Effects of the Interaction between Financial Development and Information and Communications Technology on Economic Growth in the Arab Region

Jamel Jouini

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These economic studies are the product of the staff of the Economic Department at the AMF. The AMF publishes these studies which survey issues pertinent to monetary, fiscal, banking, trade and capital market policies and their impact on Arab economies.

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Abstract

The study examines the effects of the interaction between financial development and ICT diffusion on economic growth by controlling for three auxiliary variables, namely investment, labor force, and trade openness for a set of 15 Arab countries over the 2001-2018 period based on the Seemingly Unrelated Regressions (SUR) approach in the framework of panel data models.

The study results are aligned with expectations and show evidence of positive and significant responses of economic growth to information and communications technology (ICT) diffusion through financial development for the considered panel of Arab economies, with the effects being different across ICT indicators. Indeed, an increase of one unit in the proxy that measures the interaction between financial development and ICT diffusion generates an increase of 0.024 unit in economic growth when proxying ICT by the number of individuals using the Internet (as a percentage of population), and an increase of 0.014 unit in economic growth when proxying ICT by the number of mobile cellular subscriptions (per 100 people). In addition, investment, labor force, and trade openness are found to be relevant drivers of economic growth, as a rise in these conventional determinants leads to increase economic growth.

The research outcomes point to the necessity of supporting the use of modern financial technologies and boosting the transition to digital

financial services through the use of the available infrastructure (communication services and the Internet) in order to enhance the contribution of the interaction between financial development and ICT diffusion in generating economic growth.

Introduction

The well-performing developing and developed economies have witnessed tremendous and rapid changes and transformations in recent years due to the high ICT diffusion, thus affecting positively economic growth (see Sassi and Goaied, 2013; Das et al., 2018; Pradhan et al., 2018; and Alimi and Adediran, 2020). In this context, Vu (2011) argues that ICT plays a crucial role in increasing economic activity by generating more demand for goods and services and by decreasing production costs.

Theoretical developments outline that economic growth reacts positively to the changes in the financial system and ICT diffusion, but empirical studies in the related literature have displayed mixed findings. We continue in the same momentum of empirical studies by examining the interaction between financial system and ICT to check whether ICT diffusion strengthens the responses of economic growth to the fluctuations in the financial system in the Arab region. It is worth noting that the study of the effects of financial development and ICT diffusion on economic growth in the Arab countries is an attractive issue given that some of them almost witnessed a boom in the spread of ICT, which contributes to enhancing their financial system.

The study is conducted by using the SUR procedure to estimate a panel data model for a group of 15 Arab countries over the 2001-

2018 period.[1] In addition to financial development and ICT indicators, we include investment, labor force, and trade openness into the model to shed light on other drivers through which the interaction between the financial system and ICT diffusion may influence economic growth. Accordingly, considering a more generalized model allows us to avoid biased estimations and, thus, to assess accurately how economic growth reacts to the interaction between financial development and ICT diffusion, thus providing important policy implications for decision-makers in the Arab region.

The obtained results point to the positive and significant responses of economic growth to the interaction between financial development and ICT diffusion. Additionally, the auxiliary variables, namely investment, labor force, and trade openness affect positively and significantly economic growth. Overall, the findings provide relevant economic implications for policymakers of the selected set of countries.

The remainder of the study is structured as follows. Section 1 reviews related empirical works in the field. Section 2 introduces the model and estimation issues. The empirical results are discussed in Section

[1] The choice of the study period is dictated by the availability of the financial development index determined by the International Monetary Fund.

3. Concluding remarks and policy implications are provided at the end of the study.

1. Literature review

Empirical studies related to the relationship between ICT, financial system and economic growth have been intensified given the development of e-finance technologies. In this context, Beil et al. (2005) employ Granger-Sims causality tests to investigate the links between telecommunications investment and economic growth in the United States over a period of 50 years. The results show evidence of causality running only from economic activity to investment by telecommunications firms, thus suggesting that policies aimed at boosting economic activity by hastening telecommunications investment may not be successful in the United States.

