How important is mobile telephony for economic growth? Evidence from MENA countries

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Abstract

Purpose – *The explosion of mobile telephony in recent times has led to the emergence of a significant volume of literature. One area that has been relatively under-researched has been the role of mobile telephony in impacting economic growth and the relevance of financial inclusion in this respect. Using data on MENA countries during 2001-2012, this paper aims to examine this issue within an empirical framework.*

Design/methodology/approach – *The analysis is based on longitudinal data for the period 2001-2012 and examines the interrelationships among per capita income, financial inclusion and mobile telephony. To take on board this interrelationship, the authors use a simultaneous equation model. In contrast to the ordinary least squares, 3SLS exploits the information that the disturbance terms in the two structural terms are contemporaneously correlated, thereby producing consistent estimates.*

Findings – *The analysis suggests a significant relationship among these variables. In particular, a 1 per cent increase in the fraction of population using mobile telephony improves incomes by roughly 0.3 per cent points, whereas a similar 1 per cent increase in financial inclusion has double the impact on income. The findings also support a convex, non-linear relationship between income and cellular penetration. Robustness tests lend credence to these findings.*

Originality/value – *Although there are several studies on mobile telephony and growth, this paper provides a completely original contribution in the area of financial inclusion, linking the development of access to mobile communication to new channels for the unbanked population in the Arab economies.*

Keywords *MENA, Mobile telephony, Per capita income*

Paper type *Research paper*

1. Introduction

Few technological advances have come to dominate the debate on public policy in recent times as information and communications technology (ICT). Within the realm of ICT, the advancements in mobile telephony and internet have been rapid and furious. According to *Statista*, a leading statistics company, the number of internet users has increased from 413 million in 2000 to 2.5 billion in 2012. Likewise, the number of mobile phones has increased from 750 million to 6 billion over the same period, with a major chunk of this increase taking place in emerging economies. Coupled with technological advancements, this revolution has not only re-shaped the way people think and analyze, but in a much broader sense, transformed the way they work and communicate.

In tandem with these global advancements, the experience of the economies of the Middle East economies has been nothing short of phenomenal. According to the Wireless Intelligence (GSMA, 2012), mobile expansion during 2001-2012 in the Arab states has increased from 5 per cent in 2001 to 105 per cent in 2012, representing an annual average growth of 32 per cent to touch a user base of 400 million in 2012. The penetration in this region is the second highest worldwide, next only to sub-Saharan Africa. As Gelvanovska *et al.* (2014) remark, by improving productivity and competition, increased broadband penetration has acted as a powerful driver of sustainable economic growth, human skills

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development, besides helping these countries to diversify away from natural resources. As per their estimates, every one percentage increase in internet penetration could improve exports by nearly 4.3 per cent points (Figure 1).

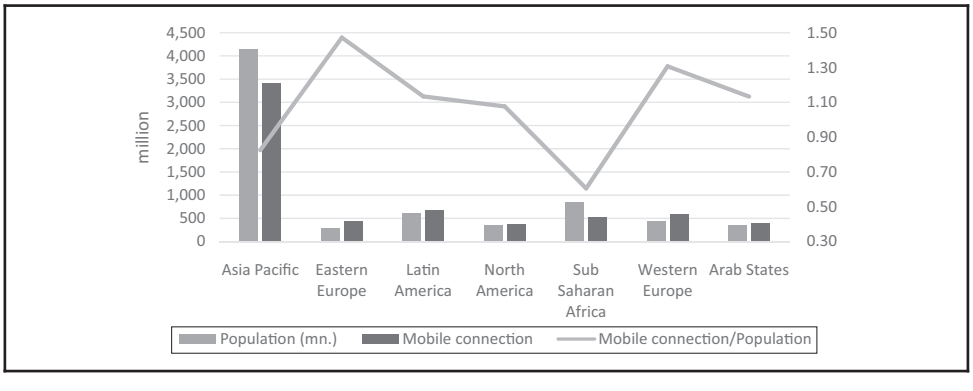
Three major reasons can be attributed to the rapid penetration of mobile telephony. First, there has been the steady reduction in handset prices, increasing the affordability to the final consumer. Between 2008 and 2012, for example, prices have decreased by as much as 50 per cent in Morocco and almost 70 per cent in UAE. Second, the growth of mobile telephony has been encouraged by the large and transient expatriate population in several of these countries. And finally, an enabling regulatory framework has facilitated the infrastructure and investment for mobile service providers.

Notwithstanding this penetration, the growth masks the wide divergence across countries. To illustrate, driven by intense competition and different deals through multi-SIM ownership, penetration rates in some of the GCC countries are close to 200 per cent, whereas in other such as Algeria, Egypt and Lebanon, these penetration rates are relatively lower, in the range of 80-90 per cent. Several factors presently impede the full-fledged expansion of mobile telephony in the Arab states. First, access to internationally harmonized spectrum on reasonable terms, which is a pre-requisite for seamless mobile connectivity, is still a challenge. According to the International Telecommunications Union (2012), between 1,340 and 1,960 MHz of spectrum will be required globally by 2020 to meet demand for mobile data traffic. As compared to that, in the MENA region, an average of just 200 MHz spectrum is available to mobile, compared to nearly 500 MHz in Europe. Second, mobile-specific taxes are a major barrier. In the Arab countries, the share of such taxes is roughly 7 per cent of the total cost of mobile ownership as compared to half these numbers globally elsewhere. Also, in several of these countries, mobile services are subject to higher taxes than fixed-line services.

Against this backdrop, the paper has a twofold purpose. First, using an extensive sample of MENA countries, we investigate the interlinkage between mobile penetration and economic growth during 2001-2012. Second, we expand the analysis further by investigating whether financial inclusion is one of the channels through which mobile phone penetration affects economic growth.

We make two major contributions. First, the analysis augments the thin literature on the impact of mobile telephony on economic growth for MENA countries. Cross-country studies are based either on cross-sectional data (Dahel, 2001; Rossotto *et al.*, 2005) or are country specific in nature (Galal, 1999; Ghaleb, 1998; Tohamy, 2002). For example, Rossotto *et al.* (2005) investigate the impact of opening up of the MENA telecom sector on the performance of the sector. The results confirm that liberalization promote efficiency in telecommunications. Country-specific studies such as Galal (1999) conclude that liberalization of the telecom sector in Egypt will engender an overall benefit for both

Figure 1 Population and mobile connection, 2012



domestic and foreign players. These studies are based on information of dated vintage and do not take on board the recent advancements in the sector including the transition to more competitive markets or even advancements in internet penetration, which we address in the paper.

Second, the paper belongs to the literature that explores the effects of financial inclusion and what role does mobile telephony or the internet play in this respect. Although several cross-country (Islam, 1995; Levine, 2003; Arcand *et al*., 2012) and country-level (Burgess and Pande, 2005) studies have focused on the finance – growth interface, few studies identify the relevance of mobile telephony in impacting economic growth, especially for MENA countries.

Two papers come close to the spirit of the present analysis. The first by Badran (2012) uses data on 22 Arab and emerging economies during 1998-2008 and uncovers a strong correlation between broadband development and foreign direct investment. According to their estimates, a 1 per cent increase in broadband penetration improves growth by 0.005 per cent. The other paper utilises data on six MENA countries for 1995-2007 and finds that cost of service and per capita incomes are the key drivers of telecom penetration (Hakim and Neaime, 2014).

Although our analysis is similar in spirit to these studies, there are also significant differences. First, we focus on a much larger set of MENA countries and consider more recent data periods. This assumes relevance, because as the Wireless Intelligence (GSMA, 2012) observes, the explosion in the growth of mobile telephony has occurred during the past several years. The increase in internet penetration is of even recent vintage. Second, we also explore whether financial inclusion is a channel which drives mobile telephony and internet services, an aspect not addressed in their study. Third, besides exploring the determinants of mobile telephony, we also examine its impact on income, akin to Waverman *et al.* (2005). Finally and methodologically, we use a simultaneous equation set-up, as opposed to a reduced form specification used in these studies. This enables us to clearly discern the interlinkages among mobile telephony, financial inclusion and income.

The results appear to suggest that mobile telephony exerts a significant and non-negligible impact on economic growth. More specifically, a 10 per cent increase in mobile telephony is associated with nearly 3 per cent improvement in income per capita, after controlling for other factors that are deemed relevant in influencing growth.

The reminder of the analysis unfolds as follows. Section 2 reviews the relevant literature, followed by a brief discussion of the evolution of mobile telephony and banking structure in the MENA countries. The database and summary statistics are delineated in Section 4, followed by the empirical analysis and robustness checks (Section 5). The final section concludes.

2. Model, theory and hypotheses

To have a sufficiently broad perspective on mobile telephony and the role played by financial inclusion in this respect, we model per capita income, mobile telephony and financial inclusion within a simultaneous equation setup. Accordingly, we first specify an empirical framework and thereafter propose several hypotheses.

