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Improving digital financial services inclusion: A panel data analysis

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Abstracts

The first goal of Sustainable Development Goals (SDGs) is the absence of poverty to be achieved by 2030. Thus, access to and usage of financial services play an important role in achieving this, where ICT and digital technologies are the main tools, that describe it as a digital financial service (DFS). It defines the provision of financial services and products through digital channels (mobile phone, cards, Internet etc.), and where DFS can be used remotely. DFS inclusion means to increase an access and usage of DFS through digital channels. We collected data for two years (Findex, 2014 & 2017) in 120 countries, overall 240 observation, and with depended variable as DFS inclusion, and independent 12 variables, such as GDP per capita, ATMs per adults, basic skills, Internet usage, mobile subscription, mobile 3G & 4G coverages (separately), mobile internet tariffs, handset prices, political stability, control of corruption and cybersecurity. In general, the regression yielded good results. Factors such as GDP per capita, political stability, control of corruption, mobile 4G coverage, ATMs per adults and mobile Internet tariffs are statistically significant factors for DFS inclusion. In addition, the r-squared value shows more than 0.8 in all models (running with 3G coverage, 4G coverage, both and also with dummy variable).

Keywords: *Digital financial service inclusion, Mobile money services, Financial services, Digital finance, Financial inclusion, Digital payments, Mobile money*

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1. Introduction

Worldwide, 2.5 billion people live on less than two dollars a day, which is doomed to remain in a state of chronic poverty³. Due to the lack of financial services for many poor people, they depend on cash that can be unsafe and difficult to manage⁴. As one solution to poverty reduction has been proposed financial inclusion (Chibba, 2009; Sharma 2014; Park & Mercado, 2015). Financial inclusion can be understood as a process that provides access, availability and use of financial services for all participants in the economy (Sarma, 2008).

Since 2010, the World Bank, together with the Group of Twenty (G20), has launched an initiative to expand access to financial services in developing economies and emerging markets to help them on poverty reductions (Ozili, 2018). Also, the United Nations General Assembly has developed 17 Sustainable Development Goals (SDGs), the first of which is the absence of poverty to be achieved by 2030 (Sachs, 2012). Thus, access to and usage of financial services play an important role in achieving this, where ICT and digital technologies are the main tools, that describe it as a digital financial service. It defines the provision of financial services and products through mobile devices and/or online using any electronic tools (cards, mobile phones, terminals), and where accounts can be accessed remotely (Buckley, 2015).

According to Naumenkova et. al (2019), financial inclusion mainly consists of three indicators: 1) access to financial services through infrastructure (financial institutions, branches, ATMs, mobile network operators); 2) quality (safety, uninterrupted services and content); 3) usage (from the consumer side: financial literacy, potential income, identity document, and internet access devices, like mobile devices or computers). As defined by Sarma (2015), financial inclusion is not only access and readiness, but also the use of financial services regularly. According to Agyekum et al. (2016), financial inclusion is closely related to digital financial services. (*Hereafter we will use DFS in our study.*) Moreover, DFS is a main component of financial inclusion, which helps to work properly and fully for everyone and everywhere.

According to Ozili (2018), digital finance is a financial service provided by financial and non-financial institutions through mobile or smart devices including personal computers, accessed through cards and the Internet, associated with a suitable digital payment system. Perlman (2019) argued that DFS is a new trend with low-cost methods of digital access to transactional financial services, often used as “mobile money” or “digital payments”.

According to Bachas et. al (2018) one advantage of DFS is it has the potential to reduce transaction costs, such as ATMs, debit cards, mobile money, and digital credit. The study found that debit card holders for accessing an account reduced the road distance by 4.8 km, and compared to non-card holders, withdrawals were increased by 59%. Similar findings from Aker et. al (2013), based on a five-month assistance program in Niger, switching to the monthly planned payment of state social benefits from cash to mobile phones allowed recipients to save an average of 20 hours on travel and waiting time to receive payments. Another advantage of DFS is that to improve to manage financial risks by making it easier to collect money from long-distance friends and relatives in difficult times. According to Jack & Suri (2014), in Kenya, when people’s potential income suddenly dropped, mobile money users did not cut household spending, whereas nonusers of M-PESA⁵ decreased household spending such as purchases of food and other goods by 7-10%. This reduction in consumption was shown in the three lower quintiles of the income distribution, and the other two upper quintiles of the income distribution⁶ were not shown. The paper explains

³ Karlan, D., Kendall, J., Mann, R., Pande, R., Suri, T. (2016). Research and impacts of digital financial services. National Bureau of Economic Research.

⁴ Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., Hess, J. (2018). The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution. The World Bank.

⁵ M-Pesa (M for mobile, Pesa is Swahili for money) is a mobile phone-based money transfer service, payments and micro-financing service, launched in 2007 by Vodafone Group and Safaricom, the largest mobile network operator in Kenya.

⁶ Measuring income inequality based on households by income, from lowest to highest by dividing all households into five groups (quintiles) with an equal number of people, where the first quintile is the smallest fifth or 20%, the second quintile is the next lowest, and etc.

that when an unexpected drop in income occurred, the use of DFS increased, in particular mobile money services for remittances.

According to World Bank report⁷, globally, there has been an increase from 62 to 69% of adults (2014-17), who has access to an account, however use of financial services and digital payments is still lower. It showed 43% in 2014 and 53% in 2017. Malady (2016) argued that although most account holders have access to DFS, consumers in emerging economies do not use them actively or do not use them at all, one of the reasons he demonstrated as a lack of trust in new digital channels.

Mobile technologies could have a huge impact on economic growth (Ghosh, 2016). Widespread use of DFS in all developing countries could increase the annual GDP by \$ 3.7 trillion by 2025 (an increase of 6%). About 65% of this expansion would originate from raised efficiency of governments, financial and non-financial businesses because of DFS, where this extra growth of GDP could help the formation more than 95 million jobs over all sectors (Manyika et. al 2016).

Abbasi & Weigand (2017) identified 39 DFS studies over the past decade that have been published in a large number of peer-reviewed scientific journals. They noted that despite the rapid technological advances in DFS over the past ten years, DFS did not receive due attention in the scientific literature.

When we reviewed previous studies, we found that data related to mobile money or digital payment using as DFS are either very limited. Possibly, at an early stage of DFS (2000s) secondary data on DFS in most countries were not available or absent, but at present, resource availability has increased significantly. Consequently, our study complements existing literature, which contains gaps in empirical studies with panel data analysis around the world.

For this study, we set objectives that include: 1) identify and consolidate the determining factors for improving DFS inclusion; 2) identify additional factors that are very important for the use of DFS and which are not empirically verified by previous research; 3) identify the best practices of income groups with good performance and recommend this experience to less efficient countries.

We perform ordinary least squares (OLS) regression in 120 countries, based on two-year data (2014 & 2017). Our results allow us to better understand the issue of DFS inclusion and identify indicators that have a significant impact on the changing nature of the trend in the use of DFS and on how they can be solved in developing and emerging countries.

The study is structured as follows. Section 2 reviews previous research on this subject. Section 3 describes our model that we applied and section 4 introduces the data. Section 5 explains the results which lead to policy implications discussed in section 6. Section 7 concludes.

2. Previous research

Although digital accounts and ATMs were launched in the financial sector in the 1960s, DFS began to be widely used when online banking and mobile payments (2000s) appeared. This trend was especially evident in developing countries, which helped to improve financial business, banking, electronic commerce and the economy of the country as a whole. From the early stages to the present, most of the previous studies used different terms, but with a similar meaning, the definitions of which are close to DFS. We examined all of these possible options in our research to do empirical analysis.

Ouma et.al (2017) described mobile financial services as relatively cheap, safe, reliable and affordable, with the result that most poor and low-income people expand their financial platforms to include mobile banking, agent banking and other types financial services. Yousif et al. (2013)

⁷ globalfindex.worldbank.org; Global Findex 2017

divided mobile financial services into three groups: mobile banking services (e.g. withdrawals, deposits, repayment of loans), remittances and mobile payments (e.g. payment of bills or making online shopping). Srivastava (2019) noted that mobile money services are also a part of the DFS.

Financial inclusion can be constructed by multidimensional factors, such as socio-economic, infrastructure-related, banking and individual factors (Sarma, 2008; Sarma & Pais, 2011). Most of the previous studies on financial inclusion mentioned that the key role of financial inclusion is DFS, namely financial services through digital channels. In this study, DFS inclusion is also explained by these aforementioned factors, including digital channel factors (mobile phones and Internet usage) and additional factors (mobile internet tariffs, smartphone prices and cybersecurity).

2.1 GDP per capita

According to Sarma & Pais (2011), income, measured by GDP per capita, is an important factor explaining the level of financial accessibility in a country. A study by Chithra & Selvam (2013) also showed that per capita GDP has a significant positive effect on the inclusion of financial services in India. Similar findings by Evans (2015), Evans & Alenoghena (2017) that per capita GDP has a significant impact on the inclusion of DFS, thereby showing how an increase in per capita GDP can be used to stimulate the necessary financial inclusion in Africa. Also, studies by Agyekum et al. (2016) and Sharma (2014) discussed that per capita GDP is the main determinant of DFS inclusion. Based on these studies, we expect that per capita GDP would have a positive effect on DFS inclusion.

