Policy Research Working Paper 9104

# Stages of Development of Payment Systems

## Leapfrogging across Countries and MENA's Place in the World

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January 2020

Policy Research Working Paper 9104


## Abstract

This paper studies the relationship between the level of economic development and the incidence of three forms of payments across countries, namely the incidence of bank accounts, digital payments, and mobile money accounts among the adult populations across countries. It presents simple statistical tests of leapfrogging, the phenomenon by which poor countries surpass rich countries in the provision of payments mechanisms. It contributes to a broader and long-standing literature on stages of development, as well as to the literature on financial development and access to finance. The findings suggest that there is evidence of "absolute" and "relative" leapfrogging, with both terms defined in the paper. In addition, the Middle East and North Africa region, on average, suffers from a notable underperformance gap across all observed stages of payment-systems development. This finding suggests that the region suffers from structural impediments to the development of its financial and banking systems that go well beyond the adoption of digital-technology tools.


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**Stages of Development of Payment Systems:**
**Leapfrogging across Countries and MENA's Place in the World**

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JEL classification: E42, G21, O00, O11, O30

Keywords: payment systems, innovation, banking, digital payment, mobile money, leapfrogging, digital technology, digital economy, MENA

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## 1. Motivation

Since the 16th century, banking has been at the heart of modern payment systems by allowing changes to a centralized ledger rather than physically exchanging assets (Bank of England 2014, p.263). The introduction of credit cards in the 1950s propelled the use of cashless payments now common across both advanced and developing economies.[2] In the 21st century, mobile wallets and digital finance have yielded widely recognized benefits in both economic performance and financial inclusion (Klapper et al 2014, Beck et al 2018). This chronology of innovations could be interpreted as there being stages in the adoption of payment technology, possibly implying that poor countries move from one stage of development to the next as the economy grows. Indeed, the idea that economies follow stages of development is a popular idea in the history of economic thought (see, for example, Rostow 1960). This note tests the hypothesis of the existence of stages of development in payments systems with simple econometric models relying on cross sections of international data. The key dependent variables are proxies of the incidence of use of the three stages of payment systems, based on publicly available survey data collected by the World Bank, namely the Global Findex database.[3]

The main finding is that even though historically we can observe stages in the advent of various forms of payments, the data show that many poor countries have higher incidences of digital payments (per adult) than high-income economies, even though large segments of populations in poor countries remain under-served by traditional banking. We discuss the characteristics of different payment systems and estimate a series of Ordinary Least Square (OLS) models to study the relationship between the level of development (proxied by Gross Domestic Product, GDP, per capita) and the incidence of the three types of payments.

Ideally, to study transitions between stages of development (in this case of payment systems), we would rely on panel data. By following countries over time, we would be able to ascertain for sure whether poor economies have in fact leapfrogged from 16th century bank-centered payment systems to 21st century digital payments. Unfortunately, the available data do not cover enough countries over sufficiently long periods of time to enable this type of research.[4] However, with rich cross-sectional data covering hundreds of countries, we can estimate two key parameters that can be interpreted as suggesting evidence of leapfrogging.

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[2] Digital (or electronic) payments are transfers of value that are executed and/or received using digital (or electronic) devices and channels to transmit the instructions. They include payments that are initiated by mobile phone or computer. Card payments are cashless digital payments but distinct from payments made through the internet.

[3] Global Findex database: https://globalfindex.worldbank.org/.

[4] The Findex data on ownership of a mobile money account, for example, cover data in the 21st century, and most countries do not have more than one observation over time. For the 2014 and 2017 waves of the survey, fewer than 70 countries have data for both years.

First, by estimating the cross-sectional relationship between the incidence of one type of payments on the level of development, we can see whether the relationship is positive or negative. A negative coefficient suggests that the incidence of a payment type is higher, on average, among poor countries than among rich countries. We interpret such a result as evidence of "absolute" leapfrogging for that stage of development of payment systems.

Second, by statistically selecting the best fitting functional form of the relationship between the incidence of a payments type and the level of development, we can estimate the intercepts at the lowest levels of development and compare the intercepts across the comparable estimates across the three dependent variables. If the intercept computed at the lowest level of development for one stage of development is higher than for the previous stage, we interpret such a result as evidence of "relative" leapfrogging.

We find evidence of both types of leapfrogging, implying that developing economies, even poor economies, do not need to wait for their populations to gain access to bank accounts to develop alternative and more modern forms of payments. Despite the simplicity of our proposed tests, at the time of writing, we could not find any references to existing empirical work on payment-systems leapfrogging.

In addition, the evidence indicates that the Middle East and North Africa (MENA) region, on average, suffers from a notable underperformance gap across all observed stages of payment-systems development. This finding suggests that the region suffers from structural impediments to the development of its financial and banking systems that go well beyond the adoption of digital-technology tools.

The rest of the paper is organized as follows. Section 2 discusses related literature and introduces a typology of the stages of payment-systems development. Section 3 explains the econometric strategy and discusses the use of different functional forms to estimate the model. Section 4 describes the data being used for the analysis; and section 5 presents the results.

## 2. Stages of development in payment systems and related literature

There is a longstanding literature on the relationship between indicators of financial development and economic growth. A seminal empirical paper is Beck, Levine and Loayza (2000). A recent theoretical and empirical contribution is Durusu-Ciftci et al. (2017). The literature on the effect of different types of payments on growth, however, is thin; see, e.g., Tee and Ong (2016). We found an obscure reference to research published in the early 1990s on stages of banking

and economic development: St Hill (1992). It argues that banking services play different roles in bringing about economic growth for economies at different stages of development, but it does not study transitions across payment systems. Beck et al. (2018) study the impact of mobile money adoption on entrepreneurship and economic development in a structural dynamic macro model calibrated for the case of M-Pesa in Kenya using firm-level data. Klapper and Singer (2014), relying on data from their Findex data set, advocate for using digital payments to enhance financial inclusion, particularly for women and rural dwellers in developing and emerging economies, thus implicitly arguing that digital payments can be adopted in developing economies as a means for overcoming social exclusion in the access to traditional payments services processed through formal bank accounts.