Shamim (2007) makes use of the generalized method of moments (GMM) technique to investigate the linkages between e-finance technologies and economic growth for a set of 61 economies, characterized by heterogeneous level of financial development over the period from 1990 to 2002. The findings reveal that high level of connectivity, manifested by increases in the number of mobile cellular subscribers and the number of individuals using the Internet, boosts financial system and, thus, economic growth. As for practical implications of the results, the study recommends developing countries with weak financial system invest in ICT.

Koutroumpis (2009) examines the responses of economic growth to broadband penetration by estimating a macroeconomic production function for a set of 22 OECD economies over the period from 2002 to 2007. The findings conclude in favor of a significant and positive causality, especially when a critical mass of infrastructure is present. Andrianaivo and Kpodar (2011) examine whether financial inclusion is a channel through which ICT enhances economic growth for a sample of 44 African economies over the 1988-2007 period. The system GMM estimators reveal that mobile phone penetration affects significantly and positively economic growth, and that part of this impact comes from greater financial inclusion.

Dahl et al. (2011) show evidence of positive and significant effects of ICT on productivity growth in Europe after 1995 based on a multi-country sectoral panel data set. This outcome challenges the consensus in the related literature that the bad performance of ICT-using sectors does not boost productivity growth in Europe. Ahmed and Ridzuan (2013) apply panel testing and estimation procedures to explore the empirical evidence of the relationship between telecommunications investment and output growth for ASEAN5+3 economies over the period from 1975 to 2006. The results outline that telecommunications investment is a relevant driver of economic growth in the considered set of countries.

Chavula (2013) employs the Barro's (1991) endogenous growth model to examine the effects of mobile, fixed telephone main lines and the Internet use on per capita income for a set of 49 African economies. The findings reveal that people's living standards are significantly caused by telephone main lines and mobile telephony, whereas the Internet use is not a significant driver of economic growth. It is also found that fixed telephony, mobile telephony and the Internet use influence significantly economic activity in the upper-middle-income economies, while only mobile telephone penetration enhances significantly output growth in both the upper-low-income and the low-income economies. Another striking feature is that the mobile growth impact is the greatest among the country groups.

Sassi and Goaied (2013) assess empirically the joint effect of ICT and financial system on economic growth in MENA economies by estimating a dynamic panel data model by the system GMM procedure. The findings reveal a negative impact of financial development on economic growth, a positive and significant influence of ICT on economic growth, and positive and significant interactions between ICT penetration and financial development. These results imply that for MENA countries, a threshold of ICT development is required to benefit from financial development.

Hanclova et al. (2015) apply the panel general least squares method to estimate the Cobb-Douglas production function to assess the effects of labor, ICT capital services and non-ICT capital services on economic growth in European countries over the 1994-2000 and 2001-2008 periods due to changes in ICT capital development. The results indicate that the slower non-ICT capital growth and the stagnated ICT capital growth cause drops in economic growth. Pradhan et al. (2015) opt for Granger-causality in the context of panel vector autoregressive models to study the connection between ICT, financial development and economic growth for a set 21 Asian economies over the 2001-2012 period. The results show evidence of short-run and long-run causal links between ICT, financial development and economic growth.

Salahuddin and Gow (2016) investigate the ICT-growth nexus in South Africa over the 1991–2013 period based on time series testing and estimation methods. The results reveal positive and significant linkages between ICT, financial development and economic growth over the long-run. The study recommends that policymakers invest more resources in ICT to further enhance output growth. Das et al. (2018) opt for the system GMM technique in the context of dynamic panel data models to study empirically how economic growth reacts to the changes in ICT and financial system for a set of 43 developing economies (low-income countries and lower middle-income countries) over the 2000-2014 period. The results point out that for

the full panel of countries, ICT affects positively and significantly economic growth, and that this direct effect is achieved because of development of the financial system. They also reveal that the ICT-finance joint impact on economic growth is positive in low-income economies but insignificant in lower middle-income economies. The results provide important policy implications for developing countries, which face the challenges of allocating more resources to boost ICT.

