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Effects of the Information and Communications Technology on Labor Productivity in the Arab Region

Jamel Jouini

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Abstract

The study investigates the responses of labor productivity to the fluctuations in three Information and Communications Technology (ICT) indicators by controlling for auxiliary drivers, namely trade openness, investment, and government expenditures for a set of 13 Arab economies over the 2000-2019 period based on the Seemingly Unrelated Regressions (SUR) approach in the framework of panel data models.

The research findings are aligned with expectations and indicate that labor productivity responds significantly and positively to the changes in all ICT indicators and auxiliary determinants for the panel of Arab countries over the study period. Indeed, the results reveal that the fixed telephone use enhances labor productivity more than the Internet access and the mobile cellular subscriptions that have slight impacts. It is also found that trade openness, investment, and government expenditures are more influential in affecting positively labor productivity than the Internet and mobile use. By cons, the responses of labor productivity to the fixed telephone use are more important than the responses to the changes in the auxiliary drivers. The results provide relevant policy implications for the decision-makers to enhance the efficiency of ICT in boosting labor productivity in the Arab region.

Introduction

The analysis of the reactions of economic aggregates to the changes in ICT[1] has received an increasing attention from researchers during the last decades, due to the spread of the ICT in the early 1990s. Using the ICT effectively may reduce the production costs and enhance labor productivity, thus increasing economic efficiency in the economy. Labor productivity is an important factor in the economy, as it is considered a revealing factor of many economic variables. It is also an explanatory indicator of the main economic foundations required for economic growth and social development (see OECD, 2001). In this context, we investigate the relationship between ICT and labor productivity in the Arab region, given the relatively massive use of ICT in such a region, especially in the Gulf Cooperation Council (GCC) countries, thereby allowing decision-makers to undertake pertinent policies in order to enhance the efficiency of ICT in boosting labor productivity.

[1] ICT may be proxied by telecommunications investment, ICT spending and production, ICT capital services, number of individuals using the Internet, number of fixed broadband subscriptions, number of secure Internet servers, number of fixed telephone subscriptions, number of mobile cellular subscriptions, number of personal computers, etc. (see Shamim, 2007; Koutroumpis, 2009; Andrianaivo and Kpodar, 2011; Ahmed and Ridzuan, 2013; Najarzadeh et al., 2014; Hanclova et al., 2015; Das et al., 2018; Alimi and Adediran, 2020; among others).

The study is conducted in the framework of panel data models for a set of 13 Arab economies over the 2000-2019 period. In addition to the ICT indicators, we include trade openness, investment, and government expenditures into the model to highlight the responses of labor productivity to the fluctuations in other determinants. This allows us dealing with a more generalized model to avoid biased outcomes and, hence, to assess accurately how labor productivity responds to the changes in ICT by controlling for auxiliary variables. Therefore, relevant policy implications may be provided for policymakers in the Arab region to improve the influence of ICT on labor productivity.

The obtained results are aligned with expectations. Specifically, they reveal that labor productivity responds significantly and positively to the changes in ICT proxied by the Internet access, the mobile cellular use, and the fixed telephone subscriptions for the panel of Arab countries over the study period. In this context, the fixed telephone use boosts labor productivity more than the Internet access and the mobile use that exert weak effects. The results also indicate that trade openness, investment, and government expenditures have the power to significantly and positively affect labor productivity. A striking feature is that the auxiliary variables are more influential in affecting positively labor productivity than the Internet and mobile use. However, the reactions of labor productivity to the fixed telephone use are more important than the reactions to the fluctuations in the auxiliary determinants for the considered panel of Arab economies

over the study period. The outcomes provide relevant policy implications for the Arab policymakers to enhance the efficiency of ICT in improving labor productivity.

The remainder of the study is structured as follows. Section 1 presents a brief literature review in the field. Section 2 introduces the model and estimation issues. Section 3 analyzes the estimate results. Concluding comments and policy implications are introduced at the end of the study.

1. Literature review

Many empirical studies have been undertaken in the literature on the relationship between ICT and various economic aggregates in developed and developing economies. Indeed, Beil et al. (2005) reveal that for the United States over a period of 50 years, telecommunications investment does not exert any effect on economic growth. Belorgey et al. (2006) show that ICT determinants exert a significant and positive effect on labor productivity for many set of economies in the 1990s. Noh and Yoo (2008) find that the Internet use does not have the power to predict economic growth for economies with high–income inequalities over the 1995-2002 period. Choi and Yi (2009) reveal that economic growth reacts significantly and positively to the fluctuations in the Internet use for a set of 207 countries over the 1991-2000 period.