To clarify key concepts, it is worth recalling the basic definition of a payments system. The Federal Reserve Bank of New York defines a payment system as "the mechanism--the rules, institutions, people, markets, and agreements--that make the exchange of payments possible." One of the earlier attempts to analyze the digitization of payment systems can be found in Bossone (2001). The author points at the emerging issues of electronic payment systems offered by private actors outside the banking community and national financial regulators. The Bank of England (2014) offers a typology of digital payment systems. *Wrappers* create a digital interface for traditional payment systems to improve their accessibility; *mobile money* is a new type of payment system that does not require having a bank account; *credits and local currencies* are new or alternative currencies, generally making use of existing payment systems; while *digital currencies* incorporate both a new payment system and a new currency such as cryptocurrencies. Another approach is suggested by Natarajan (2019) who proposes four stages of innovation in payments. The first, second and fourth stages proposed by this author are like the types described by the Bank of England (2014). The third, however, differs by introducing the notion of decoupling payment initiation from the maintenance of an account, a process enabled by real-time and transparent data processing between retailers, customers and payment service providers. In table 1, we follow Natarajan's framework but add an initial level of traditional banking. Of the five stages listed in table 1, our empirical analysis focuses on stages 1-3, since the last two stages are not yet captured in international data.

**Table 1: Five stages of innovation in the business of payments**

| |
|---|
| **Stage 1: Traditional banking**. This is the main means of managing money and payments through the 19$^{th}$ century centered around bank accounts and paying through cash or checks. |
| **Stage 2: Introduction of digital access to bank accounts**. This is the digitization of traditional banking with debit and credit cards, and online banking to process cashless payments. |
| **Stage 3: Prepaid accounts and mobile money**. This includes prepaid payment cards, apps and mobile money accounts which may not require a bank account. |

| |
|---|
| **Stage 4: Decoupling payment systems**. This includes digital wallets where payment is initiated in a connected device, and the money remains in a bank or prepaid account. |
| **Stage 5: Decoupling currency account**. This includes digital wallets where money is converted into a private or local currency available only on the device or application. |

Source: Adapted from Natarajan (2019)

## 3. Empirical strategy

As mentioned, the empirics are limited by the lack of historical data about the incidence of access to bank accounts, use of cashless payments and mobile money. Consequently, it is virtually impossible to analyze the movement between stages over time. In addition, data for stages 4 and 5 can be hard to come by. For the first three stages of payments, we rely on pooled cross-sectional data from two years of the Findex data, 2014 and 2017. Importantly, we work with a common sample of country observations for the three estimations, which allows for comparisons of the key estimated coefficients across the three models.

The main estimation equation is:

$$Y_{c,t} = C + \beta_1 * \log\left(GDPpc_{c,t}\right) + \nu_t + \varepsilon_{c,t} \qquad (1)$$

The variable $Y$ represents the incidence of one of the three indicators of payments adoption and is observed for country $c$ in year $t$ with $t$ being either 2014 or 2017. $C$ is the intercept term, which reflects payment systems adoption when GDP per capita ($GDPpc$) is equal to 0. We also include $\nu_t$ as a dummy variable taking the value of 1 for the latest year in the survey, namely 2017.

We estimate this model for each indicator $Y$ in order to assess the different stages of payment systems – see the data section below for the descriptions of the variables. Regarding inference, a negative sign on $\beta_1$ would indicate a pro-poor bias of payments adoption in each stage of the payments system, thus we interpret such evidence as indicating absolute leapfrogging. In addition, a comparison between the three stages would indicate that there is leapfrogging if more recent payment technologies see a higher adoption rate at low levels of development than, say, the incidence of bank accounts. This is estimated by looking at the intercept level or by estimating fitted values $\hat{Y}_{c,t}$ when $GDPpc$ is at its minimum and 20$^{th}$ percentile value.

Equation (1) presumes that the functional form is log-linear, but it is not guaranteed, and it could also be non-linear. Choosing the best-fitting functional form might be critical for precise comparisons of the magnitudes of the intercept coefficients across the three models. Hence, we explore this possibility by estimating quadratic functional forms:

$$Y_{c,t} = C + \beta_1 * \log(GDPpc) + \beta_2 * \log\left(GDPpc_{c,t}\right)^2 + \nu_t + \varepsilon_{c,t} \quad (2)$$

If both $\beta_1$ and $\beta_2$ are significant, it can be interpreted as the function being quadratic. If only $\beta_2$ is significant but not $\beta_1$, one can choose the log-linear over the quadratic form only if the goodness of fit is superior. Therefore, we also report the adjusted $R^2$ statistic and choose the functional form that yields the highest goodness of fit.

## 4. Data

The empirics rely on pooled cross-sectional data from the Global Findex database to explore payment technology adoption across the globe with a special focus on economies from the Middle East and North Africa (MENA). The focus on the latter is justified on statically grounds, because, as will become apparent in subsequent sections of this paper, most countries in this region appear to be systematically below the predictions of the three models. That is, many MENA countries have populations that are under-served in terms of payments mechanisms conditional on their levels of development.

Due to lack of data on the use of the most recently developed forms of payments, the analyses rely on proxy variables only for the first three stages of payments-system development listed in Table 1. The proxy for stage 1 is the share of the population having an account at a bank or another type of financial institution.[5] Stage 2 is measured by the percentage of the population who reported making a digital payment in the past 12 months.[6] Stage 3 is the percentage of respondents who reported using a mobile money service in the past 12 months.[7] The right-hand side variable in the estimation equations is the (natural logarithm of) GDP per capita in current

[5] The Findex database defines this variable as follows: Accounts per adult (% age 15+) "denotes the percentage of respondents who report having an account (by themselves or together with someone else) at a bank or another type of financial institution." See https://globalfindex.worldbank.org/sites/globalfindex/files/databank/Glossary2017.pdf.