Niebel (2018) investigates the ICT-growth nexus for a sample of 59 economies over the 1995-2010 period based on panel data regressions. The results show evidence of no significant differences in the responses of output growth to ICT penetration across developing, emerging and developed economies. Pradhan et al. (2018) examine the effects of ICT on economic growth in the G20 economies over the 2001–2012 period using panel data testing and estimation procedures. The findings indicate that ICT enhances economic growth in the considered countries. Ahmed and Adediran (2020) assess the role of ICT in the finance–growth nexus in the ECOWAS (Economic Community of West African States) region over the 2005–2016 period by opting for the pooled mean group estimator in the context of dynamic panel autoregressive-distributed lag models. The results indicate that financial development impedes economic growth in the ECOWAS region, but its interaction with ICT enhances growth. The implication of the results is that

ECOWAS countries should invest more in ICT infrastructure to develop financial system.

2. Model and estimation issues

We assess the responses of economic growth to the interaction between financial development and ICT diffusion by controlling for three relevant drivers into the model. Practically, we propose the following paned data model:

$$GR_{it} = \alpha_0 + \alpha_1 FD_{it} + \alpha_2 ICT_{it} + \alpha_3 FICT_{it} + \alpha_4 INV_{it} + \alpha_5 LF_{it} + \alpha_6 TO_{it} + u_{it} \quad (1)$$

where the cross-section index i refers to the country, the time-dimension index t refers to the time period for each country, GR_{it} is the real gross domestic product (constant 2010 US$) growth rate, FD_{it} is the financial development index,[2] ICT_{it} is the ICT indicator,[3] $FICT_{it}$ is the interaction between financial development and ICT

[2] We consider the financial development index determined by the International Monetary Fund to provide a relative ranking of countries on the depth, access, and efficiency of their financial markets and financial institutions.

[3] We make use of two proxies for ICT, namely individuals using the Internet as a percentage of population (INT_{it}), and mobile cellular subscriptions (per 100 people) (MOB_{it}).

diffusion,[4] INV_{it} is the investment proxied by the gross fixed capital formation as a share of GDP, LF_{it} is the labor force participation rate proxied by the proportion of the population ages 15-64 that is economically active, TO_{it} is the trade openness measured by the sum of exports and imports of goods and services as a percentage of GDP, and u_{it} is the error term.

We consider annual data for a panel of 15 Arab countries, namely Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Tunisia, and the United Arab Emirates (UAE)[5] over the 2001-2018 period[6]. Data on the financial development index are gathered from the International Monetary Fund database, while data on all the other variables are collected from the World Development Indicators database published by the World Bank.

We employ the SUR procedure to estimate the above panel data model. This procedure can be applied in case of dependence between countries and when the cross-section dimension N is smaller than the

[4] The interaction between financial development and ICT diffusion is proxied by $FICT_{it} = FD_{it} \times INT_{it}$ and $FICT_{it} = FD_{it} \times MOB_{it}$.

[5] The evolutions of the time-varying patterns of growth rate, financial development index, and ICT proxies across all countries are reported in Figures 1-4.

[6] The sample period is long enough to assess the relationship between economic growth and the interaction between financial development and ICT diffusion in the panel data framework.

time series dimension T. The cross-country dependence can be checked by conducting the CD test of Pesaran (2004) that is normally distributed under the null hypothesis of no cross-section dependence, and has satisfactory sample properties even for small N and T.

3. Analysis of the results

We first report results from the estimation of two versions of the model given by Eq. (1) without the interaction between financial development and ICT diffusion ($\alpha_3 = 0$). Indeed, ICT is proxied by individuals using the Internet as a percentage of population (i.e. $ICT_{it} = INT_{it}$) in the first model, and by mobile cellular subscriptions (per 100 people) (i.e. $ICT_{it} = MOB_{it}$) in the second model. We second report results from the estimation of two versions of the model given by Eq. (1). Indeed, the interaction between financial development and ICT diffusion is proxied by $FICT_{it} = FD_{it} \times INT_{it}$ in the third model, and by $FICT_{it} = FD_{it} \times MOB_{it}$ in the fourth model.

3.1. Descriptive analysis

The summary statistics reported in Table 1 indicate that the UAE experience the highest average of the Internet use and mobile cellular subscriptions (63.24 and 133.13) followed by Bahrain (55.59 and 118.32), which may be due to the high ICT diffusion in the Gulf Cooperation Council (GCC) countries. These average values are

greater than those experienced for the full panel of countries (33.40 and 85.14). Additionally, six out of fifteen countries experience relatively high level of financial development whose average exceeds 0.40.

