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Socioeconomic Impacts of Digitisation in Saudi Arabia

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ABSTRACT

The aim of this paper is to measure and analyse the socioeconomic effects of digitisation in Saudi Arabia by using data for the period 1981-2016. Adopting the autoregressive distributed lag and the fully modified least squares approaches, the results reveal significant relationships between the digitisation and socioeconomic variables. Notably, digitisation contributes to the gross domestic product, reduces unemployment, and enhances transparency. Thus, digitisation can be considered a new impetus growth and a powerful instrument of economic diversification that permits the transition to a knowledge-based economy.

Keywords: Digitisation, Socioeconomic, Transparency
JEL Classifications: J24, O3, O47, O5

1. INTRODUCTION

Defined as the social transformation triggered by the massive adoption of digital technologies to generate, process, share, and transact information, digitisation is growing quickly (OECD, 2015). The digital economy is everywhere in the world; it has transformed and will continue to transform the economy, in terms of productivity and social service, especially for SMEs. Several theoretical and empirical studies have illustrated these effects (Nirnfeld (2015), Selim (2013), Bilbao-Osorio et al. (2013), Imaizumi (2011)).

At a time of slowed growth and continued volatility, many countries are looking for policies that will stimulate growth and create jobs. In this new environment, the competitiveness of economies depends on their ability to leverage new technologies. Elena Kvochko (2013) listed five ways technology can help the economy: Contribution to gross domestic product (GDP), job creation, emergence of new services and industries, workforce transformation, and business innovation.

Considering the important socioeconomic benefits[1] that can be derived from a developed digital infrastructure, many countries have recognised the urgent need to transform their economies (internet Corporation for Assigned Names and Numbers, ICANN, 2017). In this context, the Digital Agenda for Saudi Arabia was launched in 2015 as one of the nine flagships of the 2030 vision. The National Transformation Program 2020 has prioritised the digital transformation of Saudi Arabia's entire economy.

The Saudi Arabian economy is based on the oil sector, which accounts for approximately 87% of government revenues, 42% of GDP, and 90% of export earnings in 2016 (The World factbook, 2018). The decline in oil revenues since 2014 requires diversification measures to create new sources of income and ensure the economy's resistance to unpredictable fluctuations in oil prices.

1 A sophisticated digital infrastructure is integral to today's advanced industrial activities. It attracts investors and enhances the fundamental competitiveness of the Saudi economy'. *AMONG OUR GOALS BY 2030, 2030 vision Kingdom of Saudi Arabia, P-57. Web site: file:///C:/Users/USER/Downloads/Saudi_Vision2030_EN.pdf.*

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In Saudi Arabia, as the majority of the oil economy, the endowment in internet and mobile innovations and technologies in business and economic life plays a vital role for growth and employment. Therefore, digitisation can be an important economic strategy of the post-oil era. Thus, digitisation can be considered as the new impetus of growth and the powerful instrument to realise welfare for citizens. In Saudi Arabia, the information and communication technologies (ICT) sector contributes in 2016 with about 6% of the GDP[2]. The internet usage penetration continues to progress steadily. According to the Communication and Information Technology Commission (CITC, 2017), internet penetration in Saudi Arabia increased to 76%, surpassing the Middle East average of 59% and the global average of 51%. This rate was 2.21% in 2000. In terms of the networked readiness index, Saudi Arabia ranks 33rd among 139 countries, with score of 4.8 (Baller et al., 2016).

According to the Boston Consulting Group[3], the contribution of the internet economy to GDP increased to 3.8% in 2016 from 2.2% in 2010. Saudi Arabia had 23.21 million internet users in 2017. The rapidly increasing access to internet proves that Saudi Arabia has indicated a readiness to engage in e-commerce. In 2017, the number of e-commerce users increased to 12.5 million. Online retail was 8% of the total retail in 2016. E-commerce is undergoing massive growth, and the electronic commerce market increased to 7.9 billion dollars in 2017. Furthermore, revenue in the e-commerce market accounted for 7.074 million dollars in 2018 (Saudi Communications and Information Technology Commission, 2018).

Furthermore, there are nearly 70 million website hits per month, and user growth is projected to continue to expand at an estimated 9.3% per annum. Souq.com is considered the largest e-commerce entity in Saudi Arabia's economy and has a 13% market share[4].