[6] The Findex definition is the percentage of adults who made digital payments in the past year (% age 15+). It "denotes 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 or sending remittances directly from a financial institution account or through a mobile money account in the past 12 months." See https://globalfindex.worldbank.org/sites/globalfindex/files/databank/Glossary2017.pdf.

[7] Findex defines this variable as the percentage of adults (% age 15+) who report using a mobile money account, which "includes respondents who report personally using services included in the GSM Association's Mobile Money for the Unbanked (GSMA MMU) database to pay bills or to send or receive money in the past 12 months. It also includes an additional 0.60 percent of respondents in 2017 who report receiving wages, government transfers, a public sector pension (included in 2017 data), or payments for agricultural products through a mobile phone in the past 12 months." See footnote 2 in https://globalfindex.worldbank.org/sites/globalfindex/files/databank/Glossary2017.pdf.

PPP levels from the World Development Indicators database, so that they are comparable across countries in each year.

Descriptive statistics, including sample means, medians, and indicators of the distributions for the largest possible samples for each variable are presented in Annex 1. These samples are used in the scatter plots discussed in the following section. Annex 2 presents the descriptive statistics for the common sample used in the econometric estimations.

Since inference from the econometric results requires the use of a common sample for the three models, it is worth discussing how the restricted common sample differs from the larger samples for each variable of interest. Table 2 compares the means and medians across the two samples. The restricted sample covers countries with typically lower levels of development, as both the mean and the median of the full sample are significantly higher than that of the restricted sample. An implication of this is that the incidence of bank accounts and digital payments is lower in the restricted than in the full samples. Interestingly, this is the not the case for the case of mobile money; the means and medians across the two samples are virtually identical. These descriptive statistics thus anticipate one of the main findings of the empirical results discussed in the following section.

**Table 2. Sample means and medians**

| Variable | Full sample mean | Full sample median | Restricted sample mean | Restricted sample median |
|---|---|---|---|---|
| Log GDP per capita | 9.35 | 9.49 | 8.74 | 8.73 |
| Bank accounts | 0.557 | 0.523 | 0.389 | 0.340 |
| Digital payments | 0.423 | 0.336 | 0.267 | 0.231 |
| Mobile money | 0.106 | 0.045 | 0.105 | 0.045 |

Source: Authors' calculations based on data from the Findex database from 2014 and 2017. See Annexes 1 and 2 for details. Notes: The "full sample" contains different numbers of observations across variables. The restricted sample contains 149 observations. GDP per capita is in logs; other variables are the number of adults reporting use of each form of payment divided by adult population in each country (age 15+).

## 5. Results

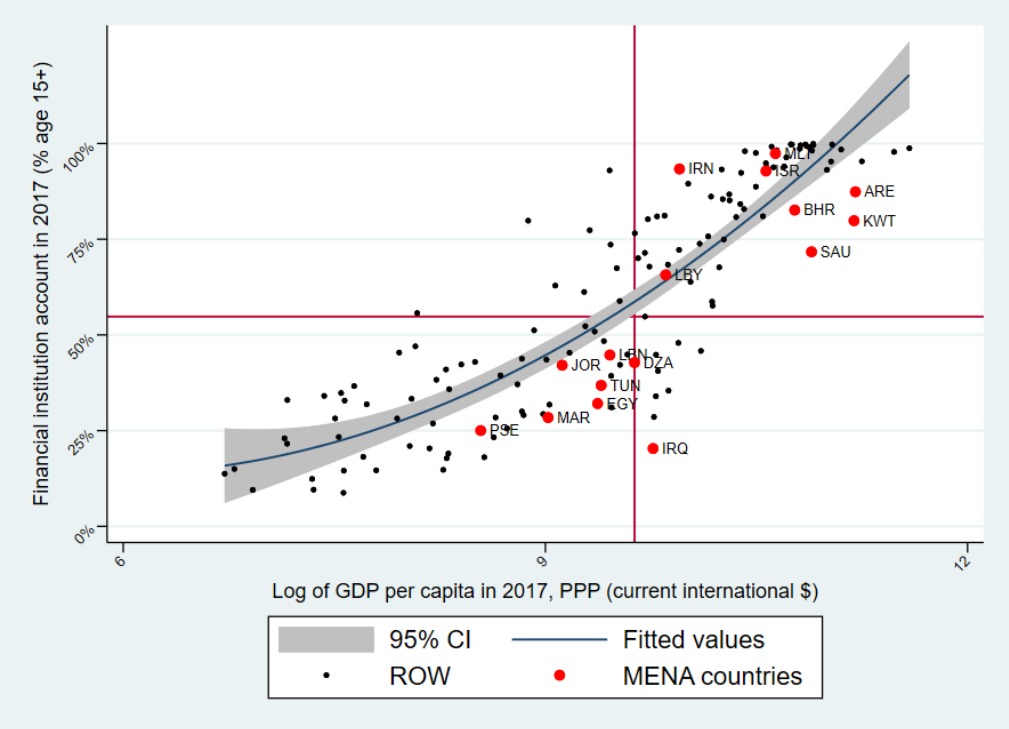
The first set of results are shown in scatter plots depicting the relationship between each of the three payments variables and the logarithm of GDP per capita. In turn, for each of the indicators, we discuss the econometric results, including the criteria for selecting the functional forms.