The values by country of the empirical correlations displayed in Table 2 indicate that for eight out of fifteen countries, growth rate is negatively correlated to financial development. All countries, except Libya and Oman (Oman and Saudi Arabia), experience negative connection between growth rate and the Internet use (mobile subscriptions). Additionally, growth rate is negatively correlated to the interaction between financial development and ICT diffusion for almost all Arab economies. For the full set of countries, growth rate is positively and weakly linked to financial development, and negatively and weakly correlated to ICT diffusion, and the interaction between financial development and ICT. These insights are not conclusive concerning the responses of economic growth to the interaction between financial development and ICT diffusion, thus appealing us to conduct an in-depth analysis of the relationship between these variables based on the above model and estimation issues to achieve the required objectives.

3.2. Effects of financial development and ICT diffusion on economic growth

We start by checking the applicability of the SUR procedure to estimate the considered panel data model. Indeed, the CD test rejects the null hypothesis for all models (CD = 4.571 in the first model, CD = 5.919 in the second model, CD = 4.577 in the third model, and CD = 5.885 in the fourth model), thus leading to cross-country dependence, which may be explained by the economic links and common characteristics about economic policy across the Arab economies. This dependence between countries, together with $N = 15 < T = 18$, allow employing the SUR procedures to assess the reactions of economic growth to the interaction between financial development and ICT diffusion by controlling for auxiliary variables in the models.

The estimate results presented in Table 3 indicate that for all models, economic growth reacts positively and significantly to the changes in financial development, as evidenced by the associated coefficient estimates. Indeed, an increase of one unit in financial development generates an increase of 4.110, 2.209, 3.825, and 3.169 units in economic growth for models 1, 2, 3, and 4, respectively. When neglecting the joint effect of financial development and ICT diffusion, the estimate results of models 1 and 2 reveal that ICT diffusion exerts a positive and significant effect on economic growth,

with the effect of the Internet use being greater than the effect of mobile subscriptions. Indeed, an increase of one unit in the Internet use leads to an increase of 0.062 unit in economic growth, while an increase of one unit in mobile subscriptions leads to an increase of 0.026 unit in economic growth.[7]

When taking into account the interaction between financial development and ICT diffusion, the estimate results of models 3 and 4 show that the impact of ICT diffusion on economic growth is still statistically significant, but it becomes negative. However, the joint effect of financial development and ICT diffusion on economic growth is statistically significant and positive, suggesting that ICT diffusion affects positively economic growth through financial development.[8] Indeed, an increase of one unit in the interaction between financial development and the Internet use leads to an increase of 0.024 unit in economic growth, while an increase of one unit in the interaction between financial development and mobile subscriptions leads to an increase of 0.014 unit in economic growth. Therefore, the responses of economic growth to the interaction

[7] Waverman et al. (2005) outline that in the low-income economies, an average of 10 additional mobile cellular phones per 100 people would rise per capita GDP growth by approximately 0.59%.

[8] The research findings are aligned with those of Das et al. (2018) who find that the direct effect of ICT penetration on economic growth is mainly through financial development in developing economies.

between financial development and ICT diffusion differ across ICT indicators.

The results also reveal that investment and labor force in all models as well as trade openness in models 2 and 4 are relevant drivers of economic growth for the selected set of countries over the study period, as the associated coefficients are statistically significant and positive.

The research outcomes are aligned with expectations and may be plausibly explained by many economic factors. Indeed, the positive effects of the interaction between financial development and ICT diffusion on economic growth may be supported by the development of the financial sector and ICT in many Arab countries due to the regulations implemented in these countries. Investment and labor force are key drivers of economic activity, which may explain the positive reactions of economic growth to the changes in both determinants. The positive sensitivity of economic growth to trade openness may be explained by the fact that many Arab countries are open economies and attract high-tech, thus boosting economic activity. Overall, the obtained outcomes may help policymakers in the Arab region make relevant policies for enhancing economic activity.

Conclusion and policy implications

The study explores the empirical evidence of the relationship between economic growth and the interaction between financial development and ICT diffusion as well as three drivers of the economic activity, namely investment, labor force, and trade openness for a panel of 15 Arab economies over the 2001-2018 period by opting for the SUR procedure in the framework of panel data models.

