similar and both of them can render asymptotically consistent, efficient and unbiased estimates. The difference is that logistic models assume the probability to be logistically distributed, but probit models assume such probability to be normally distributed. Since the empirical results of logistic and probit models tend to be very similar, probit model is more commonly preferred in econometric settings with large sample size because of being more advanced in treating non-constant error variances[2].

Following the literature review, this research aims to explain financial inclusion from the demand side, with the main variable of interest being the incoming remittances together with other individual characteristics. The baseline specification of Allen et al. (2016) is applied with new focuses on the: i) account ownership; and, two additional measures of financial products: ii) having a debit card and iii) having a credit card. Since the dependent variables Y_{ij} is proxied by three

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[2] According to Hahn and Soyer **Invalid source specified.**, both logit and probit models fit the data equally well. However, in comparison two models, the study suggests to apply logit link only in the special case (see Hahn and Soyer (2005)), while probit link provides a more consistent advantage in the random effect models from the perspective of minimizing deviance and enhancing model fit in both small, medium or large data set. For fixed effect models, probit and logit links are equally good (across the DIC and Bayes factor measures). Thus, considering the slightly overperformance of probit model in advanced econometrics, and mimicking a number of previous studies in the field, probit model is chosen in this research.

dichotomous variables: i) having an account at a financial institution, ii) having a debit card and iii) having a credit card, the following probit regression is run to identify the drivers of financial inclusion. The empirical model is estimated as follows:

$$Y^*_{ij} = \alpha_i Remittances + \beta_{ij} X + u_{ij} \qquad (1)$$

$$Y_{ij} = 1 \qquad \qquad \text{if } Y^*_{ij} > 0$$

$$Y_{ij} = 0 \qquad \qquad \text{if } Y^*_{ij} \leq 0$$

where Y^*_{ij} is the binary dependent variable representing the financial inclusion, *Remittances* is a dummy variable and X is a vector of individual characteristics, whilst α_i and β_{ij} are the two vectors parameters. Individuals and countries are indexed by i and j, respectively. Because the sample size is large, error term u_{ij} is considered to be normally distributed with zero mean and variance equal to 1. The equation (1) is estimated as a probit model by maximum likelihood.

In addition to analysing how remittance and different individual characteristics relate to financial inclusion in terms of account ownership, debit and credit card possession, this study also further examines the influences on saving activities. The dependent variable y_{Sij} is also a binary variable equal to 1 if an individual reports to have saved last year, and 0 otherwise.

$$y^*_{Sij} = \beta_{Si} Remittances + \gamma_{Sij} X + u_{Sij} \quad (2)$$

$$y_{sij} = 1 \qquad \qquad \text{if } y^*_{sij} > 0$$

$$y_{sij} = 0 \qquad \qquad \text{if } y^*_{sij} \leq 0$$

y^*_{Sij} is the binary depending variable representing the financial inclusion, *Remittances* is dummy variable and X is the vector of individual characteristics, whilst α_i and β_{ij} are the two vectors parameters. Individuals and countries are indexed by i and j, respectively. Error term u_{Sij} is assumed to be normally distributed. The model is estimated by maximum likelihood method.

Since it is only possible to observe the methods and purposes of saving whether an individual have saved before. Therefore, the following saving behaviours are identified by four yes/no questions

such as the method of saving either by formal or informal source, the purpose of saving either for business or farming investment or for future old age; which is conditional to the report of previous having saved. Therefore, the effects on saving behaviours are estimated by Heckman-style model (Heckman, 1976; Heckman, 1979) where equation (2) is the selection equation and the equation (3) below captures where an individual keeps and how they use their saving. These dependent variables are denoted by y^*_{SB}, where $SB \in \{a, b, c, d\}$ that associates with four specific saving behaviours: formal saving, informal saving, saving for business or farming, saving for old age. Heckman model also helps to mitigate the potential selection bias.

$$y^*_{SBij} = \beta_{SBi}Remittances + \gamma_{SBij}X + u_{SBij}, \quad SB \in \{a, b, c, d\} \quad (3)$$

$$y_{SBij} = 1 \qquad \qquad \text{if } y^*_{SBij} > 0$$

$$y_{SBij} = 0 \qquad \qquad \text{if } y^*_{SBij} \leq 0$$

where y^*_{SBij} is a dummy variable equal to 1 when an individual who has saved confirms certain saving behaviours, which is observed only when $y_{sij} = 1$. As before, individuals and countries are indexed by i and j, respectively. *Remittances* is dummy variable, and X a vector of individual characteristics, whilst α_i and β_{ij} are the two vectors parameters. The error term u_{SBij} is normally distributed. The model is estimated using the maximum likelihood method.

In discussing the economic significance, the results are calculated and refer to the marginal effects, which capture how the probability of account use changes with a change in the value of a covariate, holding all other variables constant. However, the original probit coefficients are reported for reference purposes (see Appendix B1). Firstly, the values of the original coefficient and marginal effect test different hypotheses and the latter are often non-linear combinations of the former. The coefficients themselves in non-linear models typically do not have a good interpretation when we want to examine the effect of the certain covariate on the outcome variables. Therefore, when interpreting the results, we would look at the marginal effects. The marginal effect of an independent variable is the derivative (the slope) of the prediction function, which is the probability of success after probit. However, testing for statistical significance of the coefficient estimates is necessary regarding the model specification, whether to include or exclude a certain covariate. Secondly, in economics research, it is important to know the probability of outcome

which is why marginal effect is computed, while probit coefficient only estimates a single effect for the entire dataset. With binary variable, the marginal effect measures *discrete change,* and with continuous variable, it measures the *instantaneous of change*. Thirdly, note that sometimes, a variable has significant effect in the original model, but not in marginal effect. Due to the noise in our data and sampling variation, the marginal effects are estimated with a certain degree of precision, and some, but not all, marginal effects will be large enough that we can bound them away from zero at that degree of precision. The marginal effect value is conditioned on particular values of the predictor values (at mean in this study), and can vary whereas regression coefficients are unconditional. In case of conflict, according to Green (2008), it is important to take into account the estimated coefficient, because marginal effect, or associated partial effect, is testing a hypothesis about a function of all coefficients, not just the one of interest.

1.5. Main results

1.5.1. Access to financial services

As anticipated in the previous paragraph, the effect of remittances on financial services access is examined by investigating three financial instruments: account ownership, credit, and debit cards ownership. Table 1.3 focuses on the impact of remittances and other individual characteristics on the probability to own an account at a bank or formal financial institution. Results show that, in general, remittances increase the probability of account ownership at all levels. However, in discussing the results we refer to the marginal effect reported in Table B1.1.

A marginal effect, or partial effect, most often measures the effect on the conditional mean of the dependent variable of a change in one of the regressors. In our case, the marginal effects capture how the probability of account ownership changes with a change in the value of a regressor, holding all other variables constant. The marginal effects that we have computed are average marginal effects (AME). Column 1 presents that the probability of having an account is about 12.7 percentage points higher than people that do not have remittances, other control variables being constant. Being female gives a marginal effect of having an account of 4.1 percentage points higher than being male. Besides, individuals that have higher education level are

more likely to have an account by 19.9 percentage points, with respect to those that have lower education levels. On the other side, the likelihood of individuals that are employed is around 12 percentage points higher than those that are not. Column 2 presents the likelihood of receiving remittances increases when being controlled by the household income quantile variables. In particular, the marginal effect of incoming remittances on the likelihood of account ownership is 14.1 percentage points higher than without remittances. For the poorest people of lowest income quantile, the chance of owning an account is 26.5 percentage points lower as compared to the richest from the highest income quintile, noting that coming from wealthier family indeed increases the probability of having an account. On this aspect, results from the household survey data in China by Zhang and Posso (2019) confirms that low-income households are more beneficial from financial inclusion than high and mid-level income ones, which helps to shorten the income inequality. In column 3, with regards to age, the link between incoming remittances and the probability of having an account is even stronger with marginal effect at 17 percentage points. Age is positively associated with the account ownership, which is 1.8 percentage point higher as people become adult, but the effect of age lessens when people get older. Lastly, the full specification is presented in the fourth column. There is indeed the expected significant positive relationship between the incoming remittances and account ownership but the impact was lessened as compared to the third column due to the negative sign of the poorer households. It seems plausible that the consideration of variables related to low income reduces the likelihood of owning account. However, the fact that the coefficient of incoming remittances remains highly significant is crucial: other things equal, a one percentage point increase in the proportion of incoming remittances increases the rate of account ownership by 13.7 percentage points.

Table 3 and 4 (and the corresponding Tables B1.2 and B1.3 in Appendix B reporting the estimations of average marginal effects) present the effects on financial products: debit card and credit card ownership, using similar probit regression method. In general, the effects of incoming remittances on the acquirement of these two financial products are smaller than the effect it has on owning an account. Unlike the previous table, the coefficients measuring the effects of incoming remittances on both debit and credit card when controlling for gender, education, and employment are insignificant, regardless the fact being female, more educated and employed still significantly increase the likelihood of adopting such financial tools (column 1, Table 1.4 and column 1, Table

1.5). However, the effects of incoming remittances become significantly positive when adding a control variable of household income. The likelihood of debit card acquirement is 3.2 percentage point higher when receiving remittances and the probability for the poorest people group is 24.8 percentage point lower compared to those who come from the wealthiest group (column 2, Table 1.4). Regarding the credit card ownership, the incoming remittances do not show any significant effect, but individuals from higher household income quintile are more likely to have a credit card rather than those from the same income quintile acquiring debit card (column 2, Table 1.5). With the control variable referring to age, the effect of incoming remittances on the debit and credit card acquirement becomes significant. While the chances of having a debit card increase by 6.1 percentage point with the incoming remittances (column 3, Table 1.4), the increase is only 1.4 percentage point on average when it comes to credit card ownership (column 3, Table 1.5). Similar to the account ownership, age is positively associated with the financial tool acquirement, but the effect of age lessens over time because the coefficients of age-squared are always negative. The last column of Table 1.4 presents the full with the significant link between the incoming remittances and the chances of owning the debit card. Their probability is 3.4 percentage points higher for those who receive remittances and those who do not. However, when it comes to credit card, though coefficients are positive, its effect is negligible. To explain the modest impact of remittances on credit tools, Chowdhury (2016) justifies remittances as a way to relax individuals' financing constraints, which may lead to lower demand for credit and have a dampening effect of credit market development.

Overall, the effect of incoming remittances on the increasing probability of account ownership is comparatively strong, followed by the impact on debit card and credit card ownership. Among the examined individual characteristics, age is the most determinant factors to encourage the usage of such financial tools while the low household income generally lessens the effect of financial inclusion.

1.5.2. Use of saving

Although the incoming remittances does not necessarily foster the demand for and use of credit in particular cases because perhaps it helps to relax the credit constraints, Anzoategui et al. (2014) links the remittances and saving behaviours in the senses that it encourages account ownership and

potentially increase the use of savings instruments. Table 1.6 (and the corresponding Table B1.4 in the appendix reporting the estimation of the AME) presents the estimated results on of a model that links the effects of remittances on saving and different saving behaviours. The first column is the probit regression result on the whole sample, while the remaining columns are the results of the probit sample selection model for only respondents who have saved in the past 12 months. In general, the incoming remittances significantly increase the probability of overall saving (column 1). In particular, the likelihood of saving is 17.4 percentage point higher among those who receive remittances than those who do not. While the effects of gender and age are not noticeable, there is a strong relation of the saving likelihood and higher level of education, wealthier family background and employed people.

The column 2 and 3 compare the effects on methods of saving, either through formal channels, such as banks and financial institutions, or informal channels, such as keep at other family members' and friends' or informal groups/clubs. The results show that incoming remittances do increase the likelihood of informal saving with a positive marginal effect of 8.59 percentage points, whereas the association between incoming remittances and formal saving is not significant. Despite such negligible link, those who are women, older, employed and more educated tend to put their money more at a formal institution (column 2). Notably, the negative sign of the two coefficients of female and education in column 3 implies that male recipients and those who have a lower level of education are more likely to engage in informal savings.

Besides, the column 4 and 5 compare the two main purposes of saving, either saving for their home business or for old age. For example, the likelihood of saving for business activities significantly increase by 7.4 percentage points for those who receive the remittances than those who do not, while the probability of saving decreases by 3.5 percentage points when it comes to saving for old age purposes. The impact of individual characteristics, namely gender, education, income and employment, is generally very significant for the saving purpose of doing business, much rather than the saving for old age purposes. A certain exception regards the variable of age, which plays a non significant role on the probability of savings (meaning that age does not influence saving behaviours), but has a significant role in the ways savings are used. However, age plays a significant role in the use of savings. For example, the probability of formal saving presents a marginal effect of 1.1 percentage points, whilst the probability of informal saving increases by

0.6 percentage points, demonstrating that with age individuals are more motivated to formal than informal savings. On the other side, the probability of saving for business increases by 0.5 percentage point, whilst the probability of saving for old age increases by 0.8 percentage point as the individual gets older.

1.6. Robustness tests: effect of remittances in various country groups

1.6.1. Unobserved heterogeneity and clustering

To explain for the heterogeneous across different countries, Allen et al. (2016) select and examines different macro characteristics that foster financial inclusion such as lower account costs, greater proximity to financial intermediaries, stronger legal rights, and more politically stable environments. Results in Allen et al. (2016)'s also show that the effectiveness of inclusion policies varies depending on the individual characteristics. Therefore, to broaden the analysis on macro perspective, considering that countries diverge substantially across socioeconomic, political, and institutional dimensions, the correlation between remittances and financial inclusion would be examined in different country settings. To make sense of these variations, many macro studies have adopted the strategy of classifying countries into a small number of categories[3]. In financial inclusion research, cluster analysis has rarely been used. So far, there are different studies that analyse the external environment to foster financial inclusion (Aggarwal, Demirgüç-Kunt, & Pería, 2011; Allen, Demirguc-Kunt, Kalpper, & Peria, 2016; Creel, Hubert, & Labondance, 2015; Grohmann, Klühs, & Menkhoff, 2018; Wang & Guan, Financial inclusion: measurement, spatial effects and influencing factors, 2017), or the reverse effect of how financial inclusion influences the macro-environment (Fromentin, 2018; Neaime & Gaysset, 2018; Sobiech, 2019). Most of these studies, however, exploit cross-section or panel-data analysis to find the macro factors important for financial inclusion without explicit grouping or clustering. Beyond regional analysis, cluster analysis can help diagnose strengths and challenges of certain groups of countries with similar

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[3] For example, using k-mean method, SSA countries are divided into two groups of small production economies (where agricultural smallholders had economic and some political participation) and extractive production economies (where foreign-owned mines and large scale farms fostered the elite politics which are urban bias and possess capital-intensive production technology) based on three criterion mineral exports, inequality, and Egalitarian Democracy Index **Invalid source specified.**.

characteristics, because it is likely that some neighbouring countries do not always share comparable socio-economic status. Cluster analysis thus helps to identify the realistic and measurable contexts to encourage economic future, which is particularly important in examining global data.

So far, this study only emphasizes on the financial inclusion using cross-sectional data, which could imply the potential bias due to parameter heterogeneity, in a way that countries differ not only by income level for instance but on many other institutional characteristics. Following the clustering method of Alimukhamedova (2019), the countries are grouped into homogenous clustered based on similar macro-institutional determinants.

1.6.2. Methodology of clustering

There are two main objectives of clustering: i) To identify certain cluster structures in a set of observations. This study relies on a priori of the previously established literature in which countries can be clustered along income, political and other macro-environment; ii) To assign observations to clusters in some optimal manner. In this study, the *k-mean clustering* method is applied to classify countries of similar characteristics into different groups. To implement k-means, the number of clusters k in the data is defined a priori, and then proceed to iteratively more observations between clusters until an optimal allocation is identified. The procedure begins with k initial group centers, observations are then assigned to the group with the closet center. The mean of the observations assigned to each of the group is computed and the process is repeated.

The number of clusters can be seen as a sequential procedure: the more clusters, the closer the distance. The optimal k clusters are decided by Elbow method, which is explained in detail in section 3, Appendix A1. As a common number of cluster groups in economic research, different values of k is tested, either five, four, or three. But the iterative procedure showed that four was optimal. All countries are assigned in the sample into homogeneous groups with respect to their economic development and quality of institutions using clustering around the mean values of five identified variables.

The selected variables are chosen on the base of Alimukhamedova (2019) in its research of micro-credit in the macro setting: i) Economic growth: benefit from Allen et al. income (2016), the GNI

per capita is selected, instead of common GDP per capita, because the probability to engage in financial inclusion is more likely related to individual; ii) Financial depth: Similar to Alimukhamedova (2019), broad money is included because financial inclusion is part of broader financial system; iii) Inequality: GINI coefficient is adopted because Neaime and Gaysset (2018) argue that financial inclusion decreases income inequality; iv) Institutional strength, proxied by the strength of legal rights index; and lastly, v) Corruption perception index is selected because financial inclusion are typically concerned in countries whose political and economic settings are often unstable. This argument holds true in micro-credit context (Ahlin & Jiang, 2008).

Four clusters, in the order of "unstable", "lower-middle stable", "upper-middle stable", and "high stable", group countries in order from the lowest to the highest level of economic growth, financial environment, and institutional health. All the individual characteristics are controlled for the multicollinearity (see Table A1.2 to report Variance inflation factor values) and the included independent variables are ensured independent. The list of countries according to cluster and descriptive statistics of clusters are presented in the appendix A1 (Section 1 and Table A1.1).

1.6.3. Results from clustering

Table 1.7 presents the impact of the full specification model regarding account ownership. The model tests the impact of incoming remittances and individual characteristics on the probability of having an account within clustered samples based on four country groups. Columns from 1 to 4 are four sub-samples of countries going from the unstable to the high stable macro environment. The effect of remittances is stronger for the first cluster group that includes the poorest countries. Such influence decreases in the more developed country groups, and becomes insignificant for the cluster that includes the wealthiest countries. This is confirmed by marginal effects (Table B1.5) that are higher for the cluster (1) and decrease when cluster (2) and (3) are analysed. In the fourth cluster group, which includes the most advanced countries, remittances do not play any effect. Similarly, the impact of education on the probability of an account ownership also lessens from the unstable to more stable countries, which ends up insignificant at the final country clusters. The marginal effect of being more educated on the likelihood of holding a bank account is higher in the first less stable cluster of countries than in the other three clusters. An interesting result regards the gender role that increases the likelihood to have an account only for individuals that belong to

the low stable cluster of countries. To be women in this group of countries gives a marginal effect of 5.0 percent to have a bank account. Other than the highly stable cluster of countries, the marginal effects of age and employment on financial inclusion (measured by holding a bank account) are similar for all country clusters. The negative side of age-square implies that effect of age lessens over time. The estimations also confirm the strong role that household income plays in every group of countries. People that belong to the lower income quintile are less likely to have a bank account. For example, to compare the percentage points between the lowest and highest income quintile, from around 20 points in cluster 1 and 2, to around 7 points in cluster 3 and 4.

Table 1.8 compares the impact of incoming remittances and other demographic determinants on the probability of having debit card in the four sub-samples characterized by macro conditions. The main coefficient – incoming remittances – result in significant and positive in the three first country groups, which starts from cluster 1, reaches its peak in the second country cluster at 7 percentage points, declines in the cluster 3 and dies out in the last cluster of the richest nations. This is intuitively plausible because the incoming remittances do not account in rich countries as much as in other countries. The marginal effects of remittances (Table B1.6) on the probability to have a debit card is higher in cluster 2 than in cluster 1 (7.3 and 4.3 percent, respectively), meaning that people that belong to the Cluster 2 if receive remittances have a higher probability to access to a debit card. Similar to the previous case of account ownership analysis, the influence of gender and education on the probability of having debit cards lessens from the unstable to more stable country group. In the last group of most wealthy countries, the links between age and employment to the probability of debit card usage even become insignificant. Within each country group, although individuals from lower income households have less chance to adopt the debit card as compared to higher-income households, especially in the cluster 2 where the incoming remittances is most contingent, the difference in probability of having a debit card for those belong to lowest income quintile and the highest income quintile is up to 22 percentage points. However, but such influence is negligible in the last cluster.

Table 1.9 examines the case of credit card ownership. Notably, the influence of remittances is only significant in the first cluster of the least developed countries. The marginal effect (Table B1.7) on the probability of having credit card among remittances receivers is 1.3 percentage point higher than those who do not receive remittances. The impact of age, education, gender and employment

on the probability of credit card ownership are more substantial when it comes to more wealthier countries. In the fourth column that reports the sub-sample of the most advanced countries, the marginal effect of age is around 2.4 points higher as someone gets older, 16.7 points higher as someone benefits from more education, and around 17.4 points higher as someone has employment. The discrepancy between the likelihood of having a credit card of those coming from poorest quintile and the richest quantile is 31.7 points in the cluster 4, whereas the discrepancy is only 2.3 points in the cluster 1. Overall, the findings imply the stronger dependence on the credit card in the wealthier countries (cluster 3 and 4), rather than the lower-income countries (cluster 1 and 2).

Overall, we have found that remittances have the potential to contribute to the financial inclusion. To this end, in developing countries, it is advisable to target, in addition to aged persons, also to educated, and employed persons. Since the contributions are different depending on the maturity of the macro-institutional environment, it can be seen that the link between remittances and financial inclusion, especially in terms of account and debit card ownership, is born and grows in originally weak environments; it develops in moderately developing settings and shrinks in the rich countries. It could also mean that once countries become more developed, remittances and financial inclusion practices could take a different shape. For the pro-poor growth and development, it is equally important to ensure sufficient economic growth and stability of the socio-institutional environment.

1.7. Conclusions

As the importance of remittances for developing countries has grown, a sizeable literature has been focusing on the impact of remittances on various aspects of countries' development, either within a specific or across countries. This study examines the impact of incoming remittances on financial inclusion using cross-section global Findex data in 2017 over 144 countries. In particular, the financial inclusion is measured based on the probability to adopt the account at a bank or formal financial institution, and the probability to have debit and/or credit cards. Our results show that receiving remittances has a positive impact on financial inclusion by promoting the adoption of account as well as debit and credit cards; although, the effect on the

credit card is not very strong. The magnitude of the marginal effects demonstrates that remittances give a higher probability to have a bank account, and a lower one to debit card ownership. Remittances are almost insignificant to increase the probabilities to have a credit card. Moreover, other individual characteristics in the study imply that the engagement to financial inclusion development is more seen among those who are older, better educated, employed and coming from wealthier families. The results suggest that policymakers in the underdeveloped and developing countries should formulate policies for financial development such that these countries can reap the potential benefits of remittances on financial inclusion.

The results also show that remittances highly increase the probability of saving behaviours. The model demonstrates a significant and positive link between receiving remittances and saving. By relaxing the credit constraints, remittances increase the demand for savings instruments, but the effect is more powerful in the saving for farm and non-farm business purpose rather than for future old age, and also stronger impact on the informal saving method such as personal, friends or family, or informal clubs/groups rather than saving in formal institutions. This suggests an implication for the policymakers regarding the saving behaviours of the remittances-recipients: along with the increase in remittances which is considered an alternative of credit supply and liquidity, a safe and tailor-made saving tool is extremely needed.

The significant popularities in adopting account and debit cards are consistent with the robustness test when the financial inclusion is examined in different sample groups of countries with similar socio-economic conditions. In particular, the impact of incoming remittances on financial inclusion is positive only in the lower income countries with less stable socioeconomic environment, while the effect lessens when it comes to richer countries with more healthy conditions. However, the pattern is opposite when it comes to the probability of adopting credit cards. Therefore, in the less developed countries, it is suggested that the formal financial institution stakeholders should take into account the strong impact of remittances in order to design and promote safe transactions among the remittances-recipients, and then provide timely support so that they can well-invest such monetary supply to enrich their lives. However, if remittances-recipients rather prefer to save money in informal ways, policy makers and financial institutions should be aware that there are problems in trusting unstable local financial institutions and their governance.