Accordingly, we propose the following three-equation model for country i at time t:

$$\log PCNSDP_{i,t} = \alpha_o + \beta_1 Mobile_{i,t} + \beta_2 FI_{i,t} + \chi_1 X_{1i,t} + \eta_t + \mu_i + \varepsilon_{1i,t} \quad (1)$$

$$FI_{i,t} = \alpha_1 + \gamma_1 \log PCNSDP_{i,t} + \gamma_2 Mobile_{i,t} + \chi_2 X_{2i,t} + \eta_t + \mu_i + \varepsilon_{2i,t} \quad (2)$$

$$Mobile_{i,t} = \alpha_2 + \delta_1 \log PCNSDP_{i,t} + \delta_2 FI_{i,t} + \chi_3 X_{3i,t} + \eta_t + \mu_i + \varepsilon_{3i,t} \quad (3)$$

The model contains a set of explanatory variables (X); μ and η are country and year fixed effects that controls for all unobservable country and year-specific factors and ε is the error term. To ensure identification of these three equations, we need to ensure that the set of

control variables included in each equation are sufficiently different. Therefore, in the remainder of this section, we review extant models concerning economic growth, financial inclusion and mobile telephony.

2.1 Mobile telephony and economic growth

Although the literature regarding the impact of mobile telephony on economic growth begun since the 1980s, it is only in recent years that availability of consistent time series data has prompted researchers to take a fresh look at this issue. In an early cross-country study, Hardy (1980) analysed the correlation between GDP and number of telephones per capita, using data for the period 1960-73. The study provided evidence in support of bi-directional causality: telephone penetration was both a cause and consequence of GDP growth. Thereafter, Norton (1992) showed that telecommunications investments cause growth in the financial sector and thereby enhances GDP growth.

Using data for the period 1975-90 coinciding with the early period of digital adoption, Roeller and Waverman (2001) estimated a simultaneous equation model of telecom investment and a macro production function for OECD countries during 1970-1990. Their results provide evidence of a strong causal relationship between telecommunications infrastructure and productivity, and additionally they indicate that this occurs only when telecommunications services reach a certain threshold, suggestive of network effects. Extending the framework to incorporate mobile phones covering a 20-year period in a cross-country framework, Torero *et al.* (2002) uncover a positive link from telecom to GDP. According to their estimates, the impact of telecom on GDP is non-linear and appears to be particularly manifest for countries with telecom penetration in the range of 5-15 per cent. Subsequently, using a sample of 63 low- and middle-income countries during 1990-2001, Sridhar and Sridhar (2004) show that there is a statistically significant effect of cellular services on national income, after controlling for the effects of capital and labor.

More recently, based on a sample of over 90 countries covering the period 1980-2003, Waverman *et al.* (2005) show that mobile phones and fixed lines are substitutes in developing countries, but complements in advanced economies. Recognizing the possible endogeneity between mobile phone penetration and economic growth, recent studies have addressed this deficiency by using system GMM estimator. Using data on sub-Saharan African economies, their results show that regions with few fixed lines are associated with a higher marginal benefit of mobile phones, reiterating possible substitutable effects. Recent research by Andrianaivo and Kpodar (2012) for a sample of African countries during 1988-2007 reveals that mobile telephone development contributed to economic growth. In addition, their work also suggests that financial inclusion is one of the channels through which mobile phone penetration contributes to economic growth.

2.2 Financial inclusion and economic growth

Empirical studies on financial inclusion have exploded in recent years, driven by the availability of data, both at the cross-country level (Beck *et al.*, 2008; European Commission, 2008; Rojas-Suarez, 2010; Demirguc Kunt *et al.*, 2013; Demirguc Kunt and Klapper, 2013; Amidzic *et al.*, 2014) and also at the country level (Burgess and Pande, 2005; Sarma and Pais, 2011; Brune *et al.*, 2011; Allen *et al.*, 2013).

From a theoretical standpoint, it is possible to advance several reasons as to why financial inclusion can augment economic growth. First, consumers gaining access to the formal financial system are likely to increase savings, which, in turn, can impact long-run economic growth (World Bank, 1993; King and Levine, 1993; Rodrik, 1998; Aghion *et al.*, 2009). Second, financial inclusion improves firms' access to credit. Additionally, lending to otherwise excluded firms might lower the average credit risk of loan portfolios (Mehrotra and Yetman, 2015). This, in turn, is likely to improve the penetration of credit, in turn, improving aggregate economic activity. According to Bayoumi and Melander (2008), a reduction in credit by 2.5 per cent lowers GDP growth by over 1 per cent. More recently,

Demirguc Kunt and Levine (2008) find strong evidence that financial development, proxied by the ratio of private credit to GDP, is an important determinant of growth. Other cross-national studies also report a positive correlation of credit and financial inclusion (Mehrotra and Yetman, 2015). Third, greater levels of financial inclusion strengthen the case for the use of interest rate as a primary policy tool, in turn, reinforcing the role of monetary policy. Theory and empirical evidence both suggests that sustainable long-run growth is associated with lower price levels (Mishkin, 2006; Cecchetti and Kharroubi, 2012). Therefore, by improving the share of economic activity that comes under the sway of interest rates, greater financial inclusion acts as a harbinger for augmenting long-term growth.

Several studies have empirically explored the financial inclusion-growth nexus and uncover a positive relationship. Burgess and Pande (2005) for example, show that branch expansion in rural areas exert a positive effect on economic growth. Similarly, Brune *et al.* (2011) show that increased financial access through commitment savings account in rural Malawi improved the well-being of poor households. Dabla-Norris *et al.* (2015) shows that by eliminating the major blockages to the flow of credit, financial inclusion has significant and unambiguous direct impact on GDP growth. A simulation exercise for some of the African countries suggests that greater credit access is associated with 0.2-0.6 per cent increase in the investment-GDP ratio.

2.3 Mobile telephony and financial inclusion

Mobile financial services can be categorized into three classes: mobile payments (P2P, P2M or M2M), mobile microfinance (loan disbursement and payments) and mobile banking (bill pay or account information. To promote financial inclusion, several low-income countries (e.g. Kenya) have adopted non-bank led models, whereas others such as India and South Africa have adopted bank-led models.

The pervasive use of mobile telephony is providing evidence that this innovation is impacting the socio-economic structure of modern societies and economic growth. Perhaps the best-known example is Kenya, where the mobile-based SIM platform for communicating with agents has enabled a tremendous growth in the number of mobile money providers and led to a leapfrogging in the levels of financial inclusion in the country. As reported by the World Bank (2011) and Demirguc Kunt *et al.* (2015), the percentage of adults having account has nearly doubled from 42 per cent in 2011 to 75 per cent in 2014; the percentage of mobile accounts stood at 58 per cent in 2014. According to the Central Bank of Kenya (2015), as at the end of September 2015, there were nearly 40,000 agents licensed by 17 commercial banks facilitating transactions worth US$10bn, up from transactions worth US$2bn facilitated by 11,000 agents in March 2011.

Following from the Kenyan experience, non-bank mobile service providers have been introduced in several African countries. Penetration rates however are quite uneven, ranging from under 10 per cent in Ethiopia to nearly 100 per cent in Gabon with an average of around 35 per cent for the continent as a whole (GSMA, 2012).

Mobile applications have thereafter emerged in Asia and Latin America, with varying success. In Latin American, for example, less than 2 per cent of the total population uses a mobile phone for banking purposes (Meyer, 2014), despite having over 100 per cent mobile penetration. The situation is slightly better in Asia, where despite a 60-70 per cent mobile penetration, the use of mobile banking transactions is around 5 per cent (GSMA, 2014).

Studies on the interlinkage between mobile banking and financial inclusion are limited and often of indirect nature. McKay and Pickens (2010), for instance, find that branchless banking (including mobile money) to be nearly 20 per cent cheaper, on average. Mas and Radcliffe (2010) note that some of the attractive features of M-PESA including strong latent demand for domestic remittances driven by a rapidly rising urbanisation ratio, enabling

regulatory environment, a dominant mobile operator with low airtime commissions and simple and transparent pricing have augmented the scalability of the process. By enabling people to receive and send money as and when they need it, mobile banking has led to "anytime" financial inclusion (Stuart and Cohen, 2011). Field experiments by Aker *et al.* (2011) found that mobile money enabled recipients to enjoy better diets and deplete fewer assets during times of natural calamities.

In sum, the discussion appear suggests that mobile telephony, growth and financial inclusion are inter-related, with each tending to reinforce and augment the other. It is to analyzing this interrelationship that we turn next.

3. Mobile telephony and banking in the Arab states

Prior to the empirical analysis, we provide a snapshot of the status of mobile telephony in each of the Arab states in our sample. This, in essence, can provide us with a sense of how far the incremental mobile penetration in each of these countries can influence per capita incomes.

3.1 Algeria

The fixed telephony sector in the country is served exclusively by Algeria Telecom, the incumbent state-owned operator established in 2001. The mobile sector is shared between three operators: Mobilis-AT, Djezzy-Orascom and Ooredoo (formerly, Nedjma). By the end of 2012, there were nearly 34 million mobile cellular subscribers, entailing a penetration rate of 100 per cent. Unlike several other countries where the incumbent operator also has a mobile license, the AT group and its subsidiary are not the leaders in the voice market, having only a 30 per cent market share, with Djezzy having a market share of nearly 50 per cent. By the end of 2012, there were a total of 1 million fixed (wired) broadband internet subscribers; the internet user penetration was around 15 per cent.