Koutroumpis (2009) finds that a significant and positive causality between broadband penetration and economic growth for a panel of 22 OECD countries over the 2002-2007 period. Andrianaivo and Kpodar (2011) indicate that economic growth responds significantly and positively to the changes in the mobile phone penetration for a set of 44 African countries over the 1988-2007 period. Dahl et al. (2011) reveal positive and significant impacts of ICT on productivity growth in Europe after 1995. Ceccobeli et al. (2012) provide evidence of significant and positive linkages between ICT capital and labor productivity for a sample of 14 OECD economies over the 1995-2005 period. Ahmed and Ridzuan (2013) find that output growth reacts significantly and positively to the fluctuations in telecommunications investment for ASEAN5+3 countries over the 1975-2006 period.

Chavula (2013) reveals that fixed telephony, mobile telephony, and the Internet use are relevant drivers of economic growth in the upper-middle-income economies of the sample of 49 African countries. However, only mobile telephone penetration affects significantly and positively economic activity in the upper-low-income and the low-income countries. Sassi and Goaied (2013) show evidence of a positive and significant effect of ICT on economic growth in MENA countries. Najarzadeh et al. (2014) find that labor productivity is significantly and positively affected by the Internet use for a panel of 108 economies over the 1995-2010 period. Pradhan et al. (2015)

provide evidence of causal links between ICT and economic growth for a panel of 21 countries in Asia over the 2001-2012 period.

Salahuddin and Gow (2016) find a significant and positive relationship between ICT and economic growth in South Africa over the 1991–2013 period. Das et al. (2018) indicate that economic growth responds significantly and positively to the changes in ICT for a sample of 43 developing countries over the 2000-2014 period. Niebel (2018) reveals that the reactions of economic growth to ICT penetration do not relatively differ across developing, emerging, and developed economies for a set of 59 countries over the 1995-2010 period. Pradhan et al. (2018) find that ICT boosts economic growth in the G20 countries over the 2001–2012 period. Bakari and Tiba (2020) indicate that the Internet use affects significantly and negatively economic growth for a set of four North African economies over the 1995-2017 period.

2. Model and estimation issues

The study includes a panel of 13 Arab countries (Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Tunisia, and the United Arab Emirates (UAE)) over the 2000-2019 period.[2] We claim that the time series dimension (20 years), together with the cross–section dimension (13 countries), are

[2] Data are extracted from the World Development Indicators database published by the World Bank.

sufficient to conduct the study in the panel data framework. Specifically, the study examines the effect of ICT on labor productivity by controlling for auxiliary determinants into the following panel data model:

$$LP_{it} = \alpha_0 + \alpha_1 ICT_{it} + \alpha_2 TO_{it} + \alpha_3 INV_{it} + \alpha_4 GOV_{it} + \varepsilon_{it} \quad (1)$$

where $i = 1,2,\dots,N$ with $N = 13$ the number of countries, and $t = 1,2,\dots,T$ with $T = 20$ the sample size, LP_{it} is labor productivity measured by the Gross Domestic Product (GDP) per person employed (constant 2017 PPP $), ICT_{it} is proxied by three indicators, namely the individuals using the Internet (percentage of population), INT_{it}, the mobile cellular subscriptions (per 100 people), MOB_{it}, and the fixed telephone subscriptions (per 100 people), TEL_{it}, TO_{it} is the trade openness proxied by the sum of exports and imports as a share of GDP, INV_{it} is the investment measured by the gross fixed capital formation as a percentage of GDP, GOV_{it} is the general government final consumption expenditure as a percentage of GDP,[3] ε_{it} is the error term.

The variables are converted into natural logarithm, so the estimated coefficients represent the elasticities of labor productivity with respect to the ICT, the trade openness, the investment, and the government expenditures. The coefficient of the ICT is expected to

[3] Government expenditures are included in the analysis to highlight the influence of health and education expenditures on labor productivity.

be positive, as the ICT indicators allow spreading knowledge through the economy. Trade openness is expected to positively affect labor productivity, as international trade allows transferring advanced technologies. Investment is expected to enhance labor productivity through increasing capital stock per person employed. Government expenditures are expected to increase labor productivity, as investments in health and education may pay off for the economy.