Table 1.1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Account	155000	.631	.482	0	1
Debit card	155000	.451	.498	0	1
Credit card	155000	.194	.420	0	1
Receive remittance	120000	.229	.420	0	1
Emergency funds	155000	.563	.496	0	1
Age	154000	41.842	17.912	15	99
Female	155000	.46054	.498	1	1
Education	155000	1.834	.718	1	3
Income quantile	155000	3.184	1.423	1	5
First quintile	154932	.170	.375	0	1
Second quintile	154932	.180	.384	0	1
Third quintile	154932	.193	.394	0	1
Fourth quintile	154932	.210	.408	0	1
Fifth quintile	154932	.247	.431	0	1
Employment	154000	.627	.484	0	1
Average income by GNI	154000	10251.81	14412.14	0	64306.96
GINI coefficient	152000	.72	.152	.354	.953
Broad money	154000	20045.27	19457.64	0	89840
Political stability	155000	-.099	.983	-2.801	2.241
Strength of legal right index	154000	5.443	3.066	0	12

Table 1. 2: T-test on mean equality on the baseline characteristics between the population that owns deposit accounts and debit/credit cards and the population that does not

	Account			Debit card			Credit card			Saving		
	With	W/o	Diff	With	W/o	Diff	With	W/o	Diff	With	W/o	Diff
Remittance	0.279	0.169	0.109	0.229	0.217	0.037	0.247	0.227	0.019	0.247	0.227	0.019
	[.448]	[.375]	(.002)	[.435]	[.412]	(.003)	[.431]	[.419]	(.004)	[.431]	[.419]	[.004]
Female	0.493	0.405	0.088	0.500	0.427	0.073	0.518	0.446	0.072	0.518	0.446	0.072
	[.499]	[.491]	(.003)	[.500]	[.495]	(.003)	[.499]	[.491]	(.003)	[.499]	[.497]	{.003)
Education	2.023	1.509	0.514	2.144	1.578	0.565	2.291	1.723	0.568	1.985	1.678	0.301
	[.699]	[.628]	(.004)	[.669]	[.654]	(.003)	[.639]	[.691]	(.004)	[.711]	[.691]	(.004)
Employment	0.682	0.533	0.149	0.699	0.568	0.131	0.741	0.599	0.142	0.715	0.538	0.177
	[.466]	[.498]	(.003)	[.459]	[.495]	(.002)	[.437]	[.489]	(.003)	[.452]	[.499]	(.002)
Income: first 20%	0.137	0.225	-0.089	0.126	0.206	-0.080	0.103	0.186	-0.828	0.121	0.221	-0.10
	[.344]	[.418]	(.002)	[.332]	[.405]	(.002)	[.304]	[.389]	(.002)	[.326]	[.415]	(.001)
Income: second 20%	0.163	0.209	-0.047	0.156	0.199	-0.043	0.147	0.188	-0.041	0.153	0.207	-0.053
	[.369]	[.407]	(.002)	[.363]	[.399]	(.002)	[.354]	[.391]	(.002)	[.361]	[.405]	(.002)
Income: third 20%	0.187	0.202	-0.015	0.184	0.199	-0.015	0.182	0.195	-0.013	0.185	0.200	-0.015
	[.390]	[.401]	(.002)	[.388]	[.399]	(.002)	[.386]	[.396]	(.003)	[.389]	[.400]	(.002)
Income: fourth 20%	0.221	0.193	0.028	0.224	0.199	0.025	0.228	0.206	0.022	0.228	0.192	0.036
	[.415]	[.395]	(.002)	[.417]	[.399]	(.002)	[.419]	[.405]	(.003)	[.419]	[.394]	(.002)
Age	43.82	38.44	5.38	44.63	39.54	5.09	46.27	40.77	5.49	41.50	42.19	-0.69
	[17.52]	[38.29]	(0.09)	[17.07]	[18.25]	(.09)	[16.20]	[18.13]	(.11)	[17.31]	[18.49]	(.09)

This table reports average characteristics for population who with and without financial instruments (account, debit card, credit card, and saving). Columns "with" and "w/o" (without) show average characteristics of the group of individuals specified by the column heading. Columns "diff" (difference) report the difference between the average characteristic for individuals with and without financial instruments. Standard deviations are in brackets; standard errors are in parentheses.

Table 1. 3: Probit results on the impact of remittances on account ownership

	(1)	(2)	(3)	(4)
Remittances	0.354***	0.370***	0.442***	0.398***
	(0.0411)	(0.0410)	(0.0415)	(0.0410)
Female	0.115***			0.0990***
	(0.0252)			(0.0243)
Education	0.556***			0.559***
	(0.0452)			(0.0467)
Employment	0.332***			0.349***
	(0.0401)			(0.0439)
Income: poorest 20%		-0.689***		-0.455***
		(0.0343)		(0.0332)
Income: second 20%		-0.540***		-0.347***
		(0.0284)		(0.0269)
Income: third 20%		-0.418***		-0.273***
		(0.0233)		(0.0223)
Income: fourth 20%		-0.272***		-0.173***
		(0.0210)		(0.0190)
Age			0.0480***	0.0362***
			(0.00376)	(0.00331)
Age-squared			-0.000443***	-0.000259***
			(0.0000416)	(0.0000408)
Constant	-1.163***	0.384***	-1.066***	-1.906***
	(0.119)	(0.0599)	(0.0795)	(0.136)
N	118788	119788	119535	118535
McFadden's R^2	0.0931	0.0384	0.0300	0.1272
Wald $\chi 2$	266.29	486.22	385.06	808.28

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 4: Probit result on the impact of remittances on debit card ownership

	(1)	(2)	(3)	(4)
Remittances	0.0597	0.0913*	0.170***	0.109**
	(0.0392)	(0.0405)	(0.0378)	(0.0365)
Female	0.0895**			0.0749*
	(0.0316)			(0.0307)
Education	0.641***			0.637***
	(0.0462)			(0.0460)
Employment	0.290***			0.291***
	(0.0381)			(0.0360)
Income: poorest 20%		-0.692***		-0.423***
		(0.0394)		(0.0400)
Income: second 20%		-0.549***		-0.327***
		(0.0331)		(0.0327)
Income: third 20%		-0.421***		-0.251***
		(0.0265)		(0.0247)
Income: fourth 20%		-0.260***		-0.143***
		(0.0234)		(0.0207)
Age			0.0558***	0.0451***
			(0.00420)	(0.00361)
Age-squared			-0.000534***	-0.000357***
			(0.0000449)	(0.0000388)
Constant	-1.793***	-0.0976	-1.685***	-2.726***
	(0.113)	(0.0614)	(0.0900)	(0.135)
N	118788	119788	119535	118535
McFadden's R^{2}	0.1033	0.0289	0.0215	0.1375
Wald $\chi 2$	340.23	345.88	321.79	911.14

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 5: Probit result on the impact of remittances on credit card ownership

	(1)	(2)	(3)	(4)
Remittances	0.00510	0.0287	0.0798*	0.0374
	(0.0388)	(0.0389)	(0.0356)	(0.0339)
Female	0.0509*			0.0454
	(0.0239)			(0.0243)
Education	0.506***			0.478***
	(0.0342)			(0.0371)
Employment	0.402***			0.343***
	(0.0373)			(0.0351)
Income: poorest 20%		-0.588***		-0.341***
		(0.0426)		(0.0484)
Income: second 20%		-0.456***		-0.250***
		(0.0319)		(0.0388)
Income: third 20%		-0.354***		-0.197***
		(0.0252)		(0.0316)
Income: fourth 20%		-0.217***		-0.110***
		(0.0185)		(0.0221)
Age			0.0655***	0.0495***
			(0.00594)	(0.00512)
Age-squared			-0.000701***	-0.000476***
			(0.0000709)	(0.0000626)
Constant	-2.526***	-1.003***	-2.604***	-3.386***
	(0.0842)	(0.0733)	(0.103)	(0.147)
N	118788	119788	119535	118535
McFadden's R^2	0.0893	0.0224	0.0222	0.1101
Wald $\chi 2$	290.76	260.60	231.88	1106.13

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 6: Probit result on the remittances and the usage of saving

| | Probit | Probit selection | | | |
| | Saved | Formal saving | Informal saving | For business | For old age |
	(1)	(2)	(3)	(4)	(5)
Remittances	0.479***	0.0587	0.267***	0.220***	-0.104***
	(0.0265)	(0.0338)	(0.0300)	(0.0240)	(0.0272)
Female	0.0116	0.0566**	-0.185***	0.135***	0.0402*
	(0.0147)	(0.0211)	(0.0315)	(0.0164)	(0.0170)
Age	-0.00149	0.0312***	0.0190***	0.0160***	0.0242***
	(0.00302)	(0.00349)	(0.00478)	(0.00290)	(0.00462)
Age-squared	0.00000882	-0.000230***	-0.000324***	-0.000268***	-0.00000110
	(0.0000319)	(0.0000352)	(0.0000505)	(0.0000349)	(0.0000461)
Education	0.184***	0.375***	-0.308***	0.189***	0.173***
	(0.0292)	(0.0421)	(0.0435)	(0.0213)	(0.0346)
Income: poorest 20%	-0.583***	-0.343***	-0.0649*	-0.130***	-0.244***
	(0.0273)	(0.0484)	(0.0314)	(0.0253)	(0.0379)
Income: second 20%	-0.424***	-0.286***	-0.0501	-0.127***	-0.166***
	(0.0226)	(0.0385)	(0.0310)	(0.0239)	(0.0295)
Income: middle 20%	-0.324***	-0.207***	-0.0303	-0.0990***	-0.127***
	(0.0179)	(0.0327)	(0.0265)	(0.0207)	(0.0282)
Income: fourth 20%	-0.185***	-0.155***	-0.0161	-0.0831***	-0.0907***
	(0.0149)	(0.0276)	(0.0236)	(0.0171)	(0.0235)
Employment	0.432***	0.139***	0.0914*	0.487***	0.0771**
	(0.0259)	(0.0327)	(0.0390)	(0.0316)	(0.0286)
Constant	-0.515***	-1.823***	-0.240*	-0.894***	-1.613***
	(0.103)	(0.125)	(0.123)	(0.0690)	(0.122)
N	118535	53249	53249	53249	53249
McFadden's R^2	0.0772	0.0452	0.0487	0.0810	0.0487
Wald χ^2	1806.30	283.71	743.35	672.46	743.35

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 7: Robustness test: Probit result of the account ownership according to country cluster

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.515***	0.385***	0.194**	0.143
	(0.0636)	(0.0542)	(0.0643)	(0.212)
Female	0.147***	0.0604	0.0837	0.322
	(0.0378)	(0.0341)	(0.0635)	(0.275)
Age	0.0317***	0.0384***	0.0570***	0.102*
	(0.00435)	(0.00443)	(0.0117)	(0.0399)
Age-squared	-0.000268***	-0.000313***	-0.000519***	-0.000851**
	(0.0000558)	(0.0000467)	(0.000147)	(0.000284)
Education	0.466***	0.385***	0.284***	0.151
	(0.0503)	(0.0623)	(0.0793)	(0.255)
Income: poorest 20%	-0.520***	-0.583***	-0.406***	-1.302*
	(0.0486)	(0.0451)	(0.105)	(0.599)
Income: second 20%	-0.415***	-0.427***	-0.317***	-0.689
	(0.0425)	(0.0384)	(0.0871)	(0.511)
Income: middle 20%	-0.329***	-0.325***	-0.240**	-0.604*
	(0.0334)	(0.0355)	(0.0774)	(0.295)
Income: fourth 20%	-0.227***	-0.187***	-0.0786	-0.596
	(0.0271)	(0.0272)	(0.0835)	(0.391)
Employment	0.302***	0.358***	0.766***	0.724*
	(0.0601)	(0.0472)	(0.117)	(0.337)
Constant	-1.774***	-1.346***	-1.058**	-0.525
	(0.157)	(0.219)	(0.329)	(1.202)
N	64240	39794	10501	2000
McFadden's R^2	0.1180	0.0960	0.1601	0.2982
Likelihood $\chi 2$	10361.66	5038.82	1372.74	158.63
Log likelihood	-38724.53	-23712.22	-3602.05	-186.68

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 8: Robustness test: Probit result of the debit card according to country cluster

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.181*** (0.0461)	0.206*** (0.0609)	0.147** (0.0557)	-0.202*** (0.0449)
Female	0.141* (0.0592)	0.0752* (0.0311)	0.0331 (0.0665)	-0.102* (0.0454)
Age	0.0406*** (0.00505)	0.0459*** (0.00456)	0.0513*** (0.00938)	0.0222 (0.0489)
Age-squared	-0.000339*** (0.0000592)	-0.000433*** (0.0000465)	-0.000534*** (0.000110)	-0.000189 (0.000526)
Education	0.613*** (0.0394)	0.406*** (0.0694)	0.237** (0.0784)	-0.220*** (0.0258)
Income: poorest 20%	-0.565*** (0.0564)	-0.606*** (0.0455)	-0.432*** (0.0706)	-0.0360 (0.0901)
Income: second 20%	-0.470*** (0.0478)	-0.445*** (0.0424)	-0.312*** (0.0792)	0.0378 (0.0535)
Income: middle 20%	-0.347*** (0.0349)	-0.343*** (0.0310)	-0.221*** (0.0547)	0.162** (0.0551)
Income: fourth 20%	-0.224*** (0.0311)	-0.182*** (0.0259)	-0.0837 (0.0550)	0.151 (0.107)
Employment	0.203*** (0.0396)	0.342*** (0.0437)	0.591*** (0.0913)	0.0555 (0.0463)
Constant	-2.832*** (0.130)	-1.916*** (0.244)	-0.998*** (0.294)	0.206 (0.227)
N	64240	39794	10501	2000
McFadden's R^2	0.1436	0.1006	0.1257	0.0182
Likelihood $\chi 2$	9169.92	5504.60	1467.49	48.36
Log likelihood	-27340.64	-24593.23	-5136.71	-1305.41

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1. 9: Robustness test: Probit result of the credit card according to country cluster

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.174***	0.0937	0.119	0.111
	(0.0455)	(0.0496)	(0.0643)	(0.0775)
Female	0.0607	0.0583	0.166**	0.0869***
	(0.0396)	(0.0345)	(0.0530)	(0.00589)
Age	0.0282***	0.0483***	0.0626***	0.0885*
	(0.00777)	(0.00669)	(0.00672)	(0.0373)
Age-squared	-0.000278***	-0.000498***	-0.000764***	-0.000883*
	(0.0000736)	(0.0000811)	(0.0000860)	(0.000419)
Education	0.393***	0.338***	0.152*	0.611***
	(0.0612)	(0.0341)	(0.0659)	(0.0952)
Income: poorest 20%	-0.300***	-0.569***	-0.380***	-1.104***
	(0.0522)	(0.0814)	(0.107)	(0.0627)
Income: second 20%	-0.247***	-0.383***	-0.385***	-0.817**
	(0.0411)	(0.0586)	(0.0699)	(0.251)
Income: middle 20%	-0.171***	-0.352***	-0.215***	-0.584***
	(0.0380)	(0.0386)	(0.0532)	(0.0505)
Income: fourth 20%	-0.148***	-0.172***	-0.211***	-0.466***
	(0.0408)	(0.0243)	(0.0504)	(0.0198)
Employment	0.249***	0.305***	0.302***	0.637***
	(0.0465)	(0.0284)	(0.0513)	(0.0682)
Constant	-3.160***	-2.731***	-2.255***	-2.766***
	(0.220)	(0.213)	(0.284)	(0.800)
N	64240	39794	10501	2000
McFadden's R^2	0.0818	0.0899	0.0915	0.2531
Likelihood $\chi2$	1737.93	2961.82	1019.51	656.41
Log likelihood	-9748.83	-14987.52	-5060.75	-968.53

Standard errors in parentheses. Standard errors are clustered at country level.
$^{*} p < 0.05,$ $^{**} p < 0.01,$ $^{***} p < 0.001$

Appendix A1: Supported explanations on methodology

1. List of countries by cluster

Cluster 1: Afghanistan, Armenia, Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Central Africa Republic, Chad, Congo Dem Rep., Congo Rep., Cote d'Ivoire, Egypt, El Salvador, Ethiopia, Georgia, Ghana, Guatemala, Guinea, Haiti, Honduras, India, Jordan, Kenya, Kyrgyz Republic, Laos, Lesotho, Liberia, Madagascar, Malawi, Mali, Malta, Mauritania, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Philippines, Rwanda, Senegal, Sierra Leone, South Sudan, Tajikistan, Tanzania, Togo, Uganda, Ukraine, Uzbekistan, Venezuela, Vietnam, Zambia, Zimbabwe.

Cluster 2: Bahrain, Cyprus, Czech Republic, Estonia, Greece, Hong Kong, Hungary, Italy, Korea, Latvia, Lithuania, Malaysia, Malta, Poland, Portugal, Saudi Arabia, Slovak Republic, Slovenia, Spain, Trinidad and Tobago, Turkey.

Cluster 3: Albania, Algeria, Argentina, Azerbaijan, Belarus, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Gabon, Indonesia, Iran, Iraq, Kazakhstan, Lebanon, Libya, Macedonia, Mauritius, Mexico, Montenegro, Namibia, Panama, Paraguay, Peru, Romania, Russia, Serbia, South Africa, Sri Lanka, Thailand, Tunisia, Turkmenistan, Uruguay.

Cluster 4: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Japan, Kuwait, Luxembourg, Netherlands, New Zealand, Norway, Singapore, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States.

Note: Two countries Taiwan and West Bank Gaza are excluded from the clustered groups because of missing data.

2. Table A1. 1: Summary statistic according to country clusters

	min	Mean	max
Cluster 1: Low stable countries			
Average income	242.938	1387.437	3785.246
GINI	.354	.58	.78
Broad money	0	4710.569	11510
Political stability	-2.801	-.7	2.237
Strength of legal right index	0	5.497	11
Cluster 2: Low-middle stable countries			
Average income	242.938	6313.352	14185.31
GINI	.647	.763	.843
Broad money	10800	17447.87	25940
Political stability	-1.713	-.375	2.139
Strength of legal right index	0	5.02	12
Cluster 3: Upper-middle stable countries			
Average income	305.05	14035.33	26537.36
GINI	.784	.862	.933
Broad money	27520	36180.3	64380
Political stability	-1.482	.469	2.193
Strength of legal right index	1	5.087	9
Cluster 4: High stable countries			
Average income	28637.76	41816.52	64306.96
GINI	.803	.916	.953
Broad money	38470	56723.72	89840
Political stability	-1.173	1.67	2.241
Strength of legal right index	1	6.093	12

3. Choosing number of k for the cluster analysis

To decide the optimal number of k clusters, the scree plot is often used to detect the kink in the curve generated from the within-cluster sum of squared (WSS) or its logarithm [log(WSS)] for all cluster solutions. The squared error for each point is the square of the distance of the point from its representation i.e. its predicted cluster center. The WSS score is the sum of these squared errors for all the points.

Since each observation is allocated to the closest cluster, and the distance between an observation and a cluster is calculated from the Euclidean distance between the observation and the cluster center. Each cluster center will then be updated as the mean of observation sin each cluster. The within-cluster sum of squares is:

$$\text{WSS} = \sum_{k=1}^{K} \sum_{i \in S_k} \sum_{j=1}^{p} (x_{ij} - \bar{x}_{kj})^2$$

where S_K is the set of observation in the kth cluster and $\bar{x}_{kj}$ is the jth variable of the cluster center for the kth cluster.

Besides, another method to detect k is using proportional reduction of error (PRE) coefficient. Here the WSS(k) [WSS(k-1)] is the WSS for cluster solution k(k-1), and WSS(1) is the WSS for cluster solution k=1, that is, for the non-clustered data. PRE_k measures the proportional reduction of the WSS for cluster solution k compared with the previous solution with $k-1$ clusters.

$$\text{PRE}_k = \frac{WSS\ (k-1) - WSS(k)}{WSS(k-1)} \ \forall\ k \geq 2.$$

We obtain the first plot for WSS-vs-k for the dataset. As expected, the plot looks like an arm with a clear elbow at k = 4. The results indicate that cluster with k = 4 to be the optimal solution. At k = 4, there is a diminishing turn in the WSS, log(WSS) and PRE_4 respectively.

The graph of WSS, log(WSS) and PRE is plotted in Figure 1.5

4. Table A1. 2: Variance inflation factors (VIF)

	VIF	1/VFI
Remittances	1.02	0.981415
Female	1.05	0.951585
Age	1.05	0.955486
Education	1.08	0.925982
Income: poorest 20%	1.49	0.669396
Income: second 20%	1.48	0.676268
Income: middle 20%	1.48	0.677157
Income: fourth 20%	1.48	0.674526
Employment	1.09	0.919490

VIF detects multicollinearity in the regression, in which according to the rule of thumb, the VIF ranges from 1 as uncorrelated to 10 as highly correlated.

