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Mobile money for women's economic empowerment: the mediating role of financial management practices

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Abstract
This article examines whether mobile money adoption contributes to women's economic empowerment, and considers the mediating effect of financial management behavior. Cross-sectional data analysis is conducted utilizing a sample of women in seven countries across South Asia and Sub-Saharan Africa. We also investigate whether these effects vary between rural and urban areas. Three measures of mobile money adoption are considered to reflect the process of engaging in mobile money services. We find supportive evidence for the impact of mobile money adoption on women's economic empowerment and the influencing mechanism of financial management behavior for the whole sample and the rural sub-sample. Moreover, the results are consistent for three alternative measures of mobile money adoption. Our findings suggest that mobile money can be harnessed to promote women's economic empowerment; however, the impact appears to be greater if women are equipped with proper financial management skills.

Keywords Mobile money · Women's economic empowerment · Financial management behavior · Mediating effect

Mathemetics Subject Classification 62J05 · 91B28

1 Introduction

Financial inclusion, particularly digital financial services, is known to foster an increase in women's income and helps to reduce poverty, which are important elements for women's economic empowerment (Hendriks 2019). However,

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approximately 1.7 billion people are reported to be unbanked (Demirgüç-Kunt et al. 2018), which poses several challenges to sustainable development. Furthermore, women account for 56% of the unbanked population and are over-represented in some countries, such as China, Bangladesh and India. With the penetration of cell phones and the Internet, mobile-enabled financial services have been perceived as one of the most important engines for further financial inclusion and the flourishing of social development.

Mobile money is a modern innovation which utilizes mobile phones to deliver financial services and has evolved dramatically in recent years. Starting with the successful launch of M-Pesa in Kenya in 2007, the mobile money industry is now actively engaged in by more than one billion registered mobile money accounts and 750 operators in 95 countries, with the total value of transactions being nearly $2 billion a day (GSMA 2019). Mobile money has opened up a huge opportunity to access financial services for unbanked communities and people who live in remote and rural areas, where a very few or no bank branches or other formal financial institutions are available.

Mobile money shows its importance in several aspects. Despite remarkable achievements of the financial system, progress towards sustainable development seems to be hindered in some countries due to the insufficient financial inclusion of women. Inequality in access to finance remains severe in developing economies, since the percentage of women owning an account is reported to be 9% less than that of men (Demirgüç-Kunt et al. 2018). Closing this financial gap is important, as a greater financial inclusion of women will contribute substantially to positive changes in their financial health, such as increased income, a higher purchasing power and better business opportunities (Siddik et al. 2017; Hendriks 2019). The impact of access to finance on women's empowerment, however, depends on the question of how effective and sustainable financial services are (Kabeer 2001). Mobile money can be an innovative and efficient model for delivering financial services with several desirable benefits such as convenience, low costs and security (Donovan 2012). Therefore, mobile money appears to be a crucial enabler for enhancing women's ability to make life-determining financial decisions. Additionally, a positive change in financial behavior due to the usage of mobile-based financial services is another advantage of mobile money. According to Ouma et al. (2017) individuals tend to save more and with higher values when they use mobile money. The significant association between better financial management behavior and greater financial access is also documented in the study of Birkenmaier and Fu (2019).

The existing body of literature provides a wide range of qualitative and quantitative analyses on mobile money services, financial management behavior and women's economic empowerment aligned with financial inclusion. The linkages among these three topics have been considered in a number of academic papers that draw some reasonable conclusions regarding their influence on each other (Donovan 2012; Buvinić and Furst-Nichols 2016; Yen and Wu 2016; Dorfleitner et al. 2019). However, those studies do not investigate the impact of mobile money on women's economic empowerment through the influencing mechanism of financial

management practices.[1] Furthermore, the dominance of single-country-level studies and M-Pesa case-study analyses in the literature creates a demand for more comprehensive studies regarding broader aspects. Our study, to the authors' knowledge, provides the first empirical evidence to tackle these issues.

The emphasis of the current paper is to investigate how the adoption of mobile money helps empower women economically and how financial management practices mediate this relationship. For this purpose, we run several regressions for a sample of women in seven developing countries whose total inhabitants account for more than one-fourth of the global population. Three measures of mobile money adoption are employed to capture the more restricted definitions, namely, mobile money user, mobile money account owner and active mobile money account owner. For robustness checks, we further conduct regressions on rural and urban sub-samples, as previous literature on mobile financial services indicates different results between the two areas (Jack and Suri 2011; Lyons et al. 2020). In addition, models with an appropriate instrumental variable are estimated to avoid the potential problem of endogeneity.

The main findings of our paper show that the use of mobile money can promote women's economic empowerment. Moreover, better financial management practices contribute to explaining this linkage as the mediating effect. The results hold for all measures of mobile money adoption. Regarding our robustness tests, the obtained results indicate significant differences between rural and urban areas. While the effects of mobile money on women's financial empowerment remain positive in the case of rural women, these effects turn out to be insignificant when considering the sub-sample of urban women. However, the sign and significance of the coefficients between financial management behavior and women's economic empowerment do not vary across sub-samples.

The remainder of this article is organized as follows: Section 2 reviews the related literature and develops our hypotheses. Section 3 describes the data sample, methodologies and detailed variables, while Sect. 4 reports descriptive analysis and empirical results. A brief conclusion is presented in Sect. 5, along with several suggestions for future studies.

2 Literature

Mobile money refers to the application of mobile phones in delivering financial services, which allows users to store or transfer money, make a payment, withdraw cash at legal physical agents and to access other possible financial services. While mobile banking services facilitated by traditional banks have undergone a long path of growth, mobile money has recently emerged extensively as a new alternative to deliver financial services for unbanked segments. Mobile money is different from mobile banking in the way that it can be offered by a network of mobile money

[1] In this study, the terms "financial management behavior" and "financial management practices" are interchangeable.

agents and/or their partners. For example, M-Pesa, which offers flagship microfinancing services through mobile phones, was established in 2007 with the cooperation of two famous mobile network agents in Kenya, namely, Vodafone and Safaricom (Morawczynski 2009). In this case, a bank account is not a mandatory prerequisite since money is stored in a digital account operated through a mobile phone account. Another model of mobile money highlights the partnership between banks and mobile money operators to launch a mobile money business (Weber and Darbellay 2010). For this service, the electronic money account linked to a bank account is accessible through mobile telephones.

Mobile money is an innovative financial model for the poor and the unbanked to overcome the problem of access to affordable and sustainable financial services, especially for those who are living in regions where bank exclusion remains persistent (Donovan 2012). Due to their lack of creditworthiness and low collateral, financially disadvantaged groups of people have borrowed mainly from the informal financial sector to complement their exhausted internal sources of finance, which are commonly unreliable, uncertain and high cost. Some examples of informal finance are pawnbrokers, private moneylenders, rotating savings and credit associations.

According to data from Demirgüç-Kunt et al. (2018), mobile money is increasingly prevalent, especially in countries with a low level of financial accessibility. A possible explanation could be that mobile money agents are relatively easier and more convenient to access, and hence this financial service is more likely to attract customers. By 2019, the number of mobile money agents was 20 and seven times more than that of bank branches and ATMs (GSMA 2019). As suggested in the previous literature on mobile financial services, the customer's perception of ease of use is one of the key determinants in the adoption decision Lee et al. (2012). Thus, the rapid growth of mobile money possibly lies in its simple operational mechanism through mobile network agents. Customers need only a basic mobile phone with an active SIM card in order to use mobile money services. In addition, the lower cost of mobile money services' usage in comparison with other alternatives could be another reason why individuals are keen on mobile money (Donovan 2012). Lastly, mobile money services appear to be more secure and safer than cash finance (Suri 2017).