In terms of e-service, the Ministry of Communication and Information Technology established, in 2005, a plan for providing government services electronically to improve the productivity and efficiency of the public sector (education, health, justice, transport, labour market). The Saudi government has launched many digital programmes (Yesser, Absher) to facilitate the citizens' access to public services.

The remainder of this paper is organised as follows. Section two presents an overview of the positive impacts of digitisation, such as the economic, social, and government impacts. In section three, we measure the socioeconomic effects of digitisation in Saudi Arabia. Conclusions and recommendations are provided in section four.

2. SOCIOECONOMIC IMPACTS OF DIGITISATION: LITERATURE REVIEW

Policymakers everywhere seek to define the impacts of digitisation. They are interested in economic and societal benefits. The concept of digitisation has principally been pioneered by Booz & Company, the global management consulting firm. Defined as the mass adoption of connected digital services by consumers, enterprises, and governments (Bilbao-Osorio et al., 2013), digitisation can play an important role in economic growth and employment. Notably, digitisation has been considered a main means to improve productivity and facilitate job creation.

According to Nirnfeld (2015), ICT is considered the foundation of all modern innovative economic systems and the single most important impetus of innovation, competitiveness, and growth.

Digitisation is resulting in profound changes and is emerging as a new tool to realise economic and societal benefits for communities. Thus, digitisation concerns many facets of society (e.g. GDP, employment, healthcare, education, government).

The digital economy has produced fundamental and rapid changes in the economic, social, cultural, and governmental environments. ICTs are transforming how social interactions and personal relationships are conducted through fixed and mobile networks (OECD, 2015).

2.1. Impacts on GDP

Digitisation results in significant economic benefits. In this context, Bilbao-Osorio et al. (2013) considered digitisation a fundamental impetus of economic growth and job creation in developed and emerging markets worldwide.

The digitisation of the economy, through using new technology, which has long been characterised by exponential growth (e.g. mobile, internet, tablets), has created a virtuous circle with various economic advantages. According to the European commission (2010), the ITC sector represents 4.8% of the GDP in the European Union (EU) and contributes 50% of productivity growth.

According to Boston Consulting Group (2012), across the G-20 nations, the internet economy amounted to 4.1% of GDP. Furthermore, the internet is contributing up to 8% of GDP in some economies, powering growth and creating jobs.

The share of the internet economy in the GDP in G-20 countries will increase to 5.7% in the EU. In G-20 countries, the contribution of the internet economy will increase 5.3% and employ 32 million additional people. The United Kingdom remains the leader in the internet economy. According to Boston Consulting Group, the internet contributed £121 billion to the British economy in 2010, representing 8.3% of GDP, and is expected to increase to £225 billion, representing 12% of GDP in 2016.

Arab countries have made significant progress regarding use of ICT. According to Arab Economic Outlook Annual Report (2015), the region is quickly adopting the latest internet and mobile innovations and technologies in business and economic life. However, the digital economy's share of the combined GDP

2 Communications and Information Technology Commission, KSA, Annual report(2016) www.citc.gov.sa.

3 the Boston Consulting Group, www.bcg.com

4 U.S.COMMERCIAL SERVICE AND U.S. DEPARTMENT OF STATE (2016). "Doing Business in Saudi Arabia": website:https://sa.usembassy.gov/wp-content/uploads/sites/60/CCG-2017-Saudi-Arabia.pdf

of Arab countries as of 2015 is very low compared with 33% in the United States and 11% in China. Furthermore, there are wide disparities between the Arab countries. These disparities are more accentuated between the Gulf region and the other Arab countries.

2.2. Impact on Employment

According to OECD Digital Economy Outlook (2015), the ICT sector employed more than 14 million people, which is equivalent to almost 3% of total employment in OECD countries in 2013. Furthermore, the ITC sector accounted for 22% of total employment growth in OECD countries.