Appendix B1: Output tables for marginal effects

Table B1. 1: Marginal effects on account ownership (AME)

	(1)	(2)	(3)	(4)
Remittances	0.127***	0.141***	0.170***	0.137***
	(0.0145)	(0.0155)	(0.0159)	(0.0137)
Female	0.0410***			0.0340***
	(0.00898)			(0.00832)
Education	0.199***			0.192***
	(0.0144)			(0.0141)
Employment	0.119***			0.120***
	(0.0139)			(0.0143)
Income: poorest 20%		-0.265***		-0.159***
		(0.0134)		(0.0122)
Income: second 20%		-0.207***		-0.121***
		(0.0116)		(0.00984)
Income: middle 20%		-0.158***		-0.0947***
		(0.00970)		(0.00814)
Income: fourth 20%		-0.101***		-0.0594***
		(0.00872)		(0.00683)
Age			0.0184***	0.0124***
			(0.00137)	(0.00115)
Age-squared			-0.000170***	-0.0000888***
			(0.0000154)	(0.0000143)
N	118788	119788	119535	118535

Standard errors in parentheses. Standard errors are clustered at country level.
$^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Table B1. 2: Marginal effects on debit card ownership (AME)

	(1)	(2)	(3)	(4)
Remittances	0.0195	0.0323*	0.0608***	0.0340**
	(0.0127)	(0.0142)	(0.0134)	(0.0115)
Female	0.0292**			0.0235*
	(0.0102)			(0.00953)
Education	0.209***			0.200***
	(0.0122)			(0.0119)
Employment	0.0946***			0.0910***
	(0.0135)			(0.0120)
Income: poorest 20%		-0.248***		-0.135***
		(0.0130)		(0.0128)
Income: second 20%		-0.204***		-0.106***
		(0.0114)		(0.0109)
Income: middle 20%		-0.160***		-0.0827***
		(0.00933)		(0.00812)
Income: fourth 20%		-0.101***		-0.0478***
		(0.00862)		(0.00665)
Age			0.0199***	0.0141***
			(0.00171)	(0.00125)
Age-squared			-0.000191***	-0.000112***
			(0.0000182)	(0.0000132)
N	118788	119788	119535	118535

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B1. 3: Marginal effects on credit card ownership (AME)

	(1)	(2)	(3)	(4)
Remittances	0.000828	0.00502	0.0140*	0.00594
	(0.00628)	(0.00665)	(0.00580)	(0.00525)
Female	0.00826*			0.00721
	(0.00390)			(0.00389)
Education	0.0822***			0.0760***
	(0.00881)			(0.00857)
Employment	0.0652***			0.0545***
	(0.00858)			(0.00738)
Income: poorest 20%		-0.103***		-0.0535***
		(0.0113)		(0.00858)
Income: second 20%		-0.0862***		-0.0412***
		(0.00917)		(0.00711)
Income: middle 20%		-0.0711***		-0.0334***
		(0.00733)		(0.00591)
Income: fourth 20%		-0.0470***		-0.0196***
		(0.00514)		(0.00422)
Age			0.0115***	0.00786***
			(0.00169)	(0.00109)
Age-squared			-0.000123***	-0.0000756***
			(0.0000188)	(0.0000122)
N	118788	119788	119535	118535

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B1. 4: Marginal effects on the usage of saving (AME)

	Probit		Probit selection		
	Saved (1)	Formal saving (2)	Informal saving (3)	For business (4)	For old age (5)
Remittances	0.174***	0.0208***	0.0859***	0.0745***	-0.0355***
	(0.00902)	(0.00440)	(0.00400)	(0.00417)	(0.00431)
Female	0.00420	0.0201***	-0.0596***	0.0457***	0.0136***
	(0.00533)	(0.00411)	(0.00387)	(0.00398)	(0.00400)
Education	0.0669***	0.133***	-0.0993***	-0.0302***	0.0586***
	(0.0104)	(0.00284)	(0.00283)	(0.00294)	(0.00286)
Employment	0.157***	0.0495***	0.0294***	0.165***	0.0262***
	(0.00883)	(0.00493)	(0.00459)	(0.00485)	(0.00480)
Income: poorest 20%	-0.215***	-0.122***	-0.0208**	-0.0442***	-0.0823***
	(0.0104)	(0.00697)	(0.00649)	(0.00677)	(0.00671)
Income: second 20%	-0.159***	-0.103***	-0.0161**	-0.0431***	-0.0568***
	(0.00870)	(0.00644)	(0.00600)	(0.00623)	(0.00625)
Income: middle 20%	-0.122***	-0.0754***	-0.00981	-0.0339***	-0.0439***
	(0.00689)	(0.00609)	(0.00569)	(0.00588)	(0.00589)
Income: fourth 20%	-0.0698***	-0.0568***	-0.00522	-0.0286***	-0.0315***
	(0.00571)	(0.00564)	(0.00529)	(0.00543)	(0.00546)
Age	-0.000539	0.0111***	0.00613***	0.00541***	0.00822***
	(0.00110)	(0.000626)	(0.000612)	(0.000644)	(0.000613)
Age-squared	0.00000320	-0.0000815***	-0.000104***	-0.0000908***	-0.000000375
	(0.0000116)	(0.00000687)	(0.00000692)	(0.00000730)	(0.00000670)
N	118535	53249	53249	53249	53249

Standard errors in parentheses. Standard errors are clustered at country level.
$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table B1. 5: Additional test: Marginal effects on account ownership according to country cluster (AME)

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.177***	0.131***	0.0367**	0.00712
	(0.0190)	(0.0189)	(0.0138)	(0.0111)
Female	0.0505***	0.0205	0.0158	0.0161
	(0.0128)	(0.0115)	(0.0124)	(0.0124)
Education	0.160***	0.131***	0.0538***	0.00752
	(0.0141)	(0.0212)	(0.0162)	(0.0133)
Employment	0.104***	0.121***	0.145***	0.0361
	(0.0186)	(0.0156)	(0.0256)	(0.0196)
Income: poorest 20%	-0.183***	-0.202***	-0.0775***	-0.0607**
	(0.0153)	(0.0163)	(0.0224)	(0.0229)
Income: second 20%	-0.148***	-0.145***	-0.0580***	-0.0180
	(0.0136)	(0.0137)	(0.0173)	(0.0132)
Income: middle 20%	-0.118***	-0.108***	-0.0422**	-0.0145***
	(0.0112)	(0.0125)	(0.0131)	(0.00416)
Income: fourth 20%	-0.0817***	-0.0606***	-0.0128	-0.0142
	(0.00974)	(0.00970)	(0.0130)	(0.00780)
Age	0.0109***	0.0130***	0.0108***	0.00507*
	(0.00166)	(0.00152)	(0.00239)	(0.00239)
Age-squared	-0.0000921***	-0.000106***	-0.0000983**	-0.0000425*
	(0.0000207)	(0.0000157)	(0.0000300)	(0.0000175)
N	64240	39794	10501	2000

Standard errors in parentheses. Standard errors are clustered at country level.
$^{*}\ p < 0.05,\ ^{**}\ p < 0.01,\ ^{***}\ p < 0.001$

Table B1. 6: Additional test: Marginal effects on debit card according to country cluster (AME)

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.0430***	0.0727***	0.0405*	-0.0755
	(0.0107)	(0.0216)	(0.0170)	(0.0014)
Female	0.0333*	0.0265*	0.00910	-0.0383
	(0.0143)	(0.0110)	(0.0183)	(0.0261)
Education	0.145***	0.143***	0.0651***	-0.0823
	(0.0120)	(0.0224)	(0.0190)	(0.0102)
Employment	0.0482***	0.121***	0.162***	0.0207
	(0.00981)	(0.0156)	(0.0282)	(0.0123)
Income: poorest 20%	-0.137***	-0.219***	-0.122***	-0.0138
	(0.0147)	(0.0178)	(0.0235)	(0.0323)
Income: second 20%	-0.118***	-0.163***	-0.0849***	0.0144
	(0.0130)	(0.0169)	(0.0245)	(0.0174)
Income: middle 20%	-0.0910***	-0.126***	-0.0582***	0.0602
	(0.00958)	(0.0118)	(0.0155)	(0.0055)
Income: fourth 20%	-0.0613***	-0.0672***	-0.0210	0.0563
	(0.00880)	(0.00949)	(0.0137)	(0.0255)
Age	0.00962***	0.0162***	0.0141***	0.00829
	(0.00145)	(0.00157)	(0.00265)	(0.01626)
Age-squared	-0.0000803***	-0.000153***	-0.000147***	-0.0000707
	(0.0000159)	(0.0000165)	(0.0000314)	(0.0001794)
N	64240	39794	10501	2000

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B1. 7: Additional test: Marginal effects on the credit card according to country cluster (AME)

	Cluster 1 Unstable	Cluster 2 Lower-middle stable	Cluster3 Upper-middle stable	Cluster 4 High stable
Remittances	0.0136***	0.0195	0.0322	0.0302
	(0.00291)	(0.00999)	(0.0190)	(0.0241)
Female	0.00477	0.0121	0.0449**	0.0237***
	(0.00292)	(0.00686)	(0.0156)	(0.00388)
Education	0.0309***	0.0701***	0.0412*	0.167***
	(0.00736)	(0.00833)	(0.0169)	(0.0100)
Employment	0.0196***	0.0633***	0.0818***	0.174***
	(0.00446)	(0.00778)	(0.0174)	(0.00196)
Income: poorest 20%	-0.0235***	-0.117***	-0.106**	-0.317***
	(0.00463)	(0.0185)	(0.0328)	(0.0534)
Income: second 20%	-0.0201***	-0.0859***	-0.107***	-0.224*
	(0.00371)	(0.0151)	(0.0217)	(0.110)
Income: middle 20%	-0.0148***	-0.0801***	-0.0632***	-0.152***
	(0.00336)	(0.0112)	(0.0167)	(0.0391)
Income: fourth 20%	-0.0130***	-0.0424***	-0.0619***	-0.117***
	(0.00333)	(0.00787)	(0.0152)	(0.0145)
Age	0.00221**	0.0100***	0.0170***	0.0242
	(0.000804)	(0.00147)	(0.00223)	(0.0125)
Age-squared	-0.0000218**	-0.000103***	-0.000207***	-0.000241
	(0.00000771)	(0.0000167)	(0.0000317)	(0.000138)
N	64240	39794	10501	2000

Standard errors in parentheses. Standard errors are clustered at country level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
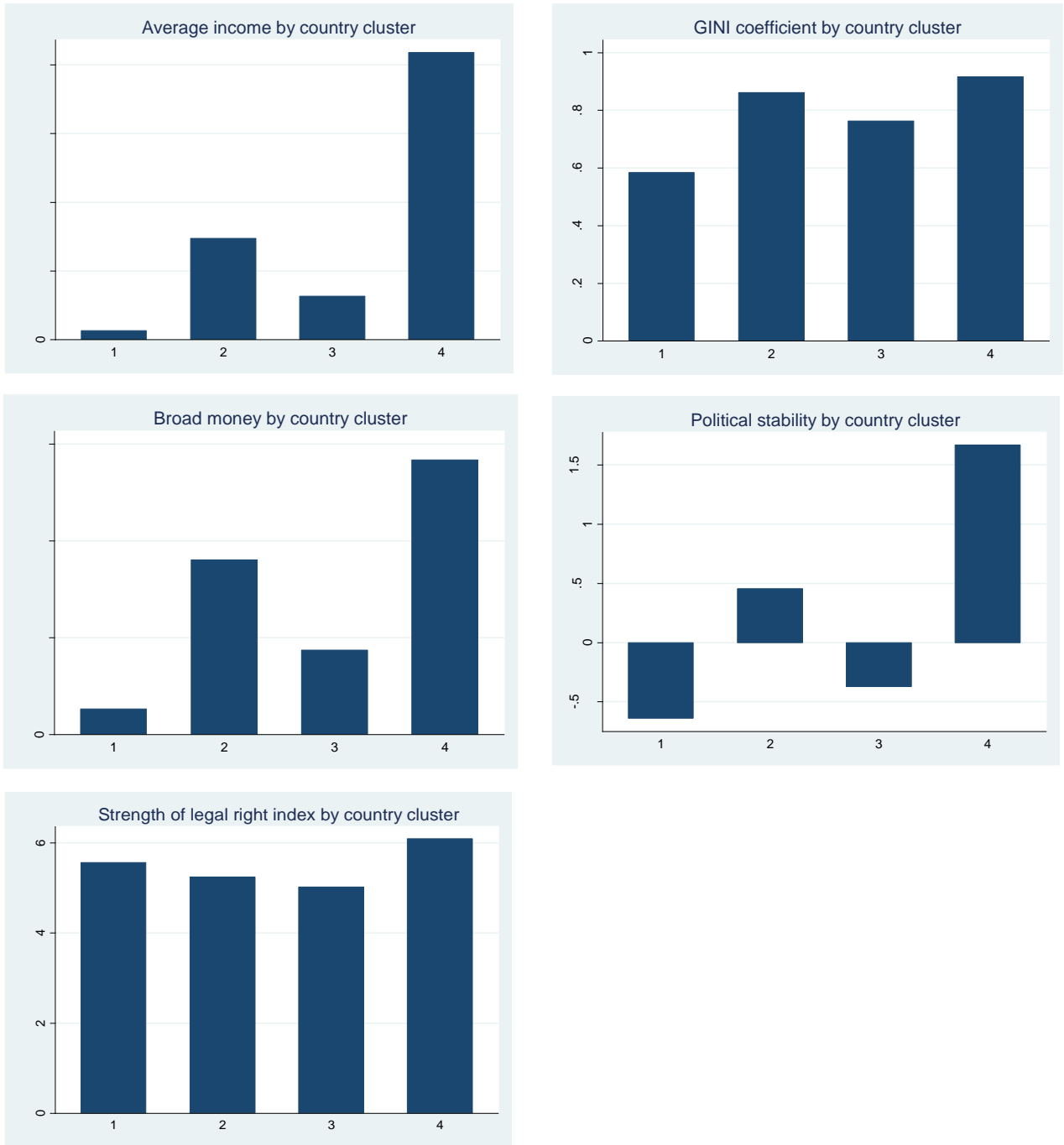
Figure 1. 4: Mean values for five indicators by cluster
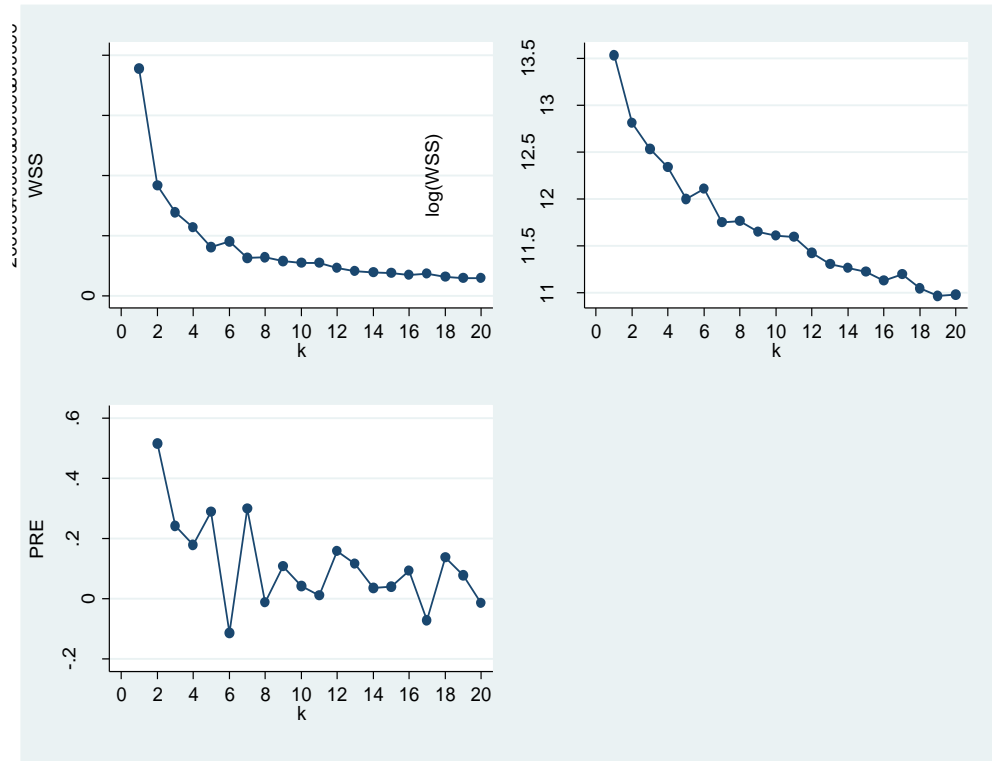
Figure 1. 5: WSS, log(WSS) and PRE for all K cluster solutions

Chapter 2

Technology adoption and microfinance borrowing among Asian women

Abstract

Technology advancement is an important driver to build an inclusive financial system, which could be a promising development to bring microfinance to more people. New digital channel such as a website or mobile services allows the microfinance institutions (MFIs) to disseminate information, improve the quality of services, and reduce the transaction cost, making the loans more accessible to more people. Nevertheless, to date, there has been a few literatures that explores the reversed approach which specifies the causal effect of microfinance clients or MFIs on the development of technology. Therefore, this is one of the pioneer studies on this topic, particularly looking at the link between information and communication technology adoption and female microfinance borrowers. The sample includes 311 MFIs from 23 Asian countries in the year 2015 and technology adoption is measured by the availability of the website and mobile financial services, which two-stage least square method is applied to address the potential endogeneity issue. The findings suggest that women borrowing does encourage the prevalence of website availability but not the mobile financial service, however, the South Asia region where consists of a great number of microfinance hubs that pioneer in mobile service application. Further, profit-oriented MFIs with assumably less budget constraints are more likely to digitalize their services. Overall, the findings imply the importance of maintaining a sufficient women client proportion, and MFIs' economic conditions to develop the ICT systems.

2.1. Introduction

One of the central economic mechanisms emerging over the past three decades, which has been considerably promoting economic development, is the provision of microfinance services. Microfinance has been defined as bringing "financial services to the poor or low-income clients, including consumers and the self-employed[4]". One major product of microfinance, microcredit, is the offering of small loans to such clients, which has been greatly valuable to the small businesses and households – those are excluded from traditional financial institutions due to economic constraints. One among resounding studies in the field, which investigates the microfinance program in Bangladesh (Khandker, 2005), shows that microfinance helps to reduce poverty, especially the women through the increase in household consumption. The study also finds that not only does the microfinance positively contributes to the livelihoods of the borrowers, but the spillover is also significant that the neighbouring nonparticipants are benefited through local income growth.

As the financial service industry grows, the microfinance sector also experiences a various improvement in operational efficiency and increased outreach to the poor, in which digitization in services, or information and communications technology[5], have greatly contributed to such contemporary advancement (Kapoor, Morduch, & Ravi, 2007). Conventionally, microfinance was comparatively low tech; but the maturing of the industry, the development of technology hardware and software tools, and the rise of new entrants into the market have forced microfinance institutions (MFIs) up to the new levels of technical sophistication. ICT adoption can positively change the processes of analysing and controlling risk, reaching existing and new customers, closing the boundary between traditional lending institutions and MFIs, and attracting new third-party organizations such as the microfinance information exchange (MIX market). All have

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[4] According to microcreditsummit.org, microfinance is the extension of small loans to the very poor, in combination with other financial services, such as saving accounts, training, health services, networking, and peer support, which allow the beneficiaries to pursue entrepreneurial projects that generate extra income, thus helping them to better provide for themselves and their families. Retrieved from https://www.microcreditsummit.org/what-is-microfinance2.html

5 Information technology (IT) and information and communications technology (ICT) are often used interchangeably. ICT is more often used in the international development and microfinance literature.

fostered the competition among MFIs for management, donor funds, and investments (Kauffman & Riggins, 2012).

In the developing countries, for example, in Ghana, the study by Attom (2013) finds out that the majority of SMEs do not make use of ICT, which leads to a negative effect on their growth potential and success. For example, ICT adoption positively contributes to the image of the small businesses, gaining advantage in bank's credit evaluation (Dalla Pellegrina, Frazzoni, Rotondi, & Vezzulli, 2016). The study by Dalla Pellegrina et al. (2016) also specifies that banks tend to account for ICT adoption when they evaluate customer creditworthiness by offering better lending conditions to small entrepreneurs who use ICT more extensively in terms of hiring computer technicians, using extranet devices, and exploiting online relationships with the banking system. The study also shows a significant correlation between credit growth rates and ICT adoption, which corresponds to firms improving their external communications through technology, especially towards both the financial system, customers, and suppliers.

Even though there is some literature on technology adoption (Besley & Case, 1993; Berger, 2003; Dalla Pellegrina, Frazzoni, Rontondi & Vezzulli, 2016; Schmiedel, Malkamaki & Tarkka, 2006), little is known about what drives the development of technology particularly in the microfinance industry. The contribution of this study to current literature is that it examines the impact of women borrowers who are considered to be the main target of the microfinance program, on the likelihood of ICT application, which has not explored by any previous study. In particular, the study explores the linkage between the percentage of women clients and the availability of websites and mobile banking service in 311 microfinance institutions (MFIs) from 23 developing Asian countries in the year 2015. The empirical evidences show that a higher percentage of female borrowing increases the probability of website availability but not the provision of mobile banking services. Further, the results are stronger in for-profit MFIs than in the nonprofits, implying the advantage of financial health and collaboration that most for-profit MFIs, or bank-typed, have. However, South Asia region, consisting of the biggest microfinance hubs, witnesses a significant link between women borrowing and mobile services, which again emphasizing on the critical role of not only active clients, but also the ICT investments among the MFIs. Besides, the results are robust to potential endogeneity bias, which the two-stage least square is applied, using the weather variation as the instrument variable (IV).

The content of this study is as follows. The second section reviews some prominent literature; the third section explains the model specification; next, we discuss the data and variable construction; then the empirical results are present in the section 5; and section 6 provides the robustness test of our results in different Asian regions; while the last section concludes with some limitations and policy implications.

2.2. Literature review

2.2.1. MFI operation

Traditionally, MFI is always perceived as a "social business" driven by social missions (Yunus, 2006). However, the discussion about the double bottom-line responsibility of MFIs has become well-known lately, arguing that MFIs have to compromise between financial and social goals. According to Cull et al. (2009), between two main MFI-types, bank and non-bank (mainly non-government organization) institutions, bank-MFIs are more likely to be profitable but the proportion of nongovernmental microfinance organizations the market is large so that more customers are served. However, some profitable NGO-MFIs prefers to stay nonprofit status because they can enjoy the regulation and taxes' benefits. Generally, nongovernmental microfinance organization are more likely to be a nonprofit, performing group lending method, giving smaller loans, serving more women, employing subsidies more heavily, facing higher costs per dollar lent, and thus being less profitable (Cull, Jonathan, & Demirguc-Kunt, 2009). In the same line, Tchakoute-Tchuigoua (2010) carries one way ANOVA test to examine 202 MFIs of different legal status including cooperatives, private companies and NGOs; and concludes that for-profit MFIs have better financial sustainability (measured by portfolio quality) and social efficiency (measure by the number of borrowers and loan amount) than nonprofit MFIs. Results from Tchakoute-Tchuigoua (2010) also shows that for-profit MFIs are more socially efficient that non-profit MFIs.

From the gender approach, using logit as well as Hausman-Taylor performance regressions in a large global dataset of 398 MFIs active in 73 countries, D'espallier et al. (2013) show that focus on women is significantly linked to international orientation, collective lending methods, smaller

loans and non-commercial legal status, but does not enhance the MFI's performance because of higher relative costs, which comes from the nature of the loans but not the gender.

Different indicators might lead to different results, which according to Kar (2013), the discussion about "mission drift" is still ambiguous. Using the panel database containing 4-6 years' observations from 409 MFIs in 71 countries, most results from Kar (2013) do not support the hypothesis of mission drift which is measured by the trade-off between profitability and depth of outreach. Instead, it is suggested to look at behaviour changes of the same MFI over time but appropriate data are limited.

Regarding the MFI's performance in the long term, Li et al. (2019) apply intertemporal Data Envelopment Analysis, and find that capital is essentially important for the MFIs at the early stage, which open the opportunities for technology adoption in later years, helping the MFIs to grow over time. The results from Li et al. (2019) also see the strong convergence of performance among MFIs with notable changes in increased commercialization, competition with commercial banks, and involvement of private investors.

In terms of capital and resources, a for-profit MFI (mainly bank-type) seems to gain advantage thanks to its current business which offer a source of lendable funds at a reasonable cost. To stay independent from subsidy and donor, nonprofit MFI faces a major challenge regarding the transaction cost, potentially leading to the prioritized role of the technology as a solution.

2.2.2. Technology adoption and microfinance

The importance of MFIs in providing credit and other support services to the financially excluded people is recognized as an important part of poverty reduction strategies. However, the traditional microfinance context is especially complicated due to the service distances, the necessity for building operational processes that are lean and effective, without undue complexity or expensive maintenance requirement (Kauffman & Riggins, 2012). Mathison (2005) supposes that technological innovation could be great hope to eliminate such barriers, improving customers' reach and the range of services offered, from back-office management information systems to mobile computing, branchless banking, card service, and internet banking. ICT development does not only increases the information transparency, but it can also mean an effective platform for developing new products like emergency loans and flexible savings accounts (Kapoor, Morduch,

& Ravi, 2007). From a macro level, Mushtaq and Bruneau (2019) use the panel dataset from 62 countries over 2001-2012 to examine the impact of ICT development on the financial inclusion and find out that poverty and inequality decrease over time in the lower and middle income countries. Besides, Diniz et al. (2012) on the operational and institutional networks for microfinance and rural branchless banking services in Brazil report the changes that network-based microfinance has made to the remote areas of the Amazon River Basin. These include bringing a cash economy to small villages, localizing salary disbursements, and improving the financial security of banking clients; and such financial inclusion through the correspondent's process positively contributes to local socio-economic development. In India, a large-scale randomized experiment that measures the impact of biometrically authenticated payments infrastructure in India is recorded (Muralidharan, Niehaus, & Sukhtankar, 2016). The results show that new system delivered a faster, more predictable and effective payment process, while reducing the "leakage" of funds between government and beneficiaries of the program. The study also points out that the beneficiaries who are integrated with the technology overwhelmingly preferred the new system, and suggests that investing in secure payment infrastructure can significant enhance "state capacity" in developing countries.