The SUR approach is employed to estimate the above panel data model. This approach can be applied when the cross-section dimension N is lower than the time series dimension T and there is evidence of cross–country dependence. Such a dependence can be checked by applying the CD test of Pesaran (2004) that is normally distributed under the null hypothesis of no cross-country dependence, and has satisfactory sample properties even for small cross-section and time series dimensions.

3. Analysis of the results

3.1. Descriptive analysis

The evolution of labor productivity and ICT indicators across Arab countries is graphed in Figures 1-4. There is evidence of upward trends in the Internet use and, to a lesser extent, in the mobile cellular subscriptions, implying that the Arab countries experience permanent increases in the Internet and mobile use between 2000 and 2019. However, labor productivity and fixed telephone subscriptions

are characterized by downward trends in their patterns for some economies. Another feature of substantial importance is that countries perform differently in terms of labor productivity and ICT diffusion over the study period.

The descriptive statistics reported in Table 1 indicate that the GCC countries experience the highest average labor productivity followed by the other Arab countries, which may be explained by the high GDP in the GCC economies compared to the other Arab economies. As regards ICT, there is evidence of discrepancy in the averages and volatility of the indicators across Arab countries.

The correlation analysis displayed in Table 2 reveals evidence of mixed (positive and negative) correlation between labor productivity and ICT indicators across countries under study. For the full panel of economies, labor productivity is positively correlated to ICT proxies, as the correlation coefficient is equal to 0.189 for the Internet use, 0.259 for the mobile cellular subscriptions, and 0.759 for the fixed telephone use. The correlation values do not reflect causality between labor productivity and ICT indicators, leading us to conduct a meticulous analysis of such a causality based on the above model and estimation issues to achieve the study objectives.

3.2. Effects of ICT on labor productivity

We present results from the estimation of three versions of the above model given by Eq. (1). Indeed, ICT is proxied by the individuals

using the Internet (percentage of population) (i.e. $ICT_{it} = INT_{it}$) in the first model (Model 1), the mobile cellular subscriptions (per 100 people) (i.e. $ICT_{it} = MOB_{it}$) in the second model (Model 2), and the fixed telephone subscriptions (per 100 people) (i.e. $ICT_{it} = TEL_{it}$) in the third model (Model 3).

We first check the applicability of the SUR approach to estimate the three versions of the panel data model. Indeed, the CD test rejects the null hypothesis for all models (CD = 7.042 for Model 1, CD = 9.528 for Model 2, and CD = 25.589 for Model 3), thus leading to dependence between countries, which may be due to economic links and common characteristics about economic policy across the considered Arab countries. This cross-country dependence, together with $N = 13 < T = 20$, allow applying the SUR approach to assess the responses of labor productivity to the changes in ICT and the auxiliary determinants.

The estimate results reported in Table 3 reveal that all the estimated coefficients have the expected signs, as labor productivity reacts significantly and positively to the fluctuations in all ICT and auxiliary variables. In this context, the estimated coefficients of the main determinants in this study, the ICT indicators, are equal to 0.033 for the Internet use, 0.074 for the mobile cellular subscriptions, and 1.069 for the fixed telephone subscriptions. These estimates indicate that an increase of the Internet use, the mobile cellular subscriptions, and the fixed telephone subscriptions by 1% generates an increase of

labor productivity by 0.033%, 0.074%, and 1.069%, respectively. This outcome implies that a rise in the fixed telephone subscriptions increases labor productivity more than the Internet and mobile use that have slight effects, suggesting that the Arab economies under consideration have not yet reached the phase where the Internet access and the mobile use may affect labor productivity substantially compared to the fixed telephone use.

As regards the auxiliary determinants, an increase of trade openness, investment, and government expenditures leads to increase labor productivity, as the associated coefficients are positive and statistically significant at the 1% level.[4] It is worth noting that investment and government expenditures have almost the same effect on labor productivity, especially when using the Internet access and the mobile cellular subscriptions as ICT indicators. In terms of magnitude, it is clear that the conventional drivers, namely trade openness, investment, and government expenditures are more influential in affecting positively labor productivity than the Internet and mobile use. By cons, the third ICT indicator, namely the fixed telephone subscriptions, has the power to boost labor productivity more than the conventional determinants for the considered set of Arab countries over the 2000-2019 period.

[4] This outcome supports the view that the auxiliary variables boost economic growth and, thus, labor productivity.