Various aspects of mobile money have been extensively investigated in the literature. One of the important strands of research is the determinant of mobile money adoption. While some studies highlight the importance of supportive regulations for the telecommunications sector and market conditions (Lashitew et al. 2019), sociodemographic characteristics, such as gender, education level and income, are also shown to influence the adoption of mobile money (Amoah et al. 2020). Furthermore, some factors associated with the development of mobile money services have been examined extensively. Della Peruta (2018) and Rewilak (2017) argue that countries with low access to formal financial services exhibit more mobile money evolvement. Donovan (2012) and Weber and Darbellay (2010) suggest that a proper regulation system and adequate policies can support mobile money deployment. Benefits accompanying the adoption of mobile money have also been of interest to scholars. The clearest impacts are the improvements of livelihood and poverty reduction (Kikulwe et al. 2014; Suri 2017). Better shock management is another highlight

that has emerged from mobile money adoption (Jack and Suri 2011; Afawubo et al. 2020). To be more specific, households with access to mobile money services are less likely to be vulnerable to shock events like droughts and floods than those without such access.

The above review demonstrates that mobile money can be an important financial tool to accelerate financial inclusion, and thus helps to achieve sustainable development. Within the scope of this study, we empirically investigate the impact of mobile money on women's economic empowerment, an area of study which remains sparse in the existing body of literature. Following this, we also explore its influencing channel through financial management practices.

2.1 Links between mobile money and women's economic empowerment

Women's empowerment is an important issue as it is one of the main goals to achieve a sustainable development according to the United Nations (2015).[2] The term *empowerment* refers to the process in which individuals become more involved in making decisions (Kabeer 2005). Accordingly, women are economically empowered if they have control over their resources such as savings, expenditures and business investment (Pereznieto and Taylor 2014).

With the growing prevalence of mobile money, the question of its influences on women's empowerment is gaining more and more attention from scholars. This relationship has recently been discussed in several academic contributions. Within the research on the impacts of mobile money, studies have found that mobile money results in better financial inclusion (Demirgüç-Kunt et al. 2018; Hendriks 2019) and financial welfare (Suri and Jack 2016). Especially, these impacts are even more profound for women. Moreover, there is growing evidence that the deployment of mobile phones for delivering financial services positively affects the economic empowerment of women (Buvinić and Furst-Nichols 2016; Wieser et al. 2019; Riley 2019). However, these studies rather provide country-level evidence on the linkage between mobile money and women's economic empowerment, while we explore the issue on the individual level.

Nevertheless, the expectation from the above-mentioned literature can be clearly summarized with the following hypothesis:

Hypothesis 1 (H1) The use of mobile money is positively and significantly linked to women's economic empowerment.

2.2 Financial management practices and women's economic empowerment

Financial management behavior is generally defined as individuals' practices of seriously managing their resources, such as budgeting, saving, spending, managing risks

[2] The Sustainable Development Goal 5 is called "Achieve gender equality and empower all women and girls".

and investing (Xiao et al. 2009; Dew and Xiao 2011). According to Buvinić and Furst-Nichols (2016), women encounter more social constraints than men, which subsequently triggers disproportionate economic outcomes. The existing body of knowledge recognizes financial knowledge as a crucial determinant for women's empowerment (Bijli 2012; Johnson et al. 2016). In addition, Robb and Woodyard (2011) present findings that confirm the close relationship between financial knowledge and financial behavior. Thus, it is likely that women equipped with good financial practices and financial knowledge tend to exhibit better economic development. On another note, financial management behavior can have a positive influence on financial inclusion (Birkenmaier and Fu 2019) and financial well-being (Gutter and Copur 2011), which subsequently contributes to an enhancement in the economic power of women (Hendriks 2019). Other studies provide evidence on the importance of financial management behavior in women's socioeconomic status. For instance, financial management skills are shown to be the key driver of women's engagement in business in rural Bangladesh (Afrin et al. 2010). Moreover, Buvinić and O'Donnell (2019) identifies that savings help to increase women's financial independence. Moreover, Stavins (2021) argues that good financial management practices help individuals prepare for future unwanted economic events, as they can avoid financial distress through these practices. With the focus on working women in Pakistan, Haque and Zulfiqar (2016) conduct a study to investigate how financial attitudes (i.e. financial management, spending tendency, risk attitude and attitudes to financial knowledge) have impacts on the economic empowerment of women. The results show supportive evidence for the argument that there is a positive and significant relationship between these two variables.

Altogether, it can be proposed that the practices of financial management are crucial for the positive change in women's economic power.

Hypothesis 2 (H2) Financial management practices are positively associated with women's economic empowerment .

2.3 Mobile money adoption and women's economic empowerment: the mediating effect of financial management practices

While, as mentioned above, there is growing evidence on the relationship between the usage of mobile money and women's economic empowerment, antecedents and consequences of these two quantities also raise scholars' concerns. One factor that can be located in between is financial management practices. A growing body of literature suggests that financial innovation plays an important role in promoting financial management behavior (Krivosheya 2020; Farida et al. 2021). On the other side, several studies emphasize the effect of financial management on women's improved control over their finance (Haque and Zulfiqar 2016; Hendriks 2019). In addition, the adoption of financial services such as mobile money could indirectly influence women's economic empowerment via the impact of other factors (Buvinić and Furst-Nichols 2016). As financial management behavior is generally influenced by the available financial technology and while it precedes women's empowerment,

it is reasonable to conjecture that financial management practices contribute to explaining the linkage between the usage of mobile money and women's economic empowerment. Additionally, several studies indicate that the relationship between access to finance and the economic empowerment of women is possibly affected by the ability to manage financial resources. For example, Suri and Jack (2016) illustrate the positive impact of mobile money on the financial welfare of poor women. The authors further suggest that the ability of financial management rather than the increase of capital results in better financial outcomes for women, conditionally on access to finance. Moreover, Samineni and Ramesh (2020), who examine the relationship between microfinance and the economic enhancement of women in India, suggest that further management skills and economic activities are necessary for the economic empowerment of women who have access to finance.

Altogether, we expect financial management practice to have a mediating effect in the relationship between mobile money and women's financial empowerment. Therefore, we propose the following hypothesis:

Hypothesis 3 (H3) Financial management practices mediate the relationship between mobile money adoption and women's economic empowerment.

3 Data and methodology

3.1 Data

The individual cross-sectional data are taken from the 2017 InterMedia Financial Inclusion Insights (FII) survey which was undertaken in seven countries: Bangladesh, India, Kenya, Nigeria, Pakistan, Uganda, and Tanzania. The FII survey has been carried out every year from 2013 to draw meaningful insights about the current stages of financial inclusion in eight South Asian and Sub-Saharan Africa economies.[3] Up to now, six rounds of surveys have been undertaken. However, the countries included in each round are different, to an extent. Although the 2018 FII survey provides the most recent data, we choose the 2017 FII survey for a broader coverage due to seven out of eight countries being included in it instead of only two countries in the 2018 round. To obtain data, face-to-face interviews under close supervision are conducted in the respective local languages or English in each country. The survey samples are selected randomly using a stratified multi-stage design. In each region of each country, the survey data proportionally cover inhabitants aged 15 and older in rural and urban areas. Sampling weights were used to make the sample nationally representative.[4]

The FII survey collects information on various aspects, including the respondent's socio-demographic profile, the adoption and usage of different types of

[3] Indonesia is excluded from the 2017 FII survey.