In this respect, the study by Kar and Rahman (2018) applies the data envelopment analysis to estimate the production technology of MFIs and associated measures of productivity and efficiency. The findings show that 10 years duration from 2003 to 2013 witnesses a very promising picture about performance of 342 MFIs from 61 countries in the sample, where technical progress and technical efficiency change positively link to MFIs' productivity, especially in Eastern Europe, Central Asia and South Asian regions, although scale efficiency and resource allocation are still in need of much improvement.

Considering that the adoption of information technology by MFIs in developing countries has lagged behind due to digital divided barriers, if being correctly utilised, technology can greatly improve the outreach of financial products to the unbanked population and foster an MFI's operational efficiency and ensure repayment (Kauffman & Riggins, 2012). For example i) at the customer level, ICT disseminates the information that helps reduce the asymmetry risks and facilitates the distribution of money despite the geographical barrier; ii) at the MFI level, ICT increases the operational efficiency and risk management in internal data processing and archive;

iii) at the donor level, ICT helps to secure funding and provide transparency to the donors and investors, especially when the majority number of MFIs nowadays are strategically moving away from dependence on the donor model to the internally self-sustaining model based on expanded savings services to the poor. iv) at the microfinance industry level, the impact of ICT can be valuable for the competition on interest rates, market entry and exit, and the number of intermediaries in the industry. Intuitively, for instance, group leaders act as intermediaries between the lenders and the microloan recipients to ensure repayment accountability; while banking correspondents are intermediaries between the more distant financial institutions and the recipients to ensure safe and convenient transactions; MFIs are intermediaries between international donors or relief organizations and local loan recipients, and also the ability for small entities to enter the market. With ICT, it could allow all of these intermediaries to perform such functions on the same platform.

Though microfinance is not the only panacea, but technology has the potential to take microfinance beyond the bounds of villages and neighborhoods, making the services more accessible services, and maintain long-term operational efficiency and gain attraction from the investors.

2.2.3. Website availability among MFIs

Considering a database of 51 European banks, a research by DeAndres et al. (2009) shows that website accessibility adoption can be motivated by operational factors because it improves the functionalities, and be considered as a part of the corporate social responsibility strategy, so banks that are more committed to social development should be more prone to enhance their websites. Regarding the website channel, which is expected to serve the largest possible audience using the broadest range of hardware and software platforms, a study of 600 firms in European countries finds out that big firms pay more attention to website accessibility because of three reasons: they have high political costs which can be mitigated with website; they are more innovative and they have easier access to specialized IT sources (Lorca, De Andres, & Martinez, 2012). Another study from Lorca et al. (2012) also finds out an interesting point that English common law firms have more accessible websites because they exhibit high levels of individualism, low power distance, and low uncertainty avoidance, which all fosters the innovation. In details, the quantile regression

shows that the effect of size is only for companies which are trying to excel or trying to avoid being in the last positions; however, national culture effect seems to be significant only in the case on firms with lower levels of website accessibility.

Nevertheless, results from the above mentions cannot make an inference to microfinance industry because (i) microfinance clients' demographic is special as they are mainly the poor living in the rural or mountainous areas, probably bearing the disadvantaged living condition and attaining comparatively low education level; (ii) MFIs are financial institutions that provide periodically small financial services, raising the transaction costs and administrative costs; (iii) the microfinance industry has a diversified ownership structure that is composed of bank MFIs, non-bank financial institutions, NGOs and cooperatives.

So far, studies about website accessibility in the microfinance industry is still scarce. There is one that examines the website content of MFIs, discovering that MFIs with a high degree of public exposure on the internet disclose greater amounts of information on their websites than smaller MFIs with a lower degree of public exposure (Gutiérrez-Nieto, Fuertes-Callén, & Serrano-Cinca, 2017). It was also found that for-profit MFIs disclose more financial information on their websites, while non-profit non-governmental organizations tend to demonstrate more information about social impact. Most recently, a study by Tadele et al. (2018) uses GLM regression to identify factors that affect MFI website accessibility on a global dataset of 947 MFIs, which confirms the positive links between website accessibility and social performance, funding, national economic development; especially to the MFIs' size and financial structure.

2.2.4. Mobile financial service offering and MFIs

Mobile service which allows users to make basic financial transactions via mobile phone, has exhibited potential to foster financial inclusion in developing countries (Jack & Suri, 2014), especially in among the rural communities with limited or no access to formal financial credit (Munyegera & Matsumoto, 2018). For example, M-PESA is a mobile phone-based money transfer service that is very popular in Kenya. A large experiment from 2008-2010 conducted by Jack and Suri (2014) examines the effect of mobile banking services among microfinance customers. The panel difference-in-differences specification is applied to compare the changes in the responses of consumption to shocks across M-PESA users and nonusers. The findings provide evidence that

consumption falls for nonusers when they experience a negative income shock, as it does for those who lack good access to the agent network. But M-PESA users experience no such reduction in consumption, especially among the poorer (bottom three quintile of the income distribution). Such results are explained by a higher amount of remittance during the economic shocks, which the mobile application helps liquidate the access to finance. This is similar to the context of rural Uganda, which Munyegera and Matsumoto (2018), when examining the dataset of 820 households, confirms the linkage between mobile money and better financial access, increased remittances, saving and borrowing transactions.

Afawubo et al. (2020) observe the usage of mobile money in five steps: have a mobile phone, have heard of the service, use the product once, have an account, and have confidence in the product of which the final stage leads to frequent use. Using the national survey in Togo in 2016, Afawubo et al. (2020) examine the sample of 5200 households, implementing an ordered logit regression and a sequential logit model, and show that those who are highly literate are more likely to go far in the adoption process. Also, they find out that mobile money increases households' ability to deal with some life emergency especially environmental and agricultural vulnerabilities.

A Rwanda survey conducted by Uwamariya et al. (2020) adds that mobile banking reduces the transaction cost and loan default, thus increasing MFI's efficiency. Besides, Mora and Prior (2018), using the dataset of ENDA – a leading MFI in Tunisia in 2009 - 2015, show that there is a strong reduction in delinquency for microfinance customers who registered the mobile financial service. Late payment decreases even more significantly among the active technology adopters.

According to Reeves and Sabharwal (2013), there are three main barriers for mobile financial services' penetration in low-income sector: first, the comparatively higher telecommunication expenses in developing countries and the size of the initial investment, a mobile handset, for nonusers; second, involving and teaching new clients on new practices, for example, many of the mobile financial services users who are low-income earners tend to stop using the services after one or two months; third, lack of trust and illiteracy on the technology, being confused about conducting a transaction with a machine or where to turn to when something goes wrong.

Therefore, to encourage the usage, Uwamariya et al. (2020) suggests that MFIs should have high agent visibility and sufficiency savings. Also, Dorfleitner et al. (2018) emphasizes on the size, age and current depth of outreach of the MFIs, especially the institutions with a high share of deposits that drive the application of mobile banking services. However, consider how costly and time-consuming to build develop a mobile system, Kumar et al. (2010) advice the potential MFIs to negotiate partnerships with third-party big organizations or banks in order to leverage the technical expertise, plus to maintain a required number of active microfinance customers to make the investment worthwhile.

2.2.5. Technology adoption and women

A study that uses the Technology Acceptance Model (TAM[6]) amongst 342 employees and found that females tend to use the technology that requires less effort (Venkatesh & Morris, 2000). It also shows that women were having lower perceived ease of use because they were having higher levels of computer anxiety as compared to their male counterparts. Therefore, women tend to be more motivated to apply technology if they find it easy to use and when their social circle encourages technology-friendly behaviours. Further in this topic, Venkatesh et al. (2003) analyse women's characteristics and find out that female users are more sensitive to the peers' suggestions and hence the effect of social influence will be stronger when it comes to the intention of technology adoption. It also reveals that females are more anxious than men when it comes to IT utilisation and this nature of females negatively links to self-effectiveness which in turn leads to an increased perception of the effort required to use IT. Besides, a study about 2675 customers of Scandinavian Bank in Finland (Laukkanen & Pasanen, 2007), applying backward stepwise for the logistic regression model finds out that demographics such as education, occupation, household income and size of the household do not differentiate mobile banking users, but age and gender are important attribute: mobile banking users are dominated by the 30-49 years old and men are more likely to use mobile banking services than women.

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[6] Technology Acceptance Model (TAM) assumes the success of a system is determined by the user acceptance of the system which is measured by three factors: perceived usefulness, perceived ease of use and attitudes towards usage of the system

2.2.6. Women and microfinance

To the microfinance customers, it is found that women have been the target of microfinance program since it is first initiated, although men dominate labour decisions but women play a larger role in running a household side-businesses, even in countries where gender equality is far from the norm, for example, 95% of Grameen Bank customers in the year 2000 were women (Cull, Jonathan, & Demirguc-Kunt, Microfinance Meets the Market, 2009). Some MFIs thus even exclusively serve women because women represent 85 percent of the poorest microfinance clients reached, let alone the spillover effects such as children of women microfinance borrowers can reap the benefits like lower drop-out rates, increased full-time school enrollment, or the new households of microfinance clients appear to have better health practices and nutrition (Banerjee A. , Duflo, Glennerster, & Kinn, 2015; Daley-Harris, 2007). Also, female microfinance participants gain significant empowerment than those who do not (Swain & Wallentin, 2009), and the longer she engages in the program, the better empowerment she benefits in terms of autonomy, financial independence and mobility (Weber & Ahmad, 2014). Further, behavioural reasons could also make women better borrowers than men. Study by Goetz and Gupta (1996) shows that women are more susceptible to peer pressure and tend to stay at home, which could implies women's better ability of loan control.

To the business, it is estimated that there are around 70% of MFIs' customers are women and 47% of MFIs exclusively focus on women from the global dataset (D'espallier, Guerin, & Mersland, 2013). The study also finds that focusing on women is significantly related to the international orientation and lower default risk. Interestingly, they observe that regulated and more commercial MFIs, such as banks and non-bank financial institutions, serve women to a lesser extent than non-regulated or non-profit NGOs do. This is because women's lending is generally smaller in amount which leads to higher administration costs. Nevertheless, they confirm that focusing on women is a good business strategy as long as repayment is maximized and operational costs are under control. Besides, the advantage of the women-centric approach can "result in the development of more focused microenterprises, a lower likelihood that the money will be used for no-productive purposes" thus bringing "a more positive impact on children, and higher repayment rate" (Kauffman & Riggins, 2012).

Gender aspects in the labour market is also an important issue: a growth in the numbers of women in self-employment and entrepreneurial activities explain the increased demand for microcredit (Armendáriz & Morduch, 2010). For a long time, women are always considered to be more vulnerable in various aspects, including education, employment, political representation, and intra-household oppression due to social norms that encourage such status differences (Armendáriz & Morduch, 2010). Being suffered from many disproportionately disadvantages, especially in developing countries, women thus constitute the overwhelming majority of microfinance beneficiaries (Khandker, 2005); therefore, to study about the role of women in general, and in the microfinance development particularly, is a humane approach. Furthermore, it is also believed that offering access to microfinance services to women is a promising mean to empower women and increase gender equity (Armendáriz & Morduch, 2010).

2.3. Model specification

The empirical analysis focuses on determining the impact of women borrowing on technology adoption, where women borrowing is specified as the percentage of women borrowing in the MFIs.

2.3.1. The effect of women borrowing on technology adoption

The effect of women borrowing on technology adoption is examined using probit model:

$$Tech_{ij} = \alpha FemaleBorrower_{ij} + \beta CountryControl_j + u_{ij} \tag{12}$$

where $Tech_{ij}$ measures technology adoption that is proxied by *the availability of website* and *mobile banking service* that the MFI offers, equals to 1 if there exists, and 0 if otherwise. *FemaleBorrower_{ij}* is the percentage of female borrowers at MFI; *CountryControl_j* includes two control variables at country level namely *percentage of adults who are financially literate* and the *price of 500 MB using on mobile* phone; u_{ij} is the zero-mean idiosyncratic MFI-level error term. The results are interpreted as marginal effect at mean, or the instantaneous rate of change that affects the mean. The MFI level and country level are indexed by *i* and *j*.

It is expected that, among microfinance borrowers in which women play a large composition, ceteris paribus, more women borrowing would encourage the MFI to go digital.

2.3.2. Instrumental variable approach

The link between microfinance borrowing and ICT application might contain endogeneity issue[7], which previous studies have not addressed. Two of the closest studies in the same topic when trying to estimate the links between MFI's characteristics and the tendency to present website (Tadele, Roberts, & Whiting, 2018) and mobile banking services (Dorfleitner, Nguyen, & Rohe, 2018) make assumption about the exogenous variables. In fact, on the one hand, the MFIs with a good internal indexes are expected to involve in technology (Dorfleitner, Nguyen, & Rohe, 2018; Tadele, Roberts, & Whiting, 2018); on the other hand, strong technology infrastructure also brings certain benefits to the organizations. For instance, ICT increases overall productivity, quality and variety of services in banks (Berger, 2003), enhances the economies of scale in payment processing, clearing and settlement systems of the financial institutions (Schmiedel, Malkamaki, & Tarkka, 2006), or helps the small and medium firms gain credit advantage from the international bank (Dalla Pellegrina, Frazzoni, Rotondi, & Vezzulli, 2016).

To correct the potential bias, the instrumental variable (IV) estimation strategy is applied. An IV must satisfy two requirements: uncorrelated with the error term and correlated with the endogenous explanatory variable. In this study, variables related to weather variation are introduced as IVs for the percentage of the female borrower. First, weather change is a valid instrument because it does not directly affect the tendency of either technology adoption, among MFIs or customers, though it could be a strong motive. In this case, the sample including low-income countries in Asia which have comparatively low internet penetration. Similarly, the Digital Dividends report (World Bank, 2016) discusses the obstacles to the lower adoption of digital technologies by businesses in developing countries: gaps by income, age, location and gender, let alone many areas still remain unconnected, high cost of internet, lack of skilled staff and reliable infrastructure. And the main reasons are illiteracy and lack of skills among citizens (World Bank, 2016). A case study of MFIs in Cameroon (Mwafise & Stapleton, 2012) emphasizes two key attributes to increase technology take-up: socio-technical (i.e. security, MFI trustworthiness, and technology literacy), and

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7 The Durbin–Wu–Hausman (DWH) test of endogeneity is implemented. Because the dependent variable "Website accessibility" is a binary variable, I run the OLS regression then apply the DWH test. Results for the regression of website accessibility are: Robust score Chi-square(1) = 9.8336, p-value = 0.00017; Robust regression F(1,306) = 9.9175, p-value = 0.00018. Both test statistics are highly significant, so we reject the null of exogeneity, and continue to treat *Female Borrower* variable as endogenous

institutional factors (business operation and partnership). Therefore, although harsh climate could be a motivation for technology development, in the case of developing countries, it hardly become a direct factor due to rather low infrastructure and literacy level which potential makes the new technology adoption among MFIs unfavourable. Instead, substantial initial investment and available collaboration of MFIs with other organizations like banks or technology providers should be far more important indicators. This ensure the exclusion restriction of the IV related to weather.

Second, the effect of natural shocks on borrowing has been widely discussed so far. Berge and Schrader (2012) study the effect of volcanic eruptions in Ecuador and find out that natural shock increases the credit demand despite access to credit is restricted for the new borrowers. Czura and Klonner (2010) analyze the effect of Indian tsunami on credit demand in the Rotating Savings and Credit Association in India, in which there is a sharp increase in the price of credit in particular locations where are heavily affected. Closest to this study, Pelka et al. (2015) show that excessive rainfall increases credit risks, especially among the small-scale farmers. Clearly, natural changes, which could result in income fluctuation, do affect the demand for credit as well as credit risk, especially regard to the poor people whose lives are more precarious.

The instrumental variables related to weather shock is proxied by temperature shock and rainfall shock at the district level. The first stage that measures the effect of temperature shock and rainfall shock and the percentage of female borrower is modeled as follow:

$$FemaleBorrower_{ij} = \sigma_{1ij}TemperatureShock_{ij} + \sigma_{2ij}RainShock{ij} + \sigma_{3j}CountryControl_j + \varepsilon_{ij} \text{ (13)}$$

where $RainShock_{ij}$ and $TemperatureShock_{ij}$ are the levels that measure rainfall or temperature changes during a long period calculated in later section, ε_{ij} is the zero-mean idiosyncratic MFI-level error term. The MFI level and country level are indexed by i and j.

2.3.3. Comparison technology adoption between for-profit and non-profit organizations

As one of the important factors that motivates MFIs to apply technology is their current infrastructure, network and budget, this section discusses the tendency of technology adoption among MFIs of different legal status. On this aspect, a study by Cull et al. (2014) suggests that commercially oriented MFIs bear the costs of active prudential supervision by making traditional

bilateral lending contracts (rather than group lending methods favoured by microfinance NGOs), less outreach to poorer clients (as reflected in larger average loan sizes) but stronger financial performance. A similar comparison between nonprofit and for-profit MFIs are widely discussed. While nonprofit MFIs are more focused on social impact (Cull, Jonathan, & Demirguc-Kunt, Microfinance Meets the Market, 2009; Tchakoute-Tchuigoua, 2010), for-profit orientation corresponds with higher interest rates for microfinance clients (Roberts, 2013). However, strong penetration of bank-type MFIs gain an advantage in the sense that it can reach more clients, thus lending more to women (Cull, Demirguc-Kunt, & Morduch, 2014), which suggests that for-profits are more potential than non-profits to serve poorer clients and women.

Previous empirical findings suggest that MFIs that are larger and highly leveraged or bank-typed tend to have greater website accessibility and mobile financial services (Dorfleitner, Nguyen, & Rohe, 2018; Tadele, Roberts, & Whiting, 2018). Indeed, if the challenge for MFIs is the high transaction costs of handling small deposits (Cull, Jonathan, & Demirguc-Kunt, Microfinance Meets the Market, 2009) and increase the outreach, technology adoption would be a great help to manage the lending portfolios as well as close the geographical barriers.

In this sample, among non-profit MFIs, there are 74% of MFIs having website while only 19.3% offering mobile banking services; whereas among for-profit MFI, up to 79% having a website and 42.7% introducing financial practices on cellphones. Intuitively, such descriptive status suggest for-profit MFIs are more likely to engage in technology.

Therefore, to examine whether relaxing budget constraint is an important component, similar probit and IV regression is conducted with the sample being divided into two groups: non-profit and for-profit MFIs.

2.4. Variable construction and data

The data set are taken from three different sources. First, data of MFI-level were obtained in October 2018 from the Microfinance Information Exchange (MIX Market), not-for-profit organization that provides standardized and widely accepted information about MFIs. The sample

includes 344 MFIs in 22 Asian countries[8] in 2015, however, there are only 311 MFIs are examined due to the lack of information about women's borrower percentage. The advantage of the dataset is that it comprises a large number of MFIs with carefully-collected details which are served as a source for donors and investors' investigation. However, the sample selection might be bias because it is highly likely that listed MFIs on the website are somehow qualified enough to be able to deliver and disclose their synthesized data, which could possibly be more attractive to investors. Since the MFI's participation in providing database is voluntary, we could probably miss the small and medium MFIs that suffer from limited data auditing, which could make the result misleading. However, our chosen sample in this study covers the most prominent MFIs that overspread the wide fraction of microfinance customers. The later data used in IV approach are clustered at the district level; thus, the composition of microfinance institutions and their clients in this dataset could be considered acceptably representative.

Second, data about MFI's website availability and mobile banking service are self-reported in February 2019, which potentially contains two limitations: first, the information about website and mobile banking services are collected as one-time access, with no regard for the starting time of the channels. Second is about the validity of data, for example, an MFI can provide mobile banking services but do not mention on the website and vice versa. However, while data are collected at its best, there are 268 MFIs in the sample having a website on disclosure (about 86 percent) and 114 of them (about 46 percent) offering mobile financial services (MFS). These figures are rather proportional to the self-reported global statistics in 2012 in Dorfleitner (2018), that there were about 70% MFIs having websites and 17% MFIs offering mobile banking services.

Technology adoption

Our main dependent variable is Technology Adoption, proxied by the availability of the *website* and *mobile financial service*, which takes a value of 1 if the MFI offers an alternative, and 0 if

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[8] List of countries: East Asia includes China; Western and Central Asia includes Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan; Southeast Asia includes Cambodia, East Timor, Indonesia, Laos, Myanmar, Thailand, The Philippines, and Vietnam; South Asia includes India, Pakistan, Bangladesh, Sri Lanka and Nepal

otherwise. On the one hand, the website helps to improve ways of information disclosure. And on the other hand, mobile financial services include both transactional and non-transactional services (such as viewing financial information on the user's mobile phone), both mobile banking and mobile payment. The data are self-reported by examining the published website of 344 MFIs in 23 developing countries in Asia.

Female borrowers

The independent variable measures percentage of the female borrower in each MFI because women have been always considered to be the target of microfinance industry (Armendáriz & Morduch, 2010). Data are taken from the MIX Market.

Weather changes

Weather variation is measured by the amount of temperature and rainfall shock. Similar to Cole and Werker (2012), temperature shock is normalized as follow:

$$\text{TemperatureShock}_{ij} = \frac{Temperature_{ij} - \overline{Temperature_d}}{s_d}$$

where *Temperature$_{ij}$* is the average temperature measured for each specific MFI in the year 2015, calculated by the average temperature of all districts where MFI has representative branches, data being hand-collected from the forecast website *worldweatheronline.com* of 1175 districts that 344 MFIs have representative branches; $\overline{Temperature_d}$ and s_d are mean and standard deviation of temperature measured for that specific MFI in the long run of 20 years from 1991 to 2015. Long-run data being collected from the Climate Change Knowledge Portal – World Bank. The rainfall shock is calculated similarly.

Profit orientation

The dummy variable tells whether a MFI is for-profit, denoting 1, or non-profit, denoting 0. From the economics standpoint, the main difference between for-profit and nonprofit status is the ability to distribute profits, and if nonprofit earn revenues greater than costs, they are expected to invest

back into business for further social missions, whereas for-profit institutions are free to pursue anything (Hansmann, 1980). This data is taken from the MIX Market.

Other country control variable

To control for the level of *technology adoption*, the study uses *percentage of adults who are financially literate*, and *cost of 500MB mobile internet.* Since the target of this study is microfinance borrowers who are comparatively poorer and lower educated, thus they are more likely to suffer from financial knowledge gaps, not only in developing economies but also in countries with well-developed financial markets (Klapper, Lusardi, & Oudheusden, 2015). In a study of technology adoption among farmers in Madagascar, Moser and Barrett (2006) agree that learning effects play a significant influence on adoption decisions. Besides, cost of 500 MB mobile internet is also included to control for the level of technology adoption, because the comparatively high cost of mobile internet to the living standard could decrease the likelihood to promote mobile banking services among the poor people.

Data of the percentage of financial literate among adult is taken from the Global Financial Literacy Survey conducted by Klapper et al. (2015). The cost of 500 mobile internet is from the International Telecommunication Union. The profit orientation of the MFI is from MIX Market.

2.5. Empirical results

2.5.1. Descriptive analysis

Table 1 reports the summary statistics for the MFI-specific and country-level variables used in this study. About the technology adoption, among 344 MFIs, there are about 77% having website accessibility, whereas only one third offering mobile banking service. This is higher than the statistics of Tadele et al. (2018) in 2011-2013 that only half of MFIs globally having a website; and comparable to that of mobile financial services conducted by Dorfleitner et al. (2018) that

approximately 32% of MFIs in East Asia and South Asia providing mobile services as of 2017[9]. Please note that data in the two aforementioned references are also self-constructed.