2.2 Automated teller machines

The use of automated teller machines (ATMs) for financial services continues to grow. ATMs are used not only for cash withdrawals based on debit / credit accounts, but they are also used to make deposits, loan payments and transfers from / to / between accounts maintained by a user in a financial institution (Clark, 2000). According to Bachas et. et al. (2018), transaction costs are one of the significant barriers to the use of official financial services. DFS, such as ATMs, debit cards, and mobile money, can help reduce them. In addition, the location of ATMs is important, so increasing the ATMs per adults can increase DFS inclusion. Weihuan et.al (2015) indicated that ATMs is one of determinant of DFS usage. A study by Siddik & Kabiraj (2020) found that a ATMs per adults is a positive relation with digital finance and financial inclusion, so it has a positive influence on DFS inclusion. Similar findings by Ajide (2017) showed that ATMs has positive impacts on DFS inclusion. The study explained by the convenience that such financial services are provided to users, and are not forced to stand in queues in bank halls for hours. Based on these analyses we can deduce that the ATMs per 100'000 adults have positive effect on DFS inclusion. We expect that ATMs would have positive impact on DFS inclusion.

2.3 Basic skills

Basic skills are very important. Everyone needs them. These are such skills as numeracy, literacy, reading and writing skills, and also mobile phone, computer and Internet usage skills. Murray (1995) proposed measurement as basic skills for combining variables as adult literacy, school life expectancy, mean years of schooling, tertiary enrollment into one. According to Akudugu (2013), Chithra & Selvam (2013), Evans (2015), Uddin et. al (2017), Akileng et. al (2018), Jana et. al (2019), Le et. al (2019), literacy rate is positively related to financial inclusion. Almenberg & Widmark (2011) showed that numeracy is positively correlated with financial inclusion. Studies by Atkinson (2013), Zins & Weill (2016), Xiuhua & Guan (2017), Sanderson et. al (2018) noted that education level has positive relationship with DFS usage, and high influence on financial inclusion. We expect that basic skills would have positive impact on DFS inclusion.

2.4 Internet usage

About 3 billion people live in the mobile coverage area but they do not use mobile Internet services (GSMA report, 2018). According to Evans (2018) showed that the Internet has a significant positive relationship with the inclusion of DFS, which means that the level of the Internet is associated with increased financial inclusion. It also implies that increased Internet usage plays an important role in increasing of DFS inclusion. Shen et al. (2018) argued that the Internet plays a multiple intermediary role between financial literacy and financial accessibility. The study found that Internet usage can contribute to the use of DFS and achieve the goal of financial inclusion. A study by Nagpal et. al (2019) found that internet usage and mobile penetration rates have a positive association with DFS inclusion in India. As indicated Sha'ban et. (2020), the relevance of factors depends on the level of national income, as a result of which Internet usage and the competition of banks are apparently more important for ensuring DFS inclusion in low-income countries. A similar study by Chatterjee (2020) showed that the impact of Internet users on the number of deposit accounts is positive and significant. Then the study explained this by the fact that Internet usage has a significant impact on DFS inclusion. These studies measured Internet usage as a percentage of the population in countries that have used the Internet in the last three months in a given year. The Internet can be used through a computer, mobile phone, personal digital assistant, gaming machine, digital television, etc. Analysing these studies, we expect that Internet usage has positive impact on DFS inclusion.

2.5 Mobile subscription

Worldwide, the number of mobile subscriptions in 2019 exceeded 8 billion⁸. According to Jack & Suri (2014), a growing number of mobile phone users in rural India provides ample opportunity to enable DFS in general in India, for example, in 2011, connecting to mobile phones in rural areas accounted for only 32.67% of the total number of mobile subscribers, while the rural population accounted for more than 70% in India. A study by Lenka & Barik (2018) found a positive and significant relationship between the growth of DFS inclusion and the expansion of mobile phone and Internet usage in SAARC⁹ countries. Perlman & Wechsler (2019) stated that a mobile phone is the primary mechanism for accessing DFS, so using a mobile phone is one of the factors determining DFS inclusion. Based on these analyzes, we can conclude that mobile phones (internet-enabled device) positively affect DFS inclusion. We expect that the mobile subscription rate would have a positive impact on DFS inclusion.

2.6-2.7 Mobile coverages (3G & 4G networks)

At the end of 2017, 3.3 billion people were connected to the mobile Internet. However, more than 4 billion people remain offline, and 1 billion of them are not covered by mobile broadband coverage (GSMA report¹⁰, 2018). According to Perlman & Wechsler (2019), mobile coverage has a significant effect on DFS inclusion in developing countries. The study notes that rural DFS users often find themselves in the greatest financial isolation, and they are forced to use 2G coverage, which can only provide phone calls and short text messaging services (SMS). Although DFS requires 3G or 4G broadband networks or higher speeds, they may be mostly absent in these areas. As reported GSMA in 2018, globally, only 45% of the population had 3G coverage, of which 68% had connections, and only 16% were mobile broadband connections. A study by Hernandez (2019) found that Bangladesh needs mobile coverage to use DFS, especially in places with relatively high purchasing power, where people are likely to be the first to receive disposable income, which

⁸ Data from Statista, it is a German online statistics portal whose data is collected by market research and public opinion research institutes. www.statista.com

⁹ The South Asian Association for Regional Cooperation (SAARC) is the regional intergovernmental organization and geopolitical union of states in South Asia.

¹⁰ GSMA, 2018, "State of Mobile Internet Connectivity 2018" www.mobileconnectivityindex.com

threatens to leave poverty behind. Based on these studies, we would say that mobile coverage (3G and 4G coverage) has positive impact on DFS inclusion.

2.8 Affordable mobile internet tariffs

As a rule, affordable tariffs or cheap prices can lead to widespread use of services or more sales. This can also be seen in the use of mobile internet. Yusuf-Asaju et al. (2018) noted that the mobile Internet tariff is the amount of money that is exchanged for data packets, that is, the sum of the values that the mobile Internet exchanges to take advantage of access to mobile Internet services. According to Adebisi et al. (2016), data tariffs are commonly used as a competitive tool in most telecommunications companies. For example, mobile operators that offer lower data rates are more likely to attract more customers than those with higher data speeds. Similarly, expanding the use of DFS requires affordable mobile Internet tariffs, especially in emerging and developing countries. Based on these studies, we expect that affordable mobile Internet tariffs would have a positive influence on DFS inclusion.

2.9 Handset prices (Cost of cheapest internet-enabled device)

Like internet tariffs, cheap mobile phone prices can increase mobile device sales, which will lead to an increase in mobile service consumption. Since mobile phones (internet-enabled devices), are the basic tools for accessing to DFS, they can improve the DFS inclusion (Perlman & Wechsler, 2019). As stated Björkegren (2018) and Purohit et al. (2019), handset prices are falling all over the world, it's cheaper to buy phones. However, some people still cannot afford to have such as internet-enabled mobile devices, especially in countries with emerging and developing economies. Sultan et al. (2015) found that the average handset price correlates well with mobile money services, and infrastructure in general. Based on these analyses we can deduce that the handset prices have positive effect on DFS inclusion. We say that handset prices would have negative impact on DFS inclusion.

2.10 Political Stability

Some studies have shown the factor of measuring governance as political stability. Wang & Shihadeh (2015) showed that because of a political stable situation time in Palestine, there was improved access to financial services. The study showed that with political stability in Palestine, the use of online payments, transactions and other DFS has increased, and the quality of banking products and services has improved, reducing the cost of services. As a result, more people were involved in financial activities due to DFS inclusion. Bakari et. (2018) indicated that one of the main factors determining financial inclusion in Africa is political stability, and the other remaining factors are mobile banking, bank branches, interest rates and inflation. In countries with higher political stability there was a high level of financial inclusion. As an explanation for this, the article shows the correspondence of economic theory. A study by Ravikumar (2020) was devoted to a comparative analysis of indicators of access to financial inclusion in the SAARC countries. The study found that political stability was very important for achieving financial inclusion through a development of banking and DFS system, rather than a favorable government policy regarding financial inclusion. Allen et al. (2016) indicated that the existence of strong legal institutions and a stable political environment can bring to greater financial inclusion. Because countries with greater political stability use more DFS, such as access to bank accounts and remittances, compared to political instable countries. Based on these analyses we expect that political stability has a positive effect on DFS inclusion.

2.11 Control of corruption

Corruption level of a country is likely to be negatively correlated with the general public's attitude towards digital financial services because the use of digital financial services leaves traces. In other words, in an economy with high level of corruption, economic agents including individuals tend to prefer cash over digital financial services. Galli et al. (2017) investigated

whether corruption affects financial services, such as bank loans in small businesses. The paper finds that the control of corruption plays a role in the use of financial services. And it emphasizes that small enterprises in countries with lower levels of control over corruption are more likely to self-restrain their financial services (about 7.4%) than economies with the higher control of corruption (about 6%). Pelletier et al. (2020) finds that the control of corruption is a significant factor determining the provision of mobile money by banks. The results of the study show that with an increase in control of corruption per unit, the mobile money services increase by 4.01. Zulkhibri & Ghazal (2017) showed that control of corruption is essential for development and increasing prospects for DFS inclusion, especially for the poor segment of society, because financial markets, economic activities and transactions in general cannot function well if control of corruption is absent. Thereby, we expect that control of corruption has positive effect on DFS inclusion.