The findings are in line with expectations and reveal that economic growth reacts positively to the interaction between financial development and ICT diffusion, a finding that may be explained by the development of the financial sector and the adoption of digital transformation in many Arab countries. The reactions of economic growth to the interaction between financial development and ICT penetration differ across ICT proxies. The results also indicate that investment, labor force, and trade openness exert significant and positive effects on economic growth, which is expected, as they are considered the conventional drivers of economic activity.

The outcomes provide relevant economic implications for the Arab policymakers. Indeed, governments could strengthen the regulatory and legislative rules to support the use of modern financial technologies, and provide the appropriate infrastructure to support the transition to digital financial services. They could also promote

digital financial transformation and increase reliance on digital financial services by making use of the available infrastructure (communication services and the Internet) to develop the financial and banking services and deliver them to beneficiaries in safe, fast and easy ways. Overall, enhancing the interaction between financial development and ICT diffusion by these actions could play an important role in achieving inclusive and sustainable economic growth.

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Table 1. Summary statistics

Country	GR	FD	INT	MOB
Algeria				
Mean	3.40	0.14	17.88	69.84
Std. Dev.	1.59	0.01	17.61	44.27
Bahrain				
Mean	4.52	0.44	55.59	118.32
Std. Dev.	1.93	0.03	34.08	51.20
Egypt				
Mean	4.22	0.34	21.50	60.64
Std. Dev.	1.66	0.05	14.73	44.11
Jordan				
Mean	4.60	0.47	30.10	76.62
Std. Dev.	2.50	0.07	21.87	40.49
Kuwait				
Mean	3.66	0.44	50.26	113.44
Std. Dev.	5.99	0.07	30.28	63.04
Lebanon				
Mean	3.80	0.30	39.06	44.04
Std. Dev.	3.46	0.02	29.40	22.39
Libya				
Mean	5.56	0.14	10.58	89.71
Std. Dev.	34.89	0.01	7.63	64.59
Mauritania				
Mean	3.83	0.10	6.01	59.48
Std. Dev.	4.54	0.01	7.31	38.95

Table 1 - bis. Summary statistics

Country	GR	FD	INT	MOB
Morocco				
Mean	4.33	0.32	34.65	78.03
Std. Dev.	1.65	0.03	23.75	44.23
Oman				
Mean	3.36	0.37	36.84	101.19
Std. Dev.	3.20	0.04	30.38	57.81
Qatar				
Mean	9.55	0.53	53.60	100.11
Std. Dev.	7.68	0.04	34.19	40.76
Saudi A.				
Mean	3.55	0.42	39.75	112.63
Std. Dev.	3.91	0.06	28.86	65.52
Sudan				
Mean	4.74	0.09	12.39	38.82
Std. Dev.	3.67	0.02	11.23	32.24
Tunisia				
Mean	3.18	0.21	29.50	81.10
Std. Dev.	2.03	0.03	20.58	47.07
UAE				
Mean	4.01	0.43	63.24	133.13
Std. Dev.	3.54	0.09	26.73	52.70
Full panel				
Mean	4.413	0.32	33.40	85.14
Std. Dev.	9.584	0.15	29.07	54.67

Table 2. Correlations between economic growth, and financial development and ICT diffusion

Country	FD	INT	MOB	FD*INT	FD*MOB
Algeria	-0.482	-0.496	-0.622	-0.496	-0.627
Bahrain	0.578	-0.497	-0.270	-0.470	-0.195
Egypt	0.651	-0.004	-0.235	0.166	-0.085
Jordan	0.853	-0.751	-0.588	-0.705	-0.368
Kuwait	-0.282	-0.459	-0.361	-0.477	-0.395
Lebanon	0.279	-0.505	-0.385	-0.482	-0.335
Libya	-0.172	0.003	-0.038	-0.027	-0.066
Mauritania	0.286	-0.116	-0.120	-0.114	-0.110
Morocco	-0.470	-0.492	-0.477	-0.502	-0.489
Oman	0.253	0.114	0.385	0.095	0.395
Qatar	0.305	-0.419	-0.231	-0.373	-0.149
Saudi A.	-0.194	-0.131	0.097	-0.146	0.044
Sudan	-0.152	-0.624	-0.638	-0.592	-0.611
Tunisia	-0.546	-0.485	-0.397	-0.489	-0.453
UAE	-0.343	-0.230	-0.225	-0.290	-0.295
Full panel	0.045	-0.076	-0.063	-0.045	-0.021