[4] For more detailed information on the used method as well as the FII program, please visit the website: http://finclusion.org.

financial services, especially digital financial services (DFS), and the driving factors of and obstacles to financial inclusion, financial behaviors and the individual's well-being. Apart from a few metric variables, such as age, the reported responses are mostly categorical and dummy variables. The survey data are appropriate for this study for the following reasons. Firstly, the total population of participating countries accounts for more than one-fourth of the global population. Secondly, the respondents are selected randomly from all regions of each country; hence, the data set is nationally representative. Thirdly, the survey contains comprehensive information on the usage and adoption of mobile money, which is the main focus of the study. Lastly, the information on respondents' characteristics is rich, which allows us to control for more important variables.

In total, the number of respondents who took part in the 2017 FII survey was 74,346, of which 59,132 people were from South Asia and 15,232 people were from Sub-Saharan Africa. Due to the focus on women, the sample of male respondents is excluded. Furthermore, observations with missing values for relevant variables are dropped. The final sample size is 30,549 observations for seven developing economies across South Asia and Sub-Saharan Africa.

3.2 Variable construction

3.2.1 Main variables

Women's economic empowerment (*EMP*) is our dependent variable which we observe on an individual level. The women's economic empowerment index contains 10 items related to the decisions of the answering person about income spending and control over financial resources and services (see Appendix for more detailed information). The scale is constructed by summing up the scores across all items and ranges from 10 to 50. Higher scores mean better women's economic empowerment. Cronbach's alpha test and factor analysis are applied to test for the reliability of the index. The value of Cronbach's alpha indicates the internal consistency of the index ranging from 0 to 1. An acceptable value of alpha is commonly suggested to be higher than 0.5. In our test, the resulting coefficient of alpha is 0.8707, which is relatively reliable.

The main explanatory variable in this paper is the adoption of mobile money. In order to reflect the process of adoption, three measures of mobile money adoption are employed: mobile money (MM) user, MM account owner and active MM account owner. The variable *MM user* takes the value of 1 if the respondent has used mobile money services for financial activities and otherwise 0. Meanwhile, the variable *MM account owner* indicates whether individuals who have an MM account registered in their name or not. If yes, this variable value equals to 1 and otherwise 0. The variable *active MM account owner* with the value of 1 defines those respondents who conduct financial activities using their registered MM account in the past 90 days. Otherwise, its value equals to 0.

To measure the mediator variable, financial management practice (*FMP*), we construct an index based on the idea of Dew and Xiao (2011) on financial management

behavior scale. Due to the dependence on the available questions related to financial management practices in the survey, we adopt nine items from the survey about the respondent's ability to manage savings, consumption, cash flow and debts to measure the FMP index (see Appendix for more detailed information). The values of this scale are an aggregation of the scores of each item ranging from 10 to 45. The higher the scores means the more the involvement of respondents in financial management practices. Similar to the construction of the women's economic empowerment index, Cronbach's alpha test and factor analysis are performed to test the suitability of the index. The quality of the financial management behavior index is sufficient, as the internal consistency of the index data is acceptable with the Cronbach's alpha value of 0.8449.

3.2.2 Control variables

In this part, we briefly summarize the employed variables and the construction of the index variables. More detailed information is provided in the Appendix.

The mobile phone proficiency variable (*Phone proficiency*) reflects how the respondents use mobile phones to perform specified functions in the past 90 days. The functions used to compute this index include: (1) Send or receive a text message; (2) Send/receive photo messages; (3) Use/browse the Internet; (4) Download music, video or games; (5) Make a financial transaction; (6) Use Facebook, Whatsapp, Twitter, Instagram or another social networking site; (7) Take a color picture; and (8) Download/use any other mobile application. Each task performed is assigned to the value of 1, otherwise 0. The scale scores range from 0 to 8. The value of α is 0.9083 for Cronbach's alpha test, and factor analysis shows reliable results for the internal consistency.

The financial literacy index is computed to measure the respondent's ability to correctly answer questions related to financial concepts. Each correct answer is assigned to the value of 1, otherwise 0. The respondents were asked about compound interest, inflation and diversification. The final scores for this scale range from 0 to 5. Similar to the other indices, Cronbach's alpha test and factor analysis are conducted to determine for the reliability of this index. The obtained results reveal that the index is internally consistent with $\alpha = 0.5711$, and the results of the factor analysis are suitable.

The control variables related to respondents' socio-demographic profile encompass age, working status, marital status, education level and residential status. Other household characteristics and respondents' information are also included: household head; main income earner; poverty status; smartphone ownership; insurance; perceptions about the future, life and financial situation; shock experience; and the use of bank and non-bank financial services. An additional categorical variable representing the countries in which the respondents live is also included. These variables have been employed in a range of literature in regard to mobile money, for instance Ouma et al. (2017) for Sub-Saharan African countries and Afawubo et al. (2020) for the case of Togo.

3.3 Econometric model

To evaluate the impact of mobile money adoption on women's economic empowerment, several OLS regressions are estimated. The basic equation is expressed as follows:

$$EMP_i = \beta_0 + \beta_1 MM_i + \beta_2 X_i + \epsilon_i, \tag{1}$$

where EMP_i represents the women's economic empowerment index for woman i. MM_i refers to one of the measures of the MM adoption, namely, MM user, MM account owner and active MM account owner. The symbol X_i represents a set of control variables, including the respondents' characteristics, financial literacy, and the subjective well-being. ϵ_i is the random error term.

To explore the mediating effect of financial management practices[5], the following specifications are employed:

$$FMP_i = \alpha_0 + \alpha_1 MM_i + \alpha_2 X_i + \epsilon_i \tag{2}$$

$$EMP_i = \gamma_0 + \gamma_1 MM_i + \gamma_2 FMP_i + \gamma_3 X_i + \epsilon_i, \tag{3}$$

where FMP_i represents the financial management practices index for women i. To investigate whether the linkage between mobile money adoption and women's economic empowerment is mediated by financial management practices, we perform the following steps as described by Baron and Kenny (1986). After performing Model 1, we run a regression with *FMP* being the dependent variable (Model (2), *MM* being the independent variable and keep a series of control variables as in Model (1). The coefficient α_1 represents the total effect of mobile money adoption on financial management practices. Subsequently, the explained variable in Model (3), i.e. *EMP*, is regressed on the mediating variable *FMP*, the main explanatory variable *MM* and the same set of control variables (Model (3)). The coefficient γ_1 measures the effect of the adoption of mobile money under the influencing mechanism of financial management practices. The coefficient γ_2 measures the impact of *FMP* in this case. In order for a certain degree of the mediating effect (partial mediation) to exist, the coefficients α_1, β_1, γ_1 and γ_2 must be significant. Furthermore, the absolute value of γ_1 must be smaller than that of β_1. In other words, the coefficient of the variable *MM* when paired with the variable *FMP* must be smaller than in the model without the variable *FMP*. If α_1, β_1 and γ_2 are significant, but γ_1 is insignificant, the relationship between mobile money adoption and economic empowerment for women is fully mediated through the variable *FMP* (i.e. full mediation).

[5] The moderation model is not considered since the variable *FMP* may have causal effect with our main independent variable.