2.12 Cybersecurity

One of the important drawbacks of the new digital era is the growth of cybercrime, cyber-attacks or cyber espionage globally, but also thanks to innovations and the latest technologies, cybersecurity companies must create products and services that successfully combat cybercrime. According to Malady (2016), the lack of consumer confidence in digital channels negatively affects in DFS inclusion in emerging and developing countries, and this problem is greater in countries where there are no strong cybersecurity institutions. Studies by Chung & Kwon (2009) and Kim, et. al (2011) mentioned that perceived trust is a sense of security, confidence, and the willingness of customers to rely on a DFS system, product, or service to prevent them from failing. Srivastava (2019) stated the most serious problem in DFS is cybersecurity issues, the extent of digital transactions after demonetization, the risk of online fraud, confidential information leakage, cybercrime, malware and virus attacks. Based on these aforementioned studies, we expect that cybersecurity level would have positive influence on DFS inclusion.

3. Research hypothesis and model

3.1 Research hypothesis

This study has one set of hypotheses, which is designed to test the effect of the explanatory variables used in previous research and newly added on DFS inclusion across countries. These hypotheses, summarized in *Appendix 1*, are intended to reconfirm the signs of the determinants of DFS inclusion in previous studies (GDP per capita, the ATMs per adults, basic skills, Internet usage, mobile subscription, 3G mobile coverage) and to estimate the effects of newly added 6 variables, such as 4G mobile coverage, mobile Internet tariffs, handset prices, political stability, control of corruption and cybersecurity.

Most of the factors in the study are expected to have a positive effect on DFS inclusion, and only one determinant, such as handset prices, would have a negative relationship with the dependent variable.

3.2 Model

The study mainly deals with the digital financial services in the perspective of the financial inclusion improvement. Thus, first of all, to identify each features' level of influence, we use pooled ordinary least squares (OLS) estimation approach. Our main estimation model is the following:

$$\begin{aligned} DFS_{inclusion} = & \beta_0 + \beta_1 GDP_{per\,capita} + \beta_2 Number_{ATMs} + \beta_3 Basic_{skills} + \beta_4 Internet_{usage} + \beta_5 Mobile_{subs} \\ & + \beta_6 Mob_{3G\,Cov} + \beta_7 Mob_{4G\,Cov} + \beta_8 Mob_{Int\,tariff} + \beta_9 Handset_{prices} + \beta_{10} Politic_{Stabl} \\ & + \beta_{11} Control_{Corrup} + \beta_{12} Cyber_{Security} + \varepsilon \end{aligned}$$

We also launch the model for each generation of mobile networks (3G and 4G) separately. Despite the fact that the main function of mobile coverage is to connect to the Internet, the technical and infrastructure are different. We test how the third and fourth generations affect the inclusion of DFS. Finally, the model runs with dummy variables as income groups that have been classified by the World Bank. The reason for this is to check for DFS inclusion in developing and emerging economies.

To measure the DFS inclusion (our dependent variable), we use the percentage of digital payments made or received over the past 12 months from Worldbank Findex dataset. Because it covers the responses of participants who said that used mobile money, a debit or credit card, or a mobile phone to make a payment from an account, or used the Internet to pay bills or buy something online, send or receive remittances, or receive payments for agricultural products, or receive government transfers, wages or a pension from a financial institution account or through mobile a money account over the past 12 months.

To run the model, we developed hypotheses for 12 independent variables, among which half are the variables of the previous study, and the other half are newly added variables to determine the effect on the dependent variable.

1) Variables from previous studies are the following:

- *GDP_per_capita* – It is used to describe the standard of living of the population, with higher GDP means a higher standard of living and income. This is shown in current US dollars, then it was divided by 1000 to reduce income ranges. The World Bank source;
- *ATMs_per_adults* – It is measured as the number of ATMs per 100,000 adults. The World Bank source;
- *Basic_Skills* - It is measured on the basis of 4 factors: adult literacy index, school life expectancy, mean years of schooling and tertiary enrollment to combine them in equal proportions (1/4) into one factor. Source: GSMA as indicator of Mobile Internet Connectivity index;
- *Internet_usage* – It is measured as a percentage of the population in countries that have used the Internet in the last three months of a given year. The World Bank source;
- *Mobile_subs* – It is measured as a percentage of mobile cellular subscribers in the population of countries. The World Bank source;
- *Mob_3G_Cov* – It is measured as a percentage of population covered by 3G networks signals. This is calculated by dividing the number of inhabitants that are covered by 3G mobile cellular signal by the total population and multiplying by 100. GSMA Intelligence;

2) Newly added variables are the following:

- *Mob_4G_Cov* - It is measured as a percentage of population covered by 4G networks signals. This is calculated by dividing the number of inhabitants that are covered by 4G mobile cellular signal by the total population and multiplying by 100. GSMA Intelligence source;
- *Mob_Int_tariff* – It is measured based on the cost of mobile Internet tariffs by dividing the monthly GDP per capita. This is calculated at a cost of 100 MB and 500 MB with equal proportions of 40%, and the remaining 20% of the proportion the cost of 1 GB data. GSMA Intelligence with Tarifica¹¹ sources;
- *Handset_prices* – It is measured as a percentage of the cheapest prices for internet-enabled device by dividing the monthly GDP per capita in countries. GSMA Intelligence with Tarifica sources;
- *Politic_stabl* – It is measured the perception of the likelihood of political instability and / or politically motivated violence, including terrorism. The percentage rank indicates the country rank among all countries covered by the aggregated indicator, where 0 corresponds to the lowest rank and 100 to the highest. The World Bank source;

¹¹ Tarifica is the Global Expert in Telecom Plan and Pricing Data. It focuses exclusively on the collection, analysis, dynamic modeling and delivery of telecom plan and pricing data worldwide www.tarifica.com

○ *Control_Corrupt* – It is captured perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. The World Bank source;

○ *Cyber_Security* – It is a multi-stakeholder initiative to raise cybersecurity awareness and to measure the commitment of countries to cybersecurity and its wide field of application cutting across industries and sectors. The World Bank source.

3) *Dummy variable is the following:*

▪ *Income_groups* – This is a dummy variable that is grouped based on per capita GDP provided by the World Bank. It is divided into four income groups: low, lower-middle, upper-middle, and high incomes. The World Bank source.

4. Data and descriptive statistics

4.1 Data

There is a huge amount of literature on various factors affecting financial inclusion in different countries. Most of them used the Worldbank Global Findex individual database compiled by Gallup World Poll, which data were collected through nationally representative surveys of more than 150,000 adults in more than 140 countries since 2011. Following the literature, we use the Global Findex dataset as our primary worldwide data source. Because last two editions (2014 & 2017) were included data about usage of mobile phones and the Internet to access to digital financial services, and to make or receive digital payments.

Also, we use GSMA data, which was used to measure the mobile communications index for 165 countries. Countries are scored in the range from 0 to 100 for a number of indicators, with a higher score reflecting higher indicators in providing the ability to connect to the mobile Internet.

As a result, we collected data for two years (2014 & 2017) in 120 countries, overall 240 observation, and with depended variable as DFS inclusion, and independent 12 variables, such as GDP per capita, ATMs per adults, basic skills, Internet usage, mobile subscription, mobile 3G & 4G coverages (separately), mobile internet tariffs, handset prices, political stability, control of corruption and cybersecurity.

In order to test the hypotheses, this paper uses the most recent panel dataset with policy variables, determinant factors of DFS inclusion. All variable definitions, measurements, sources, was shown in Appendix 1.

4.2 Descriptive statistics¹²

The study collected data for 120 countries, dividing them into four groups depending on the level of GDP per capita. Figure 1 shows a map of these countries, and income groups are shown in different colors. High-income countries are blue, and the total number of countries is 41, with a share of 34.2%. The second group consists of upper middle-income countries and red, in total 33 countries with a share of 27.5%. The third group is lower middle-income groups that belong to 29 countries, and its green color is 24.2% of the total number of countries. The latter, and a small proportion (14.2%), belongs to a group of low-income countries. The map also shows countries in which there was no relevant available data or was missing. Most of them belong to African countries. However, there were also some of the developed countries, such as the United States and the United Kingdom.

¹² All descriptive analysis, figures and regressions were performed in a Jupyter notebook environment with the Python programming language.