Using new technology such as mobile phones and the internet, the labour market can be increase efficiency through the reduction of information failure between labour demand and labour supply. In this context, Imaizumi (2011) considered that the mobile phone can act as an intermediary to connect job providers with job seekers. Through her three principal functions (voice, SMS, and mobile application), the mobile phone can be used to collect data, provide information and services, and act as an intermediary platform to solve issues in different sectors Imaizumi (2011). Thus, a mobile phone is a tool to reduce information asymmetry in labour markets. Against, Selim (2013) affirm that new technological applications such as mobile phones and the internet are increasing job opportunities through better links employers and job seekers compared with traditional methods and equipping individuals with necessary skills Furthermore, digitisation of employment agencies leads to the building of common database-information for all actors of the labour market. This database can reduce the mismatch between the skills of the job seekers and the characteristics of existing jobs. The emergence of platforms for transmitting job market information has reduced job search costs. Thus, digitisation of the labour market is a means to encourage job seekers to become more active through increased flexibility and transparency.

The growth of online markets for contract labour has been fast and steady (Agrawal et al., 2015). The digitisation of the labour market can serve as a coordination mechanism between employers and employees, and supports job matching. Thus, labour market digitisation permits many social benefits through increased efficiency in matching, reduced job search costs, reduced duration of unemployment, and improved transparency.

2.3. Social Impacts of Digitisation

Digitisation has the potential to enhance the quality of life for society. The process of digitisation can lead to overall social welfare. Notably, digitisation permits institutions to generate, cooperate, and create larger for the benefit society and help society progress through digital communications and applications (Saima et al. (2015)). The digitisation of many social services, such as education and health, can involve benefits in terms of money, time, and mainly life-quality.

Healthcare digitisation (medical files, digitally registered electronic health information about patients or broader patient populations, electronic prescribing) leads to building a centralised database containing all aspects of a patient's health. In this case, the risk of medical errors is reduced as physicians could independently access full information about allergies, medications, and health conditions of patients. Furthermore, the digitisation of healthcare allows a patient's team of healthcare to connect with each other. The digitisation of healthcare could help health policymakers to maximise effectiveness and facilitate decision-making that increases the quality of life.

In terms of education, digitisation aims to improve the effectiveness of the education system and ensure the development of basic and advanced ICT skills (OECD, 2015). Digitisation has transformed the learning and teaching process. Currently, it is much easier for students to find and select appropriate scholarly materials online (online library, online courses).

Therefore, and notably, digitalization has helped transmit education faster, more efficiently, and at a lower cost than traditional methods. Because of the speed and ease of the delivery of eLearning; the costs of learning and development for an organisation are reduced.

Digitisation of education can lead to immediate cost-effective gains, for example, reducing training time and increasing cost-effective savings in terms of trainers, course materials, travel, and accommodation. Furthermore, eLearning can improve an organisation's profitability.

In terms of governance, ICTs are used as a tool to improve the activities of public sector organisations through the provision of services and the passing of laws and regulations. This phenomenon can be qualified as elelctronic government (e-government). The World Bank (2010a) defined e-government as "the use of information and communications technologies to improve the efficiency, effectiveness, transparency and accountability of government." ICTs permit the modernisation of administration services, which has positive impacts that improve the standard of living for global citizens. Thus, digitisation of some public services, for example, healthcare, education, and transport services, leads to improvements in citizens' quality of life. Furthermore, using ICT in public services can increase coordination within public administrations (G2G), between the government and citizens (G2C), and between government and businesses (G2B). E-government enhances transparency (Rodriguez et al., 2010) and eradicates bureaucracy in the public sector to stimulate economic and social development with increased equitability.

Jamshed and Jalal (2012) demonstrated that when the use of e-government increases the corruption decreases[5] and found that developing countries benefitted the most from the increased use of ICT. Furthermore, digitisation improves transparency and allows governments to operate with greater efficiency.

The use of internet and the application of ICTs in government, as well as the promotion of investments in telecommunication infrastructure and capacity building in human capital, can

5 For example, mobile phones reduce corruption by making it easier to spread the word about malfeasance and increasing the potential for detection.

transform public administration into an instrument of collaborative governance that directly supports sustainable development outcomes (Hongbo, 2014).