3.2 Bahrain

Established in 2002, the Telecom Regulatory Authority is the ICT regulatory body in the country. The cellular market hosts three operators, of which the state-owned Batelco dominates with a market share of 55 per cent. The mobile cellular subscriber base stood at 2 million at the end of 2012, having dipped somewhat during the previous two years owing to political unrest. Mobile cellular penetration reached an estimated 120 per cent at the end of 2012, declining from its peak of over 125 per cent by year end 2010.

3.3 Egypt

Two main entities regulate the telecom sector in Egypt, the Ministry of Telecom and the National Telecom Regulatory Authority. The market currently has several operators as also internet service providers authorized to market asymmetric digital subscriber line. Total subscriptions are around 80 million, translating into a penetration rate of 90 per cent. 3G services began in 2007 by Etisalat Misr, followed shortly afterwards by Vodafone and Mobinil. All mobile operators also have internet subsidiaries.

3.4 Jordan

Established in 1995, the Telecom Regulatory Commission is tasked with regulating the telecom and information technology sector in the country. The cellular market presently has 25 individual licensees, which includes 22 for fixed networks (such as Jordan Telecom Group, Vtel, Damamax) and three for mobile (3G) network, such as Orange (JTG), Zain and Unmiah. The incumbent JTG continues to be the leading player in fixed broadband, but faces strong competition in mobile broadband from Zain and Unmiah. Total mobile cellular subscriptions aggregated 8 million by the end of 2012, translating into a penetration rate of around 115 per cent. There are 16 internet service providers in the country, with total fixed

(wired)-broadband subscriptions close to 2 million, entailing a penetration rate of around 5 per cent.

3.5 Kuwait

The Ministry of Communications regulates the telecom sector in the country. There are currently three GSM operators – Zain, Ooredoo and Viva – with the former having a market share of just 45 per cent, followed by Ooredoo Kuwait at 40 per cent. Total mobile cellular subscriptions stood at 6 million at the end of 2012, raising the penetration rate to 180 per cent. The broadband internet market boasts of four operators; there were a total of 2 million active mobile broadband internet subscriptions by the end of 2012.

3.6 Lebanon

Established in 2007, the Telecom Regulatory Authority is the entity responsible for oversight of the telecom sector in the country. The mobile cellular market is served by a duopoly – Touch and Alfa – controlled by the government. Total subscriber base was 3.8 million at the end of 2012, with penetration rates of 80 per cent. Internet services are provided by OGERO, the government-owned fixed operator. A total of 300,000 fixed (wired) broadband subscribers were there at the end of 2012.

3.7 Morocco

The Agence Nationale de Reglementation des Telecommunications is responsible for regulating the telecom market. There are currently three mobile cellular operators, of which Maroc Telecom is the leader with a 60 per cent market share, whereas the private operator Meditel has a 37 per cent market share. Mobile subscriber base stood at 40 million at the end of 2012, resulting in a penetration rate of around 115 per cent. The three cellular service providers are also active in the broadband market. By the end of 2012, fixed (wired) broadband internet subscription amounted to 6 million, entailing a penetration rate of around 55 per cent.

3.8 Oman

The Telecom Regulatory Authority regulates the telecom sector, while the Information Technology Authority oversees the information technology market. Strong competition exists between the two mobile service providers, Ooredoo and Omantel. Three virtual network operators who entered in 2009 enhanced the competition in the market. By the end of 2012, there were a total of 5 million subscribers, translating into a penetration rate of over 160 per cent. There were also a total of 50,000 fixed (wired) broadband subscriptions, corresponding to a penetration rate of nearly 3 per cent. Active mobile broadband subscriptions amounted to 320 million by the end of 2012, entailing a penetration rate of around 12 per cent.

3.9 Qatar

Established in 2004, Supreme Council of Information and Communications technology (ictQatar) is responsible for regulation of the sector. The market is currently served by two operators – Ooredoo which has a market share of close to 90 per cent, with Vodafone Qatar which launched operations in 2009, gradually gaining market share. Total cellular subscribers aggregated 4.5 million at the end of 2012, translating into a penetration rate of over 300 per cent. By the end of 2010, active mobile broadband subscribers totalled 520,000, entailing mobile broadband penetration rate of 35 per cent.

3.10 Saudi Arabia

The Communications and Information Technology Commission regulates the ICT sector. The market is served by several GSM operators, of which the state-owned Saudi Telecom Company is the market leader with a share of 52 per cent. The other players include Mobily,

Zain, Bravo, Virgin and Lebara. By the end of 2012, total mobile cellular subscriptions stood at close to 55 million, with a penetration rate of nearly 180 per cent, among the highest globally. Fixed (wired) broadband penetration stood at around 8 per 100 inhabitants in 2012.

3.11 Tunisia

The Tunisian telecom market is regulated jointly by the National Telecom Commission and the National Agency for Frequencies. Competition exists between the three telecom operators, i.e. Tunisie Telecom, Tunisiana and Orange Tunisie, the last having a 53 per cent market share. Mobile cellular subscriptions totaled 12.5 million at the end of 2012, leading to a penetration rate of 110 per cent. The market is also served by 11 internet service providers, of which six are government owned. Fixed (wired) broadband internet subscriptions reached 500,000 at the end of 2012, with an internet penetration rate of close to 40 per cent.

3.12 UAE

The Telecom Regulatory Authority is the entity responsible for regulating the telecom market. Etisalat and Du are the two mobile cellular service providers. Competition is fierce, with the share of Du, which entered the market in 2007 reportedly being close to 40 per cent in 2012. Total mobile cellular subscriptions were 15 million at end-2012, with a penetration rate of over 200 per cent. The total (fixed) wired broadband subscriptions reached 900 million, while active mobile broadband subscriptions reached 5 million by the end of 2012.

3.12.1 Banking sector structure. The financial sector in these countries is essentially bank based with bank asset to GDP ranging from around 35-50 per cent (as in Algeria and Kuwait) to well over 100 per cent (as in Bahrain, Jordan, Lebanon and Qatar). The presence of Islamic banks is a prominent feature, accounting for a quarter or more of the banking system in most (except Oman, where it has started recently) countries. Foreign bank presence is low ranging from 10-15 per cent, except in Bahrain (52 per cent), Jordan (25 per cent) Lebanon (29 per cent) and Tunisia (28 per cent), where these shares are high (Claessens and van Horen, 2014). Bank concentration remains high, with the assets of the three largest (usually, domestic) banks comprising between half to nearly 90 per cent of total banking assets. The value is the lowest in Tunisia at 41 per cent.

In terms of ownership, the banking sector is preponderantly domestically owned, reflecting barriers to enter and licensing restrictions on foreign banks (Al-Hassan *et al.*, 2010). As a result, the presence of banks across borders is primarily in the form of branches, often of unitary nature. Public ownership of banks (comprising government, quasi government and domestic royal family) is high in several countries such as UAE, Saudi Arabia and Oman, although in others such as Bahrain, Kuwait and Morocco, it is much lower (Al-Hassan *et al.*, 2010).

The rapid credit growth in the run-up to the crisis has been a mixed blessing. On the one hand, it improved financial penetration, thereby ensuring the flow of credit to productive sectors. On the flip side, given the limited size of domestic markets, this translated into increased concentration risk, either in the form of larger exposures to traditional corporate clients or in the form of sectoral concentration (IMF, 2010a, 2010b). Not surprisingly, non-performing loans of most banking systems trended upward in the wake of the crisis (IMF, 2013). As a consequence, bank profitability took a hit, having halved compared to the numbers obtaining prior to it. Following these crises, growth has slumped, reflecting a combination of general and country specific, including among others, slowdown in oil demand, Dubai World episode and, more recently, the Arab Spring (IMF, 2013; Ghosh, 2016).

4. Database, variable measurement and empirical strategy

4.1 Database

We use a sample comprising an unbalanced longitudinal data for 12 MENA countries[1]. The analysis spans the period 2001-2012. We choose this time period for two reasons. First, this period coincides with the availability of consistent data on the empirical variables of interest. Second, available data suggests that, aided by advancements in communication networking, it was during this period that the growth of mobile telephony exploded in the MENA region. According to the Wireless Intelligence (GSMA, 2012), the mobile penetration during 2001-12 in the Arab states has increased from 5 per cent in 2001 to 105 per cent in 2012, representing an annual average growth of 32 per cent. The growth has been particularly spectacular during the past five years, with the user base doubling from 200 million in 2008 to 400 million in 2012. This growth is only next only to sub-Saharan African at 36 per cent. The countries which have been excluded are primarily those with lack of relevant data or extremely misrecorded data. With an average of six years of observations per country, we have maximum of 60 country-years.

The analysis combines several sets of data: financial inclusion data, technology-related data, banking industry data, macroeconomic data and, finally, other country-specific data.

4.1.1 Financial inclusion data. The financial inclusion data is extracted from the International Monetary Fund, Financial Access Survey (FAS). The FAS is a supplier-side survey, such that the data are collected from the suppliers of financial services. It contains around 50 key indicators, which are grouped into geographic outreach and use of financial services. Using this database, we cull out information on the relevant variables such as the number of deposit and loan accounts with commercial banks, number of commercial bank branches and number of Automated Teller Machines.