### 5.1. Visual evidence

Figures 1, 2 and 3 show the indicators for the first three stages of payment systems and point clearly at the heterogeneity in the relationship between the incidence of modes of payments and the level of development across countries. The vertical and horizontal red lines show the median values for the respective series. The blue lines are the fitted values with the most appropriate functional form – see section 5.2 for the discussion of functional forms. In all three stages, MENA countries appear below the fitted values except for Israel, Malta and the Islamic Republic of Iran, thus suggesting that the region underperforms relatively to other countries at similar levels of development. This underperformance implies that MENA's population lacks access to payments and other financial instruments.

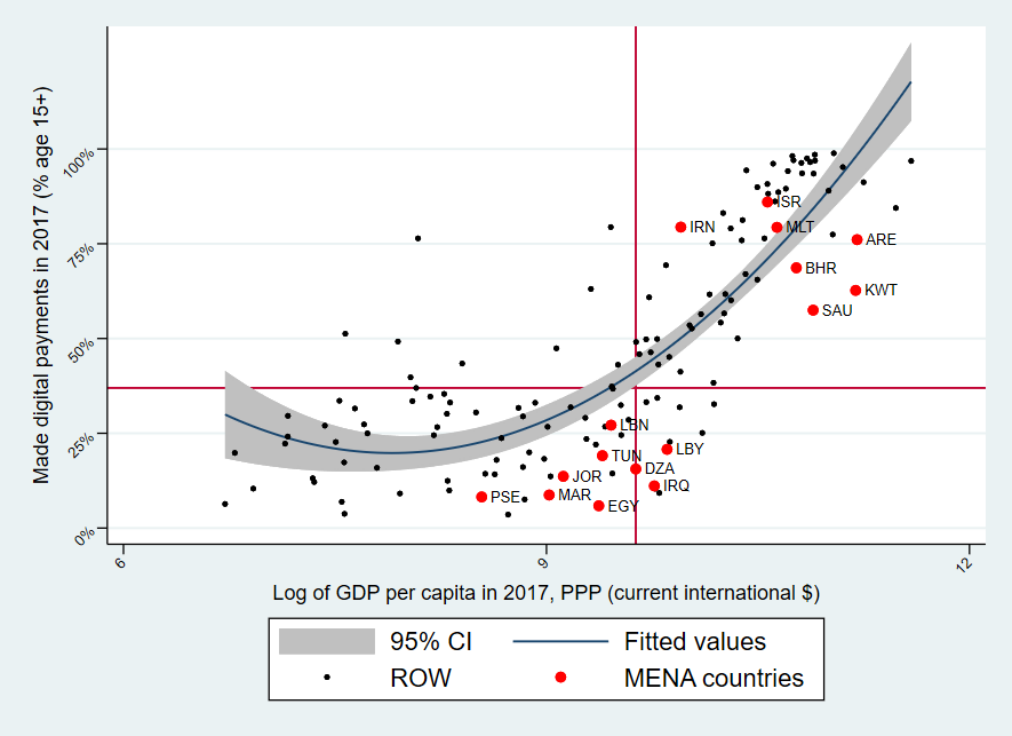
Regarding evidence of leapfrogging, the graphs show the heterogeneity in the estimated slopes as we move towards more digitized financial systems. This suggests a pro-poor bias of payment-technology adoption, which supports the argument for leapfrogging and financial inclusion commonly associated with digital payments (see, e.g., Klapper and Singer 2014). We interpret these results as evidence of absolute leapfrogging for the case of the incidence of mobile money accounts, which is higher among poor countries than in rich economies.

**Figure 1: Traditional bank account (Stage 1)**



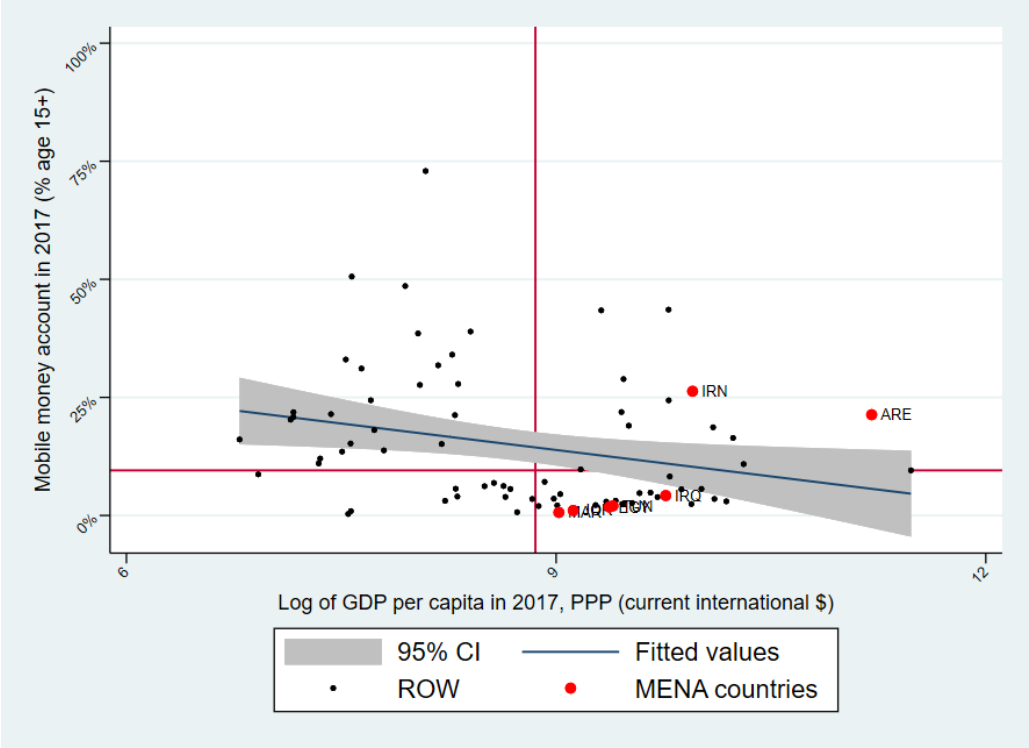

Source: Authors' calculations based on the full-sample data set described in Annex 1. Notes: Red dots represent MENA countries. Blue lines are the predicted values. The grey bands show the 95% confidence interval around the predictions. Red lines are the median values for each series.