Table 1 Frequency table of categorical variables (in percent)

	MM user		MM acc. owner		Active MM acc.	
	No	Yes	No	Yes	No	Yes
Married						
No	21.09	5.89	22.58	4.40	23.12	3.86
Yes	64.98	8.04	67.58	5.44	68.39	4.63
Household head						
No	74.73	10.35	78.25	6.83	79.28	5.80
Yes	11.34	3.58	11.91	3.01	12.24	2.68
Main income earner						
No	77.05	10.02	80.57	6.50	81.58	5.49
Yes	9.02	3.91	9.59	3.34	9.93	3.00
Smartphone						
No	79.68	10.64	83.18	7.14	84.35	5.98
Yes	6.39	3.29	6.98	2.70	7.17	2.51
Poverty						
No	32.32	7.42	33.79	5.95	34.33	5.42
Yes	53.75	6.51	56.37	3.89	57.19	3.07
Rural						
No	11.11	5.36	12.44	4.04	12.87	3.61
Yes	74.96	8.57	77.72	5.80	78.65	4.88
Life satisfaction						
No	20.86	4.58	22.02	3.43	22.56	2.89
Yes	65.21	9.35	68.14	6.41	68.96	5.60
Financial satisfaction						
No	29.04	7.07	30.82	5.28	31.64	4.46
Yes	57.04	6.86	59.34	4.56	59.87	4.02
Worry						
No	23.18	5.11	24.39	3.90	24.91	3.38
Yes	62.90	8.82	65.77	5.94	66.613	5.10
Death						
No	80.39	12.04	83.87	8.56	85.05	7.38
Yes	5.68	1.89	6.29	1.28	6.47	1.10
Illness						
No	60.51	6.26	62.23	4.54	62.80	3.97
Yes	25.57	7.67	27.93	5.30	28.72	4.51
Floods						
No	75.91	9.80	79.09	6.62	80.00	5.71
Yes	10.16	4.13	11.07	3.22	11.52	2.78
Insurance						
No	74.52	11.10	78.25	7.37	79.41	6.21
Yes	11.55	2.83	11.91	2.47	12.10	2.28
Bank account owner						
No	36.44	10.23	40.02	6.64	41.08	5.58

Table 1 (continued)

	MM user		MM acc. owner		Active MM acc.	
	No	Yes	No	Yes	No	Yes
Yes	49.63	3.70	50.14	3.20	50.43	2.90
NBFI account owner						
No	78.85	11.94	82.54	8.25	83.75	7.04
Yes	7.22	1.99	7.62	1.59	7.76	1.45

Note: All the data reported as percentages display the relative frequency of each cell in a 2 × 2 matrix

Table 2 MM usage by country

	Bangladesh	India	Kenya	Nigeria	Pakistan	Tanzania	Uganda	Total
MM user								
No	68.88	98.66	15.17	98.18	95.28	45.31	42.10	86.95
Yes	31.12	1.34	84.83	1.82	4.72	54.69	57.90	13.05
MM account owner								
No	88.93	98.80	30.64	98.09	99.53	53.93	62.65	91.21
Yes	11.07	1.20	69.36	1.91	0.47	46.07	37.35	8.79
Active MM account owner								
No	91.46	98.90	35.27	98.94	99.56	66.81	68.37	92.49
Yes	8.54	1.10	64.73	1.06	0.44	33.19	31.63	7.51
N	2,584	18,940	1,794	2,289	2,298	984	1,660	30,549

Note: All the data reported as percentages have been weighted

Table 3 Descriptive statistics for indices and metric variables

	Mean	S.D.	Min	Median	Max
Age	35.32	14.28	15.00	32.00	100.00
Women's economic empowerment	33.86	8.50	10.00	35.00	50.00
Financial management practices	25.39	8.02	9.00	26.00	45.00
Financial knowledge	1.78	1.44	0.00	2.00	5.00
Mobile phone proficiency	1.02	2.02	0.00	0.00	8.00
Observations	30,549				

4 Results

4.1 Descriptive analysis

Tables 1 and 2 show the relative frequencies of categorical variables by the adoption of MM and the usage of MM by country respectively. Table 3 presents the data

description for the employed indices and metric variables. At first glance, the data in Table 1 indicate the dominance of married and rural female residents who have used MM in comparison with their counterparts who also have access to MM. To be more specific, among those who have used MM, 57.8% (= 8.04%/(8.04% + 5.98%)) and 61.52% (= 8.57%/(8.57% + 5.36%)) are married and rural women, respectively. Moreover, the high usage of MM in rural areas could be due to the low level of access to banking services as previously discussed. Indeed, 21.88% (= 10.23%/(10.23% + 36.44%)) of respondents without a bank account are MM users, while the respective percentage is 6.93% among those with a bank account.

As can be seen in Table 2, the tendency of using mobile money services varies across countries. While the percentages of women who have used mobile money services are at least higher than 30% in Bangladesh, Uganda, Tanzania and Kenya, these proportions remain low in the rest of the countries, which is lower than 5%. One possible explanation could be the prevalence of mobile money in these countries, as shown in several studies (GSMA 2019; Demirgüç-Kunt et al. 2018). Furthermore, there are significant differences between the percentages of MM user, MM account owner and active MM account owner in all countries. For example, 84.83% and 57.90% of female respondents in Kenya and Uganda have used MM services, respectively; however, just approximately two-thirds of them have registered for an MM account.

4.2 Empirical results

4.2.1 Main results

Table 4 illustrates the empirical findings on the linkage between mobile money adoption and women's economic empowerment and the mediating effect of financial management practices. The estimation results in model specifications (1), (4) and (7) reveal that all the measures of mobile money adoption have significant and positive impacts on the change in women's economic power. In other words, the deployment of MM proves to empower women economically, no matter in which way the deployment of MM is measured. Our hypothesis 1 on the impacts of MM on women's economic empowerment is therefore supported by the evidence. Furthermore, we observe that employed and well-educated women tend to be involved in economic decision making to a larger extent, as the coefficients are significantly positive. These findings are consistent with a previous study on women's economic empowerment (Kabeer 2005). As expected, women who are equipped with financial knowledge tend to make their own financial decisions. On the contrary, there is no difference in the decision of using MM between the poor and non-poor women, which is opposed to the argument on the linkage between poverty and the adoption of MM (Wieser et al. 2019).

Regarding the influencing mechanism of financial management practices, we first run the model specification (2), (5) and (8) to investigate the linkage between the practices of financial management and the adoption of MM. The results from our estimations show significant and positive coefficients for different variables

Table 4 Estimation results for the mediation model utilizing different measures of MM adoption