Figure 1. World map by income group: 120 countries with 4 income groups

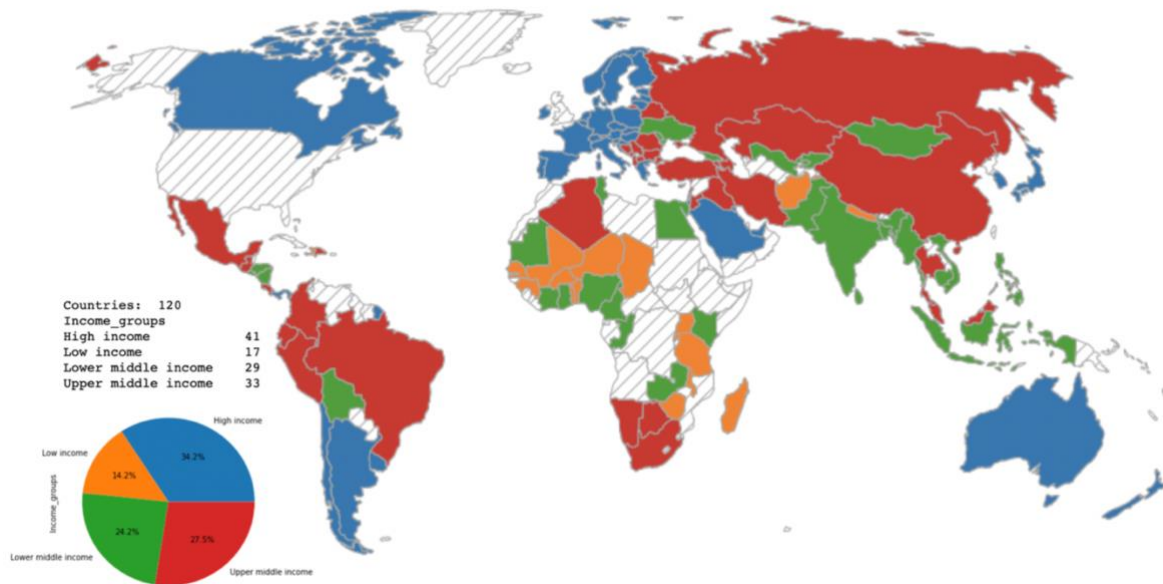


Table 1. County classification groups

High income (41)	Israel, Saudi Arabia, Greece, Kuwait, Argentina, Korea, Rep., Panama, Spain, France, Italy, Chile, Latvia, Belgium, Cyprus, Poland, Germany, United Arab Emirates, Croatia, Hungary, Estonia, Lithuania, Portugal, Denmark, Slovenia, Australia, Japan, Slovak Republic, Netherlands, Sweden, Czech Republic, Uruguay, Ireland, Austria, Finland, Canada, Norway, Malta, Singapore, Switzerland, Luxembourg, New Zealand
Upper middle income (33)	Iraq, Lebanon, Turkey, Algeria, Colombia, Russian Federation, Iran, Islamic Rep., Thailand, Mexico, Azerbaijan, Guatemala, Armenia, Peru, Jordan, China, Brazil, Bosnia and Herzegovina, South Africa, North Macedonia, Ecuador, Montenegro, Belarus, Kazakhstan, Romania, Bulgaria, Serbia, Dominican Republic, Malaysia, Albania, Costa Rica, Namibia, Mauritius, Botswana
Lower middle income (29)	Pakistan, Nigeria, Ukraine, Egypt, Arab Rep., Kenya, Bangladesh, Myanmar, Philippines, Cameroon, Côte d'Ivoire, Tunisia, India, Kyrgyz Republic, Mauritania, Honduras, Congo, Rep., Indonesia, Georgia, Bolivia, Moldova, Sri Lanka, El Salvador, Uzbekistan, Ghana, Nicaragua, Vietnam, Cambodia, Zambia, Mongolia
Low income (17)	Afghanistan, Mali, Chad, Niger, Guinea, Uganda, Burkina Faso, Togo, Zimbabwe, Nepal, Haiti, Tanzania, Madagascar, Rwanda, Malawi, Senegal, Benin

Figure 2 shows a map of the DFS inclusion level in the world with reflection of blue shaded colors. Dark blue means a high level of DFS inclusion, and light blue with less in DFS. Accordingly, it can be explained as developed countries have more DFS usage than developing and emerging economies.

The following two figures show a comparative analysis of the DFS inclusion graph for periods and groups. Figure 3 shows the improvement in the four groups compared to 2014 and 2017, as it has changed in three years. Each group has growth, but low-income countries show better movement.

Figure 4 shows a statistical overview of each group and all. Most of them are less included in DFS, only high-income countries show a high level of DFS inclusion. However, there is less included DFS countries in high-income group by showing less 40%. Majorities are in the other three groups. The range of countries with upper-middle income is too large, which means that it may be found countries with a very good inclusion and none of them included DFS. In addition, the lower-middle income group has an exciting 3 points above the range, which means that there are three countries with a high DFS inclusion. We can assume that for these three lower groups it is necessary to develop the correct policy of DFS inclusion.

Figure 2. World map for digital financial service inclusion in across countries

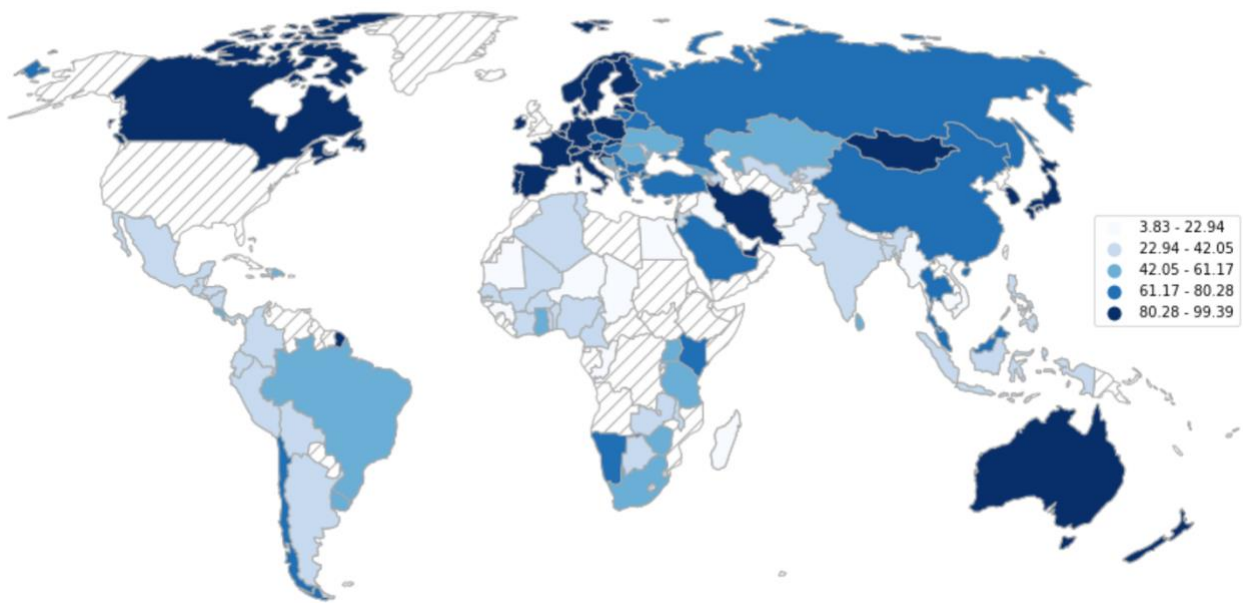


Figure 3. DFS Inclusion: 2014 vs 2017

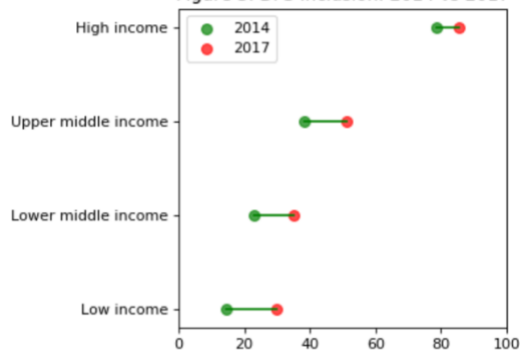


Figure 4. DFS Inclusion by groups

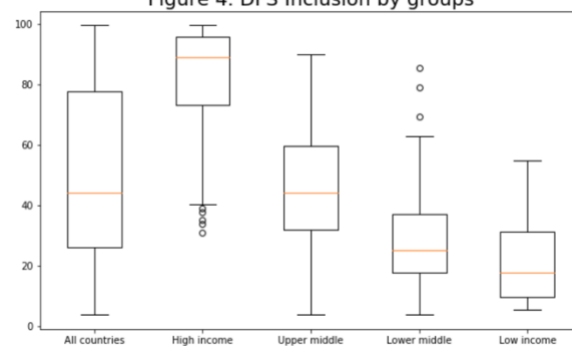


Table 2. Descriptive statistics

	mean	std	min	max
DFS_inclusion	50.52	29.61	3.83	99.39
GDP_per_capita	15.24	20.34	0.38	106.52
ATMs_per_adults	53.39	48.38	0.74	280.97
Basic_Skills	61.48	20.75	5.71	97.57
Internet_usage	52.88	27.66	1.25	100.00
Mobile_subs	112.59	31.06	34.14	208.98
Mob_3G_Cov	81.88	23.67	0.00	100.00
Mob_4G_Cov	52.51	38.39	0.00	100.00
Mob_Int_tariff	50.16	23.38	0.00	100.00
Handset_prices	44.49	20.97	0.00	93.30
Politic_Stabl	45.27	27.28	0.48	99.52
Control_Corrup	49.51	28.29	3.85	100.00
Cyber_Security	44.03	23.25	2.90	92.50