Table 3. SUR estimate results

Exp. variable	Model 1	Model 2	Model 3	Model 4
FD	4.110***	2.209***	3.825***	3.169***
	(0.635)	(0.501)	(0.677)	(0.638)
ICT	0.062***	0.026***	-0.070***	-0.021***
	(0.002)	(0.001)	(0.008)	(0.003)
FD*ICT	-	-	0.024***	0.014**
			(0.003)	(0.006)
INV	0.022***	0.054***	0.027***	0.047***
	(0.008)	(0.007)	(0.009)	(0.007)
LF	0.076***	0.063***	0.076***	0.063***
	(0.006)	(0.005)	(0.006)	(0.006)
TO	0.004	0.010***	0.004	0.009***
	(0.003)	(0.002)	(0.003)	(0.002)

Notes: Model 1 includes financial development and the Internet users as a percentage of population, as well as the control variables; Model 2 includes financial development and mobile cellular subscriptions (per 100 people), as well as the control variables; Model 3 includes financial development, the Internet users as a percentage of population, and the interaction between financial development and ICT diffusion, as well as the control variables; and Model 4 includes financial development, mobile cellular subscriptions (per 100 people), and the interaction between financial development and ICT diffusion, as well as the control variables. The value in parentheses is the standard deviation. *** and ** denote significance at the 1% and 5% levels, respectively.