4.1.2 Technology-related data. The technology-related data have been sourced from the International Telecommunications Union (ITU) database, complemented by the World Bank. The range of included indicators has expanded over time and currently contains over 150 indicators covering the telecom network, mobile services, tariffs, revenue and investment. The ITU relies primarily on official country data, as a result, the coverage is uneven across countries and years. Using this and the World Bank database, we extract information on the relevant variables such as the number of cellular and internet users per 100 people and fixed (wired) broadband per 100 inhabitants.

4.1.3 Banking industry data. The banking industry variables are obtained from the World Bank (Financial Structure Database), whereas the macroeconomic variables are obtained from the International Financial Statistics (IMF) and the World Development Indicators (World Bank).

4.1.4 Macroeconomic data. The country-specific macroeconomic data, such as real per capita income, inflation measured by changes in the CPI index and unemployment rates, are sourced from the World Bank. The information on schooling is from Barro-Lee (Barro and Lee, 2013)[2].

4.1.5 Other data. We utilize the Regional Economic Outlook of the IMF to obtain information as to whether a country is an oil exporter or not. Finally, information regarding the presence of an explicit deposit insurance system in a country is provided in the study by Demirguc Kunt *et al.* (2014).

4.2 Measurement of income

Income is measured as the logarithm of per capita GDP (at 2005, constant prices in USD). This is the most popular measure of growth, typically used in both academic (Islam, 1995; Mankiw *et al.*, 2002; Acemoglu *et al.*, 2008) and policy research (IMF, 2010a, 2010b; World Bank, 2014a, 2014b).

4.3 Measurement of financial inclusion

Using data from the FAS, we consider six measures of financial inclusion:

1. geographic branch penetration (i.e. commercial bank branches per 1,000 sq. kms);
2. demographic branch penetration (i.e. commercial bank branches per 100,000 adults);
3. geographic ATM penetration (i.e. commercial bank ATMs per 1,000 sq. kms);
4. demographic ATM penetration (i.e. commercial bank ATMs per 100,000 adults);
5. deposit accounts per capita, i.e. number of deposit accounts per 100,000 adults); and
6. finally, loan accounts per capita (i.e. number of loan accounts per 100,000 adults).

The first four indicators measure the access (i.e. supply) aspect of financial inclusion, while the last two are concerned with use (i.e. demand). These measures are similar to the ones used by Demirguc Kunt *et al.* (2008) in their cross-national study.

Using these variables, we construct an index of financial inclusion by combining the branch penetration measures (indicators 1 and 2), ATM penetration measures (indicators 3 and 4) and the two measures relating to use (indicators 5 and 6). More specifically, we use a maxi-min strategy to combine these measures into a scale-free number that lies in the unit interval (OECD, 2008) and take their simple average. The measure so constructed is labeled as INCLUSION.

4.4 Measurement of mobile penetration

By integrating the ITU data with the World Bank population data, we construct two measures of mobile penetration:

1. fraction of population employing cellular phones; and
2. fraction of population using internet.

Table I enlists the key indicators by country for the initial and final years of the sample. Per capita income levels are the highest in Qatar, for both periods. In 2001, for instance, Qatar's per capita income was US$47,000 as compared to an average of US$7,200 for the sample as a whole. Inclusion levels have improved significantly over the period, averaging 0.33 in 2012 as compared to a lowly 0.06 in 2011. The most striking difference is in terms of their mobile penetration. Average mobile penetration, which was 22 per cent in 2001, has increased sevenfold during this period, with the figures for some countries such as Kuwait, Oman and Saudi Arabia nearing the 200 per cent mark.

Table I Key indicators by country

	INCOME		*INCLUSION*		*CELLULAR*		*INTERNET*		*Log population*	
Country	*2001*	*2012*	*2001*	*2012*	*2001*	*2012*	*2001*	*2012*	*2001*	*2012*
Algeria	3.41	3.50	. . .	0.11	0.003	0.97	0	0.15	3.47	3.65
Bahrain	4.18	4.15	. . .	0.29	0.47	1.56	0.15	0.88	−0.35	0.28
Egypt	3.07	3.19	. . .	0.12	0.04	1.05	0.008	0.44	4.21	4.39
Jordan	3.29	3.45	0.06	0.22	0.18	1.39	0.05	0.41	1.59	1.84
Kuwait	4.41	4.47	0.05	0.33	0.44	1.91	0.09	0.79	0.68	1.18
Lebanon	3.75	3.85	0.07	0.32	0.20	0.93	0.07	0.61	1.21	1.49
Morocco	3.23	3.40	0.07	0.27	0.16	1.19	0.01	0.55	3.37	3.48
Oman	4.09	4.14	0.07	0.26	0.14	1.82	0.06	0.60	0.81	1.19
Qatar	4.67	4.73	0.06	0.43	0.29	1.74	0.06	0.88	−0.49	0.81
Saudi Arabia	4.09	4.25	0.05	0.35	0.12	1.85	0.05	0.54	3.04	3.34
Tunisia	3.45	3.58	0.06	0.37	0.04	1.19	0.04	0.41	2.27	2.38
UAE	4.65	4.49	0.06	0.38	0.61	1.70	0.26	0.85	1.14	2.22
All countries	3.86	3.88	0.06	0.33	0.22	1.42	0.07	0.59	1.74	2.18

Note: See Table II for a description of the variables

4.5 Control variables

In the growth equation, the control variables fixed capital formation (as ratio to GDP), educational attainment, inflation and a measurement of financial development. Capital formation captures the overall investment taking place. Education is measured as the average years of schooling of males and females above 15 years of age. The endogenous growth theory would suggest that higher levels of human capital would entail higher growth (Lucas, 1988; Romer, 1990, 1986). Inflation is measured by the consumer price index after deleting outliers and applying an inverse hyperbolic sine transformation (Arcand *et al.*, 2012). Finally, to capture the country-specific differences in financial development, we use the ratio of private credit to GDP.

The main control variables in the financial inclusion equation include educational attainment, urbanization ratio, unemployment rate, real deposit rate and foreign bank share. Literacy is likely to be related positively to financial inclusion, as higher literacy implies greater literacy about the benefits of availing formal finance (Sarma and Pais, 2011). The geographic factor indicates that people living in rural areas and in locations that are remote from urban financial centers are likely to be financially excluded (Leyshon and Thrift, 1995). Unemployment is another factor associated with financial inclusion (Goodwin *et al.*, 2000). Higher deposit rate improves the attractiveness of deposits and therefore might incentivize people to enter the fold of formal finance. Finally, advocates of financial sector liberalization have argued that foreign bank entry will lower credit access (Gormley, 2010) or even lower the number of accounts (Beck *et al.*, 2007).

Finally, in the equation for mobile telephony, the control variables are educational attainment, population size and population density. Technology adoption entails a skill bias and human capital plays a critical role in determining its diffusion (Lee, 2001). Therefore, education might be an important factor driving the spread of mobile telephony. Population density, reflecting network effects and cost conditions, is expected to exert a positive effect on mobile telephony. The total population is a control variable representing market size.

Table II provides a definition of the relevant variables, including data source and summary statistics. The log of per capita income translates into an income of US$7,700; the minimum (US$2,800) and maximum (US$17,700) numbers indicate wide divergence across countries. The average levels of cellular penetration at nearly 80 per cent are quite high, although here again, the minimum levels are 34 per cent. Although internet penetration has increased, it is not commensurate with mobile penetration, averaging 28 per cent. Regarding financial inclusion, the evidence is mixed: the numbers are typically on the lower side for most countries, although some GCC and North African countries have values of around 0.3. Among the controls, private credit levels are quite high, average 75 per cent of GDP. These countries also have a higher share of urban population and unemployment rates at over 8 per cent are also high, on average, consistent with those reported by IMF (2013).

4.6 Empirical strategy

Given the simultaneous equations setup of (1)-(3), the empirical strategy has to account for the endogeneity of the regressors. In contrast to the ordinary least squares, 2SLS and 3SLS estimators take the endogeneity into account, thereby producing consistent estimates. As Zellner and Theil (1962) have observed, 3SLS exploits the information that the disturbance terms in the two structural terms are contemporaneously correlated and thereby ensures consistent estimates[3]. As the estimates under the two models are similar, we present the results using the 3SLS technique. Contextually, it may be mentioned that Waverman *et al.* (2005) used a similar approach in their cross-national analysis of the interlinkage between mobile telephony and growth.