Dependent variable	(1) EMP	(2) FMP	(3) EMP	(4) EMP	(5) FMP	(6) EMP	(7) EMP	(8) FMP	(9) EMP
MM user	1.113***	0.727***	0.888***						
	(0.286)	(0.214)	(0.276)						
MM account owner				1.148***	0.439*	1.013***			
				(0.317)	(0.231)	(0.309)			
Active MM account user							1.043***	0.392*	0.922***
							(0.329)	(0.209)	(0.328)
FMP			0.309***			0.309***			0.309***
			(0.008)			(0.008)			(0.007)
Age	0.042***	0.031***	0.032***	0.041***	0.031***	0.031***	0.041***	0.031***	0.031***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Married	2.874***	1.514***	2.407***	2.866***	1.514***	2.399***	2.868***	1.515***	2.400***
	(0.164)	(0.127)	(0.158)	(0.164)	(0.127)	(0.158)	(0.164)	(0.127)	(0.158)
Household head	2.988***	− 0.161	3.038***	2.985***	− 0.160	3.034***	2.983***	− 0.161	3.032***
	(0.230)	(0.180)	(0.218)	(0.230)	(0.180)	(0.219)	(0.230)	(0.180)	(0.219)
Main income earner	2.840***	0.095	2.810***	2.822***	0.094	2.793***	2.830***	0.097	2.800***
	(0.258)	(0.195)	(0.251)	(0.256)	(0.194)	(0.250)	(0.256)	(0.195)	(0.249)
Work									
Employed, regular salary	0.518**	1.113***	0.174	0.519**	1.122***	0.172	0.520**	1.122***	0.173
	(0.222)	(0.164)	(0.212)	(0.222)	(0.164)	(0.212)	(0.222)	(0.164)	(0.212)
Employed, irregular salary	1.376***	− 0.189	1.434***	1.381***	− 0.187	1.438***	1.384***	− 0.186	1.441***
	(0.208)	(0.178)	(0.204)	(0.208)	(0.178)	(0.204)	(0.208)	(0.177)	(0.204)
Self-employed	2.231***	1.801***	1.675***	2.232***	1.816***	1.671***	2.241***	1.820***	1.679***
	(0.290)	(0.237)	(0.277)	(0.290)	(0.237)	(0.277)	(0.289)	(0.236)	(0.277)
Looking for jobs	− 0.482	− 0.627	− 0.289	− 0.494	− 0.626	− 0.301	− 0.501	− 0.628	− 0.307
	(0.509)	(0.450)	(0.515)	(0.508)	(0.450)	(0.514)	(0.508)	(0.450)	(0.514)

Table 4 (continued)

Dependent variable	(1) EMP	(2) FMP	(3) EMP	(4) EMP	(5) FMP	(6) EMP	(7) EMP	(8) FMP	(9) EMP
Education									
Primary school	0.599***	0.991***	0.293**	0.601***	0.993***	0.294**	0.600***	0.992***	0.293**
	(0.150)	(0.134)	(0.141)	(0.150)	(0.134)	(0.141)	(0.150)	(0.134)	(0.141)
Secondary school	0.359*	1.675***	− 0.158	0.369*	1.685***	− 0.151	0.369*	1.684***	− 0.151
	(0.189)	(0.156)	(0.178)	(0.190)	(0.155)	(0.178)	(0.189)	(0.155)	(0.178)
Higher education	1.400***	2.794***	0.537*	1.399***	2.801***	0.534*	1.411***	2.805***	0.544*
	(0.303)	(0.274)	(0.290)	(0.303)	(0.274)	(0.290)	(0.303)	(0.274)	(0.290)
Smartphone	1.072***	0.793***	0.827***	1.059***	0.786***	0.816***	1.064***	0.788***	0.821***
	(0.248)	(0.235)	(0.229)	(0.248)	(0.235)	(0.229)	(0.248)	(0.235)	(0.229)
Poverty	− 0.198	− 0.110	− 0.164	− 0.192	− 0.113	− 0.157	− 0.195	− 0.114	− 0.160
	(0.124)	(0.113)	(0.114)	(0.124)	(0.113)	(0.115)	(0.124)	(0.113)	(0.115)
Rural	− 0.213	− 0.510***	− 0.056	− 0.225	− 0.530***	− 0.061	− 0.229	− 0.532***	− 0.065
	(0.181)	(0.156)	(0.170)	(0.181)	(0.155)	(0.170)	(0.181)	(0.155)	(0.170)
Mobile phone proficiency	− 0.202***	0.194***	− 0.262***	− 0.199***	0.203***	− 0.262***	− 0.198***	0.203***	− 0.261***
	(0.037)	(0.033)	(0.035)	(0.037)	(0.033)	(0.035)	(0.038)	(0.033)	(0.035)
Financial knowledge score	0.373***	0.465***	0.229***	0.374***	0.466***	0.230***	0.375***	0.467***	0.231***
	(0.043)	(0.037)	(0.042)	(0.043)	(0.037)	(0.042)	(0.043)	(0.037)	(0.042)
Insurance	0.521***	1.316***	0.115	0.515***	1.320***	0.107	0.518***	1.321***	0.110
	(0.200)	(0.142)	(0.192)	(0.199)	(0.142)	(0.191)	(0.199)	(0.142)	(0.191)
Life satisfaction	− 0.131	0.852***	− 0.394***	− 0.130	0.851***	− 0.393***	− 0.132	0.851***	− 0.395***
	(0.141)	(0.125)	(0.137)	(0.141)	(0.125)	(0.137)	(0.141)	(0.125)	(0.137)
Financial satisfaction	− 0.524***	2.287***	−1.230***	− 0.517***	2.292***	−1.225***	− 0.520***	2.291***	−1.228***
	(0.143)	(0.118)	(0.136)	(0.143)	(0.118)	(0.136)	(0.143)	(0.118)	(0.136)
Worry about future	0.138	−1.145***	0.492***	0.141	−1.142***	0.494***	0.141	−1.142***	0.494***

Table 4 (continued)

Dependent variable	(1) EMP	(2) FMP	(3) EMP	(4) EMP	(5) FMP	(6) EMP	(7) EMP	(8) FMP	(9) EMP
	(0.130)	(0.109)	(0.125)	(0.130)	(0.109)	(0.125)	(0.130)	(0.109)	(0.125)
Death	−1.029***	0.049	−1.044***	−1.027***	0.059	−1.045***	−1.022***	0.061	−1.041***
	(0.299)	(0.229)	(0.286)	(0.299)	(0.229)	(0.286)	(0.298)	(0.230)	(0.285)
Illness	− 0.184	− 0.855***	0.080	− 0.174	− 0.850***	0.088	− 0.175	− 0.850***	0.088
	(0.140)	(0.118)	(0.134)	(0.140)	(0.117)	(0.134)	(0.139)	(0.117)	(0.134)
Floods	− 0.920***	−1.142***	− 0.568***	− 0.917***	−1.135***	− 0.566***	− 0.911***	−1.133***	− 0.561***
	(0.183)	(0.153)	(0.177)	(0.183)	(0.153)	(0.177)	(0.183)	(0.152)	(0.177)
Bank account owner	1.634***	0.606***	1.447***	1.624***	0.609***	1.436***	1.630***	0.611***	1.441***
	(0.140)	(0.123)	(0.133)	(0.139)	(0.123)	(0.133)	(0.139)	(0.122)	(0.132)
NBFI account owner	1.110***	− 0.111	1.145***	1.101***	− 0.104	1.133***	1.107***	− 0.102	1.138***
	(0.179)	(0.166)	(0.179)	(0.178)	(0.167)	(0.178)	(0.177)	(0.166)	(0.177)
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30549	30549	30549	30549	30549	30549	30549	30549	30549
R^2	0.133	0.140	0.206	0.133	0.139	0.206	0.133	0.139	0.206

Standard errors in parentheses: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

The constant terms are included but skipped to present in the table

representing MM adoption. The positive effect of MM adoption means that the use of mobile money is positively related with the practices of more financial activities such as savings and budget planning. Relevant literature on financial inclusion also considers access to financial services as a driving factor of the engagement in financial management behavior such as the habits of saving or the use of credit. For example, mobile money proves to boost the probability and amount of savings of households in several Sub-Saharan African countries (Ouma et al. 2017). Furthermore, based on the data from Uganda rural households, Munyegera and Matsumoto (2018) investigate whether financial innovation, i.e. mobile money, leads to a change in financial behavior. The results show that mobile money users tend to save and borrow more than their non-user peers. Hence, our findings are in line with findings from previous studies.