Table 3. A correlation matrix

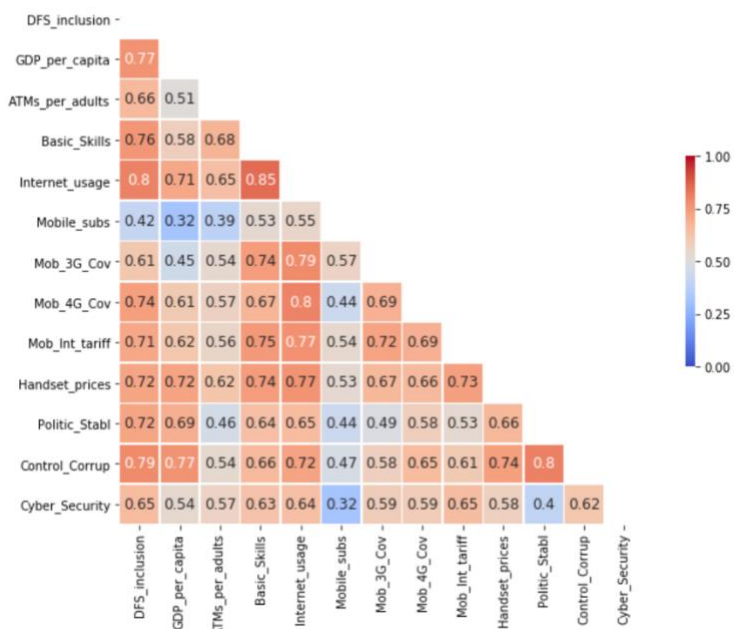


Table 2 describes a statistical overview of all variables. As can be seen from this table, there are good ranges for evaluating variables, while the minimum value is 0, the maximum is 280.97 (Mobile subscription factor).

To check the correlations of the variables with each other, we created a correlation matrix in table 3. According to the matrix, highly correlated variables of more than 90% were not found. The maximum correlation was 0.85 in the relationship between Internet use and basic skills. The next maximum value was 0.8 in three correlations (Internet usage & DFS inclusion, Internet usage & Mobile 4G coverage, Control of corruption & Political stability). Among them, a lower correlation value was found in mobile subscription rate, 0.32 (min) and 0.57 (max). A more correlated variable was Internet usage. So, the study decided to test for multicollinearity through the variance inflation factor (VIF)¹³. Internet usage shows also high value among variables, but it was less than 10 of VIF. It shows 7.96 in VIF.

After preparing and checking the variables, the study proceeds to the next step to verify the models shown in Table 4. There are six regression results in total. The main differences with / without dummy variables, as well as with mobile coverage variables (running only with 3G, only with 4G and with both mobile coverage).

Table 4. OLS Regression results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	6.199 (4.373)	4.785 (3.937)	6.965 (4.326)	8.090 (8.835)	8.108 (8.577)	8.758 (8.750)
GDP_per_capita	0.274*** (0.085)	0.318*** (0.080)	0.287*** (0.084)	0.216** (0.087)	0.242*** (0.085)	0.234*** (0.087)
ATMs_per_adults	0.097*** (0.026)	0.091*** (0.026)	0.089*** (0.026)	0.090*** (0.026)	0.083*** (0.026)	0.083*** (0.026)
Basic_Skills	0.156 (0.096)	0.194** (0.096)	0.204** (0.096)	0.179* (0.099)	0.219** (0.099)	0.221** (0.100)
Internet_usage	0.225*** (0.082)	0.102 (0.083)	0.136 (0.088)	0.181** (0.091)	0.087 (0.091)	0.100 (0.096)
Mobile_subs	-0.069* (0.037)	-0.067* (0.037)	-0.060 (0.037)	-0.055 (0.038)	-0.050 (0.037)	-0.048 (0.037)
Mob_3G_Cov	-0.062 (0.069)		-0.084 (0.069)	-0.005 (0.071)		-0.028 (0.071)
Mob_4G_Cov		0.100** (0.040)	0.106*** (0.040)		0.093** (0.039)	0.095** (0.040)
Mob_Int_tariff	0.185*** (0.070)	0.142** (0.069)	0.157** (0.070)	0.202*** (0.070)	0.172** (0.069)	0.176** (0.070)
Handset_prices	-0.116 (0.082)	-0.133* (0.080)	-0.120 (0.081)	-0.088 (0.088)	-0.098 (0.086)	-0.095 (0.087)
Politic_Stabl	0.171*** (0.061)	0.157*** (0.060)	0.152** (0.060)	0.148** (0.060)	0.133** (0.060)	0.133** (0.060)
Control_Corrupt	0.197*** (0.069)	0.180*** (0.068)	0.187*** (0.068)	0.138* (0.071)	0.130* (0.069)	0.134* (0.070)
Cyber_Security	0.106* (0.059)	0.086 (0.059)	0.093 (0.059)	0.111* (0.059)	0.098* (0.059)	0.100* (0.059)
Income_groups[T.Low income]				-1.244 (6.524)	-1.227 (6.446)	-1.219 (6.458)
Income_groups[T.Lower middle income]				-7.935* (4.778)	-7.912* (4.665)	-7.623 (4.731)
Income_groups[T.Upper middle income]				-7.831** (3.459)	-7.296** (3.379)	-7.057** (3.440)
R-squared	0.801	0.806	0.807	0.809	0.814	0.814
No. observations	240	240	240	240	240	240

Standard errors in parentheses.

* p<.1, ** p<.05, ***p<.01

¹³ VIF value: GDP_per_capita (3.94), ATMs_per_adults (2.11), Basic_Skills (5.34), Internet_usage (7.96), Mobile_subs (1.78), Mob_3G_Cov (3.59), Mob_4G_Cov (3.16), Mob_Int_tariff (3.59), Handset_prices (3.88), Politic_Stabl (3.62), Control_Corrupt (5.0), Cyber_Security (2.52).

5. Results of analyses

In general, the regression yielded good results. Factors such as GDP per capita, political stability, control of corruption, mobile 4G coverage, ATMs per adults and mobile Internet tariffs are statistically significant factors for the inclusion of DFS. In addition, the r-squared value shows more than 0.8 in all models, which means good results for OLS regression.

Comparing the first two models, we found that when the models work only with 3G coverage and other determinants, Internet usage and the cybersecurity index become significant, with 1% and 10%, respectively. However, when the models work with 4G coverage with other factors, Internet usage and the cybersecurity index become insignificant, instead of them come the basic skills and handset price show significant, with 5% and 10%, respectively.

Another finding was with a mobile subscription rate. It shows a negative sign in all regressions. However, a positive impact was expected on the inclusion of DFS. Moreover, a significant impact on DFS was expected, but the significance level was shown only in models 1 and 2 with p-value less than 0.10

The last three models (with dummy variables) provide two more significant variables, such as basic skills and the cybersecurity index. In addition, when 4G coverage was eliminated and then running regression, Internet usage again becomes statistically significant. Interestingly, the models did not yield significant results for the low-income group. Given that the upper middle group and the lower upper middle group gave significant results of 5 and 10 %, respectively. Also note that all dummies are negative because a high-income group was taken as an estimate.

According to the result of the regression of Model 1, among 11 determinants there were 8 significant factors (6 and 2 factors with 1% and 10%, respectively) and remaining 3 factors do not impact on DFS inclusion. These factors are basic skills, mobile 3G coverage and handset prices.

Regarding the result of the regression of Model 2, among the 11 determinants there were 9 significant factors (4, 3, and 2 factors with statistical levels such as 1%, 5%, and 10%, respectively) and 2 non impactation factors, as Internet usage and Cyber security.

The regression results of Model 3 show that among 12 variables there are 7 significance of 12 variables with meaningful levels, such as 4 factors with 1% and 3 factors with 5%. The variables that do not affect DFS are 5, namely: Internet usage, mobile subscription, mobile 3G coverage, handset prices and cybersecurity.

Model 4 run with 14 variables, which 3 of them are dummy variables. The result shows 10 significant determinants that can influence the inclusion of DFS, and 4 non-affecting variables: namely, mobile 3G coverage, mobile subscription, handset prices and dummy variable as low-income groups. Significance levels were as followings: 2, 4, 4 variables have 1%, 5%, 10%, respectively.

The result of Model 5 showed that 2 factors with 1% significance, 5 factors with 5% significance, 3 factors with 10% significance, a total of 10 variables out of 14. The remaining 4 factors were found as non-essential level variables: Internet usage, mobile subscription, handset prices, and the dummy variable as low-income countries.

Last regression result belongs to Model 6. It was run by 15 variables, among them 3 dummies. It was found that 9 significant important factors (2, 5 and 2 with a significance level of 1%, 5% and 10%, respectively)

Overall, there were factors that continuously demonstrated significant and insignificant variables. For example, GDP per capita, ATMs per adult, basic skills, mobile Internet tariffs, mobile 4G coverage, political stability and the control of corruption, these 7 factors have always had any level of significance for influencing the DFS inclusion. Among them are 4 newly added variables. There was continuously demonstrated minor variable were mobile 3G coverage,

although it was shown in the significance some of previous studies. The remaining 5 variables show fluctuations with statistical significance or not significant at all. This is due to other determinants in the model.

6. Discussion

To identify the determinants of DFS inclusion, the model used 12 independent (6 previous study variables and 6 newly added variables) and one dummy variable with 4 groups. To test our hypotheses, which may affect DFS inclusion positively and / or negatively, the study interprets it as follows: most of the variables are shown as expected, but only the mobile subscription rate showed the opposite.