**Figure 2: Use of digital payments (Stage 2)**



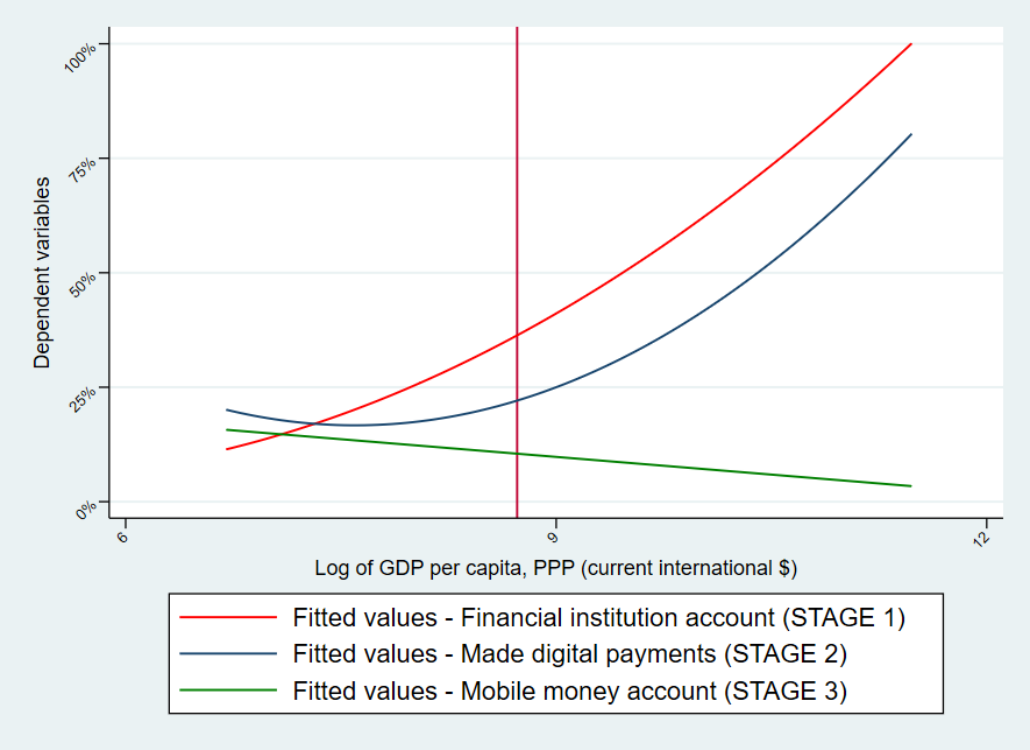

Source: Authors' calculations based on the full-sample data set described in Annex 1. Notes: Red dots represent MENA countries. Blue lines are the predicted values. The grey bands show the 95% confidence interval around the predictions. Red lines are the median values for each series.

**Figure 3: Mobile money accounts (Stage 3)**




Source: Authors' calculations based on the full-sample data set described in Annex 1. Notes: Red dots represent MENA countries. Blue lines are the predicted values. The grey bands show the 95% confidence interval around the predictions. Red lines are the median values for each series.

**Figure 4: The three stages of payment systems across countries**




Source: Authors' calculations based on the common-sample data set described in Annex 2.

Figure 4 plots the three fitted lines using the common sample of 149 observations together to show that richer countries are expected to have higher incidence rates of traditional banking across the whole distribution. In contrast, poorer countries are expected to perform better on digital mobile money than rich countries, because the prediction line is downward sloping with respect to the level of development. The incidence of digital payments is somewhere in between. Toward the left-side of the distribution of GDP per capita, at the lowest levels of development observed in the sample, the slope of the fitted line is negative, but it rises after reaching a relatively low level of development. As mentioned above, we interpret these results as evidence of absolute leapfrogging for the case of mobile money accounts and of relative leapfrogging for the case of transitioning from bank accounts to digital payments, since the incidence of the latter tends to be higher than that of traditional bank accounts among the poorest economies in the sample. The following section presents the coefficient estimates and discusses the selection of the functional forms depicted in Figures 1-4.

### 5.2. Econometric analysis

The model helps us compare the slope and intercept coefficients and measure a possible pro-poor bias in the distributions, which in turn allows us to compute fitted values for the payment

adoption indicators at very low levels of development. For the latter, we compute the fitted values at the minimum and 20th percentile levels of income per capita in the common sample of 149 observations.

Table 3 shows the regression results for equation (1), which assumes that the relationship between the incidence of payment systems and the level of development is log linear. As we move towards more digitized payment technologies, Table 2 shows that the slope coefficient decreases up to the point of it being negative in stage 3. On the other hand, the value of the constant increases, perhaps suggesting that poorer countries are early adopters of digital payment technology. The predicted values at minimums confirm this result, but we see that it holds only under the 20th percentile after which traditional banking accounts become more prevalent.

**Table 3. Regression results: Log-linear specifications**

| RHS Variables: | Stage 1 LHS Variable: Bank accounts | Stage 2 LHS Variable: Digital payments | Stage 3 LHS Variables: Mobile money |
|---|---|---|---|
| log_gdppc | 0.172*** | 0.100*** | -0.028*** |
| | (0.0125) | (0.0123) | (0.00957) |
| year2017 | 0.0336 | 0.0784*** | 0.0888*** |
| | (0.0258) | (0.0254) | (0.0198) |
| Constant | -1.127*** | -0.645*** | 0.300*** |
| | (0.110) | (0.108) | (0.0844) |
| Observations | 149 | 149 | 149 |
| Adjusted $R^2$ | 0.563 | 0.340 | 0.146 |
| Min. log_gdppc | 6.70 | | |
| **Predicted minimum** | **0.040** | **0.063**** | **0.161**** |
| 20th percentile log_gdppc | 7.64 | | |
| **Prediction at 20th perc.** | **0.201**** | **0.157**** | **0.135**** |

Source: Authors' calculations. Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).
LHS = Left-Hand Side Variables in equation (1). RHS = Right-Hand Side variables in equation (1).