3. EMPIRICAL STUDY

This part of the study is to measure and analyse the socioeconomic effects of digitisation in Saudi Arabia by using annual time series data for the period 1981–2016. Adopting two approaches of modeling; the autoregressive distributed lag (ARDL) and the fully modified least squares approach (FMOLS). Data, description, and source of the variables used are shown in the table below (Table 1):

3.1. Relationship between Digitisation Index and GDP Growth Rate

To analyse the influence of digitisation on economic growth in Saudi Arabia, we used an endogenous growth model, inspired by Katz and Koutroumpis (2012), which links GDP to the stock of capital, labour force (LF), and digitisation. In this paper, we divided the stock of capital into two parts. The first part, K_{ICT} represents the contribution of capital services provided by *ICT* assets to *GDP* growth, which is considered a proxy of the digitisation index. The second part, K_{NICT}, is the contribution of capital services provided by non-ICT assets to *GDP* growth. The model is based on a simple Cobb-Douglas form:

$$Y = A.K_{ICT}^{\alpha_1}.K_{NICT}^{\alpha_2}.LF^{\alpha_3} \tag{1}$$

Where *Y* stands for *GDP* per capita, and *A* represents the level of technological progress, such as considered by Solow. K_{ICT} and K_{NICT} are defined as aforementioned.

To measure the elasticity between the variables, we must linearise equation (1) by adopting the logarithmic form in equation (2):

$$LogGDP_t = \alpha_0 + \alpha_1 LogK_{ICTt} + \alpha_2 LogK_{NICTt} + \alpha_3 LogLF_t + \varepsilon_t \tag{2}$$

Where *GDP* is the growth rate of *GDP* (GGDP); K_{ICT} is the contribution of capital services provided by *ICT* assets to *GDP* growth; K_{NICT} is the contribution of capital services provided by non-ICT assets to *GDP* growth; and *LF* measures the LF.

The Table 2 bellow summarises the stationarity test.

According to the result of stationarity test in equation (3), the suitable model to perform the estimate is the ARDL model. The ARDL approach was originally proposed by Pesaran and Shin (1998). The main advantage of ARDL modelling is its flexibility when the variables are of a different order of integration.

The ARDL model estimated in this study is expressed as:

$$\begin{aligned}\Delta \ln GDP_t = {} & \alpha_0 + \alpha_1 T + \beta_1 \ln K_{\boldsymbol{ICT}\,t-i} + \beta_2 \ln K_{\boldsymbol{NICT}\,t-i} \\ & + \beta_3 \ln LF_{t-i} + \sum_{i=1}^{n-1} \gamma_1 \Delta \ln K_{ICT\,t-i} \\ & + \sum_{i=1}^{n-1} \gamma_2 \Delta \ln K_{\boldsymbol{NICT}\,t-i} + \sum_{i=1}^{n-1} \gamma_3 \Delta \ln LF_{t-i} + \varepsilon_t \end{aligned} \tag{3}$$

Where the dependent variable (*GDP*) is explained by exogenous variables through the long-run and short-run relationship. β_i represents the long-run parameters, and (γ_i)are the short-run parameters. *T* is time trend, and (ε) is random error.

The ARDL model has advantages compared with other cointegration approaches (the approaches of Engle-Granger (1987) and Johansen-Juselius (1990)). The ARDL model is appropriate for small samples and generally used to incorporate I(0) and I(1) variables in the same estimation (Pesaran et al., 2001). When the variables are all stationary I(0), the OLS method fits but if they are all non-stationary I(1), the vector error correction model (Johanson Approach) is suitable.

3.1.1. Bound cointegration test

To test the existence of the long-run relationship between the variables, we must calculate the bound F-statistic (bound test for cointegration). Developed by Pesaran et al. (2001), this technique

Table 1: Description of variables and data sources

Variables	Definitions	Sources
GDP	Growth of gross domestic product	WDI, World bank
GDPC	GDP per capita (constant 2010 US$)	WDI, World bank
KICT	Contribution of Capital Services provided by ICT Assets to GDP growth	The Conference Board
KNICT	Contribution of Capital Services provided by Non-ICT Assets to GDP growth	https://www.conference-board.org/data/economydatabase/index.cfm?id=27762
IDI	ICT-Development index, considered as the digitization index	ITU (International Telecommunication Union)
LF	Labor Force	WDI, World bank
U	Unemployment, total (% of total labor force)	WDI, World bank
EDU	the education rate	HDI, WDI, World bank
LP	Labor productivity per hour worked in 2016 US$ (converted to 2016 price level with updated 2011 PPPs)	The Conference Board
INFR	Inflation rate, consumer prices (annual %)	WDI, World bank
EF	Index of Economic Freedom Score	The Heritage Foundation database, US
OPEN	Trade (% of GDP)	World bank
GR	GR is the growth rate of gross domestic product	World bank
GINI	GINI index (World Bank estimate)	World bank
TI	Is the Transparency International which is measured by a corruption perception index (CPI)	Transparency international, www.transparency.org