Although DFS requires at least a 3G mobile coverage but we found that 4G mobile network coverage is more important than 3G coverage for DFS inclusion. It can be explained that 4G has higher data internet speed, more stable internet connection and high relationship with DFS inclusion.

Among these determinants, inclusion in DFS was largely driven by GDP per capita, ATMs per adult, basic skills, mobile Internet tariffs, mobile 4G coverage, political stability and the control of corruption. These 7 factors come first to determine DFS inclusion. In second place is improvement in 2 factors: increased use of the Internet and the cybersecurity index. And third place, two other factors, such as the number of mobile subscribers and the reduction in handset prices. Lastly, mobile coverage with 3G, because it is negligible among other determining factors.

GDP per capita is one of the significant factors including DFS. One unit of improvement in per capita GDP can lead to an increase of 0.216–0.318 units in the DFS inclusion. Since GDP itself is a strong indicator of economic performance and the strengths of the country, which is measured by the added value of all final goods and services produced in the country over a certain period of time, or by adding the income of each person during this period of time. That is, when GDP per capita grows, the inclusion of DFS will also improve.

ATMs per adults was the second variable determining for DFS inclusion. If one unit of this factor increase, it can impact on DFS inclusion by 0.083-0.097. Although it shows less value for including DFS, we would like to remind that this variable is the number of ATMs per 100,000 adults. This means that by significantly increasing the number of ATMs, this can quickly affect the inclusion of DFS.

Basic skills also determine DFS inclusion factors, although it was not shown significances in Model 1. It will work when 4G mobile coverage and / or dummy variables appear. One unit of this factor will improve, this may affect the inclusion of DFS with an increase of 0.179-0.221 units.

Internet usage is one of the indecisive factors determining the inclusion of DFS. Because it only works when there is no 4G mobile coverage in the model. But when this is a significant factor, it shows a coefficient of 0.181-0.225 with the inclusion of DFS.

Mobile subscription negatively affected the inclusion of DFS. Although some studies have shown that this can have a positive effect on the inclusion of DFS. Moreover, the study found that it can show significance when in the model either 3G coverage exist or 4G coverage exist. If there are both of them and / or dummy variables, it stops working in models. If it decreases by one unit, it will be increased DFS inclusion by 0.067-0.069.

Mobile 3G coverage has not been shown as a significant factor in enabling DFS. We used it in 4 models. Although some of previous studies have shown that this is one indicator of the inclusion of DFS.

Mobile 4G coverage has a high ratio with the inclusion of DFS. It works well with the determinants of enabling DFS. An increase by one unit of this factor can lead to an improvement

in the inclusion of DFS by 0.093-0.106. Compared to mobile 3G coverage, this is an obvious factor in mobile coverage which identify DFS inclusion.

Mobile Internet tariff is also one of the main factors enabling DFS. This factor describes the affordable cost of mobile Internet tariffs in countries. It showed significant levels of more than 5% in all models. Increasing one unit of this factor, DFS inclusion can increase by 0.142-0.202.

Handset price has a negative effect on DFS inclusion. Because cheaper mobile phones can affect the widespread use of DFS. However, we find that handset price was significant only in Model 2, in other cases it was a negligible factor for DFS. If this factor decreases by one unit, it can increase the inclusion of DFS by 0.133.

Political stability is a significant factor in determining DFS inclusion. An increase of this indicator by one unit leads to an improvement in the inclusion of DFS by 0.133-0.171. This can be explained by the fact that in an unstable political situation, financial exclusion will occur, and when there is strong political stability, this will lead to an acceleration of financial inclusion.

Control of corruption is also one of the best determinants of DFS inclusion. In models, it shows a significant level of 1% and 10% with dummy variables. If it increases by one unit, it can increase also DFS inclusion by 0.130-0.197.

Cybersecurity is the last independent variable in the study. It has a significant level of 10%. Also, it works well in the models with dummy variables. An increase in this coefficient by one unit can bring for DFS inclusion by 0.098-0.106.

Dummy variables as Income groups can impact on DFS inclusion. In particular, for countries with upper-middle income, these determinants are more suitable at a significant level of 5%. For countries with lower-middle income, these determinants are also suitable but with a significant level of 10%. Interestingly, no significant levels were shown for low-income groups. Thus, these models will work properly with middle-income countries.

Summing up our discussion, we would like to recommend this model for middle-income countries, as well as highlight the main points for developing a policy regarding inclusion in DFS as follows:

- Firstly, pay attention to these 7 determining factors of DFS inclusion: GDP per capita, ATMs per adult, basic skills, mobile Internet tariffs, mobile 4G coverage, political stability and control of corruption. How they can be improved or developed for increasing DFS inclusion in the country.
- Secondly, divide these factors for 3 groups as “vital”, “important” and “need”, and develop strategy for each group with 15, 10, 5 years period, respectively, as following:
 - * A “vital” group should have three factors such as GDP per capita (coefficient: 0.216–0.318), basic skills (coefficient: 0.179-0.221) and mobile Internet tariffs (coefficient: 0.142-0.202);
 - * An “important” group should have two factors: control of corruption (coefficient: 0.130-0.197) and political stability (coefficient: 0.133-0.171);
 - * The “need” group should have also two factors: mobile 4G coverage (coefficient: 0.093-0.106) and ATMs per adult (coefficient: 0.083-0.097).

As can be seen here, these main 7 factors are grouped based on coefficient level with DFS inclusion.

- Lastly, run model annually with latest dataset, to check of process policy about DFS inclusion.

7. Conclusion

Globally, 2.5 billion people live on less than \$ 2 a day, and they are in a state of chronic poverty. As a solution to poverty reduction, financial inclusion has been proposed. Also, in 2019 the number of mobile subscriptions has exceeded 8 billion, whereas 3.3 billion of them were connected to the mobile Internet. Due to the increase in the number of mobile phones, the Internet and other digital channels, there has been proposed digital financial inclusion to poverty reduction. There were more studies in this area. However, there was not paper related to digital financial service inclusion (DFS inclusion). Main difference of them is digital financial inclusion focused on access and quality side, whereas DFS inclusion focuses not only access them but also use them through mobile technologies and digital channels.

There has been set 3 objectives which include, followings: identifying and consolidating of the determining factors for improving DFS inclusion; identifying additional factors that are very important for the use of DFS and which are not empirically verified by previous research; Lastly, identifying the best practices of income groups with good performance and recommend this experience to less efficient countries.

Based on literature review and previous studies, we developed hypotheses to test an impaction of them to DFS inclusion. Inclusion of DFS in previous studies was found such as 6 factors: GDP per capita, number of ATMs per adult, basic skills, Internet use, mobile subscription, 3G mobile coverage. Also, the paper added 6 newly variables, such as 4G mobile coverage, mobile Internet tariffs, telephone prices, political stability, anti-corruption and cybersecurity.

Mainly data was collected from two sources Worldbank and GSMA; So, data was covered two years (2014 & 2017) in 120 countries, overall 240 observation, and with depended variable as DFS inclusion, and independent 12 variables, among them 6 variables were from previous studies, and other 6 variables added newly in this area.

There were 6 models with similar variables, and additionally dummy variables which grouped by Worldbank. The result was good with r-squared above 0.8. Overall, there were factors that continuously demonstrated significant and insignificant variables. For example, GDP per capita, ATMs per adult, basic skills, mobile Internet tariffs, mobile 4G coverage, political stability and the control of corruption, these 7 factors have always had any level of significance for influencing the DFS inclusion. Among them are 4 newly added variables. There was continuously demonstrated minor variable were mobile 3G coverage, although it was shown in the significance some of previous studies. The remaining 5 variables show fluctuations with statistical significance or not significant at all. This is due to other determinants in the model. Also, there was recommendation for middle-income countries because regression results show significance in upper and lower middle-income countries

In conclusion, we would like to say, DFS inclusion can determine by GDP per capita, ATMs per adult, basic skills, mobile Internet tariffs, mobile 4G coverage, political stability and control of corruption. Therefore, policymakers should follow in our recommendation for policy.