Figure 1. Evolution of economic growth over the 2001-2018 period

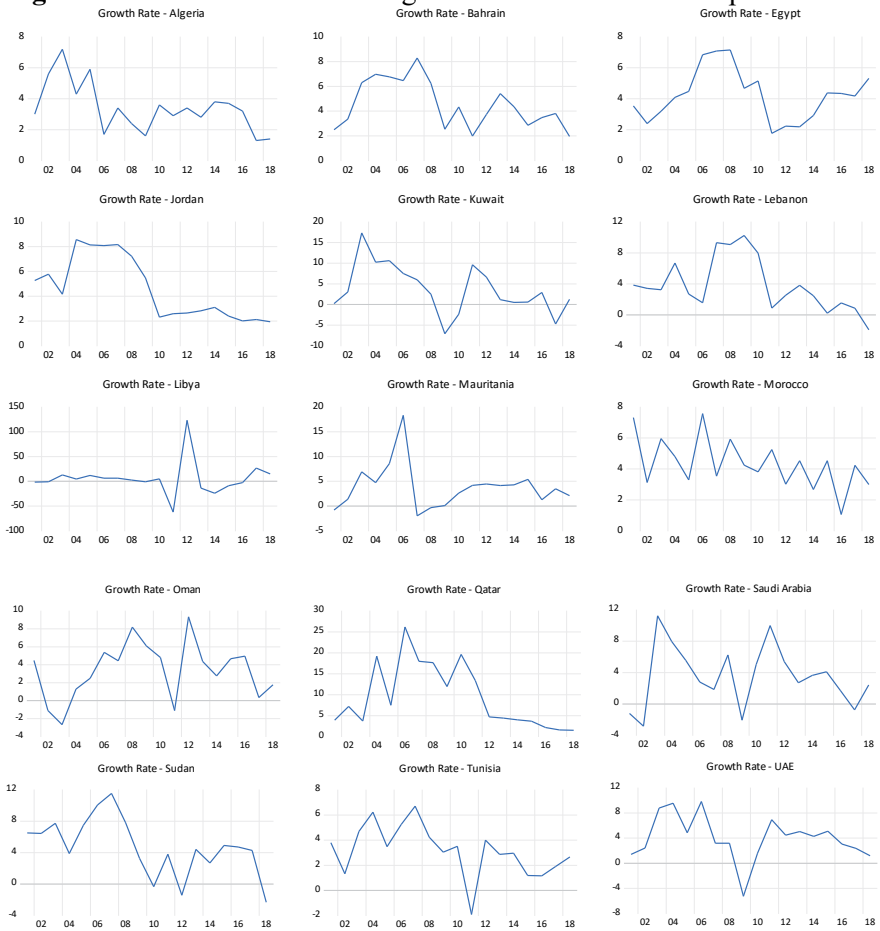


Figure 2. Evolution of the financial development index over the 2001-2018 period

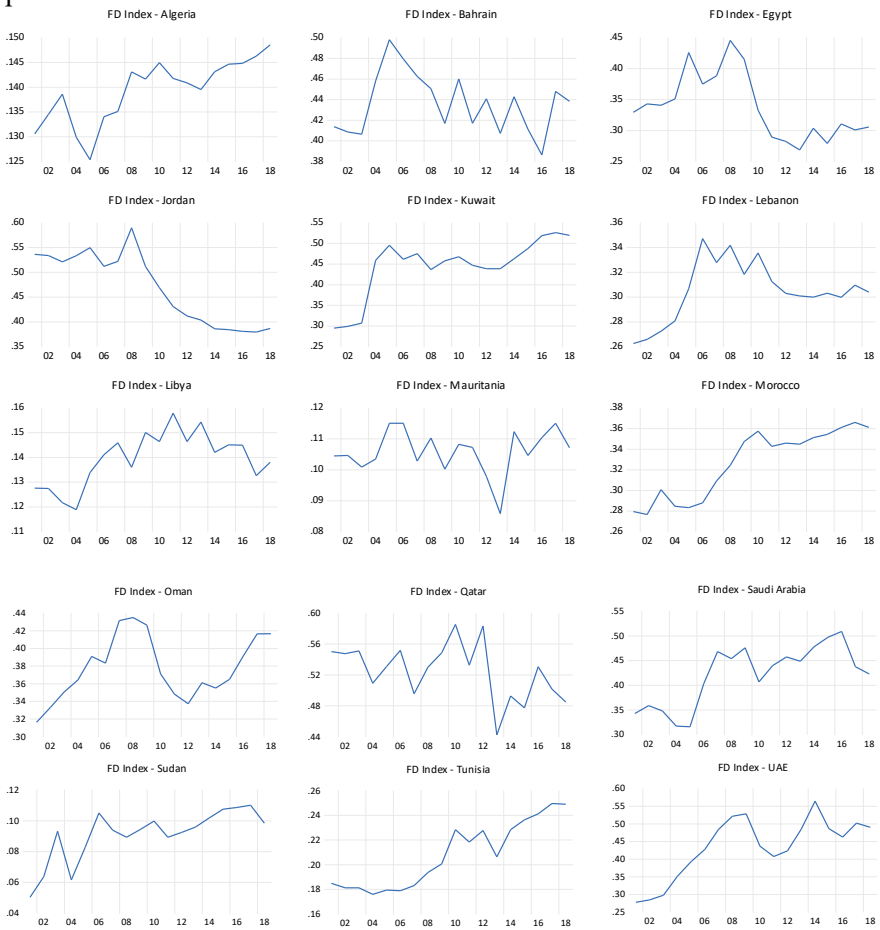


Figure 3. Evolution of the Internet users as a percentage of population over the 2001-2018 period