Besides, as targeted, a large proportion of MFI borrowers is women which consist of 77%, which is proportionate to the global statistics in 2013: 79% of customers lived in Asia and the Pacific, including 86% of all women served and 89% of all counted as being the poorest, in which 91% of "poorest women" are also from Asia and the Pacific (Cull & Morduch, 2017). The financial literacy levels in the sample countries are low, at only 22.2% which could be the challenge for financial inclusion in the developing countries (Grohmann, Klühs, & Menkhoff, 2018). The price of 500 megabyte of mobile internet is approximately US$10 per month in 2015. This is relatively expensive as compared to the monthly incomes of an individual from a low-income country which is at around US$ 85, or from upper-middle income country which is at around US$ 336[10]. Regarding the profit orientation, up to around 57% MFIs in the sample is for-profit organizations.

2.5.2. Probit estimates of female borrowing's impact on the technology adoption's likelihood

Column 1, 2 and 3 in Table 2.2 measure the impact of female borrowing on the likelihood that the MFI has a website. In discussing the economic significance, the results are referred as marginal effect (refer to Table C2.1), which captures the probability of having a website as the percentage of women borrower changes, holding all other variables constant. The first column shows that a higher percentage of women borrower increase the probability of having website among MFIs by 22.5 percentage point. The probability of website accessibility increases by 22.7 percentage point when adding the variable of financial literacy, which the level of financial literacy is also positively associated to website availability by 1.42 percentage point. However, in column 3, internet expense decreases the probability of having website by 1.2 percentage point, however, the link between female borrower and website accessibility still remains significantly positive.

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[9] Note that the data about websites and mobile financial services available in this study is self-constructed in February 2019

[10] Data retrieved from The World Bank's interactive board on May 2010, accessed at https://datatopics.worldbank.org/world-development-indicators/stories/the-classification-of-countries-by-income.html

Column 4, 5, and 6 in Table 2.2 reports the tendency of mobile banking service availability. Overall, it can be seen that the higher probability of female borrower discourages the probability that MFIs provide mobile banking services. The marginal effect is reported in three later columns in Table A1. In the column 4, one percentage increasing in female borrowers decreases the probability that MFI provide mobile financial services by 22.7 percentage point. After adding two control variables, the marginal effect of female borrower percentage on mobile service offering lower by 19.3 percentage point. Unlike the estimation of website, two control variables, percentage of financial literacy and internet expense, play a negligible role on the outcome, although the signs of coefficients are consistent.

2.5.3. Instrumental variable estimates of the female borrowing's impact on the technology adoption's likelihood

Table 2.3 reports the IV estimations of the female borrowers' impact on the website availability likelihood. This measures the relationship between the percentage of female borrowers in MFIs and the probability of MFIs having a website at disposal. Panel B from Table 2.3 shows the results from the first stage regression. Note that the results are interpreted in marginal effect which refers to Table C2.2. The instrumental variables strongly determine the female borrower percentage and the F-statistic for the test of whether the instruments' coefficients are jointly equal to zero is in all specifications are above the threshold of 10 as the rule of thumb. The high level of F-statistics (around 15) means that the jointly two instruments variable *temperature shock* and *rain shock* are not "weak". Since there are two instruments, the test of over-identification test is provided with rather insignificant results which means we do not reject the null hypothesis of valid instrument. Panel A presents the IV estimates. In general, there is a significant increase in the probability of having website when the percentage of female borrower is higher, which is consistent with the previous probit estimation. A higher level of female borrower increases the likelihood of website availability by around 18 - 24 percentage point, in which financial literacy plays an important role to encourage the technology up to 14 percentage point. However, the cost of mobile internet reduces the website tendency by around 1.1 percentage point.

Table 2.4 presents the relationship between mobile financial service offerings and the percentage of women borrowers. The first panel reports the second stage as the main model and the later reports the first stage (see the interpretation in marginal effects in Table C2.2). Unlike the website

provision, the percentage of female borrowing does not support the offering of mobile financial services, although the coefficients are not significant. Without any control, the marginal effect of female borrowing on the likelihood of mobile service offering is a decrease by 25.8 percentage point. A higher level of financial literacy is strongly linked to the probability of offering mobile services, however, the contribution of internet expense is negligible.

2.5.4. Comparison of technology adoption between for-profit and non-profit organizations

To further analyze, the sample is divided into two groups of non-profits and for-profit MFIs to see if technology adoption levels are different due to financial constraints. For-profit MFIs mainly consists of bank-types which often have an advantage in structural financial infrastructure and wider outreach to women (Cull, Demirguc-Kunt, & Morduch, 2014) over non-profit MFIs. Therefore, it is expected that the link between women borrowing and technology adoption is higher among for-profit MFIs.

Table 2.5 provides probit and IV results of the estimation of women borrowing and technology adoption with sample residing in two groups of different profit orientation. Regarding the availability of the website, the link between female borrowing and website accessibility is significant and positive, however, the results are stronger in for-profit group. Notably, when it comes to mobile financial services, the impact of female borrowing is positive, though insignificant, in the for-profit group; but becomes considerably negative in non-profit group. This means that non-profit MFIs (mainly consists of the NGO-type) are more resistant to digitalization, especially when it comes to more advanced channels like mobile services. However, the limitation of the results is the relatively small sample size after division into two groups, which might affect the consistency between probit and IV results. However, the results are in line with recent analysis at the global scale of Dorfleiner et al. (2018) that mobile financial services are independent of the depth of outreach which is measured by the percentage of women borrower. The obstacles of technology adoption in the microfinance industry are discussed by Metre (2011) with examples from Kenya and the Philippines: most microfinance clients were previously unbanked and living in rural areas, those whose education and literacy levels are limited; whereas the country conditions seem not to be supportive, emphasizing the lacking agreement between Central Bank, rule of law and intermediary institutions.

Overall, it shows that nonprofit oriented MFIs are more resistant than for-profit group to go digital, which is seen more clearly when it comes to the mobile financial service offerings. This difference implies that for-profit MFIs which are often (or being backed up by) banks are more flexible to change, and having stable financial performance or being able to take advantage of current digital financial platform from supported banks would help to smoothen the process.

2.6. Robustness check: Technology adoption across different geographical areas

To break down the effect of women borrowing on technology adoption, the sample is geographically divided into South Asia, Southeast Asia and West Asia. Table 2.6 provides the probit and IV results of the link between women borrowing and technology adoption in three regions[11]. Panel A shows the estimate results of website accessibility. The relationship between female borrowers and website adoption is significantly positive in Southeast and West Asia, leaving the coefficient insignificant in South Asia (see the IV results). This could be because according to Figure 2.2 in Digital Dividends report (World Bank, 2016), South Asia countries are demonstrated much falling behind in internet access as compared with other regions (East Asia and Pacific, and Central Asia). The report also explains the barriers to access ICT of women in South Asia which are due to the facts that many live in poor and remote localities where access is predominantly outside the home, and where social norms for socializing or safety concerns are very limited. Considering the link between MFIs' website accessibility and broad settings, the study by Tadele et al (2018) suggests website accessibility is positively associated with economic development. Besides, financial literacy is also a positive attribute to the tendency of having website availability in all three regions.

Panel B presents the probit and IV results of the link between women borrowing and mobile banking service offering by MFIs. It can be seen that the coefficients of women borrower in Southeast Asia and West are insignificant, meaning that the percentages of female borrowing do not link to the likelihood of offering mobile banking services in these regions. Interestingly, the IV results in South Asia is significantly positive. Clearly, South Asia region consists of huge microfinance hubs like India, Bangladesh and Pakistan. There are up to 70% Indian MFIs in this sample that are profit-oriented type. SKS – one of the largest MFIs in India, indicated as the for-

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[11] The first stage IV regression is not provided to avoid overlap. However, the results are provided upon request

profit type, conducted mobile banking pilot since 2007, having partnership with Union Bank and using an outside technology provider. Despite the challenging start with few active users, SKS, serving as an agent for a bank, still expects the mobile banking program will deliver commission in the long-run, saving operational costs and reducing the interest rate for customers at the end (Kumar, McKay, & Rotman, 2010). In Bangladesh, there are currently up to 18 banks and MFIs including the two biggest Grammen and BRAC offering mobile services, serving 67.52 million registered clients, among which 37.31 million are active accounts. Besides, the success of the digital system by BRAC is supported by the partnership with bKash – the largest mobile financial service provider and great subsidiary of BRAC Bank (Kibria, Islam, Amin, Yasmin, & Islam, 2019). This implies the importance of internal infrastructure, financial strength and partnership that a MFI should have before acquiring new technology. Besides, to improve technology adoption in microfinance, Gutierrez-Nieto et al. (2017) emphasize the country indicators such as GNI per capita and ICT infrastructure, which potentially links to higher use of internet for social and financial reporting. The study also analyses the cultural sensitivity and transparency leading to the fact that the MFIs located in Africa and Latin America are less likely to disclose information as compared to MFIs in Asian or Eastern European countries. Overall, our findings are also in line to Mathison (2005)'s that ICT adoption requires strong financial health and a great investment, in which for-profit MFIs might have more advantage than nonprofit ones: i) organization's regulatory hinders rather than enables innovation, high cost of ICT infrastructure and the lack of human capacity; ii) financial sector in that country is unfavorable, lacking technical capabilities of financial providers to control the systems, and complicated business processes.

2.7. Conclusion

Most of microfinance clients are rural residents, women, or the very poor that remain unserved (Armendáriz & Morduch, 2010; Yunus, 2006). And microfinance institutions have been greatly benefited millions of them who live living in uncertainties, thus it is worth paying attention to improving the organizational efficiency. This study addresses a new way to enhance the performance of the MFIs, which is to involve in information and communication technology. Using the data of 344 MFIs in 23 Asian countries in the year 2015, the study examines the link

between women borrowing and the tendency of technology adoption measured in the probability of website and mobile financial service offering. To handle the potential bias in the relationship between borrowings and technology adoption, the two-stage least square method is applied by instrumenting the percentage of the female borrower with the climate changes measured at the district level. The weather fluctuation is calculated based on temperature shock and rainfall shock.

Overall, the result shows a positive link between the percentage of female borrowers and the tendency of having a public website, however, such link is negligible when it comes to mobile financial service. However, the results are much stronger among the profit-oriented MFIs while remains insignificant in the non-profit group, which again, implies the advantage of business infrastructure, profitability leverage, and wide partnerships that profit-oriented MFIs have over the nonprofit ones. Interestingly, the tendency of technology adoption is characterized across regions. The tendency of website accessibility is stronger in West Asia and Southeast Asia, followed by South Asia, which implies that higher internet penetration might link to economic development (Tadele, Roberts, & Whiting, 2018). South Asia witnesses a strong correlation between female borrowers and mobile financial services. The reason could be because South Asia consists of large microfinance hubs like India, Bangladesh or Pakistan where the number of microfinance clients is large and the MFIs tend to be pioneering in partnership with other banks and technology providers (Kumar, McKay, & Rotman, 2010).

Similar to the two previous studies of Dorfleitner et al. (2018) and Tadele et al. (2018), the main shortfall of this study is data limitation. Self-constructed data might be inaccurate depending on the availability of information that is able to collect. Also, the sub-samples in each group regarding profit-orientation and region are small that might make the estimation results inconsistent. However, this study fills in the gap of literature by looking at the motivators of technology adoption among MFIs on gender aspects, in which the endogeneity is addressed.

The paper's main findings suggest some practical strategies and policy implications, both challenges and opportunities for the MFIs. First, while the benefits of website accessibility and mobile banking services are well regarded as substantially helpful to both MFIs' operations and clients, the findings from this study suggests a good strategy is to target female clients because empirical evidence shows the potential link between the percentage of female borrower and the

MFIs' tendency of technology adoption. Second, the financial health of a MFI is crucial to the potential success of new technology adoption, which we see profit-oriented MFIs tend to be pioneering in both website availability and mobile financial services. Therefore, the role of external investment or collaboration between MFIs and other financial institutions or technology providers should be taken into account in order to build an effective digital system. Third, designing simple technological method and education on financial literacy would help to enhance the clients' active usage. Fourth, other MFIs should take lessons from MFIs in South Asia – centre of microfinance field, which the effect of women borrowing on mobile services is significant. With technology, the organization's reputation would be considerably improved, making MFIs more attractive to funding and network opportunities (Dalla Pellegrina, Frazzoni, Rotondi, & Vezzulli, 2016). Thus, it is expected to see new initiatives from the policymakers, technicians and practitioners to improve the quality and popularity of the ICT products so that the microfinance program will be able to fulfill its ultimate mission in developing countries.

Table 2. 1: Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Website	344	.77	.421	0	1
Mobile financial services	344	.328	.47	0	1
Female Borrowers (%)	311	.771	.279	.01	1
Financial literacy (%)	344	22.23	6.552	14	52
500MB Expense	344	10.297	5.101	1	21
For-Profit Status	344	.578	.495	0	1
Temperature shock	344	9.158	12.381	-42.266	76.427
Rain shock	344	-1.036	7.976	-28.446	45.891

Table 2. 2: Probit result: The impact of women borrower percentage on website accessibility and mobile financial services

	Website accessibility			Mobile financial service		
	(1)	(2)	(3)	(4)	(5)	(6)
Female Borrowers (%)	0.745**	0.949**	0.914**	-0.648*	-0.552*	-0.561*
	(0.271)	(0.292)	(0.293)	(0.263)	(0.267)	(0.269)
Financial literacy (%)		0.0484**	0.0391*		0.0200	0.0160
		(0.0171)	(0.0161)		(0.0112)	(0.0113)
500MB Expense			-0.0434**			-0.0263
			(0.0155)			(0.0151)
Constant	0.153	-1.043*	-0.354	0.0206	-0.498	-0.135
	(0.217)	(0.478)	(0.527)	(0.212)	(0.356)	(0.412)
N	311	311	311	311	311	311
R-squared	0.0216	0.0555	0.0790	0.0157	0.0237	0.0321

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2. 3: IV result: The impact of women borrower percentage on website availability

	(1)	(2)	(3)
Panel A – Stage 2: The impact of women borrower percentage on website availability			
Female Borrowers (%)	3.405***	3.637***	3.593***
	(0.326)	(0.266)	(0.291)
Financial literacy (%)		0.0510***	0.0478***
		(0.0142)	(0.0137)
500MB Expense			-0.0176
			(0.0137)
Constant	-2.215***	-3.533***	-3.231***
	(0.376)	(0.400)	(0.500)
Over-identifying restriction $\chi 2$	1.2448	1.3693	1.2622
Over-identifying p-value	0.6207	0.5433	0.6086
Panel B – Stage 1: Impact of weather changes on female borrowing percentage			
Temperature shock	0.00370***	0.00346***	0.00342***
	(0.00111)	(0.00104)	(0.00103)
Rain Shock	0.00247	0.00225	0.00248
	(0.00140)	(0.00137)	(0.00138)
Constant	0.738***	0.920***	0.939***
	(0.0200)	(0.0666)	(0.0765)
McFadden's R^2	0.2222	0.0653	0.0659
First-stage F-statistics	15.631	15.528	15.545
p-value	0.001	0.001	0.001
N	311	311	311

Standard errors in parentheses
$^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Table 2. 4: IV result: The impact of women borrower percentage on mobile banking services

	(1)	(2)	(3)
Panel A - Stage 2: The impact of women borrower percentage on mobile banking services			
Female Borrowers (%)	-1.844	-2.131	-2.082
	(1.103)	(1.180)	(1.103)
Financial literacy (%)		0.0362**	0.0338**
		(0.0122)	(0.0128)
500MB Expense			-0.0156
			(0.0155)
Constant	-1.786*	-2.791***	-2.547**
	(0.749)	(0.840)	(0.980)
Over-identifying restrictions $\chi 2$	1.238	1.3700	1.26
Over-identification p-value	0.2658	0.2418	0.2617
Panel B - Stage 1: Impact of weather changes on female borrowing percentage			
Temperature shock	0.00371**	0.00344**	0.00344**
	(0.00115)	(0.00111)	(0.00108)
Rain Shock	0.00181	0.00160	0.00172
	(0.00173)	(0.00168)	(0.00170)
Constant	0.737***	0.920***	0.937***
	(0.0201)	(0.0669)	(0.0765)
R-squared	0.0222	0.0561	0.0537
First stage F-statistics	15.631	15.528	15.545
p-value	0.001	0.001	0.001
N	311	311	311

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 2. 5: The impact of women borrower percentage on technology adoption according to MFIs' profit orientation

	Website				Mobile financial services			
	Probit	IV	Probit	IV	Probit	IV	Probit	IV
Female Borrowers (%)	1.231**	3.295***	0.871*	1.098**	0.215	0.926	-1.607**	-0.958
	(0.401)	(0.472)	(0.505)	(0.396)	(0.340)	(1.270)	(0.512)	(1.203)
Financial literacy (%)	0.0437*	0.0583**	0.0439	0.0231	0.0199	0.0279	0.0334	0.0201
	(0.0222)	(0.0177)	(0.0295)	(0.0287)	(0.0138)	(0.0190)	(0.0200)	(0.0279)
500MB Expense	-0.0627**	-0.0358*	-0.0169	-0.0204	-0.0403*	-0.0386*	-0.00289	-0.0163
	(0.0205)	(0.0181)	(0.0287)	(0.0272)	(0.0175)	(0.0180)	(0.0298)	(0.0276)
Constant	-0.272	-2.620***	-0.878	-3.953***	-0.374	-1.070	-0.286	-1.839
	(-0.272)	(0.736)	(0.945)	(0.649)	(0.506)	(1.297)	(0.733)	(0.637)
For-profit oriented	Yes	Yes			Yes	Yes		
Non-profit oriented			Yes	Yes			Yes	Yes
Observations	173		138		173		138	138
Pseudo R-squared	0.1474		0.0434		0.0368		0.0994	
Over-identifying restrictions χ2		0.7471		0.0099		1.3785		0.1726
Over-identification p-value		0.3874		0.9206		0.2404		0.6777

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. 6: Robustness check: website availability probability and mobile financial services in different geographic areas.

	Southeast Asia		South Asia		West Asia	
	Probit	IV	Probit	IV	Probit	IV
Panel A: Website accessibility						
Female Borrowers (%)	1.101**	3.721***	0.603*	3.042	0.847**	3.575***
	(0.406)	(0.424)	(0.308)	(2.079)	(0.394)	(0.380)
Financial literacy (%)	0.0205	0.0332*	0.0632	0.0660*	0.126*	0.0976**
	(0.0182)	(0.0169)	(0.0334)	(0.0304)	(0.0526)	(0.0359)
500MB Expense	-0.0400	-0.00777	-0.0008	-0.0146	-0.0744*	-0.0184
	(0.0208)	(0.0203)	(0.0302)	(0.0330)	(0.0355)	(0.0280)
Constant	-0.200	-3.162***	-0.878	-2.975	-1.751	-4.281***
	(0.660)	(0.749)	(0.978)	(1.831)	(1.471)	(0.980)
Overidentifcation test		0.2328		0.32061		0.1305
p-value		0.6294		0.5712		0.7179
Panel B: Mobile financial services						
Female Borrowers (%)	-0.504	1.707	0.665	3.564***	-0.513	1.704
	(0.384)	(1.865)	(0.548)	(0.837)	(0.521)	(1.723)
Financial literacy (%)	0.0151	0.0275	-0.00517	-0.0310	0.0692*	0.0886**
	(0.0152)	(0.0167)	(0.0210)	(0.0229)	(0.0307)	(0.0336)
500MB Expense	-0.0353	-0.0198	-0.00529	-0.0209	-0.0276	-0.0155
	-0.0353	(0.0274)	(0.0316)	(0.0259)	(0.0309)	(0.0312)
Constant	-0.0743	-2. 41	0.245	-3.346***	-1.295	-3.414*
	(0.576)	(1.720)	(0.786)	(0.767)	(0.989)	(1.613)
Overidentification test		.06347		3.095		.0820
p-value		0.8011		0.0785		0.7746
N	161	161	78	78	70	70

Robust standard errors in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Appendix C2: Output tables for marginal effects

Table C2. 1: The marginal effect of women borrower percentage on website availability and mobile financial services for probit model

	Website			Mobile financial services		
	(1)	(2)	(3)	(4)	(5)	(6)
Female Borrowers (%)	0.225**	0.277***	0.260**	-0.227*	-0.192*	-0.193*
	(0.0795)	(0.0810)	(0.0797)	(0.0895)	(0.0911)	(0.0907)
Financial literacy (%)		0.0142**	0.0111*		0.00696	0.00552
		(0.00479)	(0.00447)		(0.00382)	(0.00386)
500MB Expense			-0.0123**			-0.00908
			(0.00425)			(0.00513)
N	311	311	311			

Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C2. 2: The marginal effect of women borrower percentage on website availability and mobile financial services for 2SLS model

	Website			Mobile financial services		
	(1)	(2)	(3)	(4)	(5)	(6)
Female Borrowers (%)	0.187	0.241	0.223	-0.2582	-0.223	-0.222
	(0.197)	(0.173)	(0.179)	(0.4757)	(0.448)	(0.4854)
Financial literacy (%)		0.014***	0.0113**		0.00723	0.00591
		(0.173)	(0.004)		(0.00448)	(0.0048)
500MB Expense			-0.0116**			-0.00876
			(0.006)			(0.0058)
N	311	311	311	311	311	311

Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 3

Measuring women's empowerment index and gender impact from microcredit program

Abstract

This study explores the impact of gender training and business training on women empowerment, using the survey data from TYM Fund - a Vietnamese microfinance institution that open to women. Firstly, the empowerment index is created with the application of factor analysis, which categorizes women empowerment into individual, household, and community levels. The item response theory is provided as a robustness check to control for the construction of the index to be appropriate. Secondly, the impact of training on different empowerment levels is examined using double-difference estimates with due attention to the spillover effect. Overall, the results show that training has a positive influence on women empowerment at all levels (individual, household, and community), in which the impact is considerably stronger when the husbands are invited to join. For the husband-joint training, the sense of confidence and community engagement considerably increase among women participants even in the long-run. However, a higher number of family members could potentially be an issue that hinders the household empowerment of women, while increases the level of self-empowerment and community engagement.

Keyword*: microfinance, women empowerment, training*

JEL*: G20, G21, B54, M53*

3.1. Introduction

Microfinance program has become increasingly applied as a poverty alleviation intervention in developing countries worldwide. Many international aid donors, governments, scholars, and other development experts have paid much attention to microfinance as a strategy to provide, particularly, women with more economic opportunities, increase their empowerment, and engage them in the development process. Gender inequality has been always recognized as a significant obstacle to national development, especially in developing countries where women still face disadvantages such as the lack of education, low employment, scarce political representation, and intra-household oppression (Armendáriz & Morduch, 2010).

In a broader view, women empowerment and economic development are interrelated, therefore many policy commitments and interventions are implemented to foster the equality between men and women (Duflo, 2012). Such development is characterized by the three main phases: i) a long phase of stagnation with low female bargaining power; ii) a rapid transition introducing a strong increase in gender equality, population acquiring skilled human capital, higher income per capita, and advanced technological level; iii) a phase of sustained growth in technology and income with high female bargaining power, almost all the population acquiring skilled human capital, while fertility rates are decreasing (Diebolt & Perrin, 2013).