Reference

1. Abbasi, T., & Weigand, H. (2017). The impact of digital financial services on firm's performance: A literature review. arXiv preprint arXiv:1705.10294.
2. Adebisi, S. O., Shitta, H. A., & Olonade, O. P. (2016). Determinants of customer preference and satisfaction with Nigerian mobile telecommunication services. *BVIMSR's Journal of Management Research*, 8(1), 1.
3. Agyekum, F., Locke, S., & Hewa-Wellalage, N. (2016). Financial Inclusion and Digital Financial Services: Empirical evidence from Ghana.
4. Ajide, Kazeem B. (2017) Determinants of financial inclusion in SubSaharan Africa countries: Does institutional infrastructure matter? *CBN Journal of Applied Statistics*, ISSN 2476-8472, The Central Bank of Nigeria, Abuja, Vol. 8, Iss. 2, pp. 69-89
5. Aker, J., Boumniel, R., McClelland, A., & Tierney, N. (2013). How do electronic transfers compare? Evidence from a mobile money cash transfer experiment in Niger. Tufts University.
6. Akileng, G., Lawino, G. M., & Nzibonera, E. (2018). Evaluation of determinants of financial inclusion in Uganda. *Journal of Applied Finance and Banking*, 8(4), 47-66.
7. Akudugu, M. A. (2013). The determinants of financial inclusion in Western Africa: Insights from Ghana. *Research Journal of Finance and Accounting*, 4(8), 1-9.
8. Allen, F., Demirguc-Kunt, A., Klapper, L., & Martinez Peria, M. S. (2016). The foundations of financial inclusion: Understanding ownership and use of formal accounts. *Journal of Financial Intermediation*.
9. Almenberg, J., & Widmark, O. (2011). Numeracy, financial literacy and participation in asset markets.
10. Arner, D. W., Buckley, R. P., & Zetsche, D. A. (2018). Fintech for financial inclusion: A framework for digital financial transformation. *UNSW Law Research Paper*, (18-87).
11. Asongu, S. and Asongu, N. (2018), "The comparative exploration of mobile money services in inclusive development", *International Journal of Social Economics*, Vol. 45 No. 1, pp. 124-139.
12. Asongu, S.A. (2015b), "The impact of mobile phone penetration on African inequality", *International Journal of Social Economics*, Vol. 42 No. 8, pp. 706-716.
13. Atkinson, A., & Messy, F. A. (2013). Promoting financial inclusion through financial education.
14. Bachas, P., Gertler, P., Higgins, S., & Seira, E. (2018, May). Digital financial services go a long way: Transaction costs and financial inclusion. In *AEA Papers and Proceedings* (Vol. 108, pp. 444-48).
15. Bakari, I. H., Idi, A., & Ibrahim, Y. (2018). Innovation determinants of financial inclusion in top ten African countries: a system GMM approach.
16. Banerjee, Abhijit, Esther Duflo, Clement Imbert, Santosh Mathew, and Rohini Pande. 2016. "Can E-Governance Reduce Capture of Public Programs? Experimental Evidence from a Financial Reform in India's Employment Guarantee." Working Paper.
17. Björkegren, D. (2018). The Adoption of Network Goods: Evidence from the Spread of Mobile Phones in Rwanda. *The Review of Economic Studies*. doi:10.1093/restud/rdy024
18. Buckley, R. P., & Malady, L. (2015). Building consumer demand for digital financial services—the new regulatory frontier. *Journal of Financial Perspectives*, 3(3).
19. Chatterjee A. (2020) Financial inclusion, information and communication technology diffusion, and economic growth: a panel data analysis, *Information Technology for Development*
20. Chibba, M. (2009). Financial inclusion, poverty reduction and the millennium development goals. *The European Journal of Development Research*, 21(2), 213-230.
21. Chithra, N., & Selvam, M. (2013). Determinants of financial inclusion: An empirical study on the inter-state variations in India. Available at SSRN 2296096.
22. Chung, N., & Kwon, S. J. (2009). Effect of trust level on mobile banking satisfaction: A multi-group analysis of information system success instruments. *Behaviour & Information Technology*, 28(6), 549–562.
23. Clark, T. A. (2000). U.S. Patent No. 6,081,791. Washington, DC: U.S. Patent and Trademark Office.
24. Cross country evidence. In *Annual Conference 2017 (Vienna): Alternative Structures for Money and Banking* (No. 168165). Verein für Socialpolitik/German Economic Association.
25. Daya, H., & Mader, P. (2018). Did Demonetisation Accelerate Financial Inclusion? *Economic & Political Weekly*, 53(45), 17.
26. Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution. The World Bank.
27. Emara, N., & El Said, A. (2020). Financial Inclusion and Economic Growth: The Role of Governance in Selected MENA Countries. *International Journal of Intelligent Enterprise (IJIE)*, Vol. 7, No. 1/2/3
28. Evans, O. (2015). The effects of economic and financial development on financial inclusion in Africa.
29. Evans, O. (2018). Connecting the poor: the internet, mobile phones and financial inclusion in Africa. *Digital Policy, Regulation and Governance*.
30. Evans, O. & Alenoghena, O. R. (2017). Financial inclusion and GDP per capita in Africa: A Bayesian VAR model. *Journal of Economics & Sustainable Development*, 8(18), 44-57.
31. Galli, E., Mascia, D. V., & Rossi, S. P. S. (2017). Does Corruption Affect the Access to Bank Credit for Micro and Small Businesses? Evidence from European MSMEs.

32. Ghosh, S. (2016). Does mobile telephony spur growth? Evidence from Indian states. *Telecommunications Policy*, 40(10-11), 1020-1031.
33. Hernandez, K. (2019). Barriers to Digital Services Adoption in Bangladesh. K4D Helpdesk Report 573. Brighton, UK: Institute of Development Studies.
34. Jack, W., & Suri, T. (2014). Risk Sharing and Transactions Costs: Evidence from Kenya's Mobile Money Revolution. *American Economic Review*, 104(1), 183–223. doi:10.1257/aer.104.1.183
35. Jana, D., Sinha, A., & Gupta, A. (2019). Determinants of Financial Literacy and Use of Financial Services: An Empirical Study amongst the Unorganized Sector Workers in Indian Scenario. *Iranian Journal of Management Studies*, 12(4).
36. Karlan, D., Kendall, J., Mann, R., Pande, R., Suri, T., & Zinman, J. (2016). Research and impacts of digital financial services (No. w22633). National Bureau of Economic Research.
37. Kim, M. J., Chung, N., & Lee, C. K. (2011). The effect of perceived trust on electronic commerce: Shopping online for tourism products and services in South Korea. *Tourism Management*, 32(2), 256–265.
38. Kulkarni, A. (2018). Recent Developments in Regulatory and Competition Scenario of Digital Financial Services in Select Asian Countries.
39. Kumar, N. (2013). Financial inclusion and its determinants: evidence from India. *Journal of Financial Economic Policy*.
40. Kumbhar, V. M. (2011). Financial inclusion through M-banking: Scope and Problems in India. Dept. of Economics, Shivaji University, Kolhapur.
41. Le, T. T., Dang, N. D. L., Nguyen, T. D. T., Vu, T. S., & Tran, M. D. (2019). Determinants of Financial Inclusion: Comparative Study of Asian Countries. *Asian Economic and Financial Review*, 9(10), 1107.
42. Lenka, S. K., & Barik, R. (2018). Has expansion of mobile phone and internet use spurred financial inclusion in the SAARC countries? *Financial Innovation*, 4(1), 5.
43. Malady, Louise. "Consumer protection issues for digital financial services in emerging markets." *Banking & Finance Law Review* 31.2 (2016): 389-401.
44. Manyika, J., Lund, S., Singer, M., White, O., & Berry, C. (2016). Digital finance for all: Powering inclusive growth in emerging economies. McKinsey Global Institute.
45. McIntosh, S. (2001). Measuring and assessing the impact of basic skills on labour market outcomes. *Oxford Economic Papers*, 53(3), 453–481. doi:10.1093/oep/53.3.453
46. Mlachila, M., Tapsoba, R. and Tapsoba, S.J.A. (2014), "A quality of growth index for developing countries: a proposal", Working Paper No. 14/172, IMF, Washington, DC.
47. Murray, T. S. (1995). Proxy Measurement of Adult Basic Skills: Lessons from Canada.
48. Mushtaq, R., & Bruneau, C. (2019). Microfinance, financial inclusion and ICT: Implications for poverty and inequality. *Technology in Society*,
49. Nagpal, A., Jain, M., & Jain, A. (2019). Unearthing digital financial services and financial inclusion: an empirical evidence from India. *International Journal of Electronic Finance*, 9(4), 287-309.
50. Naumenkova, S., Mishchenko, S., & Dorofeiev, D. (2019). Digital financial inclusion: evidence from Ukraine. *Investment Management & Financial Innovations*, 16(3), 194.
51. Ouma, S. A., Odongo, T. M., & Were, M. (2017). Mobile financial services and financial inclusion: Is it a boon for savings mobilization? *Review of development finance*, 7(1), 29-35.
52. Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review*, 18(4), 329-340.
53. Park, C. Y., & Mercado, R. (2015). Financial inclusion, poverty, and income inequality in developing Asia. *Asian Development Bank Economics Working Paper Series*, (426).
54. Pelletier, A., Khavul, S., & Estrin, S. (2020). Innovations in emerging markets: the case of mobile money. *Industrial and Corporate Change*, 29(2), 395-421.
55. Perlman, L., & Wechsler, M. (2019). Mobile Coverage and its Impact on Digital Financial Services. Available at SSRN 3370669.
56. Purohit, H., Kaur, P., Mwebesa, D. B., Choudhary, S., & Joshi, K. (2019). Channel Redundancy Analysis and Bandwidth Utilization in GSM Mobile Communication Network of Uganda. In 2019 IEEE 10th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) (pp. 0963-0967).
57. Sachs, J. D. (2012). From millennium development goals to sustainable development goals. *The Lancet*, 379(9832), 2206-2211.
58. Sanderson, A., Mutandwa, L., & Roux, P. L. (2018). A review of determinants of financial inclusion. *International Journal of Economics and Financial Issues*, 8(3), 1-8.
59. Sarma, M. (2008). Index of financial inclusion (No. 215). Working paper.
60. Sarma, M. (2015). Measuring financial inclusion. *Economics Bulletin*, 35(1), 604-611.
61. Sarma, M., & Pais, J. (2011). Financial inclusion and development. *Journal of international development*, 23(5), 613-628.
62. Sha'ban, M., Girardone, C., & Sarkisyan, A. (2020). Cross-country variation in financial inclusion: a global perspective. *The European Journal of Finance*, 26(4-5), 319-340.