Table II provides a snapshot of the key indicators by country. The table clearly brings out the unevenness in mobile penetration across countries. For instance, mobile penetration in

Table II Variable definition and summary statistics

Variable	*Definition*	*Count*	*Mean (SD)*	*p. 75 (p. 25)*
Dependent				
INCOME	Logarithm per capita GDP at constant (USD, 2005) prices	142	3.89 (0.52)	4.25 (3.45)
INCLUSION	Index of financial inclusion, computed using six measures: four measures of access (two branch penetration measures, geographic and demographic and two ATM penetration measures, geographic and demographic) and two measures of use (loan and deposit accounts per 100,000 adult persons)	96	0.31 (0.18)	0.41 (0.15)
CELLULAR	Fraction of population using cellular telephony	144	0.79 (0.49)	1.14 (0.34)
INTERNET	Fraction of population using internet	144	0.28 (0.22)	0.41 (0.10)
Independent				
INV	Investment/GDP	138	0.26 (0.07)	0.30 (0.20)
EDU	Average years of schooling of male and females above 15 years of age (the regressions use the inverse hyperbolic sine transformation), $\ln(\mathrm{LIT} + \sqrt{LIT^2+1}$	93	2.64 (0.22)	2.78 (2.49)
INFL	Change in the consumer price index. (the regressions use the inverse hyperbolic sine transformation), $\ln(\mathrm{INFL} + \sqrt{INFL^2+1}$	144	1.46 (1.13)	2.21 (0.79)
CRED	Private credit/GDP	144	0.75 (0.56)	1.17 (0.16)
GOVT.	Government consumption/GDP	139	0.17 (0.05)	0.20 (0.14)
URBAN	Share of urban population to total population	144	0.77 (0.16)	0.88 (0.65)
UNEMP	Unemployment rate	144	0.08 (0.05)	0.12 (0.04)
FBASSET	Share of foreign bank assets in total banking asset	138	0.17 (0.17)	0.24 (0.02)
IRATE	Proxied by the real deposit rate, defined as nominal deposit rate minus CPI inflation	142	−0.0005 (0.04)	0.02 (−0.02)
POP	Log (population)	144	0.85 (0.59)	1.46 (0.41)
DENSITY	Population/1,000 sq. kilometers	144	−0.16 (0.59)	0.10 (−0.61)
OILEXP	Dummy = 1 if a country is oil exporter, else zero	144	0.50 (0.50)	1 (0)
DEPINS	Dummy = 1, if a country has explicit deposit insurance, else zero	144	0.50 (0.50)	1 (0)
CRISIS	Dummy = 1 for 2009, else zero	144	0.08 (0.28)	. . .

2012 was very high in most GCC countries; these numbers are much lower for some of the MENA countries such as Algeria and Lebanon. Without loss of generality, higher mobile penetration appears to be strongly correlated with internet penetration[4].

The correlation matrix (Table III) suggest high correlation among the relevant variables. To illustrate, the correlation between per capita GDP and fraction of population using cellular phones is 42 per cent, and between per capita GDP and financial inclusion at 17 per cent. However, these raw correlations do not take into account country-specific factors or the business cycle.

5. Discussion of the results

5.1 Univariate tests

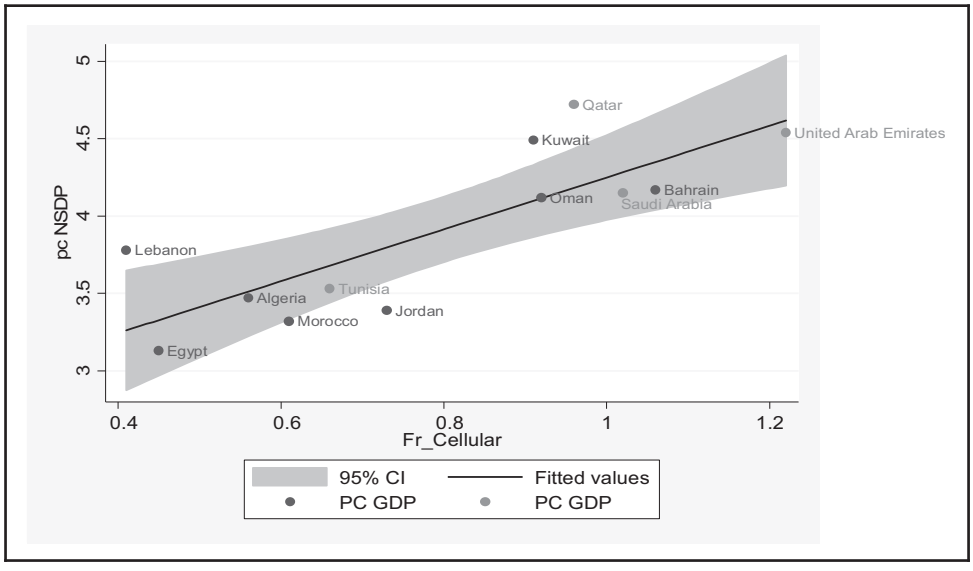
Before discussing the results, we first present graphical evidence of the link between mobile telephony and per capita income. We compute the average values of mobile penetration and per capita income growth for each country over the sample period. We plot this relationship in Figure 2, which shows that higher mobile penetration is associated with higher per capita income. While this is consistent with our contention that higher mobile

Table III Correlation matrix of dependent variables

Variables	*INCOME*	*CELLULAR*	*INCLUSION*
INCOME			
CELLULAR	0.42 (0.00)		
INCLUSION	0.20 (0.09)	0.21 (0.00)	

Note: *p*-values in brackets

Figure 2 Mobile telephony and per capita income



penetration entails higher incomes, a much rigorous econometric framework is necessary to establish a causal relationship between these empirical variables of interest.

The univariate tests of differences in means for the major variables of interest, segregated by country characteristics are set out in Table IV. Later in the analysis, we take into account these characteristics. Without the loss of generality, the evidence suggests that per capita income of oil exporters is 27 per cent higher on average and likewise, mobile telephony and internet penetration are double for oil exporters *vis-à-vis* oil importers. These differences are statistically significant in all cases.

Considering the differences in terms of deposit insurance, the evidence uniformly suggests that countries with implicit deposit insurance fare much better in terms of all parameters. The income of countries with implicit deposit insurance is on average 10 per cent higher; they also exhibit higher levels of financial inclusion and both mobile and internet penetration. Except in case of financial inclusion, the differences are statistically significant.

5.2 Baseline regressions

We first examine the response of endogenous variables. First, the parameter estimate of INCLUSION and CELLULAR in the INCOME is both positive and highly significant. In other words, improvements in financial inclusion and mobile telephony are both associated with significant improvements in income. The numbers are economically meaningful, as well. To

Table IV Univariate tests of differences across country characteristics

	Full sample		*Oil exporters*		*Oil importers*		*Differences in mean (t-test) Column 2 vs column 3*	*Explicit deposit insurance*		*Implicit deposit insurance*		*Differences in mean (t-test) Column 4 vs column 5*
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*		*Mean*	*SD*	*Mean*	*SD*	
Variables	*(1)*		*(2)*		*(3)*			*(4)*		*(5)*		
INCOME	3.89	0.52	4.37	0.24	3.44	0.21	−25.09***	3.70	0.35	4.09	0.59	4.76***
INCLUSION	0.31	0.18	0.32	0.18	0.28	0.17	2.15**	0.27	0.17	0.32	0.18	1.54
CELLULAR	0.79	0.49	1.01	0.49	0.57	0.38	5.91***	0.72	0.46	0.86	0.52	1.78*
INTERNET	0.28	0.22	0.36	0.24	0.19	0.16	5.10***	0.23	0.19	0.33	0.23	−2.73***

Notes: ***, ** and *denote statistical significance at 1, 5 and 10%, respectively

see this, consider an increase in cellular penetration by 100 per cent, equal to a move from the 25th percentile to the median of the distribution. Using the point estimates, the impact on per capita income works out to be 17 per cent. With average per capita income of US$7,700, this translates into an income differential of US$1,300, around the per capita income of a lower middle-income country (World Bank, 2014a, 2014b)[5].

Likewise, the coefficient on CELLULAR equals 0.69 so that a one standard deviation increase in inclusion – equal to 18 per cent percentage points – would improve per capita income by 0.12 per cent points. These numbers are consistent with those observed in prior cross-country research (Waverman *et al.*, 2005; Qiang *et al.*, 2009) (Table V).

In the INCLUSION equation, the coefficient on cellular is negative, suggesting that higher levels of cellular penetration do not necessarily improve financial inclusion. This apparently counter-intuitive result can be explained as follows. Many of these countries are characterized by a large and transient expatriate population, working in low- and semi-skilled sectors (Malecki and Ewers, 2007). These people are paid low wages typically in cash, who necessarily require a mobile phone to keep in touch with their families back home (GSM Association, 2012). Based on survey data, Gardner *et al.* (2013) shows that, although over 70 per cent of these workers are married and have children, legal restrictions prohibit them from bringing family members because of the low threshold income. Therefore, although mobile penetration has improved, it has not necessarily translated into higher levels of financial inclusion (Naithani and Jha, 2010).

Finally, in the CELLULAR equation, the coefficients on income are positive, whereas that on inclusion are negative. In essence, higher income improves cellular penetration, as subscribers seek to maximize special offers by offering multi-SIM ownership. This provides evidence in support of a network effect: increases in income improves subscriber density and thereby, raises the value of the phone to an individual user. In terms of magnitude, a 1 per cent increase in income per capita improves mobile penetration by 1.5 per cent points.