The goodness of fit is largely decreasing as we move across the stages, suggesting that we are capturing a declining portion of the variance for more recently introduced payments mechanisms. This finding implies that the log-linear specification is more appropriate for the stage 1 model than for the latter two stages.

Table 4 presents the results for the quadratic specifications. The Adjusted $R^2$ statistic is comparable across specifications, and higher values indicate a preferred functional form. In the case of Stage 1, only the quadratic term is significative but the linear one is not. The Adjusted $R^2$

is higher with the quadratic form, which we retain for our analysis. For stage 2, both terms in the quadratic functions are statistically significant, and the adjusted $R^2$ is higher than in the log-linear specification reported in Table 2, and thus it is our preferred specification. No coefficients are statistically significant for Stage 3 and the Adjusted $R^2$ is lower than in Table 3, which leads us to keep the log-linear form for our Stage 3 indicator.

**Table 4. Regression results: Quadratic specifications**

| RHS Variables: | Stage 1 LHS Variable: Bank accounts | Stage 2 LHS Variable: Digital payments | Stage 3 LHS Variables: Mobile money |
|---|---|---|---|
| log_gdppc | -0.234 | -0.654*** | -0.132 |
| | (0.179) | (0.167) | (0.139) |
| log_gdppc_2 | 0.0231** | 0.0428*** | 0.00593 |
| | (0.0101) | (0.00949) | (0.00789) |
| year2017 | 0.0346 | 0.0803*** | 0.0890*** |
| | (0.0255) | (0.0238) | (0.0198) |
| Constant | 0.633 | 2.624*** | 0.753 |
| | (0.781) | (0.731) | (0.608) |
| Observations | 149 | 149 | 149 |
| Adjusted $R^2$ | 0.575 | 0.417 | 0.144 |
| Min. of log_gdppc | | 6.70 | |
| **Predicted value at minimum** | **0.116*** ** | **0.206*** ** | **0.181*** ** |
| 20th percentile of log_gdppc | | 7.64 | |
| **Predicted value at 20th perc.** | **0.207*** ** | **0.169*** ** | **0.136*** ** |

Source: Authors' calculations. Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). LHS = Left-Hand Side Variables in equation (1). RHS = Right-Hand Side variables in equation (1).

The results reported in Tables 3 and 4 are interesting and confirm the results shown in Figures 1-4. To assess whether countries can leapfrog over stages of payment-systems development at low levels of economic development, it is informative to compare the predicted incidence of the three stages of payments systems at the minimum and 20th percentile of (log) GDP per capita. At the minimum level of development observed in the common sample, the estimated prevalence of bank accounts is the lowest (11.6%) compared to the prevalence of digital payments (20.6%) or mobile money (16.1% in the preferred log-linear specification reported in Table 3). These results are weaker at the 20th percentile, with banking being the most prevalent payment technology (20.7%), followed by digital payments (16.9%) and mobile money (13.5% in the preferred log-linear specification reported in Table 3). Hence there is evidence of relative leapfrogging between the poorest economy and the 20th percentile, a finding that was graphically reported in Figure 4 above.

Given MENA's apparent underperformance in Figures 1-3, Table 5 reports the results for the preferred specifications for each dependent variable plus the MENA-country dummy variable. For stages 1 and 2 of payment technology adoption, the goodness of fit is slightly improved by the addition of the MENA variable, while it remains the same for the Stage 3 estimate. In addition, the values and significance levels of the other coefficients are not much affected by the new dummy variable, signaling that the results are consistent with those reported in Tables 3 and 4. These results suggest that MENA's population is on average underserved in terms of access to bank accounts and the use of digital payments, but not necessarily for mobile money accounts, given the region's level of development.

However, the point estimates of the MENA dummy variable, regardless of their statistical significance, suggest that the magnitudes are large, even for the case of mobile money accounts. For bank accounts, the average under-performance of MENA is about 8.9 percentage points (p.p.) of the adult population. For digital payments it falls to roughly 7.3 percentage points, and to 2.7 percentage points for the case of mobile money accounts. These estimates are large considering the common-sample averages reported in Table 2 above. For the case of bank accounts, MENA's 8.9 p.p. gap is 22.9 percent of the common-sample average of 38.9 p.p.; the gap of 7.3 p.p. for digital payments is 27.3 percent of the 26.7 p.p. common-sample average; and the gap of 2.7 p.p. equals 25.7 percent of the common-sample average of 10.5 p.p.

**Table 5. Regression results: Best-fit specifications with the MENA dummy variable**

| VARIABLES | STAGE 1<br>bankaccount<br>(quadratic) | STAGE 2<br>digitalpayment<br>(quadratic) | STAGE 3<br>mobilemoney<br>(log-linear) |
|---|---|---|---|
| log_gdppc | -0.243 | -0.662*** | -0.0255** |
| | (0.177) | (0.166) | (0.00999) |
| log_gdppc_2 | 0.0240** | 0.0436*** | |
| | (0.0101) | (0.00944) | |
| year2017 | 0.0350 | 0.0805*** | 0.0889*** |
| | (0.0252) | (0.0237) | (0.0198) |
| **MENA** | **-0.0886*** | **-0.0731*** | **-0.0265** |
| | (0.0466) | (0.0438) | (0.0366) |
| Constant | 0.649 | 2.638*** | 0.285*** |
| | (0.774) | (0.727) | (0.0872) |
| Observations | 149 | 149 | 149 |
| $R^2$ | 0.594 | 0.440 | 0.161 |
| Adjusted $R^2$ | 0.583 | 0.424 | 0.144 |
| Min. of log_gdppc | | 6.70 | |
| Predicted value at minimum | 0.105** | 0.197*** | 0.157*** |
| $20^{th}$ percentile of log_gdppc | | 7.64 | |
| Predicted value at $20^{th}$ perc. | 0.200*** | 0.163*** | 0.133*** |

Source: Authors' calculations. Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). LHS = Left-Hand Side Variables in equation (1). RHS = Right-Hand Side variables in equation (1).