Subsequently, estimations which consider the mediating effect of the variable *FMP* are conducted. The results reported in the model specification (3), (6) and (9) provide favorable evidence for our hypothesis 2. We first realize that practices of financial management are positively related with women's economic empowerment, which indicates that better financial management skills are closely connected with the greater roles of women in household finances. This finding shows supportive evidence for the study by Sarban and Hassanzadeh (2014), which affirms that less skilled rural women are constrained to attain economic empowerment.

The main focus of this analysis is the linkage between MM adoption and women's economic empowerment under the influencing channel of financial management behaviors. We find that this relationship remains unchanged since the coefficients on all three measures of MM adoption are positive. In addition to that, the magnitude of the impact of MM adoption is smaller than in the models without the inclusion of *FMP*. This finding supports our hypothesis 3 that financial management practices mediate the impact of MM adoption on women's economic empowerment. In other words, the mediating effect of financial management enhances the explanatory power of mobile money usage on the economic empowerment of women. Indeed, a recent study by Buvinić and O'Donnell (2019) shows that financial services are not gender-neutral and the inclusion of program designs can yield more positive outcomes such as higher decision-making power for women. Supporting women with skill training and technical assistance in accompanied with access to finance is a key point of these program designs.

4.2.2 Robustness checks

Sub-sample rural and urban areas. According to (Rewilak 2017), mobile money appears to be used more in countries with an underdeveloped financial system or lower income per capita. Therefore, we assume that there can be a significant difference in the tendency to adopt mobile money services between rural and urban areas due to their financial and development gaps. Our study sample is divided into two sub-samples of women by geographical areas, namely, rural and urban sub-samples. For the purpose of simplicity, we report only the results for our main variables: *MM user*, *MM account owner* and *active MM account owner*. All the coefficients of other variables are subtracted from the table of results, but are available upon request.

Table 5 Estimation results for the mediation model utilizing different measures of MM adoption: Rural and urban sup-samples

	Rural			Urban		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	EMP	FMP	EMP	EMP	FMP	EMP
MM user	1.782***	0.714***	1.569***	− 0.112	0.853**	− 0.425
	(0.358)	(0.265)	(0.347)	(0.446)	(0.349)	(0.419)
FMP			0.299***			0.367***
			(0.008)			(0.019)
R^2	0.122	0.126	0.192	0.235	0.243	0.318
MM account owner	1.934***	0.847***	1.681***	− 0.048	− 0.499	0.134
	(0.420)	(0.298)	(0.410)	(0.463)	(0.378)	(0.437)
FMP			0.299***			0.366***
			(0.008)			(0.019)
R^2	0.121	0.126	0.192	0.235	0.242	0.318
Active MM account user	1.896***	0.821***	1.650***	− 0.145	− 0.524	0.047
	(0.447)	(0.253)	(0.450)	(0.464)	(0.383)	(0.437)
FMP			0.299***			0.366***
			(0.008)			(0.019)
R^2	0.121	0.126	0.191	0.235	0.242	0.318
Observations	25516	25516	25516	5033	5033	5033

Standard errors in parentheses: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

All models are weighted. All the other control variables and constant terms are also included in the models but skipped to present in the table to save space.

A test of the interaction terms based on the dummy variable *Rural* shows insignificant coefficients which indicates that there are no significant differences between the sub-samples. Therefore, the interaction effects are not reported here

The empirical findings for the sub-samples are presented in Table 5. The results for the rural sub-sample are consistent with our previous findings, which confirms the significance of MM money adoption in women's economic empowerment and the influencing mechanism of financial management behaviors. Meanwhile, observed coefficients of MM adoption are found to be insignificant across model specifications for the case of the urban sub-sample. We find only the supportive evidence for hypothesis 2, which is the impact of financial management behaviors on women's economic empowerment. The lower prevalence of MM in urban areas is a possible explanation for this finding.

Sub-sample male and female. Above we have investigated the impact of MM adoption on women's economic empowerment, but it maybe the case that men are influenced as well. We further conduct regressions with the male sub-sample and compare with the female one. The results are shown in Table 6 which indicate the similar signs for the coefficients of the all measures of MM adoption. However, we obtain that the magnitude of the coefficients are higher in the case of female

Table 6 MM for economic empowerment by gender - The mediating effect of FMP

	(Male)			(Female)		
	(1)	(2)	(3)	(4)	(5)	(6)
	EMP	FMP	EMP	EMP	FMP	EMP
MM user	0.814***	1.071***	0.514***	1.113***	0.727***	0.888***
	(0.192)	(0.177)	(0.182)	(0.286)	(0.214)	(0.276)
FMP			0.280***			0.309***
			(0.008)			(0.008)
Observations	27708	27708	27708	30549	30549	30549
R^2	0.269	0.135	0.323	0.133	0.140	0.206
MM account owner	0.664***	1.122***	0.349*	1.148***	0.439*	1.013***
	(0.206)	(0.199)	(0.197)	(0.317)	(0.231)	(0.309)
FMP			0.280***			0.309***
			(0.008)			(0.008)
Observations	27708	27708	27708	30549	30549	30549
R^2	0.268	0.135	0.322	0.133	0.139	0.206
Active MM account user	0.426**	0.873***	0.181	1.043***	0.392*	0.922***
	(0.215)	(0.208)	(0.204)	(0.329)	(0.209)	(0.328)
FMP			0.281***			0.309***
			(0.008)			(0.007)
Observations	27708	27708	27708	30549	30549	30549
R^2	0.268	0.134	0.322	0.133	0.139	0.206

Standard errors in parentheses: $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

All models are weighted. All the other control variables and constant terms are also included in the models but skipped to present in the table to save space.

A test of the interaction terms based on the dummy variable *Female* shows insignificant coefficients which indicates that there are no significant differences between the sub-samples. Therefore, the interaction effects are not reported here

sub-sample (see the model specification (1) and (4)). Thus, the adoption of mobile money appears to be more effective to women's economic empowerment. The possible explanation could be that men generally have stronger economic power in comparison with women; therefore, the effect of MM adoption is less pronounced.

Control for endogeneity. Principally, our regression results may be biased due to a possible reverse causality problem. It could be the case that women who have control over their financial resources also have more chances to access mobile money services than those who are not economically empowered. Similarly, women who exhibit more practices of managing their money might make use of mobile money due to its features of low transaction costs and security. To control for the problem of endogeneity, we follow the approach introduced by Lyons et al. (2020). To be more specific, *time to the nearest bank* is employed as an instrumental variable in several two-stage least square (2SLS) estimations. This variable is an appropriate instrument, since the further away the bank branches are located, the more

incentives the respondents have for using an alternative financial service, for example, mobile money.

In addition, this instrument is expected to only influence the women's economic empowerment indirectly via its impact on MM usage. Munyegera and Matsumoto (2016) state that the proximity to financial intermediaries is not related with household characteristics that influence income spending. Therefore, we argue that the distance to bank agents will not directly affect women's economic empowerment and, thus, consider the exclusion restriction for this instrumental variable to be satisfied.

The variable time to the nearest bank has five categories: 15 minutes or less; 15-30 minutes; 30-60 minutes; more than 1 hour; and do not know. The based category is "do not know", which indicates that this person does not know the time to the nearest bank. In the first-stage of the 2SLS model, we regress mobile money adoption on the variable *time to the nearest bank*. Subsequently, the observed values are included in the three stated baseline models as the second stage.