Table V 3SLS estimation of per capita income, financial inclusion and mobile telephony

Variables	*Model 1*			*Model 2*		
	INCOME	*INCLUSION*	*CELLULAR*	*INCOME*	*INCLUSION*	*CELLULAR*
Endogenous						
INCOME		0.731*** (0.282)	1.474** (0.661)		0.724*** (0.295)	0.839** (0.402)
INCLUSION	0.695*** (0.238)		−2.819*** (0.801)	0.351** (0.173)		−2.306*** (0.853)
CELLULAR	0.264*** (0.069)	−0.119** (0.054)		0.553*** (0.185)	0.239 (0.219)	
Sq. (CELLULAR)				−0.158** (0.068)	−0.126 (0.079)	
Controls						
INV	0.069 (0.237)			0.016 (0.233)		
EDU	2.077*** (0.427)	−1.822*** (0.741)	−6.736** (1.625)	1.535*** (0.401)	−2.098*** (0.772)	−6.083*** (1.787)
INFL	−0.010** (0.005)			−0.007* (0.004)		
CRED	0.022 (0.024)			0.014 (0.024)		
GOVT	−0.723*** (0.276)			−1.015*** (0.304)		
URBAN		0.702 (2.681)			3.598 (4.169)	
UNEMP		0.361 (0.923)			1.643 (1.079)	
FBASSET		0.419* (0.235)			0.466** (0.243)	
IRATE		−0.237 (0.186)			−0.262 (0.206)	
POP			−3.743 (6.344)			−0.457(8.285)
DENSITY			1.685 (6.134)			1.923 (8.075)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	60	60	60	60	60	60
R-squared	0.912	0.937	0.812	0.926	0.944	0.841

Notes: Standard errors in brackets; ***, ** and *denote statistical significance at 1, 5 and 10%, respectively

Among the control variables, the coefficient on education is positive, reiterating the fact that higher education levels lead to an improvement in income, consistent with the endogenous growth theory. The relationship between inflation and growth is negative, as expected. Intuitively, inflation acts as a tax on income, lowering purchasing power and thereby, lowering demand and hence, growth. Bigger governments are found to be associated with lower per capita income, consistent with prior research (Barro, 1991; Guesh, 1997). The magnitudes are consistent with those of Folster and Henrekson (2001) who in their study of develop countries report that a 10 per cent increase in government size lower annual growth rate by 0.7-0.8 per cent points.

In the inclusion equation, education bears a negative sign with a point estimate equal to −1.8, supporting out earlier assertion that several of these economies are characterized by low-skilled workers who are paid in cash. The coefficient on asset share of foreign banks is positive and significant, contrary to the "cream skimming" hypothesis, as evidenced in both country-specific (Gormley, 2010) and cross-country (Beck *et al.*, 2007) studies. Typically, most of these countries have low foreign bank penetration, which averaged 13 per cent in 2012, as compared to 25 per cent and over in Eastern Europe and Latin America (Claessens and van Horen, 2014). Therefore, foreign banks are more inclined to improve market share by raising account penetration as opposed to cream skimming creditworthy customers.

The control variable for education is negative in the cellular equation, consistent with our previous findings that cellular phone is a necessity for the low-skilled expatriate workforce to keep in touch with relatives, because of legal restrictions which prohibits families from accompanying them.

The fit of the model is high, explaining anywhere between 80-94 per cent of the variation in the dependent variable.

To examine possible non-linearities, we re-estimate the model by including the squared of the cellular variables in the regressions. Although most coefficients are unaltered in sign and significance, it is observed that in the INCOME equation, the cellular variable enters with a positive sign, while the squared term is negative. Both these coefficients are statistically significant at the 5 per cent level or higher. The inflection point in the relation is reached at when the value of cellular reaches 1.75[6]. This convex quadratic relationship suggests that as cellular penetration increases, income initially improves up to the threshold level. Beyond this level, the marginal value of cellular penetration leads to diminishing returns, causing the complementarity between cellular penetration and income to be retarded. This refutes the existence of network effects in MENA countries (Daganoglu and Grzybowski, 2007; Maicas *et al.*, 2009; Karacuka *et al.*, 2013) and could possible arise because of already high levels of mobile penetration in several MENA economies.

5.3 Robustness

This section discusses certain robustness tests of the baseline regressions. First, we examine whether the results with regard to cellular telephony carry over to internet use as well. All models include the full set of control variables akin to those in the baseline regressions, but these are not reported for purposes of brevity.

Accordingly, the specification in model 1 is similar to earlier, except for the fact that one of the endogenous variables is INTERNET, the fraction of people using internet instead of CELLULAR. The results are broadly similar (Table VI). In particular, greater internet penetration improves income, consistent with prior research of the beneficial effects of technological penetration, in general (Waverman *et al.*, 2005). It is possible to presume that greater internet use lowers search costs and lowers information asymmetry, making products and services most competitive. As a result, this improves the disposable income in the hands of consumers, thereby raising incomes. The only major difference is the insignificant coefficient on the INTERNET variable. As observed earlier, internet penetration

Table VI 3SLS estimation of per capita income, financial inclusion and mobile telephony – robustness

Variables	*INCOME*	*Model 1* *INCLUSION*	*INTERNET*	*INCOME*	*Model 2* *INCLUSION*	*INTERNET*	*INCOME*	*Model 3* *INCLUSION*	*CELLULAR*	*INCOME*	*Model 4* *INCLUSION*	*CELLULAR*
Endogenous												
INCOME		0.890*** (0.305)	1.496*** (0.258)		−0.210 (0.352)	0.785*** (0.271)		0.165* (0.098)	0.713*** (0.207)		0.053 (0.098)	0.188** (0.094)
INCLUSION	0.915*** (0.232)		−0.236 (0.288)	−0.024 (0.153)		0.771*** (0.268)	1.482** (0.640)		−2.242*** (0.489)	−2.425 (1.637)		1.213*** (0.509)
CELLULAR							0.745*** (0.249)	0.252*** (0.096)		0.188 (0.324)	0.163 (0.108)	
INTERNET	0.563*** (0.213)	−0.025 (0.184)		1.964*** (0.241)	1.785*** (0.557)							
Sq. (INTERNET)				−1.533** (0.186)	−0.978*** (0.395)							
OILEXP							1.097*** (0.174)	−0.134* (0.081)	0.884*** (0.184)			
CELLULAR × OILEXP							0.034 (0.196)	−0.023 (0.065)				
DEPINS										−1.169** (0.519)	−0.016 (0.064)	−0.047 (0.083)
CELLULAR × DEPINS										0.419 (0.408)	−0.006 (0.055)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	60	60	60	60	60	60	60	60	60	60	60	60
R-squared	0.901	0.939	0.932	0.917	0.935	0.936	0.883	0.846	0.686	0.554	0.874	0.724

Notes: Standard errors in brackets; ***, ** and *denote statistical significance at 1, 5 and 10%, respectively

in several of the countries is still quite low and the expatriate population, who are typically paid in cash, are more inclined to use mobile telephony and other traditional methods of transfer (e.g. exchange houses) as opposed to the internet. This could be explaining the results.

Model 2 introduces the squared term on INTERNET and finds evidence in support of non-linearity. The INTERNET term is positive and its squared term is negative, indicative of a convex relationship. The inflection point in the relationship is reached at 64 per cent. In other words, improvements in internet penetration improve income up to this threshold limit, beyond which it entails negative returns. With the maximum internet returns in the MENA countries presently being 41 per cent and average internet penetration being 28 per cent, there is still some time to go before these negative returns become overwhelming.

The more interesting result is the impact of internet penetration on INCLUSION. Based on the point estimates in Column 2, the threshold limit for diminishing returns works out to be 92 per cent. Greater use of the internet improves financial inclusion, as consumers understand the benefits of accessing formal finance. Beyond the threshold however, as banks exhaust their internet-based delivery channels for inclusion, incremental use of the internet does not provide additional benefits. These results find resonance in the finance – growth literature, wherein the findings suggest that finance beyond a particular point can actually be growth inhibiting (Cecchetti and Kharroubi, 2012; Arcand *et al*., 2012).

Model 3 focuses on the behavior of oil exporters. With a significant amount of revenues being generated by these countries during the periods of high and rising oil prices, it might be intuitive to assume that governments would dovetail some of these revenues for welfare-enhancing activities. To do this, we include two additional terms in the baseline model:

1. a dummy variable which equals one if a country is an oil exporter (OILEXP); and
2. its interaction with CELLULAR.

Provided an increase in cellular penetration improves incomes and inclusion, the sign on this variable would be positive.

The results show that when significant, most of the coefficients have the expected signs. Our coefficients of interest are OILEXP and OILEXP $\times$ CELLULAR. In the income and cellular equations, the coefficient on OILEXP is positive and statistically significant, that is, oil exporters have higher levels of income and cellular penetration, conforming with the univariate findings. The magnitude is equally important: based on the income equation for example, it is observed that the income of oil exporters are 1.1 per cent points higher, on average, as compared to oil importers. The coefficient is negative in the cellular equation and statistically significant with a point estimate of -0.13, suggesting that the financial inclusion efforts of oil exporters lag behind those of their oil importing peers. The interaction term is not significant in any case, indicating that there is no differential impact of cellular telephony on oil exporters.