Conclusion and policy implications

The analysis of the effect of ICT indicators on labor productivity by controlling for trade openness, investment, and government expenditures into the model is conducted to highlight the importance of ICT in 13 Arab economies over the 2000-2019 period by employing the SUR approach to estimate the panel data model. The estimate results comply with expectations and indicate that the ICT indicators have the power to significantly and positively influence labor productivity. Indeed, it is found that the fixed telephone subscriptions boost labor productivity more than the Internet and mobile use that exert weak impacts. This implies that the Internet access and the mobile use cannot enhance labor productivity substantially compared to the fixed telephone subscriptions in the Arab economies under study.

The results also reveal that trade openness, investment, and government expenditures are relevant drivers and more influential in exerting positive effects on labor productivity than the Internet and mobile use. However, the responses of labor productivity to the fixed telephone use are more important than the responses to the changes in the conventional variables.

The research findings provide relevant policy implications for the Arab decision-makers. First, policymakers could boost efforts to enhance ICT diffusion in remote areas and orient its use towards

productive ways to achieve the desired objectives and improve the prosperity in these areas. Second, policymakers could spread ICT among productive sectors, and firm the culture of efficient ICT use in these sectors, as the responses of labor productivity to the ICT use may be restricted by inefficiency. Third, policymakers could enhance the ICT infrastructure and investments in ICT to create opportunities, allowing to boost labor productivity through increasing productive performance of people. Fourth, policymakers could work on strengthening the ICT security to enhance the users trust when implementing transactions in the economy.

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Table 1. Summary statistics of labor productivity and ICT indicators

Country	LP	INT	MOB	TEL
Algeria				
Mean	41849.600	18.981	71.814	8.091
Std. Dev.	1841.547	17.548	43.985	1.337
Bahrain				
Mean	88194.880	57.794	118.195	21.135
Std. Dev.	9326.930	34.603	49.839	2.448
Egypt				
Mean	34551.610	23.286	62.352	10.313
Std. Dev.	4386.278	16.415	43.611	2.821
Jordan				
Mean	47111.270	32.359	76.643	7.573
Std. Dev.	3013.037	23.520	39.411	3.422
Kuwait				
Mean	117857.400	52.623	116.474	17.955
Std. Dev.	21309.270	31.312	62.844	4.092
Lebanon				
Mean	50955.470	41.250	44.933	15.623
Std. Dev.	4463.728	30.237	22.155	2.957
Morocco				
Mean	19955.060	36.639	80.522	6.804
Std. Dev.	3337.018	24.763	44.475	2.599

Table 1 - bis. Summary statistics of labor productivity and ICT indicators

Country	LP	INT	MOB	TEL
Oman				
Mean	76299.40	40.112	103.047	10.198
Std. Dev.	17353.410	32.798	56.879	1.037
Palestine				
Mean	28763.160	33.387	47.508	8.865
Std. Dev.	2771.836	23.931	32.493	0.818
Qatar				
Mean	134083.100	55.905	102.021	20.149
Std. Dev.	11574.010	34.832	40.586	4.497
Saudi A.				
Mean	131202.200	43.155	113.027	15.286
Std. Dev.	7363.877	31.675	63.794	1.219
Tunisia				
Mean	31675.330	30.923	83.360	10.962
Std. Dev.	3334.002	21.075	46.913	1.416
UAE				
Mean	116802.100	65.037	136.502	24.937
Std. Dev.	36944.280	27.224	53.471	4.238
Full Panel				
Mean	70715.430	40.881	88.954	13.682
Std. Dev.	42743.360	30.014	53.902	6.328

Table 2. Correlations between labor productivity and ICT indicators

Country	INT	MOB	TEL
Algeria	0.594	0.044	0.139
Bahrain	-0.821	-0.764	0.810
Egypt	0.980	0.830	-0.608
Jordan	0.130	0.522	-0.324
Kuwait	-0.681	-0.736	0.753
Lebanon	0.205	0.468	0.258
Morocco	0.955	0.935	0.254
Oman	-0.973	-0.877	-0.274
Palestine	0.880	0.897	0.798
Qatar	-0.903	-0.929	0.929
Saudi	-0.886	-0.529	0.349
Tunisia	0.973	0.981	-0.301
UAE	-0.888	-0.802	0.934
Full Panel	0.189	0.259	0.759

Table 3. SUR model estimates

Variable	Model 1	Model 2	Model 3
ICT	0.033***	0.074***	1.069***
	(0.004)	(0.005)	(0.011)
TO	1.688***	1.649***	0.904***
	(0.007)	(0.008)	(0.015)
INV	0.558***	0.538***	0.608***
	(0.011)	(0.013)	(0.014)
GOV	0.539***	0.553***	0.816***
	(0.015)	(0.015)	(0.016)

Notes: Model 1 includes the Internet users as a percentage of population (INT) and the control variables; Model 2 includes the mobile cellular subscriptions (per 100 people) (MOB) and the control variables; and Model 3 includes the fixed telephone subscriptions (per 100 people) (TEL) and the control variables. The value in parentheses is the standard deviation. *** stands for statistical significance at the 1% level.