Sources: Collected by authors

Table 2: Unit root test results

Variables		Augmented Dickey–Fuller test		Integration results
		T-Statistic	Prob.	
In levels				
lnGDP	Intercept	4.225016	0.0021	I (0)
	Trend and intercept	−4.488605	0.0054	I (0)
	None	−3.754766	0.0004	I (0)
$\ln K_{ICT}$	Intercept	2.935076	0.0544	I (0)
	Trend and intercept	−2.567305	0.2965	Non-sta.
	None	−0.910842	0.3148	Non-sta.
$\ln K_{NICT}$	Intercept	−1.782799	0.3823	Non-sta.
	Trend and intercept	−2.749092	0.2269	Non-sta.
	None	−1.372171	0.1547	Non-sta.
lnLF	Intercept	−0.260451	0.9209	Non-sta.
	Trend and intercept:	−1.210676	0.8927	Non-sta
	None:	0.755345	0.8713	Non-sta.
In first difference				
lnGDP	Intercept:	−7.425986	0.0000	I (1)
	Trend and intercept:	7.32486	0.0000	I (1)
	None:	−7.528391	0.0000	I (1)
$\ln K_{ICT}$	Intercept:	−6.055805	0.0000	I (1)
	Trend and intercept:	−6.254797	0.0001	I (1)
	None:	6.158111	0.0000	I (1)
$\ln K_{NICT}$	Intercept :	−5.506513	0.0001	I (1)
	Trend and intercept:	−5.441165	0.0005	I (1)
	None:	−5.566096	0.0000	I (1)
lnLF	Intercept :	−5.591674	0.0000	I (1)
	Trend and intercept:	−5.683087	0.0003	I (1)
	None:	−5.389937	0.0000	I (1)

I (0), I (1) and non-sta. are respectively; stationary in level, stationary in first difference and non-stationary

has the advantage of providing consistent results for small sample and is applied irrespective of whether the series are I(0) or I(1).

The Table 3 summarises the bound cointegration test result.

According to the bound test result, we observe that the F-statistic for the bounds test is 10.33. This result exceed the lower and the upper bound-critical value at the 1% value. Therefore, we strongly reject the hypothesis of 'No Long-Run Relationship.' Consequently, a long-run relationship is among the variables when the GGDP is the dependent variable (Table 4).

In Table 4, the error-correction coefficient is negative (−1.032), as required, and very significant. This result means that 1.03 short-term errors are automatically corrected over time to achieve long-term equilibrium, that is, the GGDP requires approximately 1 year (10 months) to reach its long-term equilibrium value. Thus, we can deduce that there is a relatively quick adjustment in the GDP growth rate when the KICT, KNICT, and LF changes.

We can also deduce, from the long-run coefficients summarised in the second part of the Table 3, that capital services provided by ICT (KICT) and the LF have a positive and significant impact on the GGDP. More precisely, a 1% increase in the contribution of capital services provided by ICT (KICT) leads to a 10% increase in the GGDP for the period 1981–2016. Furthermore, a 1% increase in the LF increases the GGDP by 17.8%. However, the contribution of capital services provided by the non-ICT (KNICT) has a negative significant impact on the GGDP.

Table 3: ARDL bounds test

Included observations: 35		
Null hypothesis: No long-run relationships exist		
Test statistic	**Value**	**k**
F-statistic	10.33	3
Critical value bounds		
Significance	**Lower bound**	**Upper bound**
10%	2.618	3.532
5%	3.164	4.194
1%	4.428	5.816

Source: Eviews10 estimation output, by authors. ARDL: Autoregressive distributed lag

3.1.2. Standard efficiency tests for the model

3.1.2.1. Serial correlation test

In the ARDL approach, the test indicates a significant serial correlation or no serial correlation in the residuals. The Breusch–Godfrey Serial Correlation LM test replaced the Durbin-Watson statistic, which is not appropriate as a test for serial correlation in this case because a lagged dependent variable is on the right-hand side of the equation (Table 5).

The test accepts the hypothesis of no serial correlation up to order two. The Q-statistic and the LM test indicate that the residuals are not serially correlated, that is, the equation has a good specificity.