The final model (Model 4) is similar to earlier, except that we explore whether the behavior of countries with an explicit deposit insurance with regard to their use of mobile telephony differs from those without explicit deposit insurance. The coefficients of interest are a dummy coded one, provided the country has explicit deposit insurance (DEPINS) and its interaction with cellular, DEPINS $\times$ CELLULAR. The regression results show that the fit of the model is the lowest in this case, i.e. the income equation explains 55 per cent of the variation in the dependent variable, compared to an average of over 80 per cent in the other cases; similar is the case for the other two equations. Among the variables of interest, the only statistically significant variable is the coefficient on DEPINS in the income equation, with a point estimate of -1.16. Therefore, the income of countries with explicit deposit insurance is, on average, 1.2 per cent lower as compared to those without it. Implicit deposit insurers includes countries such as Kuwait, Qatar, Saudi Arabia and UAE, whose

average per capita income at US$20,000 in 2012 was three-and-a-half times those of countries with explicit deposit insurance at US$6,000. The findings are a manifestation of this fact.

6. Concluding remarks

The interlinkage between mobile telephony and economic growth has been a subject of policy debate in recent times. To inform this debate, we use an extended sample of MENA countries for the period 2001-2012 to examine the interlinkage between mobile telephony and economic growth and the role played by financial inclusion in this regard.

The findings appear to suggest that a significant relationship among these variables. In particular, both financial inclusion and mobile telephony improve incomes: a 1 per cent increase in the fraction of population using mobile telephony improves incomes by roughly 0.3 per cent points, whereas a similar 1 per cent increase in financial inclusion has double the impact on income. What is apparently counter-intuitive is the negative and self-enforcing relationship between mobile telephony and financial inclusion, suggesting that financial inclusion has not yet permeated to a significant extent, presumably because of the lack of comprehensive high-level commitment to the agenda (Pearce, 2011). The findings also support a convex, non-linear relationship between income and cellular penetration. With several countries have reached the estimated threshold relationship between income and cellular penetration when diminishing returns sets in, it remains to be seen what innovative policy measures can they undertake to improve their incomes.

Several of these findings are new in the literature and especially for the MENA countries. From the policy standpoint, there is a need for dedicated thrust toward financial inclusion to improve incomes. This will also raise the efficacy of monetary policy in these countries (Mehrotra and Yetman, 2015). With several countries having reached a significant level of mobile penetration, ensuring greater penetration of internet-driven services perhaps holds the key for ensuring future long-term growth.

Notes

1. The economies considered include, in alphabetical order: Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and United Arab Emirates.
2. Information on educational attainment is reported every five years in the Barro-Lee (2013) dataset. We repeat the data for the intervening years with those reported for the beginning of the period (e.g., data for 2000 is repeated for 2000-2004). The dataset does not contain information for Lebanon and Oman, for whom we proxy it by the literacy rate, obtained from the UNESCO Institute of Statistics and the World Development Indicators (World Bank, 2012).
3. The 3SLS methodology is sensitive to misspecification or measurement errors. As a result, a comparison with 2SLS estimates as a specification check becomes relevant. In the present case, estimation of equations (5) and (6) with 2SLS produce results similar to those obtained under 3SLS.
4. The correlation between mobile penetration and internet penetration for the entire periods equals 0.81, and it is statistically significant at the 1 per cent level.
5. Low-middle income and upper middle-income countries are separated by per capita income of USD 4125 World Bank, 2014a, 2014b).
6. The inflection point is calculated as the derivative of income with respect to cellular. The other reported inflection points are computed in a similar manner.

References

Acemoglu, D., Johnson, S., Robinson, J.A. and Yared, P. (2008), "Income and democracy", *American Economic Review*, Vol. 98, pp. 808-842.

Aghion, P., Boustan, L., Hoxby, C. and Vandenbussche, J. (2009), "The causal effect of education on economic growth: evidence from United States", in Romer, D. and Wolfers, J. (Eds), *Brookings Paper on Economic Activity*, Spring, available at: http://brookings.Edu/economics/bpea

Aker, J.C., Boumnijel, R., McClelland, A. and Tierney, N. (2011), "Zap it to me: the short-term impact of a mobile cash transfer program", Centre for Global Development Working Paper 268, CGD, London.

Al-Hassan, A., Khamis, M. and Oulidi, N. (2010), "The GCC banking sector: topography and analysis", IMF Working Paper No. 87, Washington DC.

Allen, F., Carletti, E., Cull, R., Qian, J., Senbet, L. and Valenzuela, P. (2013), "Resolving the African financial development gap: cross-country comparisons and a within country study for Kenya", Policy Research Working Paper 6592, The World Bank, Washington, DC.

Amidzic, G., Massara, A. and Mialou, A. (2014), "Assessing countries' financial inclusion standing – a new composite index", IMF Working Paper 36, IMF, Washington, DC.

Andrianaivo, M. and Kpodar, K. (2012), "Mobile phones, financial inclusion and growth", *Review of Economics and Institutions*, Vol. 3, pp. 1-30.

Arcand, J.-L., Berkes, E. and Panizza, U. (2012), "Too much finance?", IMF Working Paper 161, IMF, Washington, DC.

Badran, M.F. (2012), "The impact of broadband infrastructure on economic growth in some Arab and emerging countries", *Topics in Middle Eastern and African Economics*, Vol. 14, pp. 278-320.

Barro, R.J. (1991), "Economic growth in a cross section of countries", *Quarterly Journal of Economics*, Vol. 106, pp. 407-444.

Barro, R.J. and Lee, J.W. (2013). "A new data set of educational attainment in the world, 1950-2010", *Journal of Development Economics*, Vol. 104, pp. 184-198.

Bayoumi, T. and Melander, O. (2008), "Credit matters: empirical evidence on US macro-financial linkages", IMF Working Paper 169, IMF, Washington, DC.

Beck, T., Demirguc Kunt, A. and Martinez Peria, M.S. (2007), "Reaching out: access to and use of banking services across countries", *Journal of Financial Economics*, Vol. 85, pp. 234-266.

Beck, T., Demirguc Kunt, A. and Soledad Peria, M.S. (2008), "Banking services for everyone? Barriers to bank access and use around the world", *World Bank Economic Review*, Vol. 22, pp. 397-430.

Brune, L., Gine, X., Goldberg, J. and Yang, D. (2011), "Commitment to save: a field experiment in rural Malawi", World Bank Working Paper 5748, The World Bank, Washington, DC.

Burgess, R. and Pande, R. (2005), "Do rural banks matter? Evidence from the Indian social banking experiment", *American Economic Review*, Vol. 95, pp. 780-795.

Cecchetti, S. and Kharroubi, E. (2012), "Reassessing the impact of finance on growth", BIS Working Paper 381, BIS, Basel.

Central Bank of Kenya (2015), *Banking Sector Quarterly Report for the Quarter Ended September 2015*, Central Bank of Kenya, Nairobi.

Claessens, S. and van Horen, N. (2014), "The impact of the global financial crisis on banking globalization", IMF Working Paper 197, IMF, Washington, DC.

Dabla-Norris, E., Ji, Y., Townsend, R. and Filiz Unsal, D. (2015), "Identifying constraints to financial inclusion and their impact on GDP and inequality: a structural framework for policy", IMF Working Paper 22, IMF, Washington, DC.

Daganoglu, T. and Grzybowski, L. (2007), "Estimating network effects in mobile telephony in Germany", *Information Economics and Policy*, Vol. 19 No. 1, pp. 65-79.

Dahel, R. (2001), *Telecommunications Privatization in Arab Countries: An Overview*, Arab Planning Institute.

Demirguc Kunt, A., Kane, E. and Laeven, L. (2014), "Deposit insurance database", IMF Working Paper 118, IMF, Washington, DC.

Demirguc Kunt, A. and Klapper, L. (2013), "Measuring financial inclusion: explaining variation in use of financial services across and within countries", *Brookings Paper on Economic Activity* (Spring), pp. 279-321.

Demirguc Kunt, A., Klapper, L. and Singe, D. (2013), "Financial inclusion and legal discrimination against women: evidence from developing countries", Policy Research Working Paper 6416, The World Bank, Washington, DC.

Demirguc-Kunt, A., Klapper, L., Singer, D. and Van Oudheusden, P. (2015), "The Global Findex Database 2014: measuring financial inclusion around the world", Policy Research Working Paper 7255, The World Bank, Washington, DC.

Demirguc Kunt, A. and Levine, R. (2008), "Finance, financial sector policies and long run growth", Growth Commission Background Paper 11, The World Bank, Washington, DC.

European Commission (2008), *Financial Services Provision and Prevention of Financial Exclusion*, EC, Brussels.

Folster, S. and Henrekso, M. (2001), "Growth effects of government expenditure and taxation in rich countries", *European Economic Review*, Vol. 45 No. 8, pp. 1501-1520.

Galal, A. (1999), "Egypt telecom: status and prospects", in Fawzy, S. and Galal, A. (Eds), *Partnerships for Development New Roles for Governments and the Private Sector in the Middle East and North Africa*, World Bank Institute, Washington, DC, pp. 129-156.

Gardner, A., Pessoa, S., Diop, A., Al-Ghanim, K., Le Trung, K. and Harkness, L. (2013), "A portrait of low-income migrants", *Journal of Arabian Studies*, Vol. 3, pp. 1-17.