Figure 1. Evolution of labor productivity across countries over the 2000-2019 period

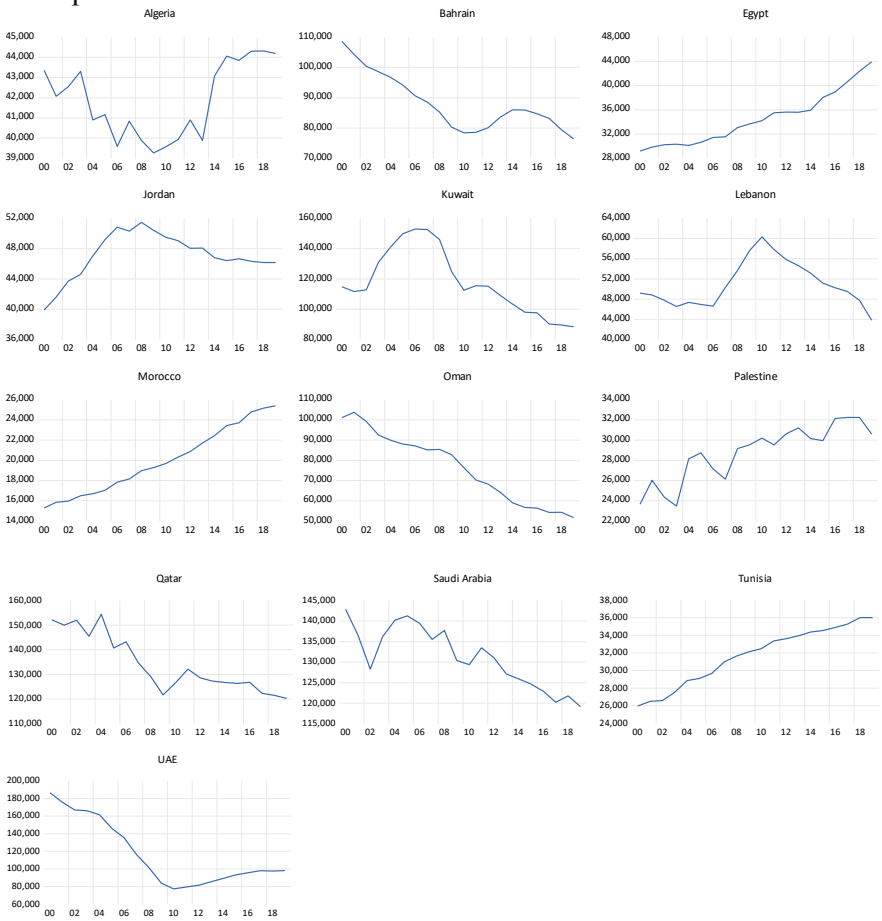


Figure 2. Evolution of the Internet users across countries over the 2000-2019 period