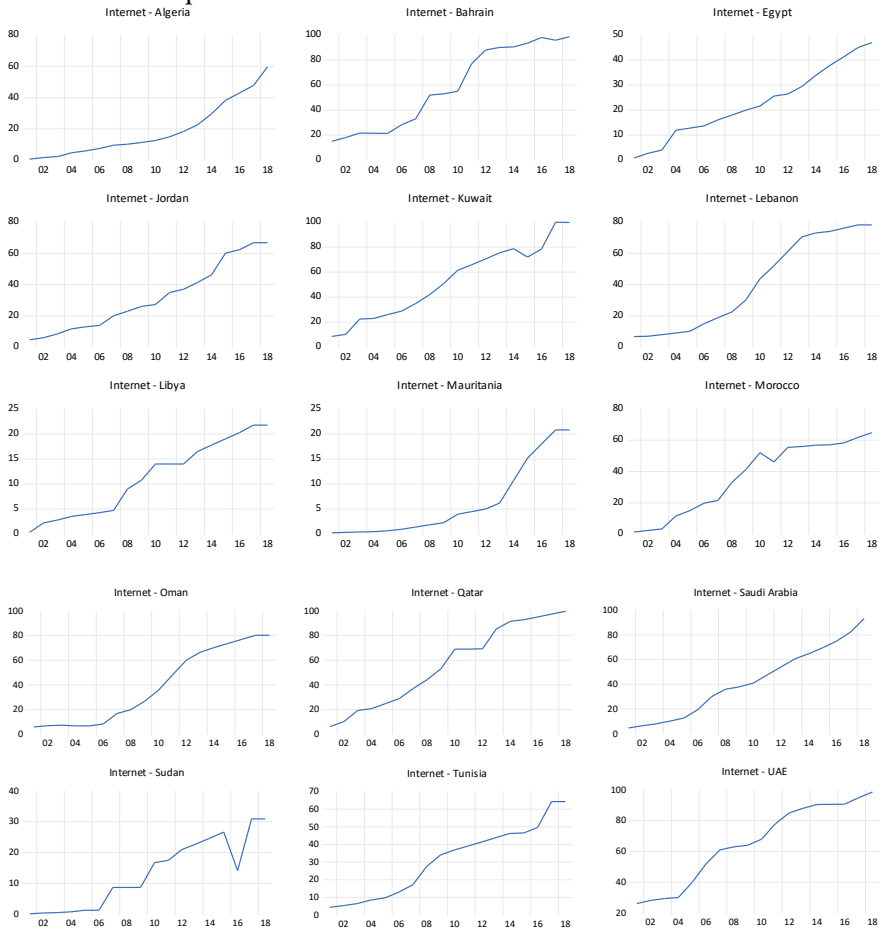
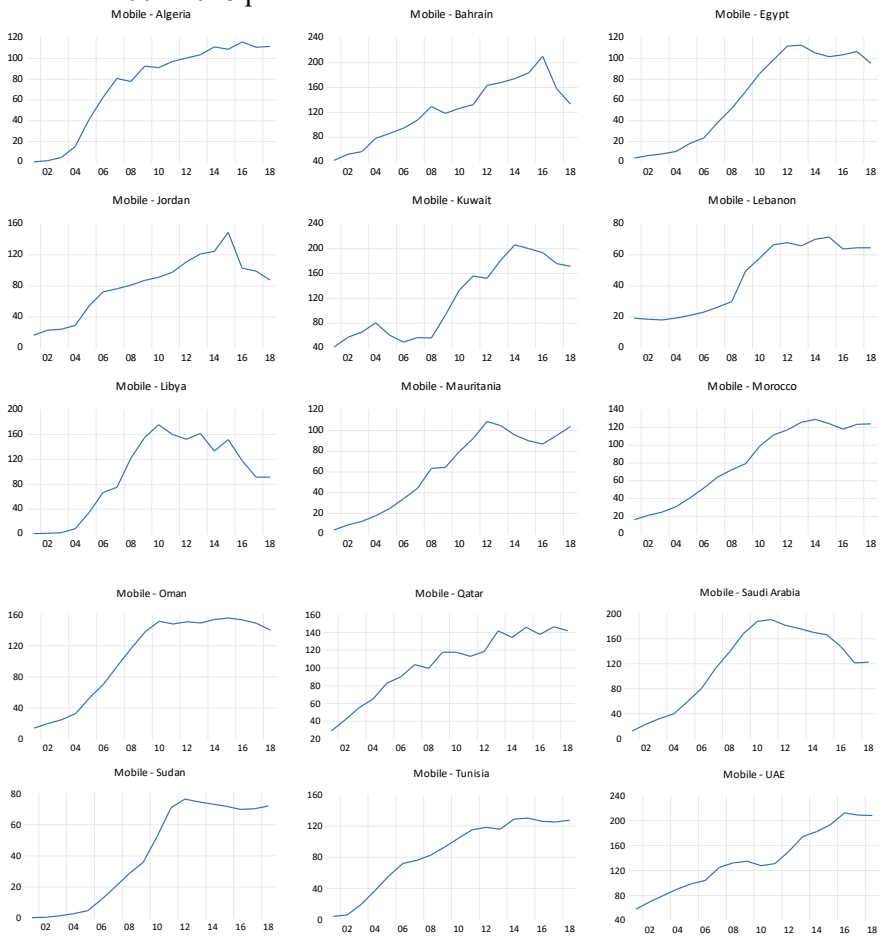


Figure 4. Evolution of the mobile cellular subscriptions (per 100 people) over the 2001-2018 period



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