Gelvanovska, N., Rogy, M. and Rossotto, C.M. (2014), *Broadband Networks in the Middle East and North Africa: Accelerating High-Speed Internet Access*, The World Bank, Washington, DC.

Ghaleb, J.R. (1998), "The Lebanese telecommunications sector and the impact of privatization in the labor market", Economic Research Forum Working Paper 107, ERF, Cairo.

Ghosh, S. (2015), "Political transition and bank performance: how important was the Arab Spring?", *Journal of Comparative Economics*, Available at: http://dx.doi.org/10.1016/j.jce.2015.02.001.

Gormley, T. (2010), "The impact of foreign bank entry in emerging markets: evidence from India", *Journal of Financial Intermediation*, Vol. 19 No. 1, pp. 26-51.

Goodwin, D., Adelman, L., Middleton, S. and Ashworth, K. (2000), Debt, Money Management and Access to Financial Services: Evidence from the 1999 PSE Survey Working Paper 8, Centre for Research in Social Policy, Loughborough University, UK.

Groupe Speciale Mobile Association (2012), *The Mobile Economy*, GSMA, London.

Groupe Speciale Mobile Association (2014), *The Mobile Economy*, GSMA, London.

Guesh, J.S. (1997), "Government size and economic growth in developing countries: a political economy framework", *Journal of Macroeconomics*, Vol. 19, pp. 175-192.

Hakim, S. and Neaime, S. (2014), "The demand elasticity of mobile phones in the Middle East and North Africa", *Research in International Business and Finance*, Vol. 32, pp. 1-14.

Hansson, P. and Henrekson, M. (1994), "A new framework for testing the effect of government spending on growth and productivity", *Public Choice*, Vol. 81 Nos 3/4, pp. 381-401.

Hardy, A. (1980), "The role of telephone in economic development", *Telecommunications Policy*, Vol. 4 No. 4, pp. 278-286.

IMF (2010a), *Regional Economic Outlook – Middle East and Central Asia*, IMF, Washington, DC.

IMF (2010b), *World Economic Outlook*, IMF, Washington, DC.

IMF (2013), *Regional Economic Outlook – Middle East and Central Asia*, IMF, Washington, DC.

International Telecommunications Union (2006), *Yearbook of Statistics 2006*, ITU, Geneva.

International Telecommunications Union (2012), *Yearbook of Statistics 2012*, ITU, Geneva.

International Telecommunications Union (2014), *Measuring the Information Society*, ITU, Geneva.

Islam, N. (1995), "Economic growth in a cross-section of countries", *Quarterly Journal of Economics*, Vol. 106 No. 2, pp. 407-443.

Karacuka, M.K., Nazif Çatık, A. and Haucap, J. (2013), "Consumer choice and local network effects in mobile telecommunications in Turkey", *Telecommunications Policy*, Vol. 37 Nos 4/5, pp. 334-344.

Kempson, E., Whyley, C., Caskey, J. and Collard, S. (2000), *In or out? Financial Exclusion: A Literature or Research Review*, Financial Services Authority, London.

King, R. and Levine, R. (1993), "Finance and growth: Schumpeter might be right", *Quarterly Journal of Economics*, Vol. 108 No. 3, pp. 717-738.

Lee, J.W. (2001), "Education for technological readiness: prospects for developing countries", *Journal of Human Development*, Vol. 2, pp. 110-121.

Levine, R. (2003), "More on finance and growth: more finance, more growth?", *Federal Reserve Bank of St. Louis Review*, July/August, pp. 31-46.

Leyshon, A. and Thrift, N. (1995), "Geographies of financial exclusion: financial abandonment in Britain and the United States", *Transactions of the Institute of British Geographers*, Vol. 20 No. 3, pp. 312-341.

Lucas, R.E. (1988), "On the mechanics of economic development", *Journal of Monetary Economics*, Vol. 22, pp. 3-42.

McKay, C. and Pickens, M. (2010), "Branchless banking 2010: who's served? At what price? What next?", CGAP Focus Note 66, CGAP, London.

Maicas, J.P., Polo, Y. and Sese, F.J. (2009), "The role of (personal) network effects and switching costs in determining mobile users' choice", *Journal of Information Technology*, Vol. 24, pp. 160-171.

Malecki, E.J. and Ewers, M.C. (2007), "Labor migration to world cities: a research agenda for the Arab Gulf", *Progress in Human Geography*, Vol. 31, pp. 467-484.

Mankiw, N.G., Romer, D. and Weil, D. (2002), "A contribution to the empirics of economic growth", *Quarterly Journal of Economics*, Vol. 107, pp. 407-437.

Mas, I. and Radcliffe, D. (2010), "Mobile payments go viral: M-PESA in Kenya", in Chuhan-Pole, P. and Angwafo, M. (Eds), *Yes Africa Can: Success Stories in a Dynamic Continent*, The World Bank, Washington, DC.

Mehrotra, A. and Yetma, J. (2015), "Financial inclusion – issues for central banks", *BIS Quarterly Review*, pp. 83-96.

Meyer, J. (2014), "Latin America and mobile banking", available at: http://borgenproject/org/latin-america-mobile-banking/

Mishkin, F. (2006), "Monetary policy strategy: how did we get here?", NBER Working Paper 12515, NBER, Cambridge, MA.

Naithani, P. and Jha, A.N. (2010), "Challenges faced by expatriate workers in Gulf Cooperation Council countries", *International Journal of Business and Management*, Vol. 5, pp. 98-103.

Norton, S.W. (1992), "Transaction costs, telecommunications and the microeconomics of macroeconomic growth", *Economic Development and Cultural Change*, Vol. 41, pp. 175-196.

OECD (2008), *Handbook on Constructing Composite Indicators: Methodology and User Guide*, OECD, Paris, pp. 35-50.

Pearce, D. (2011), "Financial inclusion in the Middle East and North Africa", Policy Research Working Paper 5610, The World Bank, Washington, DC.

Qiang, C., Rossotto, C. and Kimura, K. (2009), "Economic impact of broadband", *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, The World Bank, Washington, DC, pp. 35-50.

Rodrik, D. (1998), *Who Needs Capital Account Convertibility? Essays in International Finance 207*, Princeton University Press, Upper River Saddle, NJ.

Roeller, L. and Waverman, L. (2001), "Telecommunications infrastructure and economic development: a simultaneous approach", *American Economic Review*, Vol. 90, pp. 897-909.

Rojas-Suarez, L. (2010), "Access to financial services in emerging powers", OECD Global Development Background Paper, OECD, Paris.

Romer, P. (1986), "Increasing returns and long run growth", *Journal of Political Economy*, Vol. 94, pp. 1002-1037.

Romer, P. (1990), "Endogenous technological change", *Journal of Political Economy*, Vol. 98, pp. S71-S110.

Rossotto, C.M., Sekkat, K. and Varoudakis, A. (2005), "Opening up telecommunications to competition and MENA integration in the world economy", *Journal of International Development*, Vol. 17, pp. 931-955.

Sarma, M. and Pais, J. (2011), "Financial inclusion and development", *Journal of International Development*, Vol. 23, pp. 613-628.

Sridhar, K.S. and Sridhar, V. (2004), "Telecommunications infrastructure and economic growth: evidence from developing countries", National Institute of Public Finance and Policy Working Paper 14, NIPFP, New Delhi.

Stiroh, K.J. (2004), "Diversification in banking: is non-interest income the answer?", *Journal of Money, Credit, and Banking*, Vol. 36, pp. 853-882.

Stuart, G. and Cohen, M. (2011), *Cash in, Cash Out: The Role of M-PESA in the Lives of Low-Income People*, Financial Services Assessment, College Park, MD.

Tohamy, S. (2002), "Case study of Egypt's service liberalization, service barriers and implementation of GATS agreement", Working Paper No. 121, The Egyptian Center for Economic Studies, Cairo.

Torero, M., Chowdhury, S. and Bedi, A.S. (2002), "Telecommunications infrastructure and economic growth: a cross-country analysis", *Information and Communications Technology for Development and Poverty Reduction*, Johns Hopkins University Press, Baltimore, MD, pp. 21-63.

Waverman, L., Meschi, M. and Fuss, M. (2005), "The impact of telecoms on economic growth in developing countries", *Vodafone Policy Paper Series*, Vol. 2, pp. 10-23.

World Bank (1993), *World Development Report*, The World Bank, Washington, DC.

World Bank (2011), *Global Findex Database*, The World Bank, Washington, DC.

World Bank (2012), *World Development Indicators*, The World Bank, Washington, DC.

World Bank (2014a), *Global Financial Development Report (Financial Inclusion*), The World Bank, Washington, DC.

World Bank (2014b), *Updated Income Classifications*, available at: http://data.worldbank.org/news/2015-country-classifications

Zellner, A. and Theil, H. (1962), "Three-stage least squares: simultaneous estimation of simultaneous equations", *Econometrica*, Vol. 30, pp. 54-78.

Further reading

Groupe Speciale Mobile Association (2015), *The Mobile Economy: Arab States 2015*, GSMA, London.

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