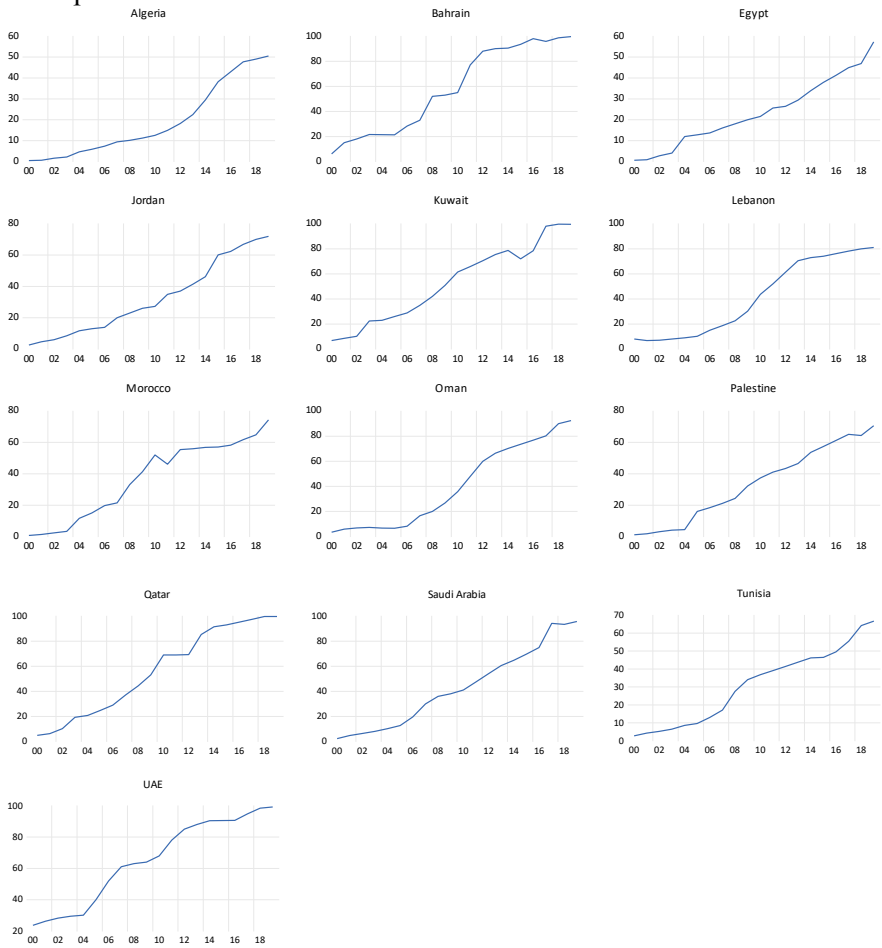
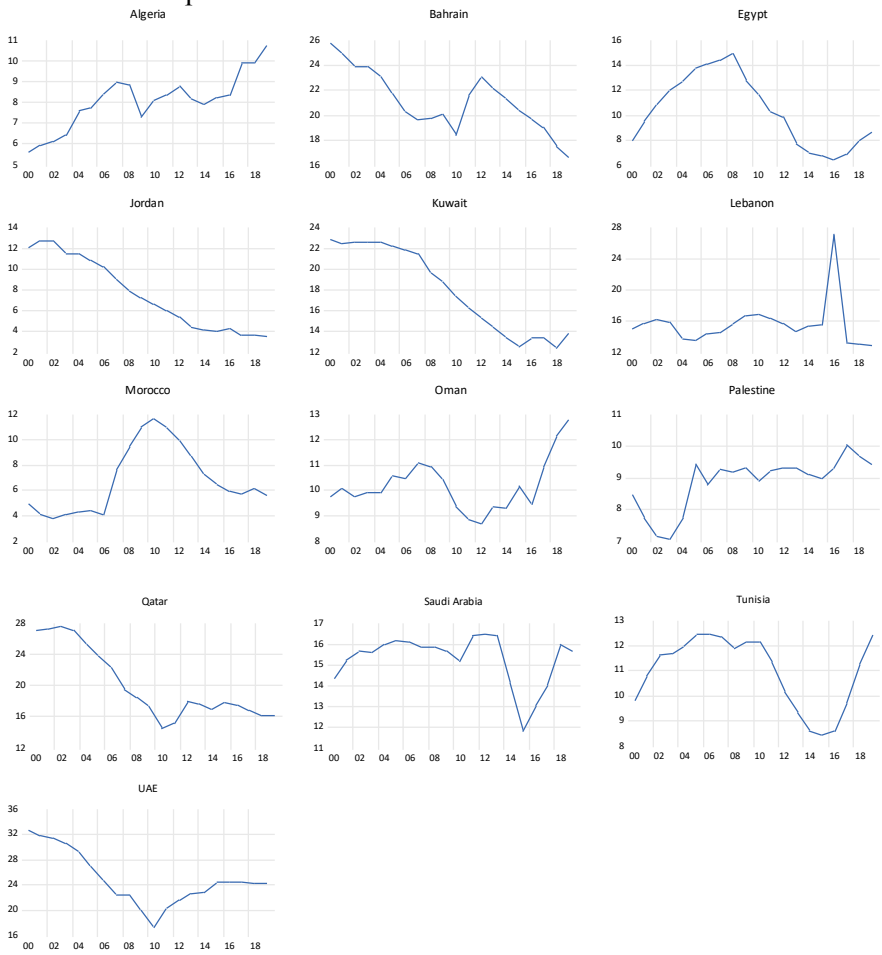


Figure 3. Evolution of the mobile cellular subscribers across countries over the 2000-2019 period

27

Figure 4. Evolution of the fixed telephone subscribers across countries over the 2000-2019 period



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