Though microfinance services are available to both men and women, a large part of borrowers is women since it is argued that offering access to microfinance services to women is a promising tool to empower women and increase gender equity (Armendáriz & Morduch, 2010). However, women's empowerment is conceptually complex and methodologically challenging to measure and analyse; therefore, to date, neither scholars nor agencies have developed a rigorous tracking method which makes it complicated for institutions to evaluate whether the undertaken efforts are succeeding (Malhotra, Schuler, & Boender, 2002). The most frequently identified dimensions of women's well-being are literacy, education, health, labour force participation, contraceptive use, mobility, ownership of clothing and assets; as well as other relative-well-being indicators such as household bargaining position. There are recent studies that have attempted to establish the relationship between credit program participation and some notion of women's empowerment, but all of these studies suffer from potential bias due to endogeneity of decisions involved in program

participation and the unobserved household individual and local characteristics (Pitt, Khandker, & Cartwright, 2006). The unobserved heterogeneity likely leads to biased estimates that concern the unobserved attitudes and characteristics of husbands, wives, and other family members, including preexisting women's empowerment and autonomy.

Given that the literature provides scares evidence on measuring the degree of empowerment among microfinance clients, the purpose of this study is to establish a comprehensive index to measure the empowerment and examine how microfinance participation benefits female clients, using the factor analysis method and applying a robustness check based on item response theory (IRT). After that, the impact of microfinance training on gender and entrepreneurship is going to be estimated to analyse the empowerment index of three levels: individual, household and community, with due attention to the heterogeneity bias.

The results demonstrate that among two kinds of training: individual and husband-joint training, the training with the husband shows a stronger impact on all three types of indexes. However, a big number of the household members could be a negative attribute to the level of empowerment of family, while increases the level of self-empowerment and community engagement. Another important finding is that positive changes based on training become more notable in the long-run, in particular, one year after the training rather in short term or six months after the training. The estimation results confirm the importance of the female empowerment training in the overall development of women, especially when the husbands are present, which implies the importance of mutual understanding and agreement in the empowerment process of microfinance clients.

The study is organized as follows. Section 2 discusses the previous literature and its salient findings related for the measure of empowerment; section 3 provides the research design and data; section 4 presents the methodology of the composition of the empowerment index using factor analysis; section 5 discusses the empirical results of the impact of training on female empowerment; section 7 presents the robustness check for the building of the empowerment index using item response theory method; while section 8 concludes.

3.2. Literature review

3.2.1. Empowerment

Women's empowerment is defined as women's ability to make strategic life choices in settings in which this ability was previously denied to them, thus it is a process of change that provides women with freedom and power and enhances their ability to exercise choices that improve their well-being (Kabeer, 1999). Women's empowerment has been studied as a multifaceted concept which includes a variety of aspects such as life cycle (Arestoff & Djemai, 2016) where age and generation effects are important to drive the changes in labour-force status, household composition, parenthood, personal beliefs and social networks (Hansen, 2015). The importance in this process is also bargaining power in land ownership (Mishra & Sam, 2016) and women's labour force participation (De Jong, Smits, & Longwe, 2017). Weber and Admad (2014) present three approaches to define the empowerment: firstly, it can be seen in a relational way, as perceived control over others or over oneself, mainly as subjective perception; secondly, it can be the way people perceive their power and whether they feel to be satisfied with their own power; thirdly, it could be more as *enabling* rather than delegating, which means enabling them to achieve certain goals such as a certain level of income or being able to decide on the children's education.

It is acknowledged that the concept of women's empowerment is elusive for a variety of reasons (Mason, 1987) and that the potential of structured surveys that contribute to our understanding of its concept is limited (Mason, 1986). The term has been used more often to advocate for certain types of policies and intervention strategies than to analyse them (Malhotra, Schuler, & Boender, 2002). Most of the literature discusses empowerment as a key part of promoting social inclusion (Duflo, 2012). For example, Narayan et al. (2000) see empowerment as "The expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives". Their study focuses on state and civil institutions at both national and local levels, including informal institutions such as kinship and neighborhood networks, where institutions at the micro level, such as those of marriage and household, are not considered a part of civil society. Bennet (2002) has developed a framework in which empowerment and social inclusion are closely related and empowerment is defined as "the enhancement of assets and capabilities of diverse individuals and groups to engage, influence and hold accountable the institutions which affect them", while social inclusion is "the removal of

institutional barriers and the enhancement of incentives to increase the access of diverse individuals and groups to assets and development opportunities". Bennet (2002) also points out that the empowerment process should be "from below" and involves agency, as exercised by both individuals and groups.

3.2.2. Microfinance and women empowerment

Microfinance, in its simplest explanation, is a provision of credits and other ancillary financial services for the poor who do not access to the formal banking system. Initiated by Professor Muhammad Yunus in the 1970s and sprung to huge popularity in the following decades, it has been considered as an effective tool for poverty alleviation as well as financial inclusion for the poor and unbanked (Armendáriz & Morduch, 2010). According to the data that refer to 2014, the microfinance sector primarily serves female borrowers, representing 81% of total and in South Asia, in which female borrower comprises up to 92% of the total, typically with a higher concentration of microenterprise lending, being the world's largest microfinance market (Khamar, 2016). Pitt and Khandker (1998) find out that the effects of program participation, measured by the cumulative borrowing, was more considerable on women as compared to man in terms of increasing flow of consumption expenditure, children education and assets. In later reveal, Pitt et al. (2003) examine the behaviours of two genders in handling additional resources from the microfinance program in their children's wellbeing. The results show that women's credit significantly improves children's health and nutrition, especially among girls.

The empowerment through microfinance has been proved by certain literature. Offering women access to credit and saving services does increase women's empowerment (Armendáriz & Morduch, 2010). Weber and Admad (2014) compare women in higher loan cycles with those in the first loan cycle and find the significant increase in empowerment in terms of financial security (how to use the loan, autonomous decision-making, improved payback rate) and mobility freedom which leads to a higher level of social engagement in the long run.

Over the years, microfinance services have evolved to not only offer microcredit but also different financial and non-financial services (Armendáriz & Morduch, 2010). One of the salient studies at the early age of microfinance research is conducted by Hashemi et al. (1996) where two types of microfinance institutions are compared: the Yunus' Grameen bank with a "minimalist" approach

and BRAC with a "holistic" approach. "Minimalist" credit programs, as opposed to those with holistic approach, primarily provide credits with little nonfinancial training and in this case, Grameen bank aims at having a "profitable lending to the rural poor on a large scale" rather than to directly empower their clients (Hashemi, Schuler, & Riley, 1996). Besides, BRAC with the holistic approach provides women with integrated educational sessions on various topics from self-development, family, and business. The results suggest that involvement in credit programs leads to empowerment, no matter in either approach, it both increases women's mobility, bargaining power, spending, sense of ownership, the social awareness and public participation.

Nevertheless, the study by Dineen and Le (2015) examine the agency dimension of empowerment by asking women to assess the qualitative statements related to the sense of self-worth such as "Women should do all household chores even if their spouse is not working", or "Women should discuss domestic violence issues with people who are not family members", on the scale from "unimportant" to "extremely important". The authors find that the respondents are more conscious about their self-worth as well as their rights and responsibilities after 4 years in the program, except for the statement regarding household chores mentioned above. Even after 4 years, the respondents placed more emphasis on their responsibility of entire household chores, implying that women's perception of household gender roles remains the same, even somewhat more intensified than before. This result was consistent with the discussion of the findings from Weber and Ahmad (2014) that conclude the status quo of gender stereotypes within households might not have been challenged by simply participating in the microfinance program alone.

3.2.3. The measurement of empowerment in microfinance

In Hashemi et al. (1996), women empowerment was measured on the basis of eight indicators: *mobility* (if the respondent is used to move), *economic security* (possession of a house or homestead land, cash savings or savings that are used for business or monetary lending), *ability to make small purchases* (small items of daily consumption products for family or for herself, the use of money without asking husband's permission), *ability to make larger purchase* (household appliances, children's clothing or her clothing, family's daily foods), *involvement in major household decisions* (if the decisions about house reparation or renovation, investment, lease or buy family land, purchase of business tools are made individually or jointly with husband), *relative*

freedom from domination within the family (deprivation of money, land, jewelry or livestock or land, limitation in visiting the natal home or working outside the home), *political and legal awareness* (being informed on a local government officials, members of parliament and the Prime Minister, on the significance of marriage registration and being awared of the law governing inheritance), and *involvement in political campaigning and protests* (participation in the campaigned for a political candidate or participation in the protests against man beating his wife, unfair wages, unfair prices, misappropriation of relief goods). The authors demonstrate that participation in credit programs indeed empowered women, either in a minimalist or holistic approach. However, in the minimalist approach, women are more empowered in terms of economic security and ability to make small and large purchases; while members from later approach perform better on mobility and legal/political awareness. It was also found that women's contribution to family support alone played a significant role in the possibility of being empowered, regardless of whether they were participating in the credit programs.

Kabeer (1999) defines power as the *ability to make choices* and thus conceptualizes empowerment into three dimensions: *resources* (pre-conditions), *agency* (process) and *achievements* (outcomes): i) *resources* include both physical assets and various human and social capital which serve to enhance the ability to exercise choice; ii) *agency* is the ability to define goals and act upon them, which encompasses the meaning, motivation and purpose that individuals bring to their activity, their sense of agency, or "the power within"; iii) *achievements* refers to the extent to which this potential is realized or not, or the outcomes of people's effort are achieved (Kabeer, 2005), which could be very basic such as life-expectancy, ability to have access to credits, healthcare, education, employment or more complex such as political representation (Kabeer, 2005). The *achievements* could be seen as "catalyst" (Malhotra, Schuler, & Boender, 2002). In the recent work by Huis et al. (2019), the women empowerment is, instead, categorized into three: i) *personal control beliefs*[12]

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[12] According to Huis et al. (2019)'s summary, internal locus of control includes: i) what happens to me is my own doing; ii) when I make plans, I am almost certain that I can make them work; iii) getting what I want has little or nothing to do with luck; iv) it is impossible for me to believe that chance or luck plays an important role in my life. External locus of control includes: i) sometimes I feel that I don't have enough control over the direction my life is taking; ii) when I make plans, it is not always wise to plan to far ahead, because many things turn out to be a matter of good or bad fortune anyhow; iii) many times, I might just as well decide what to do by flipping a coin; iv) many times I feel that I have little influence over the things that happen to me.

that only considers the internal locus of control while excludes the external ones; ii) *relational empowerment* that includes *relational friction* and *intra-household decision-making*.

Huis et al. (2017) analyse the previous literature and propose a three-dimensional model of women's empowerment as follows: starting from i) the micro-level, referring to an individual's personal beliefs as well as actions, such as locus of control, self-confidence, self-esteem, and self-efficacy; to ii) the meso-level, referring to beliefs as well as actions in relation to relevant others, such as domestic violence, bargaining power, freedom of mobility, social network size, social capital, and collective action involvement; and iii) the macro-level, referring to outcomes in the broader societal context such as percentage of female microfinance borrowers, percentage of female borrowers with school-aged children in school, percentage of female leadership in MFIs, percentage of female staff promotion and average loan balance for female borrowers.

Pitt et al. (2006) study the data in rural Bangladesh in 1998-1999 and find out that women's participation in microfinance program helps to increase women's empowerment, whereas the effects of male credit on women's empowerment were generally negative. The indicators are purchasing, resources, transaction management, husband's behaviour, mobility and networks, activism, finance, fertility and parenting, and household attitudes. Credit programs increase the role of women in decision making process within the family, economic security and more engaged in the community circle, freedom of mobility, better family planning and parenting issues. Whereas the presence of male microcredit programs had a negative effect on women's control of resources, finance, freedom of movement, network development, also on family control and household bargaining.

Interestingly, Gupta and Goetz (1996) examine a situation where empowerment often being referred to high repayment rate. The study finds that a significant proportion of women's loans is controlled by male relatives. This finding brings a new challenge to the outcome measurement, in a way that the observable results may outweigh concerns to ensure the meaning of women's personal development. In fact, recent studies point out that there is no connection between microcredit access and women's bargain power in the household, namely by Tarozzi et al. (2015) in Ethiopia, by Banerjee et al. (2015) in India, and by Crepon et al. (2015) in Morocco. Besides, regarding women themselves, Kim et al. (2009) show that those who participate in microcredit

interventions tend to exhibit more financial security and self-confidence compared to those who do not join. The finding by Garikipati et al. (2017), on dividing the source of debt into "planned loans" and "instant loans" (such as loans from the vulgar ambulant lenders or friendly shopkeepers – those are perceived as socially dishonourable) bring up a unique conclusion: instant credit is a significant part of poor women's loan portfolio which influences women's intra-household bargaining power from routine money decision to children's health and education. The reason is that when women undergo social pressure when borrowing the loans, they are more appreciated in the family and thus improve their household power. The larger planned loans are only used for productive investment with the expectation of improving the family's livelihoods.

So far, developing valid and reliable measures of women's empowerment was one of the most difficult tasks of this study. Behaviours and attitudes that might be used to measure women's empowerment in one society may have no relevance in another, leaving aside the potential ambiguity of general questions in the existing literature, depending on the respondents' perception.

3.2.4. Methodological issues of measuring the impact of microfinance: empowerment

One of the most difficult issues is to operationalize empowerment (Weber & Ahmad, 2014). Since empowerment is a broad concept with multi-dimensional features, the components of empowerment should be carefully selected and measured. In this study, the measurement is qualitatively selected and based on the current literature and data availability; as well as quantitatively chosen and based on the validity coming from the item response theory method. The measurement is categorized into three levels: individual, household, and community level.

Besides, Weber and Ahmad (2014) point out the reversed causality effect between microfinance and empowerment and there have been many studies applying the randomized control trial approach to handle the endogeneity. By using the data conducted by the International initiative for impact evaluation and assuming the treatment group as women who had access to microcredit and attended training, and control group as those who women who had access to microcredit, but did not attend training, it is possible to avoid endogeneity of the training and other individual characteristics in considering the level of women empowerment.

3.3. Research design

3.3.1. Microfinance in Vietnam

Living in a patriarchal society of strong Confucianism values, Vietnamese women used to have *three obediences*[13] and *four virtues*[14] to live up to, which directly isolate and subordinate women for many generations. The husband is considered to be the main breadwinner of the family while the priority of the wife is to take care of the family, which implicitly makes women become socially and economically dependent on men. The fact that these social norms curtail women's employment since there are fewer opportunities for them, leading to unequal treatment not only in the household but also in the society, can be gradually tackled by giving women more involvement to financial security. It is found that in lower income countries, women do the majority of household thus spend less time in labour market, for example, the amount of time that women spend on unpaid domestic work is 30 percent more than men in Cambodia and six times more in Guinea (Berniell & Sánchez-Páramo, 2012). This explains why women in developing countries are more likely to engage in informal work (Duflo, Women Empowerment and Economic Development, 2012). Many microfinance institutions are making an attempt to tailor their programs to support the women at their locals, by offering financial services and other training modules.

In Vietnam, the microfinance system is recognized by the coexistence of market-based and state-driven approaches to the provision of financial services to poor and rural households. The two state-owned banks are the Vietnam Bank for Agriculture and Rural Development and the Vietnam Bank for Social Policies, together they involve 1,130 member-based people's credit funds, 2 licensed MFIs (M7-MFI and TYM Fund) and about 50 major semiformal MFIs (Asian Development Bank, 2016). It was estimated that rural areas in Vietnam received only 17% of total bank credit and less than 20% of the rural population had access to formal financial services. This

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[13] The three obediences include: i) until she is married, submit to her father as a daughter; ii) after getting married, submit to her husband as a wife; iii) in case her husband passes out, submit to her son.

[14] The four virtues include: i) good home-caring skills; ii) appropriate appearance; iii) appropriate speech; iv) appropriate behaviours. The last one is the most important in the sense of showing respect to the elder, considerate to the younger, obey her husband, and live harmoniously with everybody. The women are expected to remain mild-tempered and modest in the society.

lack of access to finance is considered as one of the major constraints to enterprise development and employment creation (Asian Development Bank, 2016).

3.3.2. Project intervention

The data utilized in this analysis comes from the study that examines the impacts of the training project named Gender and Entrepreneurship Together – GET Ahead (Lensink, 2017). The training is conducted by TYM Fund[15] which is one of the largest MFIs in Vietnam that focuses on women in low-income households only, under the project of International Initiative for Impact Evaluation (3ieimpact.org). There are two types of training offered to women borrowers who join the training with husband and women borrowers who attend the individual training. There is also a control group that consists of women who only receive loans and do not attend any training.

According to the 3ie Grantee Final Report (Vu, Velzen, Lensink, & Bulte, 2015), the randomised controlled trials are implemented in the network of four branches (4 provinces: 1 in Hanoi, and 3 in Vinh Phuc) including 187 credit centre, each with around 30 female clients that are randomly assigned to treatment or control groups. The randomization was stratified by branch, and the training is also randomly conducted to individual at centre level in order to reduce the possibilities of spillover. The number of women in two training treatments and one control group are ensured to be proportionate, therefore the number of women in husband-join training group is doubled to avoid the low take-up rate among husbands. In total, there are 70 credit centers where husbands are invited to co-join, 31 credit centres where only female clients are invited to the training and 86 credit centres where female clients do not attend any training.

The observations are collected in three periods: October-November 2011 - three months the training started, March-May 2013 - six months after the last training module, and October-November 2013 - one year after the last training.

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[15] TYM Fund, originated from Tinh Thuong Fund project, was formed as a project of Vietnamese Women's Union in 1992 that supports disadvantaged women to access financial services. In 2010, TYM Fund separated into the first MFI licensed by State Bank of Vietnam. TYM Fund focuses on supporting low-income women living in primarily agriculture-based communities within the poorest districts and communes in the northern Vietnam. TYM Fund provides financial services (credit and savings) and social services (training, capacity building, community support activities, business development support activities). According to the Performance report 2018 **Invalid source specified.**, it has the network of 3954 centers in 13 northern Vietnam provinces.

3.4. Building Empowerment measures

The empowerment indicators are measured through a set of observed variables. According to Pitt et al. (2006) it is assumed that the unobserved latent variables account for the dependencies among the indicators, while the number of empowerment latent variables is smaller than the set of empowerment indicators. Therefore, the estimated latent variable model has two parts. The first part links the unobserved latent variables to a set of observed indicators and is called the measurement index, using factor analysis models. After fitting a factor analysis model, latent scores are calculated and used as dependent variables in the second part of the analysis.

To create the empowerment index, two main approaches are applied: principal components analysis for variable reduction and factor analysis for identifying underlying factors or constructs. In both approaches, the basic idea is to find a smaller number of entities (factors or components) that account for most of the variation or the pattern of correlations. In this study, the exploratory factor analysis utilized is based on two reasons: first, the set of questions are conceptually developed a priori; second, the unobserved latent variables are thus assumed to cause each individual to respond in predictable ways based on the prior set of questions (observed variables).

3.4.1. Exploratory factor analysis

Factor analysis is a multivariate mathematical technique that addresses the problem of how to analyse the structure of the interrelationship among many variables by identifying a set of underlying dimensions known as factors. Following the paper of Bondinuba et al. (2020) that uses factor analysis to examine the motivations behind MFI's decision to enter the housing market, this study utilizes a set of survey answers from GATE training in a TYM – one of the biggest MFIs in the northern Vietnam to formulate the index of women empowerment in the microfinance context.

For simplicity of analytical purpose, each motivation variable of the questionnaire was coded as *item* going from item 1 to item 32 (see Table 3.1). The reliability for all the 32 measurement indicator variables was ascertained using Cronbach Alpha which gives an overall reliability value of 0.9134 which is above the recommended minimum value of 0.7 (see Table 3.2). Barletts's Test is significant, indicating that there are sufficient intercorrelations to conduct the factor analysis.

The Kaiser-Meyer-Olkin measure is used to control the suitability of the data for structural detection for the appropriateness of the factor analysis[16], which is equal to 0.9231 (above the rule of thumb 0.5), indicating that the data collected is suitable for the factor analysis (Pituch & Stevens, 2016).

The number of retained factor is identified on the basis of two rules: i) retain factors having minimum eigenvalues equal to 1; ii) retain factors performing the scree test. The scree plot is shown in Figure 3.1 and demonstrates the magnitude of the eigenvalues which is plotted against ordinal numbers. In Pituch and Steven (2016, p.343), it is recommended to retain all the eigenvalues in the sharp descent before the first one, on the line where they start to level off, which in this case, the level-off point that refers to eigenvalue equaling to 3. The results of models with four and five factors have been also considered, however, 3-factor model suites better in terms of both conceptual and mathematical way.

In order to obtain a meaningful representation of items, Table 3.3 provides the factor loading results which are being rotated using orthogonal transformation. The items with loadings ≥ 0.4 were considered meaningful and extracted from factor analysis (Pituch & Stevens, 2016). Therefore, it is possible to set one group of the first 15 items of highest loadings in column 1. The differential break between item 15 and 16 makes the second group, from item 16 to item 21. The remaining items belong to the third group.

3.4.2. Confirmatory factor analysis

After constructing the three groups, it is necessary to examine their validity. The validity of the group is the accuracy of the measurement of its content. Another important aspect is the measurement of the sampling validity, which detects whether a measurement instrument has adequate and representative coverage of the variable concepts being measured. This can be achieved by conducting confirmatory factor analysis (CFA) which is a useful method to verify the

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[16] Larger Kaiser-Meyer-Olkin values show better outcomes. This test provides an overall measure of the overlap or shared variance between pairs of variables. It worth mentioning that we are trying to identify items that are related but yet provide unique information on the factors we are attempting to identify. Therefore, higher values indicate the overlap but not to the point of hindering the analysis due to multicollinearity.

extent to which items represent a distinct factor when a theoretical structure is hypothesized (Floyd & Widaman, 1995).

Before conducting CFA, the reliability test is carried out by looking at the Cronbach alpha. This is a measure of reliability that focuses on the internal consistency of the set of items forming the estimated subscale. Table 3.2 shows that Cronbach's alpha score for all 3 factors is significant, above the rule of thumb of 0.6, suggesting that the internal reliability index is adequate (Pituch & Stevens, 2016).

The measurement model is built by using the factors created by EFA. In this model, the consistency of the latent variables with the underpinning observed variables tends to improve (see Figure 3.2). When conducting CFA, the adequacy of the instrument structure is typically assessed based on model fit indices. Since in each model the fit index provides unique information, the use of multiple indices is recommended (Jackson & Gillaspy, Jr, 2009): The chi-square goodness-of-fit index equals to 391.43, with p-value = 0.08[17] (Jackson & Gillaspy, Jr, 2009); the root mean square error of approximation equals to 0.068, with recommended value <0.08 (Steiger, 1980); the Tucker-Lewis index which equals to 0.814, with the recommended value > 0.95 (Tucker & Lewis, 1973); the comparative fit index equals to 0.834, with the recommended value >0.9 (Bentler, 1990); the standardized root mean squared residual equals to 0.070, with recommended value <0.08; and lastly, the coefficient of determination equals to 0.995, indicating a good fit.

3.4.3. Discussion on factors

The outputs of EFA show that three groups have emerged and are confirmed through the CFA. The justification and implications of the corresponding dimensions are now discussed in the context of women empowerment.

Considering the multifaceted results of empowerment measures, it is acknowledged that the concept of women's empowerment varies highly and that the potential of structured surveys to contribute to its understanding is inherently limited. According to Bennet (2002), *empowerment* is characterized by *social mobilization* which approaches work "from below" to create voice and

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[17] Chi-square model assesses overall fit and the discrepancy between the sample and fitted covariance matrices. Null hypothesis: the model fits perfectly, with cut-off for good fit p-value > 0.05

demand for change; therefore, to realize empowerment, the "from below" process needs to be supported by complementary efforts of all system levels. Thus, three factors are referred to the empowerment at *individual, household, and community level.* Please note that in analyzing the dataset, all the selected responses in the factor analysis model are standardized into binary variable 1 or 0, representing "empowered" or "not-empowered", with a detailed explanation of each answer are discussed below.