63. Sharma, R., Didwania, M., & Kumar, P. (2014). Need of financial inclusion for poverty alleviation and GDP growth. Available at SSRN 2434473.
64. Shen, Y., Hu, W., & Hueng, C. J. (2018). The effects of financial literacy, digital financial product usage and internet usage on financial inclusion in China. In MATEC Web of Conferences (Vol. 228, p. 05012). EDP Sciences.
65. Shipalana, P. (2019). Digitising Financial Services: A Tool for Financial Inclusion in South Africa?
66. Siddik, M. N. A., & Kabiraj, S. (2020). Digital Finance for Financial Inclusion and Inclusive Growth. In *Digital Transformation in Business and Society* (pp. 155-168). Palgrave Macmillan, Cham.
67. Srivastava, N. (2019). Digital Financial Services: Challenges and Prospects for Liberalized and Globalized Indian Economy. In *Proceedings of 10th International Conference on Digital Strategies for Organizational Success*.
68. Sultan, S. F., Humayun, H., Nadeem, U., Bhatti, Z. K., & Khan, S. (2015, May). Mobile phone price as a proxy for socio-economic indicators. In *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development* (pp. 1-4).
69. Uddin, A., Chowdhury, M.A.F., & Islam, M.N. (2017). Determinants of Financial Inclusion in Bangladesh: Dynamic Gmm & Quantile Regression Approach. *The Journal of Developing Areas* 51(2), 221-237.
70. Wang, X., & Shihadeh, F. (2015). Financial inclusion: Policies, status, and challenges in Palestine. *International Journal of Economics and Finance*; Vol. 7, No. 8.
71. Weihuan, Z., Arner, D. W., & Buckley, R. P. (2015). Regulation of digital financial services in China: Last mover advantage. *Tsinghua China L. Rev.*, 8, 25.
72. Xiuhua Wang & Jian Guan (2017) Financial inclusion: measurement, spatial effects and influencing factors, *Applied Economics*, 49:18, 17511762, DOI: 10.1080/00036846.2016.1226488
73. Yousif, F., Berthe, E., Maiyo, J., & Morawczynski, O. (2013). Best practice in mobile microfinance. In Grameen Found.
74. Yusuf-Asaju, A. W., Dahalin, Z. M., & Ta'a, A. (2018). Exploratory analysis of mobile network traffic data: a case of a major mobile network operator in Nigeria. *e-Academia Journal*, 6(2).
75. Zins, A., & Weill, L. (2016). The determinants of financial inclusion in Africa. *Review of Development Finance*, 6(1), 46-57.
76. Zulkhibri, M., & Ghazal, R. (2017). The Impacts of Governance and Institution on Financial Inclusion: Evidence from Muslim Countries and Developing Economies. *Journal of King Abdulaziz University: Islamic Economics*, 30.

Appendix 1. Independent Variables: measurements, expected signs, sources and previous studies.

#	Variables	Measurement	Expected sign	Source	Previous studies
1	<i>GDP per capita</i>	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.	+	Worldbank	Sarma & Pais (2011), Chithra & Selvam (2013), Evans (2015), Evans & Alenoghena (2017), Agyekum et al. (2016), Sharma (2014).
2	<i>ATMs per 100'000 adults</i>	ATMs per adults / 100,000 adults. ATMs are electromechanical devices that permit authorized users, typically using machine-readable plastic cards, to withdraw cash from their accounts and/or access other services, such as balance enquiries, transfer of funds or acceptance of deposits. ATMs may be operated either online with real-time access to an authorization database or offline.	+	Worldbank	Weihuan et.al (2015), Ajide (2017), Bachas et. et al. (2018), Siddik & Kabiraj (2020)
3	<i>Basic skills</i>	Basic skills measure based on adult literacy (25%), school life expectancy (25%), mean years of schooling (25%), tertiary enrollment (25%) into one. This indicator was collected from GSMA Mobile Connectivity Index. 1) The Adult literacy index is a statistical measure used to determine how many adults can read and write in a certain area or nation. 2) The school life expectancy is the number of years a child of school entrance age can expect to spend in the education system. 3) Average number of years of total schooling across all education levels, for the population aged 25+. 4) Total enrollment in tertiary education, regardless of age, expressed as a percentage of the total population of the five-year age group following on from secondary school leaving.	+	GSMA UNDP/UNESCO	Akudugu (2013), Chithra & Selvam (2013), Evans (2015), Uddin et. al (2017), Akileng et. al (2018), Jana et. al (2019), Le et. al (2019), Xiuhua & Guan (2017), Sanderson et. al (2018)
4	<i>Internet usage</i>	Individuals using the Internet (% of population) - A percentage of the population in countries that have used the Internet in the last three months in a given year. The Internet can be used through a computer, mobile phone, personal digital assistant, gaming machine, digital television, etc.	+	GSMA, Worldbank	Evans (2018), Shen et al. (2018), Nagpal et. al (2019), Sha'ban et. (2020), Chatterjee (2020)
5	<i>Mobile subscription</i>	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services.	+	GSMA Intelligence	Jack & Suri (2014), Lenka & Barik (2018), Agyekum et al. (2016), Naumenkova et. al (2019), Perlman & Wechsler (2019)
6	<i>Mobile 3G coverage</i>	percentage of population covered by 3G networks signals: refers to the percentage of inhabitants that are within range of 3G mobile-cellular signal, irrespective of whether or not they are subscribers. This is calculated by dividing the number of inhabitants that are covered by at least a 3G mobile cellular signal by the total population and multiplying by 100.	+	GSMA Intelligence	Perlman & Wechsler (2019), Hernandez (2019)
7	<i>Mobile 4G coverage (New)</i>	percentage of population covered by 4G networks signals: refers to the percentage of inhabitants that are within range of 4G mobile-cellular signal, irrespective of whether or not they are subscribers. This is calculated by dividing the number of inhabitants that are covered by at least a 3G mobile cellular signal by the total population and multiplying by 100.	+	GSMA Intelligence	Perlman & Wechsler (2019), Hernandez (2019)
8	<i>Mobile internet tariffs (New)</i>	Mobile internet tariffs measure based on cost of 100MB (40%), 500MB (40%), and 1GB data (20) (% of monthly GDP per capita). It is measured based on the cost of mobile Internet tariffs by dividing the monthly GDP per capita. This is calculated at a cost of 100 MB and 500 MB with equal proportions of 40%, and the remaining 20% of the proportion the cost of 1 GB data. This indicator was collected from GSMA Mobile Connectivity Index	+	GSMA, Tarifica	Yusuf-Asaju et al. (2018), Adebiyi et. al (2016)
9	<i>Handset prices (New)</i>	Cost of cheapest internet-enabled device (% of monthly GDP per capita) is the cheapest internet-enabled feature phone or smartphone available (at the time of collecting data) sold by mobile operators or mobile phone retailers, which was divided the price by monthly GDP per capita to determine affordability.	-	GSMA, Tarifica	Perlman & Wechsler (2019), Björkegren (2018), Purohit et al (2019), Sultan et al. (2015)
10	<i>Political Stability (New)</i>	Political Stability measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	+	Worldbank	Bakari et. (2018), Allen et al. (2016), Wang & Shihadeh (2015)
11	<i>Control of corruption (New)</i>	Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	+	Worldbank	Banerjee et al (2016), Arner et al (2018), Srivastava (2019), Shipalana (2019), Zulkhibri & Ghazal (2017)
12	<i>Cybersecurity index (New)</i>	The Global Cybersecurity Index is a multi-stakeholder initiative to raise cybersecurity awareness and to measure the commitment of countries to cybersecurity and its wide field of application cutting across industries and sectors.	+	GSMA, ITU	Malady (2016), Chung & Kwon (2009), Kim, et. al (2011), Srivastava (2019)
	<i>Income groups (Dummy variable)</i>	Economies were divided into four income groupings: low, lower-middle, upper-middle, and high. Income is measured using gross national income (GNI) per capita, in U.S. dollars, converted from local currency using the World Bank Atlas method. Estimates of GNI are obtained from economists in World Bank country units; and the size of the population is estimated by World Bank demographers from a variety of sources, including the UN's biennial World Population Prospects.		Worldbank	Sarma & Pais (2011), Chithra & Selvam (2013), Evans (2015), Evans & Alenoghena (2017), Agyekum et al. (2016), Sharma (2014).
	<i>DFS inclusion (dependent variable)</i>	Made or received digital payments in the past year (% age 15+): The percentage of respondents who report using mobile money, a debit or credit card, or a mobile phone to make a payment from an account, or report using the internet to pay bills or to buy something online, in the past 12 months. It also includes respondents who report paying bills, sending or receiving remittances, receiving payments for agricultural products, receiving government transfers, receiving wages, or receiving a public sector pension directly from or into a financial institution account or through a mobile money account in the past 12 months		Worldbank, Findex	Daya & Mader (2018), Kulkarni (2018),