The results are shown in Table 7, in which model specifications (4), (8) and (12) present the first-stage regressions by measures of MM adoption. Meanwhile, the remaining model specification reports the impact of MM adoption on women's economic empowerment under the mediating effect of financial management practices. As expected, the instrumental variable – *time to the nearest bank*– has a positive influence on the likelihood of adopting MM. In other words, respondents who live far from bank branches are better motivated to use MM. Furthermore, we also perform control tests for the validity of the instrument. As can be seen, the estimated F-statistics are larger than the minimum commonly accepted value of 10. Accordingly, our instrumental variable does not suffer from the problem of weak statistics. Moreover, the results from the endogeneity tests show that the null hypothesis of having no endogenous problem is rejected. It is worth noting that the results reported in Table 7 affirm the reliability of our previous findings.

Path analysis. In the baseline models, we already find that FMP mediates the link between MM adoption and women's economic empowerment. However, the extent to which the direct and indirect effects between MM adoption and women's economic empowerment are not quantified by that. To solve this problem, we adopt a path analysis in the sense of (Bhattacharya et al. 2012; Ni et al. 2021). Table 8 presents the results of the path analysis, with which the direct effect of MM usage on the *EMP* and the indirect effect between these variables through the mediating variable *FMP* can be estimated separately. The ratios of total mediated path to total path are presented as percentages in model specifications (1), (2) and (3). We find that 10% to 15.07% of the effect are mediated through FMP, depending on the definition of the MM measure. So altogether, we obtain clear evidence in favor of Hypothesis 3.

5 Conclusion

Our investigation represents the first study regarding the topics of mobile money providing empirical evidence on the women's empowerment effect of different measures of mobile money adoption and the mediating effect of financial management

Table 7 Results for IV estimations

	MM user				MM account owner				Active MM account owner			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	EMP	FMP	EMP	MM	EMP	FMP	EMP	MM	EMP	FMP	EMP	MM
MM user	3.270***	3.421***	2.217***									
	(0.717)	(0.605)	(0.682)									
MM account owner					3.319***	3.238***	2.320***					
					(0.704)	(0.596)	(0.670)					
Active MM acc. user									2.997***	2.813***	2.128***	
									(0.683)	(0.575)	(0.650)	
FMP			0.308***				0.308***				0.309***	
			(0.008)				(0.008)				(0.008)	
IV: 15 mins or less				0.287***				0.321***				0.398***
				(0.087)				(0.102)				(0.085)
IV: 15-30 mins				0.226***				0.276***				0.355***
				(0.073)				(0.085)				(0.073)
IV: 30-60 mins				0.178**				0.165*				0.238***
				(0.074)				(0.085)				(0.073)
IV: More than 1 hour				0.073				0.149*				0.175**
				(0.073)				(0.084)				(0.070)

Table 7 (continued)

	MM user				MM account owner				Active MM account owner			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	EMP	FMP	EMP	MM	EMP	FMP	EMP	MM	EMP	FMP	EMP	MM
Constant	26.060***	18.809***	20.272***	−1.282***	26.763***	19.562***	20.729***	−2.335***	26.863***	19.665***	20.793***	−2.725***
	(0.446)	(0.374)	(0.451)	(0.140)	(0.401)	(0.325)	(0.418)	(0.158)	(0.396)	(0.322)	(0.414)	(0.156)
F-test				1114.77				1457.38				1625.00
Observations	30549	30549	30549	30549	30549	30549	30549	30549	30549	30549	30549	30549
R^2	0.130	0.134	0.205		0.130	0.134	0.205		0.131	0.136	0.205	

All models are weighted.

Standard errors in parentheses: $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

IV is *Time to the nearest bank* with the displayed categories. All the other control variables are also included in the models but skipped in the table to save space

Table 8 Results of path analysis

	MM user (1)	MM account owner (2)	Active MM owner (3)
Total effect			
R[MM;EMP]	0.073***	0.072***	0.065***
Direct path			
P[MM;EMP]	0.062***	0.064***	0.058***
percentage	84.93%	88.89%	89.23%
Mediated path			
P[MM,FMP]	0.081***	0.055**	0.052**
P[FMP,EMP]	0.143***	0.143***	0.143***
Total mediated path	0.011	0.008	0.007
	$(= 0.081 \times 0.143)$	$(= 0.055 \times 0.142)$	$(= 0.052 \times 0.143)$
percentage	15.07%	11.11%	10.77%

This table shows the results of path analyses for the influences of three indicators of MM usage on women's economic empowerment through financial management practices as a channel. Column (1); (2) and (3) represent findings when MM usage is measured by MM users, MM account owner and Active MM owner, respectively. R[] indicates regression coefficients and P[] indicates path coefficients.

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

All models are weighted

All the other control variables and constant terms are also included in the models but skipped to present in the table to save space

practices. For this purpose, we conduct a study using cross-sectional data of women in seven countries across South Asia and Sub-Saharan Africa in 2017. Three measures of mobile money adoption are employed to reflect the process of using digital services, ranging from having used MM services to having an actively used personal MM account in the past 90 days. Additionally, to capture the multi-dimensionality of women's economic empowerment and financial management practices, we construct two indices to measure these two variables. To gauge the reliability of the findings, robustness tests for endogeneity and sub-samples of rural and urban areas are also conducted.

The empirical findings from our study confirm the conjecture that the use of digital finance represented by mobile money contributes to the economic empowerment of women. Moreover, financial management practices appear to stimulate economic empowerment and mediate the influence of mobile money adoption. This finding implies that equipping women with financial management skills helps them take the advantage of financial services to gain independence in making financial decisions. It is noteworthy that while the obtained results are significant in the case of the whole sample and the rural women sub-sample, the regression coefficients present no explanatory power in the case of the urban women sub-sample. By analyzing the influence of mobile money adoption and financial management behavior on women's empowerment, we can identify necessary practices and provide enabling environments to improve the role of women in contributing

to economic decisions. To this end, trainings of financial management skills are proven to be necessary as an accompaniment of the increasing use of mobile money services.

One of the limitations of our research lies in the employed dataset. The sample data comprise a large number of observations which allows for drawing reliable findings. However, these results only reflect the situation in one specific year. Further research is encouraged to utilize panel data to find more predictive findings rather than the current validity as our study does. In addition, our research focuses solely on the effect of mobile money on women's economic empowerment without considering the impact of other financial services. Last but not least, future studies could consider other aspects of women's empowerment such as social and psychological empowerment. In conclusion, we hope that this analysis partly contributes to this interesting field of research and can serve as a stepping stone for future deeper and broader investigations.

Appendix Additional tables

Tables 9, 10, 11 display the questions and answers in the 2017 FII survey associated to the construction of the EMP and FMP indices, and detailed definitions of the control variables.