Individual level: The respondent was presented with a list of questions related to their economic situation, whether she has income or savings, run a farming activity or a family business with the factor loadings of 0.69, 0.577, 0.326, and 0.123 respectively. The low factor loadings of having or not having a family business is due to the limited data gathered and a low number of women having a business. However, this variable is retained because of it is important for the source of income and economic security of a woman. The answers are converted into binary variables, which equals to 1 if the respondent is secured by having income source, and 0 otherwise. Besides, the role in the family is also crucial in the woman's self-perception. A list of questions about decision making on various topics is recorded, all of them having rather consistent factor loadings. This means that these questions largely account for the individual empowerment. If the choice is made solely by the woman, or jointly with her husband, the answer is converted into 1 as "empowered" and 0 otherwise. Regarding the joint-decision making, Fonseca et al. (2012) explain that mutual agreement is suggested to be prioritized for a couple, which could also be sensitive to the level of education of spouse. Furthermore, joint-decision making means the importance of family support toward women, because culturally speaking, in Vietnam, most household heads are male who comes with the highest voice.

Household level: Similar to Huis et al. (2019), this level includes relational friction with seven items related to the extent of household violence (verbal abuse; physical assault; threatened and used with an object like sticks, knife; being kept from seeing others; being controlled where and when at all times; need permission before doing anything; insulted or humiliated in public space). The answer is equated as 1 if the respondent declares to not suffer from mentioned above family violence and 0 if otherwise.

Community level: On the one hand, having knowledge does not only helps women to increase their business but also leads them to a higher quality of life. Among the 9 questions related to business knowledge and 4 questions related to cognitive ability in the survey, which are asked in three different time periods, only 8 questions are taken into consideration. There are 6 questions[18] that are excluded from the factor analysis, which are either due to vague meaning, or insignificant loading factor. The answer is coded as 1 if the respondent gives the right answer and 0 if otherwise. On the other hand, interaction with non-family members also accounts for the level of empowerment in the community. Since the joint-liability lending model is popular in microcredit, Pitt and Khandker (1998) emphasize the importance of social ties to incentivize repayment and increase household consumption. In another way, Kono (2014) conducts an experimental study in Vietnam and finds out that people tend to act as free-riders in group lending, which shouldering behaviours seem to be the strategic default that might cause irresponsiveness and badly affect the repayment. Due to the limited availability of this type of question, only four questions are taken: willing to lend money or possessions to others, trusting non-relatives, belonging to different social groups. The positive response is coded as 1 as more "empowered" and 0 otherwise.

Composite empowerment indicators: Hashemi et al. (1996) create an index of empowerment through a linear weighted combination of individual empowerment indicators. They establish an arbitrary cutoff point such that women who score above this cutoff are labeled empowered and those who score below are labeled unempowered. Later on, Pitt et al. (2006) measure women's empowerment as a latent variable encompassing a number of indicators that proxy for different empowerment dimensions. In the same line with Pitt et al. (2006), the empowerment index is calculated in this work as an unobserved latent variable level, in which EFA and CFA refer to three sub-levels: individual, family, and community. The composite empowerment index is the sum of the three dimensions discussed above, which range from 0 to 32.

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[18] Six excluded questions due to vague meaning are: Only price determines whether customers will buy from you or your competitors; The surest path to success is to sell what you are already good at producing, rather than what your customers want; Your sister sells high quality cloth, a new seller offers a lower quality cloth at lower price, your siter should reduce her price too; Villagers with small businesses do not need to advertise their products; If you charge more than another seller, customers will not buy from you. One question of insignificant loading factor: It is not necessary to separate money used for business and money used for household. For these statements, respondents have to choose True or False.

It is noteworthy that for certain empowerment items regarding if the decision is self-made, jointly-made with husband, solely her husband or don't know; the self-made and jointly-made with husband options are considered as relatively empowered. For the effect of patriarchal culture, autonomous household decision-making is hard to measure separately because the majority of women in the rural areas are strictly confined to the tradition, thus having a business of her own with external support and validation is seen as a positive change. On the one hand, the sole financial decision is not always good: a research sample from South Indian suggests that women only gain a higher stake in matters directly related to the loan use, but not more substantial involvement in other domains of household decision-making, and only when loans are channeled via business and social intermediation, substantial shifts in decision-making patterns do emerge (Holvoet, 2005). Similarly, Gupta and Goetz (1996) propose that women tended to exert greater control on lower loans which were then invested in "women's assets" such as livestock, vegetable, or animal products; but when the loan got larger, it was likely to transfer to more masculine activities that could yield higher returns such as petty trading or rickshaw pulling. Furthermore, the joint decision seems to give out better results: it is found out that women in self-help group in Kenya are more empowered with enhanced joint decisions, reducing the gender gaps; and in particular, men have a higher decision making power in relation to more scaling issues such as household assets, while women incline to food and daily expense decisions (Lydiah, Ngare, Casper, & Immaculate, 2019). Interestingly, Garikipati (2013) suggests that giving some money to husbands might indicate women's strategy to preserve marriage and family harmony, in exchange for continued membership in microprograms. For example, a women's loan to purchase the "male productive asset", i.e. a rickshaw, helps the women to retain some control over the asset. In fact, Goetz and Gupta (1996) presume that microloan is not only served as the financial inclusion for women only, it also raises the possibility of women being treated as a new source of money by her family. Therefore, this study decides to associate both the options "self-made decision" and "jointly-made decision" as a one, indicating relatively higher empowerment.

3.5. Empirical specification

To estimate the impact of the business training program, the difference-in-difference (DD) approach is applied to compare the treatment and control group over time. Due to the

98

randomization, both estimators provide an unbiased estimate of the impact of the intention-to-treat within a business training program on the outcome regarding women empowerment level. The model is as follow:

$$Y_{ijt} = \beta_0 + \beta_1 Treatment_{ijt} + u_{ijt} \quad (1)$$

where: dependent variable Y_{ijt} measures the empowerment outcome of individual i at time t in center j. The outcomes are measured differently at three levels: individual, household, and community, and their sum provide the composite empowerment index. $Treatment_{ijt}$ is the dummy variable that equals to 1 if a woman has access to training, either the individual or husband-joint training. β_1 is the intent-to-treat effect. u_{ijt} is an i.i.d error term. In these and the rest of the analyses, the standard errors are clustered at the centre level to control for possible dependency between female borrowers in the same centres.

the DD model is also estimated with the control variables which refers to women's characteristics:

$$Y_{ijt} = \beta_0 + \beta_1 Treatment_{ijt} + \beta_2 Z_{ijt} + u_{ijt} \quad (2)$$

where Z_{ijt} includes the control variables: marital status, number of household members, number of disable members, and level of education.

3.6. Empirical results

3.6.1. Descriptive summary

Table 3.4A uses the baseline data to provide a snapshot of observable demographic characteristics before the training are carried out. All of the participants at baseline survey are married with around 4 members in the family, one-fifth of them are taking care of disable members and most of them just finished the primary or secondary school[19]. Four empowerment measures the latent variables calculated by EFA and CFA are used. The t-test of independent means between

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[19] Education is categorial variable, where 1 = primary school, 2 = secondary school, 3 = high school, 4 = college/university

the treatment and control groups, and between two groups of treatment (joint-training with husband and individual training) are carried out with significantly high p-values. This indicates that the randomization is appropriate.

Table 3.4B shows some key statistics for the endline 1 and endline 2 (EL1 and EL2), as 6 months and 1 year after the training. It is noteworthy that four latent variables regarding empowerment at individual, household, and community levels and the empowerment index have very small p-value which might indicate the significance of training effect.

3.6.2. Results of training on different empowerment levels

Table 3.5 presents the impacts of training on an individual empowered level. By the first endline, both the husband-joint and individual training bring out a significantly positive impact, the impact of the solo training is two-third greater. However, after one year, while the coefficient of solo training becomes negligible, the impact of joint training increases nearly six times. This suggests the presence of a strong effect of attending the training with the husband on the level of self-empowerment.

Regarding the empowerment at the household level, Table 3.6 shows the striking contrast between the short-run and long-run influence of the husband-joint training. Six months after the training witnesses significant decrease in treatment effect, whereas the treatment of the long term – one year after the training are considerably larger, which indicates that women might still suffer from more household tension at first, but the situation is significantly enhanced later on. The individual training, however, steadily contributes to the household empowered level, but the impact is slightly less than in the joint training.

Further, Table 3.7 compares two types of training in two periods, in a broader context. The double difference coefficients suggest that though participants are generally more empowered at the community level, the effectiveness of husband-joint training is lower in the first endline, but more impactful by the second endline. Results of regression regarding the composite women empowerment index in Table 3.8 confirm the previous results. Both types of training are overall beneficial for women, but it takes time for the husband-joint training to take effect, and the long-run impact after one year is apparently higher than in the case of the single training.

Impact of training on women empowerment together with family control variables

Table 3.9, 3.10, 3.11, 3.12 provides the result of double difference regression on the levels of empowerment with covariates regarding participants' demographics. At individual level, only the husband-joint training shows a significant impact in the long run, while the impact in short-run and those for the solo training seem to be negligible. Being married and having more household members is positively related to more empowerment at the individual level, the presence of disabled members in the family does the opposite. At the household level, the DD estimates of both types of training, either in first or second endline, result insignificant, even though the signs of treatments at EL2 are positive. In this regard, participants belonging to households of numerous members become more discouraged in their sense of family empowerment, which indicates that living in a crowded family might increase family oppression. At the community level, only the husband-joint training certainly leads to more empowerment, while the effect of individual training is not significant though positive. Again, having disable members seems to be a burden that creates barriers to the women in social involvement. Overall, the results are clear in comparing the impacts of two types of training on the composite empowerment index: while the joint-training seems to be very beneficial in most aspects, the solo training does not lead to considerable development, though all coefficients have always a positive sign. This not only implies the importance of the husband's presence in the training but also confirms the key role of husband in the personal development of woman.

3.6.3. Spillover effect

Even though the treatment and control groups are randomly selected at centre level that helps to minimize the risk of spillover effects, this section provides the estimates of control non-married group to ensure the robustness of previous results. Table 3.13 demonstrates the empowerment levels of the control group that is involved in microcredit activities but is not involved in any training. The observation is only collected at the first endline. The variable *Endline 1* is a dummy variable that measures the development of outcomes among non-participants 6 months after the training. Among four outcomes, only the sense of empowerment at the community level is enhanced, whereas the individual empowered level is strongly degraded over time. There are no significant changes in household empowered level and overall empowerment index.

Further, to test the possible spillover effect between two treatments, Table 3.14 presents the development of empowerment among non-married women who are eligible to attend the individual training, but not the husband-joint training. All the DD coefficients are insignificant meaning that there is no spillover effect among two treatment groups. This result implies the important role of being married in enforcing women empowerment, regardless of husband's presence in the training.

3.7. Robustness check: controlling measure construct by item response theory

As the three-level of empowerment are identified by using EFA in identifying the unobserved latent variables (three stage of empowerment: individual, household, and community, and the empowerment index), section 4.2 applies CFA to confirm the consistency of the measurement model. Meade and Lautenschlager (2004) suggest conducting multiple measurement invariance tests, which in item response theory (IRT) is applied to compare and complement certain flaws of CFA. While CFA is appropriate to investigate the relations between latent factors and, therefore, helps to formulate the multi-factorial measurement, IRT has an advantage in exploring the sensitivity of specific scale items within each factor thanks to the likelihood ratio test. In most cases, two methods lead to similar results. Therefore, this section provides the IRT approach to ensure the robustness of the previously established measurement.

3.7.1. Building the construct

Item response theory (IRT) is built around the central idea that the probability of a certain answer of a person in relation to an item, can be described as a simple function of the person's position on the latent trait plus one or more parameters characterizing the particular item, in which the probability of certain answer has a function of the latent trait value (Fischer & Molenaar, 1995).

The early IRT applications involved primarily unidimensional IRT models with the Rasch model's applications or one-parameter model. Later on, multidimensional IRT models have been developed to allows items' traits to be measured by different comparisons within tests or within items. The Bock and Aitkin (1981)'s marginal maximum likelihood (MML) with expectation-maximization algorithm (EM) is considered as an alternative to the classical joint maximum likelihood procedure, in which the EM algorithm for MML is an iterative procedure that improves the

expected frequencies for correct responses and trait level. Other issues in IRT such as non-response, designed missingness, multiple raters, and guessing behavior test items are solved by Patz and Junker (1999) who apply the general Markov chain Monte Carlo methodology in multiple item format (2 and 3 parameter logistics, and general partial credit) and generalize linear logistic test model.

Though the attempt of creating an index of empowerment using proxy indicators is prevalent in microfinance studies, there are few studies that apply IRT. Notably, Pitt et al. (2006) use the 1-parameter logistic model for the household survey data in rural Bangladesh in 1998-99 to build an empowerment index of nine thematic groups. However, the 1-parameter model has certain limitations, for example, it assumes all items have equal discrimination which means the results might hold true only if the sample size is small or very homogeneous. Therefore, in our study, the two-parameter (2PL) model is utilized because it is worth examining the parameter of *discrimination* which measures the differential capability of an item in a thematic group, bringing attributive insights of each item. The 2PL procedure is conducted using *irt 2pl* package in STATA. The formula of 2PL procedure follows maximum likelihood approach which is introduced in Baker (2010) whereas the procedure follows the STATA manual as follow:

All the item responses are considered in the binary form. Items are assumed to vary in discrimination a_i and difficulty b_i. The probability of person j providing a positive answer to item i is given by

$$Pr(Y_{ij} = 1/ a_i , b_i , \theta_j) = \frac{exp\{a_i(\theta_j - b_i)\}}{1 + exp\{a_i(\theta_j - b_i)\}}$$

where a_i represents the discrimination parameter of item i, and b_i represents the difficulty parameter of item i, or the point on the ability scale at which the probability of correct response to the item is 0.5, θ is an ability level. The probability of having a correct answer is, therefore, parameterized as

$$Pr(Y_{ij} = 1| \alpha_i , \beta_i , \theta_j) = \frac{exp(\alpha_i\theta_j + \beta_i)}{1 + exp(\alpha_i\theta_j + \beta_i)} \quad where \ a_i = \alpha_i \quad and \quad b_i = -\frac{\beta_i}{\alpha_i}$$

Let $p_{ij} = Pr(Y_{ij} = 1 | a_i, b_i, \theta_j)$ and $q_{ij} = 1 - p_{ij}$. Conditional on θ_j, the item responses are assumed to be independent, so the conditional density for person j is given by:

$f(y_j|B, \theta_j) = \prod_{i=1}^{I} p_{ij}^{y_{ij}} q_{ij}^{1-y_{ij}}$ where $y_j = (y_{1j}, ..., y_{Ij})$, $B = (a_i, ..., a_i, \beta_i, ..., \beta_I)$, and i is the number of items.

The likelihood for person j is computed by integrating out the latent variable from the joint density

$$L_j(B) = \int_{\infty}^{\infty} f(y_j | B, \theta_j) \, \Phi_j(\theta_j) d\theta_j$$

where $\Phi(.)$ is the density function for the standard normal distribution. The log likelihood for the estimation sample is the sum of the log likelihoods from the N persons in the estimation sample:

$$logL(B) = \sum_{j=1}^{N} log \, L_j(B)$$

The advantage of IRT is that the precision of the measurement of a given item is evaluated at each level of the latent trait. In addition, when the item information is summed across all items in a scale measuring the same latent trait, it provides scale information that gives the precision of the measurement for the scale at each level of the latent trait. The more precise the measurement for an item or a scale, the less measurement error the item or the scale produces, and the richer is the information provided by the item or scale. Because of the precision produced across all levels of the latent trait, using the item information or scale information, we can investigate which levels of the latent trait are more precisely measured. It is a notable and unique property of IRT, as other traditional approaches that measure the precision of a scale, such as Cronbach's alpha, provide only a value for the entire scale (De Ayala, 2009).

3.7.2. IRT discussion

Based on the confirming factor analysis results, IRT analysis was conducted separately for each factor. Table 3.15 reports the item parameter estimates for each factor. Following Baker's

(2010) guideline[20] to interpret the discrimination parameters, almost all discrimination parameters are considerably high, which means that each item uniquely contributes to the empowerment index. The similar patterns of the difficulty parameters b_i which are approximately distributed between -1 to -2 can be understood in the following way: the items underlying the same scale have similar characteristics, that is, the responses are from the samples of similar levels of empowerment.

The individual empowered group from the item 1 to 14 shows that all items have positive discrimination parameters, which indicates that women with slightly above the average level of empowerment are likely to give gender empowered responses, especially regarding the questions related to decision-making behaviour. The two items 2 and 3 (*Do you involve in farming activities,* and *Do you own a business)* do not seem to add many contributions to the latent construct because the discrimination parameters are low, yet they are being kept because of their distinct meanings for the economic security of the respondents. The group of items referring to decision making (item 5-14) has similar difficulty parameter values, and is generally higher than those of the group of items referring to economic security (items 1, 2, 3, and 4). This means that the answers from questions related to the decision-making are more potentially lead to "un-empowerment", or in other words, the role of women in making family choices is crucial in their individual development.

In the household empowered level group (item 15 to 20), all the discrimination parameters are positive and high, which means that items perform highly correct and differentiable explanations toward the construct, especially the items 17, 18, and 19. This also corresponds to the relatively low difficulty parameter values of these items, which could translate into the severe "unempowered" status among respondents who suffer from family violence *(being threatened with objects, being kept from seeing others, and being under control).*

The last group of community empowered level (item 21 to 32) also witnesses the consistency in the levels of discrimination parameters, which have mostly high and very high values according to Baker's guideline. The discrimination parameters of this group have approximately comparable

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[20] Baker (2010) recommends that IRT researchers interpret item discrimination parameters using the following criteria: 0 = none, 0.01 – 0.34 = very low, 0.35 – 0.64 = low, 0.65 – 1.34 = moderate, 1.35 – 1.69 = high, 1.70 = very high

values which indicate that the level of business knowledge, as well as social bonding, are necessary attributes to the empowerment at the community level.

3.8. Conclusion

Women's empowerment is the process by which the powerless gain greater control over circumstances of their lives, acquiring not only extrinsic control but also a growing intrinsic capability; obtaining greater self-confidence and inner transformation of one's consciousness that enable women to overcome obstacles to access resources and to change the traditional ideology, creating an environment that is conducive to women's empowerment. The success of the microfinance program encourages the vast number of women to reach out for more economic opportunities without eroding the basis of gender subordination. It has been argued that women's empowerment can only be achieved by increasing women's consciousness about gender and class relations and organizing them to engage in grassroots struggles for women's rights.

The study consists of two main parts: creating the empowerment index and estimating the impacts of training on the empowerment index. The creation of empowerment index is based on factor analysis and is categorized as three main groups: individual-level referring to economic security and women's role in family decision-making, household-level referring to family violence, and community level referring to business knowledge and social involvement. The results of the estimation confirm the intensive development of women empowerment thanks to the individual and husband-joint training that regards gender and entrepreneurship issues. The empowerment is particularly enhanced in the training with the presence of husbands. In fact, the training with the husband's presence does increase the empowerment at the individual and community level, which leads to higher senses of self-confidence and social engagement. The family violence is found to be significantly reduced after both types of training. However, when adding control variables where the number of household members is high the impact of training on empowerment becomes negligible in spite of positive coefficients. The two-time observations show that the impact of the training, especially with the presence of the husband, have a stronger effect in the long-term (one year after training) rather than in short-term (6 months after training).

Table 3. 1: List of question items

Factor	Question items
Individual	*Economic security*
	1 Do you have income
	2 Do you have saving
	3 Do you own any farming activity
	4 Do you own a business
	Family role
	5 Who makes the most decisions about asking for a loan
	6 Who makes the most decisions about food purchase
	7 Who makes the most decisions about educational expense
	8 Who makes the most decisions about clothing purchase
	9 Who makes the most decisions about durable item purchase
	10 Who makes the most decisions about health expenditure
	11 Who makes the most decisions about saving for farming/business
	12 Who makes the most decisions about house purchase, improvement or repair
	13 Who makes the most decisions about money surplus
	14 Who makes the most decisions about assisting financially family members
Household	15 Verbal aggression
	16 Physical assault (pushed, slapped, beat or hit with a fist)
	17 Threatened and used with an object like sticks, knife…
	18 Kept you from seeing your family member or friends
	19 Insisted on knowing where you are at all times
	20 Wanted you to ask permission before doing anything
Community	*Business knowledge*
	21 Sales do not remain the same over long periods of time, so you must think of other ways to improve or expand your business
	22 Sales records help evaluate which products sell and which do not
	23 Word-of-mouth does not affect the sales of business
	24 Many businesses lose part of their products because of poor storage facility
	25 What is 400 plus 300
	26 What is one tenth of 10
	27 In a sale, a shop is selling all items at half price. Before the sale a TV costs 4 million VND. How much will it cost in sale
	28 If you sold two items for 8,000 VND each and your customer gave you 20,000 VND. How much balance do you owe the customer
	Social trust

29 Are you willing to lend 200,000VND[21] to any center member

30 Are you willing to lend your possessions to any center member

31 Do you trust someone who is not your relative

32 Are you member of any other social group

Table 3. 2: Rotated factor correlation and Cronchbach alpha

Factor	Variance	Difference	Proportion	Cumulative	Cronchbach alpha
Factor1	9.018	7.205	0.627	0.627	0.8357
Factor2	1.812	0.478	0.126	0.754	0.6191
Factor3	1.335		0.093	0.847	0.6921

Overall Cronbach alpha = 0.9134. Kaiser-Meyer-Olkin measure = 0.9231; Bartlett's test of Shericity tests (X2:,1.46; df: 528; p-value: 0.000

[21] Equal to approximately $US 1.7

Table 3. 3: Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness[22]
Item 1: income	**0.690**	-0.183	0.163	0.464
Item 2: saving	**0.577**	-0.087	0.066	0.655
Item 3: farming	**0.326**	-0.186	0.061	0.856
Item 4: business	**0.123**	0.049	0.012	0.982
Item 5: decision on loan	**0.676**	0.076	-0.091	0.529
Item 6: decision on food	**0.815**	-0.024	0.043	0.333
Item 7: decision on tuition	**0.779**	-0.008	-0.013	0.393
Item 8: decision on cloth	**0.724**	-0.002	-0.061	0.472
Item 9: decision on dur.purchase	**0.581**	0.241	-0.183	0.572
Item 10: decision on health	**0.794**	0.059	-0.065	0.362
Item 11: decision on saving	**0.751**	0.077	-0.117	0.417
Item 12: decision on house	**0.542**	0.233	-0.154	0.628
Item 13: decision on money	**0.714**	0.098	-0.115	0.468
Item 14: decision on assisting	**0.691**	0.141	-0.143	0.482
Item 15: verbal aggression	-0.070	**0.381**	-0.074	0.845
Item 16: physical assault	0.063	**0.516**	-0.061	0.726
Item 17: threatened with objects	0.097	**0.455**	-0.027	0.783
Item 18: not seeing others	0.055	**0.421**	-0.019	0.820
Item 19: control activities	0.048	**0.459**	-0.079	0.781
Item 20: permission to do things	0.005	**0.496**	-0.081	0.748
Item 21: business knowledge 1	0.543	0.154	**0.100**	0.672
Item 22: business knowledge 2	0.415	0.068	**0.170**	0.794
Item 23: business knowledge 3	0.197	-0.089	**0.112**	0.941
Item 24: business knowledge 4	0.420	0.088	**0.180**	0.783
Item 25: business knowledge 5	0.743	-0.067	**0.190**	0.407
Item 26: business knowledge 6	0.552	-0.011	**0.127**	0.679
Item 27: business knowledge 7	0.794	-0.185	**0.215**	0.288
Item 28: business knowledge 8	0.675	-0.046	**0.182**	0.509
Item 29: lending money	0.130	-0.117	**0.545**	0.673
Item 30: lending furniture	0.201	-0.141	**0.563**	0.623
Item 31: trusting others	0.415	-0.317	**0.359**	0.598
Item 32: member of other groups	0.342	-0.309	**0.384**	0.641

Method extraction: principal factors. Rotation method: Varimax

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[22] Uniqueness is the unique contribution of each item to explain the variability in the data matrix.
1 – uniqueness = communality

Table 3. 4A: Baseline summary statistics

Variable	Obs	Mean	Std.Dev.	Min	Max	T-C	p-value	T2-T1	p-value
		Control group					Test of equality		
Married	4041	1	0	1	1	0.005	0.099	0.001	0.808
Household member	4037	4.553	1.796	0	15	0.064	0.257	0.051	0.483
Disable member	4037	.22	.542	0	4	-0.007	0.678	0.033	0.128
Education	3515	1.876	.708	0	4	0.041	0.089	-0.109	0.001
Individual (empowered) level	4030	12.783	3.058	0	15	0.253	0.008	0.145	0.262
Household (empowered) level	4036	5.416	.875	0	6	0.033	0.233	0.025	0.466
Community (empowered) level	3499	11.624	2.194	4	16	-0.098	0.238	0.234	0.013
Empowerment index	3496	29.874	4.718	11	37	0.164	0.305	0.348	0.096

Notes: Data source: Baseline household survey (conducted during October-November 2011 – 3 months before the intervention). Standard errors of differences, clustered at the center level.