Perhaps more importantly, the MENA variable is significant at the 10% confidence level and negative in the first two stages of payment technology adoption. This finding implies that MENA countries are less likely to adopt these payments mechanisms despite being situated way above the 20$^{th}$ percentile. These gaps might be due to structural factors limiting MENA's ability to promote financial innovation, including banking-sector regulations and inefficiencies, and lack of managerial capacities to lead in the digital transformation of payment systems (Chaffai et al. 2018). Yet more research is warranted to understand the underlying causes of MENA's underperformance in key indicators of access to payments and financial services, including on the role played by public banks.

## 6. Conclusion

This analysis set out to explore three initial stages of innovation in payment systems, from traditional banking to digital payments to mobile money accounts. The findings suggest that there is evidence of leapfrogging over stages of payment-systems development. Digital finance allows countries to leapfrog and implement advanced payment technology without having provided access to bank accounts for large swaths of the populations of poor countries. We called this relative leapfrogging. There is also evidence of absolute leapfrogging in the case of mobile money, since poor countries tend to have larger shares of their populations with access to mobile accounts than rich countries. In addition, MENA countries stand out in the data as underperformers across the three stages of payment-systems development. This result leads us to conclude that this underperformance is related to banking and financial system challenges other than those related to the adoption of digital technologies *per se* and points to the existence of structural impediments that limit MENA's population's access to financial and banking services in general.

Understanding the nature of the impediments to access to finance in MENA requires further analysis as to the determinants of financial inclusion and the roles that bank efficiency, regulation, and social norms (including distrust of the public sector and state owned banks) play in MENA countries. Conflict and instability might also constitute specific challenges that may hamper the universal roll-out of the digital economy. In addition, if digital finance is insufficient to allow MENA countries to leapfrog and adopt digital technologies to enhance access to financial services, it may be interesting to see whether any other pillars of the digital economy (such as digital infrastructure, digital entrepreneurship, digital skills or digital platforms) could act as a complementary push factor in the region. Given that the bottom 20% of the distribution is able to implement digital payments almost twice as much as the prevalence of bank accounts, it would

also be interesting to explore how the banking system and its regulatory environment, or lack thereof, may enable or prevent the rise of digital payments and digital currencies.

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## Annex 1: Descriptive statistics of full data set

| **Right-hand side variable (logarithm of GDP per capita)** | | | |
|---|---|---|---|
| Minimum | 6.57 | Maximum | 11.83 |
| Median | 9.49 | 2014 Mean (Std. Dev.) | 9.31 (1.18) |
| Mean (Std. Dev.) | 9.35 (1.18) | 2017 Mean (Std. Dev.) | 9.40 (1.18) |

| **Dependent variables** | | | | | |
|---|---|---|---|---|---|
| **Bank account** – The percentage of respondents who report having an account (by themselves or together with someone else) at a bank or another type of financial institution. | | | | | |
| 5th | 0.11 | Min | 0.035 | 2014 Median | 0.505 |
| 25th | 0.291 | Max | 1 | 2014 Mean (Std. Dev.) | 0.534 (0.318) |
| Median | 0.523 | | | | |
| 75th | 0.853 | Mean (Std. Dev.) | 0.557 (0.306) | 2017 Median | 0.548 |
| 95th | 0.991 | Obs. | 284 | 2017 Mean (Std. Dev.) | 0.579 (0.292) |
| MENA-specific data: | | | | | |
| Obs. | 31 | 2014 Median | 0.505 | 2017 Median | 0.552 |

| **Digital payment** – 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 or sending remittances directly from a financial institution account or through a mobile money account in the past 12 months. | | | | | |
|---|---|---|---|---|---|
| 5th | 0.049 | Min | 0.007 | 2014 Median | 0.277 |
| 25th | 0.162 | Max | 0.989 | 2014 Mean (Std. Dev.) | 0.383 (0.307) |
| Median | 0.336 | | | | |
| 75th | 0.677 | Mean (Std. Dev.) | 0.423 (0.303) | 2017 Median | 0.37 |
| 95th | 0.961 | Obs. | 284 | 2017 Mean (Std. Dev.) | 0.462 (0.295) |
| MENA-specific data: | | | | | |
| Obs. | 31 | 2014 Median | 0.23 | 2017 Median | 0.24 |

| **Mobile money** – The percentage of respondents who report personally using a mobile money service in the past 12 months. | | | | | |
|---|---|---|---|---|---|
| 5th | 0.003 | Min | 0 | 2014 Median | 0.028 |
| 25th | 0.02 | Max | 0.729 | 2014 Mean (Std. Dev.) | 0.065 (0.101) |
| Median | 0.045 | | | | |
| 75th | 0.152 | Mean (Std. Dev.) | 0.106 (0.132) | 2017 Median | 0.095 |
| 95th | 0.385 | Obs. | 151 | 2017 Mean (Std. Dev.) | 0.146 (0.145) |
| MENA-specific data: | | | | | |
| Obs. | 13 | 2014 Median | 0.009 | 2017 Median | 0.02 |

Source: Authors' calculations based on data extracted from the World Bank Global Findex database, https://globalfindex.worldbank.org/.