Table 9 Questions and answers used to construct the *EMP* index (Source: 2017 FII survey)

Question	Values
In your best estimate, about how much of your household's income do you provide each month?	1=None; 2=A little; 3=About half; 4=Most; 5=Almost all; 98=Refused; 99=DK
About how involved or uninvolved are you typically in deciding how to spend your household's income?	1=Very uninvolved; 2=Somewhat uninvolved; 3=Neither uninvolved, nor involved; 4=Somewhat involved; 5=Very involved; 98=Refused; 99=DK
About how involved or uninvolved are you typically in deciding how your household's income is spent on basic needs like food and clothing?	1=Very uninvolved 2=Somewhat uninvolved; 3=Neither uninvolved, nor involved; 4=Somewhat involved; 5=Very involved; 98=Refused; 99=DK
About how involved or uninvolved are you typically in deciding how your household's income is spent on other things beyond basic needs?	1=Very uninvolved 2=Somewhat uninvolved; 3=Neither uninvolved, nor involved; 4=Somewhat involved; 5=Very involved; 98=Refused; 99=DK
If you were to speak your mind on a decision regarding how to spend your household's income, about how much influence do you think you would have on the final decision?	1=None; 2=A little; 3=A fair amount; 4=Most; 5=Almost all; 98=Refused; 99=DK
If you happened to disagree with a decision about how your household's income is spent, how likely would you be to voice disagreement?	1=Very unlikely; 2=Somewhat unlikely; 3=Neither unlikely, nor likely; 4=Somewhat likely; 5=Very likely; 98=Refused; 99=DK
If you voiced disagreement about a decision about how your household's income is spent, how likely do you think it would be to change the final decision?	1=Very unlikely 2=Somewhat unlikely; 3=Neither unlikely, nor likely; 4=Somewhat likely; 5=Very likely; 98=Refused; 99=DK
To what extent do you typically agree or disagree with the final decisions about how your household's income is usually spent?	1=Strongly disagree 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree; 98=Refused; 99=DK
To what extent do you agree or disagree with the following statements regarding the money you personally earn or receive? You make the final decision on how your money is spent or saved	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree; 98=Refused; 99=DK
How involved are you in deciding what kind of financial services you use?	1=Very uninvolved; 2=Somewhat uninvolved; 3=Neither uninvolved, nor involved; 4=Somewhat involved; 5=Very involved; 98=Refused; 99=DK

Observations with the values of "99", "98", "97" are treated as missing values

Table 10 Questions and answers used to construct the *FMP* index (Source: 2017 FII survey)

Question	Value
About how much do you agree or disagree with the following statements when considering your personal financial situation? I have enough money to pay for my living expenses	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I spend less money than I make each month	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I pay my bills on time and in full	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I have an emergency fund that is large enough to cover unplanned expenses	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I am confident that my income will grow in the future	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I earn enough money to pay back debt and also pay for my living expenses	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I have savings or assets that will keep me financially secure in the future	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
About how much do you agree or disagree with the following statements when considering your personal financial situation? I have the skills and knowledge to manage my finances well	1=Strongly disagree; 2=Somewhat disagree; 3=Neither disagree, nor agree; 4=Somewhat agree; 5=Strongly agree
If you had an emergency and urgently needed to pay a sum equal to one year of your income, how likely is it that you could gather sufficient funds?	1=Very unlikely; 2=Somewhat unlikely; 3=Neither unlikely, nor likely; 4=Somewhat likely; 5=Very likely; 99=DK

Note: Observations with the value of "99" are treated as missing values

Table 11 Definitions of the controls variables

Variable	Definition
Socio-demographic profile	
Age	The number of years that the respondent has lived
Married	Dummy variable refers to the marital status of the respondent. It equals to 1 if the respondent has married and 0, otherwise
Work status	Categorical variable refers to the employment status of the respondent. Unemployed is the reference category, the other four categories are employed, regular salary; employed, irregular salary; self-employed; and looking for jobs
Education	Categorical variable indicates the respondent's level of education. There are four groups: no formal education (the based category); primary school; secondary school; and higher education
Rural	Dummy variable indicate the respondent's residential location. It equals to 1 if the respondent live in rural area. Otherwise, it equals to 0
Country	Categorical variable indicate the country in which the respondent live in. There are seven countries namely Bangladesh, India, Kenya, Nigeria, Pakistan, Uganda, and Tanzania. The reference category is Bangladesh
Household's characteristics	
Poverty	Dummy variable indicates whether the respondent's household live under the poverty line of $2.5 per day. If yes, it takes the value of 1 and otherwise 0
Household head	Dummy variable indicates whether the respondent is household head. If yes, it equals to 1 and 0 otherwise
Respondent's information	
Life satisfaction	Dummy variable indicates whether the respondent satisfies with his life as a whole recent days. It takes the value of 1 if the respondent's answer is "very satisfy" or "somewhat satisfy". It equals to 0 otherwise
Financial satisfaction	Dummy variable indicates whether the respondent satisfies with his financial situation presently. It takes the value of 1 if the respondent's answer is "very satisfy" or "somewhat satisfy". It equals to 0 otherwise
Worry	Dummy variable indicates whether the respondent is worried about the future. It takes the value of 1 if the respondent's answer is "very worried" or "somewhat worried". It equals to 0 in otherwise
Death	Dummy variable indicates whether the respondent experiences a shock from the death of a household member in the past 12 months. If yes, it equals to 1 and 0 otherwise
Illness	Dummy variable indicates whether the respondent experiences a shock from the illness of a household member in the past 12 months. If yes, it equals to 1 and 0 otherwise
Floods	Dummy variable indicates whether the respondent experiences drought/floods in the past 12 months. If yes, it equals to 1 and 0 otherwise
Main income earner	Dummy variable indicates whether the respondent is the main income earner in the household. If yes, it equals to 1 and 0 otherwise
Smartphone	Dummy variable indicates whether the respondent has a smartphone or not. If yes, it equals to 1 and 0 otherwise
Insurance	Dummy variable indicates whether the respondent has insurance. If yes, it equals to 1 and 0 otherwise
Bank account owner	Dummy variable indicates whether the respondent owns a bank account. If yes, it equals to 1 and 0 otherwise

Table 11 (continued)

Variable	Definition
NBFI account owner	Dummy variable indicates whether the respondent owns an account in a non-bank financial institution (NBFI). If yes, it equals to 1 and 0 otherwise
Phone proficiency	An index includes 8 items focusing on question about whether the respondent perform several mobile phone functions in the past 90 days. The functions are: (1) send or receive a text message; (2) send/receive photo messages; (3) use/browse the Internet; (4) download music, video or games; (5) made a financial transaction; (6) use Facebook, Whatsapp, Twitter, Instagram or another social networking site; (7) took a color picture; and (8) download/use any other mobile applications. Each item has a score of 1 if the respondent uses the relevant function in the past 90 days, and 0 otherwise. The index scale is a summation of the scores ranging from 0 to 8
Financial literacy	An index includes five items focusing on the respondent's ability to correctly answer the questions about financial concepts, namely, compound interest, Inflation, and diversification. Each item has a score of 1 if the respondent correctly answers the questions, and 0 otherwise. The index scale is a summation of the number of the scores ranging from 0 to 5. The questions are: (1) Is it safer to put your money into one business or investment, or to put your money into multiple businesses or investments? The correct answer is "Multiple businesses or investments" (2) Suppose over the next 10 years the prices of the things you buy double. If your income also doubles, will you be able to buy less than you can buy today, the same as you can buy today, or more than you can buy today? The correct answer is "The same" (3) Suppose you need to borrow 100 units of national currency. Which is the lower amount to pay back: 105 units or 100 units plus 3 percent? The correct answer is "100 units plus 3 percent" (4) Suppose you put money in the bank for two years and the bank agrees to add 15 percent per year to your account. Will the bank add more money to your account the second year than it did the first year, or will it add the same amount of money both years? The correct answer is "More" (5) Suppose you had 100 units in a savings account and the bank adds 10 percent per year to the account. How much money would you have in the account after five years if you did not remove any money from the account? The correct answer is "More than 150 units"
Time to the nearest bank	Categorical variable indicates the time that the respondent has to travel to reach the nearest bank branch. There are five categories: 15 minutes or less; 15-30 minutes; 30-60 minutes; more than 1 hour; and do not know. The reference category is "do not know"

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Declarations

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