Table 3. 4B: Endline 1 and 2 summary statistics

Variable	Obs	Mean	Std.Dev.	Min	Max	T-C	p-value	T2-T1	p-value
		Control group					Test of equality		
Married	7376	.845	.362	0	1	0.003	0.954	0.025	0.000
Household member	7417	4.605	1.803	0	16	0.117	0.045	0.090	0.222
Disable member	7400	.188	.489	0	5	0.010	0.548	0.052	0.007
Education	7397	1.91	.702	0	4	0.007	0.765	-0.099	0.001
Individual (empowered) level	7309	12.409	2.304	0	15	0.145	0.089	0.628	0.000
Household (empowered) level	7911	5.292	1.108	0	6	0.119	0.000	-0.183	0.000
Community (empowered) level	7324	13.321	2.321	4	17	1.508	0.000	0.638	0.000
Empowerment index	6555	31.031	4.244	11	38	1.808	0.000	1.115	0.000

Notes: Summary statistics for household survey (after the intervention, both EL1 and EL2). Standard errors of differences, clustered at the center level.

Table 3. 5: Impact of training on individual empowered level

	Husband-joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		0.289**			0.398***	
		(0.129)			(0.131)	
Treatment at Endline 2			1.372***			-0.0139
			(0.224)			(0.302)
Constant	12.36***	12.59***	12.71***	12.62***	12.92***	12.81***
	(0.0532)	(0.0509)	(0.0399)	(0.0485)	(0.0651)	(0.0356)
Observations	8,216	8,216	8,216	8,216	7,501	8,216
R-squared	0.017	0.013	0.016	0.013	0.011	0.011

Standard errors in parentheses. Standard errors are clustered at center level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. 6: Impact of training on household empowered level

	Husband-joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		-0.0744*			0.152***	
		(0.0408)			(0.0392)	
Treatment at Endline 2			0.286***			0.218**
			(0.0693)			(0.0913)
Constant	5.405***	5.357***	5.435***	5.380***	5.434***	5.430***
	(0.0165)	(0.0163)	(0.0127)	(0.0150)	(0.0199)	(0.0113)
Observations	8,611	8,611	8,611	8,611	7,806	8,611
R-squared	0.012	0.013	0.017	0.015	0.013	0.016

Standard errors in parentheses. Standard errors are clustered at center level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. 7: Impact of training on community empowered level

	Husband-joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**0.891*****			**1.421*****	
		(0.110)			**(0.104)**	
Treatment at Endline 2			**1.557*****			**0.757*****
			(0.187)			**(0.246)**
Constant	12.65***	11.94***	12.07***	13.02***	11.58***	12.19***
	(0.0417)	(0.0449)	(0.0339)	(0.0389)	(0.0540)	(0.0306)
Observations	7,817	7,817	7,817	7,817	7,097	7,817
R-squared	0.141	0.062	0.085	0.103	0.129	0.064

Standard errors in parentheses. Standard errors are clustered at center level. *** p<0.01, ** p<0.05, * p<0.1

Table 3. 8: Impact of training on women empowerment index

	Husband-joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**1.040*****			**1.972*****	
		(0.216)			**(0.217)**	
Treatment at Endline 2			**3.347*****			**0.868***
			(0.383)			**(0.521)**
Constant	30.35***	29.84***	30.16***	31.00***	29.96***	30.42***
	(0.0875)	(0.0872)	(0.0677)	(0.0806)	(0.110)	(0.0610)
Observations	7,407	7,407	7,407	7,407	6,769	7,407
R-squared	0.044	0.028	0.026	0.019	0.036	0.003

Standard errors in parentheses. Standard errors are clustered at center level. *** p<0.01, ** p<0.05, * p<0.1

Table 3. 9: Impact of training on individual empowered level (with control variable)

	Husband joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**0.265**			**-0.139**	
		(0.167)			**(0.291)**	
Treatment at Endline 2			**1.135*****			**-0.238**
			(0.315)			**(0.378)**
Married	0.610***	0.564***	0.589***	0.607***	0.561***	0.591***
	(0.146)	(0.147)	(0.142)	(0.142)	(0.144)	(0.139)
Household members	0.6***	0.486***	0.484***	0.489***	0.488***	0.487***
	(0.0416)	(0.0422)	(0.0417)	(0.0415)	(0.0421)	(0.0417)
Disable members	-0.112**	-0.0988*	-0.108*	-0.112**	-0.0986*	-0.110**
	(0.0521)	(0.0526)	(0.0541)	(0.0506)	(0.0516)	(0.0530)
Education	0.188	0.186	0.187	0.187	0.185	0.187
	(0.135)	(0.135)	(0.137)	(0.136)	(0.136)	(0.138)
	(0.548)	(0.540)	(0.539)	(0.547)	(0.528)	(0.530)
Observations	7,628	7,628	7,628	7,628	7,628	7,628
R-squared	0.132	0.125	0.138	0.129	0.125	0.135

Robust standard errors in parentheses. Standard errors are clustered at center level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. 10: Impact of training on household empowered level (with control variable)

	Husband joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**-0.0838**			**0.212**	
		(0.0919)			**(0.144)**	
Treatment at Endline 2			**0.297**			**0.248**
			(0.260)			**(0.231)**
Married	0.100***	0.0921***	0.105***	0.102***	0.0933***	0.107***
	(0.0226)	(0.0212)	(0.0214)	(0.0223)	(0.0211)	(0.0203)
Household members	-0.039***	-0.039***	-0.039***	-0.039***	-0.039***	-0.039***
	(0.00644)	(0.00642)	(0.00655)	(0.00649)	(0.00643)	(0.00646)
Disable members	0.0174	0.0202	0.0160	0.0199	0.0215	0.0156
	(0.0207)	(0.0206)	(0.0206)	(0.0208)	(0.0208)	(0.0209)
Education	0.00238	0.00162	0.00250	0.00119	0.000784	0.00161
	(0.00795)	(0.00814)	(0.00797)	(0.00848)	(0.00859)	(0.00818)
Constant	5.366***	5.354***	5.400***	5.338***	5.391***	5.392***
	(0.0933)	(0.0665)	(0.0649)	(0.0830)	(0.0608)	(0.0595)
Observations	8,006	8,006	8,006	8,006	8,006	8,006
R-squared	0.010	0.011	0.017	0.015	0.013	0.016

Robust standard errors in parentheses. Standard errors are clustered at center level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. 11: Impact of training on community empowered level (with control variable)

	Husband joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**0.775*****			**0.146**	
		(0.237)			**(0.323)**	
Treatment at Endline 2			**1.319*****			**0.576**
			(0.385)			**(0.430)**
Married	0.516***	0.629***	0.631***	0.527***	0.636***	0.638***
	(0.0989)	(0.0933)	(0.0911)	(0.0926)	(0.0888)	(0.0874)
Household members	0.272***	0.278***	0.283***	0.277***	0.281***	0.287***
	(0.0280)	(0.0281)	(0.0269)	(0.0293)	(0.0292)	(0.0282)
Disable members	-0.107**	-0.142**	-0.131**	-0.0981*	-0.131**	-0.125**
	(0.0521)	(0.0551)	(0.0578)	(0.0539)	(0.0571)	(0.0571)
Education	0.163	0.167	0.164	0.150	0.154	0.152
	(0.108)	(0.110)	(0.105)	(0.103)	(0.104)	(0.0983)
Constant	10.00***	9.144***	9.188***	10.33***	9.237***	9.331***
	(0.398)	(0.385)	(0.346)	(0.425)	(0.392)	(0.355)
Observations	7,282	7,282	7,282	7,282	7,282	7,282
R-squared	0.202	0.134	0.166	0.164	0.105	0.142

Robust standard errors in parentheses. Standard errors are clustered at center level
*** p<0.01, ** p<0.05, * p<0.1

Table 3. 12: Impact of training on women empowerment index (with control variable)

	Husband joint training			Individual training		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment at Endline 1		**0.857****			**0.361**	
		(0.349)			**(0.555)**	
Treatment at Endline 2			**2.784*****			**0.494**
			(0.785)			**(0.760)**
Married	1.315***	1.366***	1.395***	1.322***	1.367***	1.408***
	(0.244)	(0.232)	(0.231)	(0.228)	(0.222)	(0.221)
Household members	0.796***	0.803***	0.803***	0.804***	0.807***	0.810***
	(0.0685)	(0.0685)	(0.0673)	(0.0711)	(0.0706)	(0.0704)
Disable members	-0.258***	-0.279***	-0.274***	-0.242***	-0.259***	-0.267***
	(0.0832)	(0.0846)	(0.0871)	(0.0843)	(0.0858)	(0.0870)
Education	0.355	0.357	0.353	0.344	0.345	0.343
	(0.243)	(0.244)	(0.241)	(0.240)	(0.241)	(0.237)
Constant	23.28***	22.87***	23.01***	23.87***	23.17***	23.27***
	(0.935)	(0.923)	(0.874)	(0.967)	(0.917)	(0.883)
Observations	6,881	6,881	6,881	6,881	6,881	6,881
R-squared	0.186	0.174	0.176	0.160	0.156	0.153

Robust standard errors in parentheses. Standard errors are clustered at center level
*** p<0.01, ** p<0.05, * p<0.1

Table 3. 13: Results on the empowerment level of the control group

	Individual level	Household level	Community level	Empowerment index
Endline 1	-0.419***	-0.0756	0.417**	-0.145
	(0.106)	(0.0782)	(0.183)	(0.254)
Married	0.945***	0.148***	0.530***	1.696***
	(0.162)	(0.0335)	(0.129)	(0.272)
Household members	0.602***	-0.0490***	0.304***	0.935***
	(0.0581)	(0.00813)	(0.0407)	(0.0941)
Disable members	-0.163**	0.0579*	-0.165**	-0.320**
	(0.0685)	(0.0292)	(0.0737)	(0.126)
Education	0.580***	-0.0130	0.441***	0.999***
	(0.114)	(0.0323)	(0.0774)	(0.148)
Constant	7.224***	5.394***	8.285***	20.44***
	(0.609)	(0.111)	(0.421)	(0.955)
Observations	3,083	3,217	2,932	2,784
R-squared	0.194	0.016	0.105	0.204

Robust standard errors in parentheses. Standard errors are clustered at center level
*** p<0.01, ** p<0.05, * p<0.1

Table 3. 14: Results on the empowerment level of the non-married group

	Individual level		Community level		Empowerment index	
Treatment at Endline 1	**1.033**		**-0.193**		**0.638**	
	(1.163)		**(0.616)**		**(1.634)**	
Treatment at Endline 2		**-1.033**		**0.193**		**-0.638**
		(1.163)		**(0.616)**		**(1.634)**
Household members	0.217**	0.217**	0.367***	0.367***	0.667***	0.667***
	(0.107)	(0.107)	(0.0499)	(0.0499)	(0.144)	(0.144)
Disable members	0.462	0.462	0.290	0.290	0.740	0.740
	(0.403)	(0.403)	(0.231)	(0.231)	(0.502)	(0.502)
Education	1.119***	1.119***	0.699***	0.699***	1.869***	1.869***
	(0.256)	(0.256)	(0.158)	(0.158)	(0.399)	(0.399)
Constant	4.544***	4.502***	9.461***	7.494***	13.18***	11.31***
	(1.069)	(0.665)	(0.668)	(0.466)	(1.727)	(1.067)
Observations	688	688	715	715	654	654
R-squared	0.365	0.365	0.398	0.398	0.454	0.454

Notes: Empowerment index is the sum of individual (empowered) level and community (empowered) level. Robust standard errors in parentheses. Standard errors are clustered at center level. *** p<0.01, ** p<0.05, * p<0.1

Table 3. 15: Estimate of the parameters of items

|	Variable	Discrimination parameters	Difficulty parameters
Individual	Item 1: income	2.295	-2.362
	Item 2: saving	1.428	-2.398
	Item 3: farming	0.636	-2.527
	Item 4: business	0.131	2.834
	Item 5: decision on loan	3.711	-1.389
	Item 6: decision on food	4.582	-1.714
	Item 7: decision on tuition	4.322	-1.601
	Item 8: decision on cloth	3.322	-1.655
	Item 9: decision on dur.purchase	4.554	-1.002
	Item 10: decision on health	6.157	-1.447
	Item 11: decision on saving	6.035	-1.341
	Item 12: decision on house	4.059	-0.944
	Item 13: decision on money	4.862	-1.341
	Item 14: decision on assisting	4.740	-1.279
Household	Item 15: verbal aggression	1.820	-0.574
	Item 16: physical assault	2.521	-1.656
	Item 17: threatened with objects	3.837	-2.258
	Item 18: not seeing others	2.831	-2.283
	Item 19: control activities	2.470	-1.840
	Item 20: permission to do things	2.416	-1.399
Community	Item 21: business knowledge 1	1.848	-1.704
	Item 22: business knowledge 2	1.523	-1.505
	Item 23: business knowledge 3	0.486	-1.259
	Item 24: business knowledge 4	1.571	-1.437
	Item 25: business knowledge 5	3.303	-2.033
	Item 26: business knowledge 6	1.877	-1.837
	Item 27: business knowledge 7	4.456	-2.095
	Item 28: business knowledge 8	2.638	-1.988
	Item 29: lending money	0.437	-1.369
	Item 30: lending furniture	0.666	-1.732
	Item 31: trusting others	1.069	-1.440
	Item 32: member of other groups	0.901	-1.464
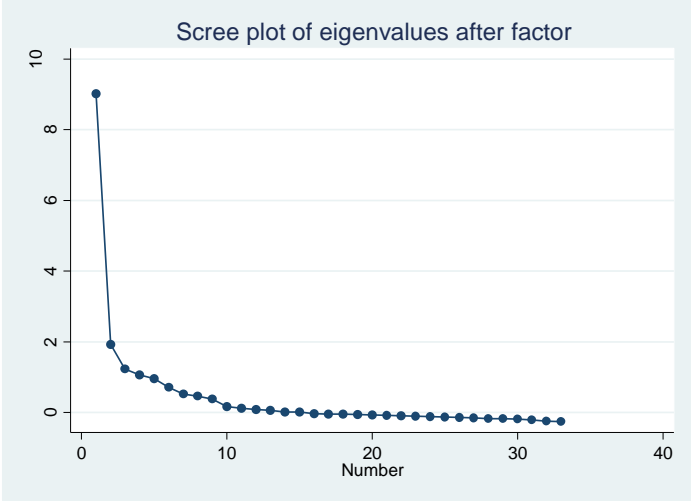
Figure 3. 1: Scree plot
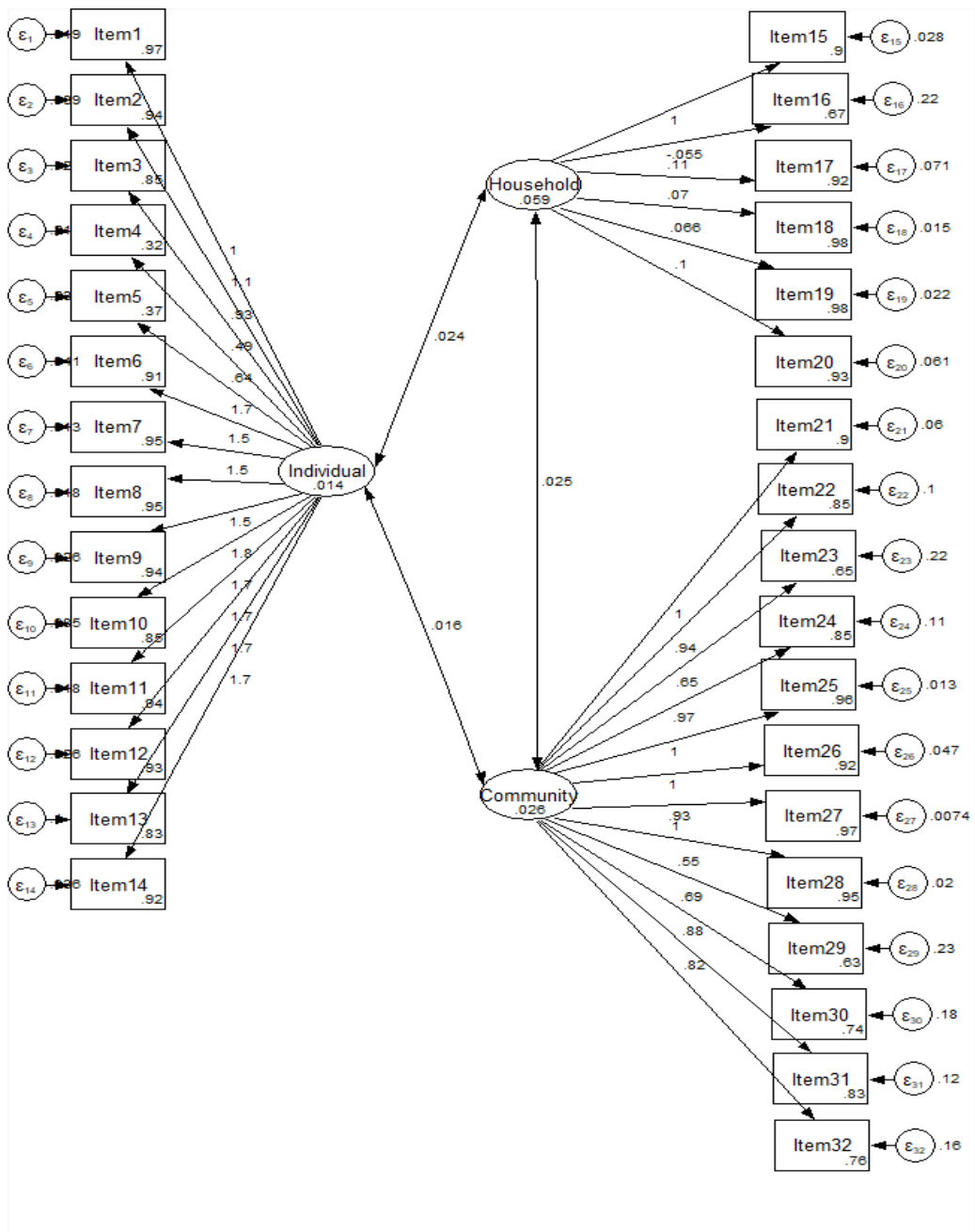
Figure 3. 2: Measurement model

Conclusion

In the developing countries, many people are suffering from the lack of access to formal financial service and very few benefits from the saving account, loan or convenient way to transfer money, let alone having credit. Although financial services cannot solve all the poverty problems, it still can be seen as an effective tool to help the poor to make autonomous decisions and improve their lives and families. This research discusses methods of the supporting systems and suggests ways that we can better integrate the formal financial services into their lives, and increase the supporting system's outreach and social impact, hoping to relieve the suffering of the underprivileged people.

In the beginning, the recent theoretical and empirical literature are analysed and discussed. The research is structured and developed into three main parts:

- The impact of remittance on financial inclusion: the formal account, debit card, and credit card ownership
- Technology adoption and microfinance borrowing among Asian women
- Measuring women's empowerment index and gender impact from microcredit program

Using the latest global Findex data in 2017, the first part studies the relationship between incoming remittance and the access to different financial means: bank account, debit cards, credit cards and saving. The results show that incoming remittance leads to a higher probability of financial access, in which such effect is stronger when it comes to account, debit card ownership and saving rather than credit cards. In particular, the remittance increases the saving for business investment instead of saving for old age, and saving at informal groups rather than saving at formal financial institution. When the sample is divided into different country group based on the level of socio-economic development, it seems that the effects of remittance on financial inclusion are only significantly strong in the under-developed and developing countries.

The second part studies the relationship between the women borrowers and the tendency that the microfinance institutions (MFIs) adopt technology, which is measured by the website accessibility and mobile banking service offering. The sample includes 311 microfinance institutions from 23 Asian countries in 2015. The findings suggest that higher percentage of female borrower

significantly increases the likelihood that the microfinance institution open the website, but not the provision of mobile banking service. However, the results vary across regions, for example the link between female borrowing and ICT application is comparatively strong in South Asia where MFIs proliferate remarkably. Further, profit-oriented MFIs are more likely to digitalize their services, which implies the importance of legal status, financial health and infrastructure of the MFIs upon the decision of introducing new technology in their services.

Finally, the third chapter uses the micro-survey conduct at a MFI to a women empowerment index and estimates the impact of training on the level of empowerment. The empowerment index is constructed using factor analysis, in which participation to the training significantly increase the empowerment at three level: individual, household and community. When there are husbands joining training, the effect of training on empowerment level is remarkably stronger as compared to individual training, especially in the long term. However, living in a household with high number of family members could potentially prevent the women from being empowered in the family; but increase the sense of self-confidence and social engagement.

Considering the benefits of various financial inclusion and microfinance programs to improve the livelihoods of the poor, the overall study examines the different methods to facilitate the supporting systems: from the means of transaction such as bank account, debit card or credit card; or the performance of microfinance institutions by involving with modern technology; to the tailor-made training hoping to bring out not only monetary but also non-monetary benefits to the borrowers. To the practitioners and policy-makers, the three main implications could be sum up to: i) to direct the promoting and supporting programs to engage the low-income people to the use of safe and formal transaction and saving, especially in the underdeveloped or developing countries; ii) to involve women in the technical and financial literacy training in order to better utilize the updated microfinance services; as well as to support the current MFIs with technology adoption which might help them to improve the operations, sustainability and looks more attractive to the local and international donor; and lastly iii) to design particular training which are suitable for people's ability, needs and conditions. Since credit access or financial support alone are not enough to increase the living standard of the poor in one night, the results of this study could help to reform current policies in the finance and development sector by demonstrating how broadening the use of financial and credit services can have a direct impact to fight against poverty in the long-run.

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