## Annex 2: Descriptive statistics of pooled sample for regression analysis

| **Right-hand side variable (logarithm of GDP per capita)** | | | |
|---|---|---|---|
| Minimum | 6.7 | Maximum | 11.48 |
| Median | 8.73 | 2014 Mean (Std. Dev.) | 8.69 (1.04) |
| Mean (Std. Dev.) | 8.74 (1.03) | 2017 Mean (Std. Dev.) | 8.78 (1.03) |

| **Dependent variables** | | | | | |
|---|---|---|---|---|---|
| **Bank account** – The percentage of respondents who report having an account (by themselves or together with someone else) at a bank or another type of financial institution. | | | | | |
| 5th | 0.095 | Min | 0.035 | 2014 Median | 0.302 |
| 25th | 0.19 | Max | 0.978 | 2014 Mean | 0.364 |
| Median | 0.34 | | | | |
| 75th | 0.512 | Mean (Std. Dev.) | 0.389 (0.238) | 2017 Median | 0.356 |
| 95th | 0.874 | Obs. | 149 | 2017 Mean | 0.413 |
| MENA-specific data: | | | | | |
| Median | 0.368 | 2014 Median | 0.371 | 2017 Median | 0.368 |

| | | | | | |
|---|---|---|---|---|---|
| **Digital payment** – 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 or sending remittances directly from a financial institution account or through a mobile money account in the past 12 months. | | | | | |
| 5th | 0.378 | Min | 0.02 | 2014 Median | 0.176 |
| 25th | 0.121 | Max | 0.854 | 2014 Mean | 0.222 |
| Median | 0.231 | | | | |
| 75th | 0.347 | Mean (Std. Dev.) | 0.267 (0.19) | 2017 Median | 0.272 |
| 95th | 0.683 | Obs. | 149 | 2017 Mean | 0.31 |
| MENA-specific data: | | | | | |
| Median | 0.136 | 2014 Median | 0.182 | 2017 Median | 0.136 |

| | | | | | |
|---|---|---|---|---|---|
| **Mobile money** – The percentage of respondents who report personally using a mobile money service in the past 12 months. | | | | | |
| 5th | 0.003 | Min | 0 | 2014 Median | 0.028 |
| 25th | 0.02 | Max | 0.729 | 2014 Mean | 0.061 |
| Median | 0.045 | | | | |
| 75th | 0.151 | Mean (Std. Dev.) | 0.105 (0.131) | 2017 Median | 0.091 |
| 95th | 0.385 | Obs. | 149 | 2017 Mean | 0.147 |
| MENA-specific data: | | | | | |
| Median | 0.018 | 2014 Median | 0.009 | 2017 Median | 0.02 |

Source: Authors' calculations based on data extracted from the World Bank Global Findex database, https://globalfindex.worldbank.org/.

**Annex 3: Full regression results**

| | Log-linear form estimates | | | Quadratic form estimates | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | bankaccount | digitalpayment | mobilemoney | bankaccount | digitalpayment | mobilemoney |
| log_gdppc | 0.172*** | 0.0998*** | -0.0276*** | -0.234 | -0.654*** | -0.132 |
| | (0.0125) | (0.0123) | (0.00957) | (0.179) | (0.167) | (0.139) |
| log_gdppc | | | | 0.0231** | 0.0428*** | 0.00593 |
| | | | | (0.0101) | (0.00949) | (0.00789) |
| year2017 | 0.0336 | 0.0784*** | 0.0888*** | 0.0346 | 0.0803*** | 0.0890*** |
| | (0.0258) | (0.0254) | (0.0198) | (0.0255) | (0.0238) | (0.0198) |
| Constant | -1.127*** | -0.645*** | 0.300*** | 0.633 | 2.624*** | 0.753 |
| | (0.110) | (0.108) | (0.0844) | (0.781) | (0.731) | (0.608) |
| Observations | 149 | 149 | 149 | 149 | 149 | 149 |
| R-squared | 0.569 | 0.349 | 0.158 | 0.584 | 0.429 | 0.161 |
| Adj. R-squared | 0.563 | 0.340 | 0.146 | 0.575 | 0.417 | 0.144 |

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

Source: Authors' calculations. year2017 is a dummy variable taking the value of one if the year is 2017. Estimates based on the sample described in Annex 2.

| VARIABLES | (1) bankaccount | (2) digitalpayment | (3) mobilemoney | (4) bankaccount | (5) digitalpayment | (6) mobilemoney |
|---|---|---|---|---|---|---|
| log_gdppc_current | 0.178*** | 0.105*** | -0.0255** | -0.243 | -0.662*** | -0.135 |
| | (0.0129) | (0.0128) | (0.00999) | (0.177) | (0.166) | (0.139) |
| log_gdppc_current2 | | | | 0.0240** | 0.0436*** | 0.00621 |
| | | | | (0.0101) | (0.00944) | (0.00791) |
| year2017 | 0.0339 | 0.0786*** | 0.0889*** | 0.0350 | 0.0805*** | 0.0891*** |
| | (0.0256) | (0.0253) | (0.0198) | (0.0252) | (0.0237) | (0.0199) |
| MENA | -0.0834* | -0.0636 | -0.0265 | -0.0886* | -0.0731* | -0.0279 |
| | (0.0473) | (0.0467) | (0.0366) | (0.0466) | (0.0438) | (0.0367) |
| Constant | -1.177*** | -0.683*** | 0.285*** | 0.649 | 2.638*** | 0.758 |
| | (0.113) | (0.111) | (0.0872) | (0.774) | (0.727) | (0.609) |
| Observations | 149 | 149 | 149 | 149 | 149 | 149 |
| R-squared | 0.578 | 0.357 | 0.161 | 0.594 | 0.440 | 0.165 |
| Adj. R-squared | 0.569 | 0.343 | 0.144 | 0.583 | 0.424 | 0.141 |

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

Source: Authors' calculations. year2017 and MENA are two dummy variables taking the value of one if the year is 2017, or if the country belongs to the MENA region, respectively. Estimates based on the sample described in Annex 2.