3.1.2.2. Stability test (CUSUM and CUSUM of squares test)

Figure 1 shows the graphical representation of cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) stability tests Brown et al. (1975). It is clear from the plots that tests statistics are within the critical bound of 5% level of significance, therefore, we cannot reject the null hypothesis of all coefficients of the regression are stable which indicate that the coefficients in the error-correction model are stable and there is no structural breaks.

The blue line is located within the two red lines this meaning that the model is stable.

3.2. Relationship between Digitisation and Unemployment

To study the relationship between digitisation and unemployment in Saudi Arabia, we apply the FMOLS approach. This approach has the advantage of producing reliable estimates for small sample sizes. To achieve asymptotic efficiency, this method modifies least squares to account for serial correlation effects and test for the endogeneity in the regressors that result from the existence of co-integrating relationships (Rukhsana and Shahbaz, 2009). Hence, the serial correlation and the test for the endogeneity in the regressors that result from the existence of co-integrating relationship are the principle ideas of FMOLS methodology.

Table 4: ARDL error correction regression

Dependent variable: D (GGDP)				
Selected model: ARDL (1, 3, 4, 2)				
Sample: 1 36				
Included observations: 32				
ECM Regression				
Case 2: Restricted constant and no trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D (KICT)	7.708419	2.931998	2.629067	0.0170
D (KICT(−1))	2.502642	2.569784	0.973872	0.3430
D (KICT(−2))	−8.772018	2.920523	−3.003578	0.0076
D (KNICT)	1.380490	0.493650	2.796495	0.0119
D (KNICT(−1))	1.733013	0.686581	2.524121	0.0212
D (KNICT(−2))	0.140752	0.467094	0.301336	0.7666
D (KNICT(−3))	1.359040	0.486631	2.792755	0.0120
D (LNLF)	1.779144	5.881415	0.302503	0.7657
D (LNLF(−1))	−27.17363	6.174298	−4.401088	0.0003
CointEq(−1)*	−1.032214	0.129915	−7.945278	0.0000
Long run coefficients				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
KICT	10.02468	3.976854	2.520756	0.0214
KNICT	−1.672964	0.668154	−2.503858	0.0221
LNLF	17.78372	5.670861	3.135983	0.0057
C	−279.8110	87.89002	−3.183649	0.0051
EC=GGDP - (10.0247*KICT−1.6730*KNICT+17.7837*LNLF−279.8110)				

*P-value incompatible with t-Bounds distribution.
Source: Eviews10 estimation output, by authors. GGDP: Growth rate of gross domestic product, ARDL: Autoregressive distributed lag

Table 5: Robustness tests

Breusch-Godfrey serial correlation LM test			
F-statistic	0.154779	Prob. F (2,16)	0.8579
Obs*R²	0.607364	Prob. Chi-square (2)	0.7381
Heteroskedasticity Test: ARCH			
F-statistic	0.372015	Prob. F (1,29)	0.5467
Obs*R²	0.392635	Prob. Chi-square (1)	0.5309
Ramsey RESET Test			
	Value	**df**	**Probability**
t-statistic	2.370004	17	0.0299
F-statistic	5.616917	(1, 17)	0.0299
Normality test			
Jarque- bera	0.990142		
Probability	0.609528		

Source: Eviews10 estimation output, by authors.

This method was originally used by Philips and Hansen (1990) to determine the optimal estimates of cointegration regression. This method was also used by Gouider and Gabsi (2018) to measure the impact of the economic freedom on the non-oil GDP in Saudi Arabia from 1996 to 2015.

To measure the impact of digitisation on unemployment in Saudi Arabia, we estimate the following models by using the FMOLS approach and data from 1996–2016 for the first equation and from 2002–2016 for the second equation.

Model 1: $$U_t = \beta_1 K_{ICTt} + \beta_2 K_{NICTt} + \beta_3 GDPC_t + \beta_4 EDU_t + \beta_5 OPEN_t + \beta_6 LP_t + \mu_t \quad (4)$$

Model 2: $$U_t = \beta_1 IDI_t + \beta_2 K_t + GDPC_t + \beta_3 EDU_t + \beta_4 OPEN_t + \beta_5 LP_t + \mu_t \quad (5)$$

Where *U* is the unemployment rate; *IDI* is the digitisation index; *K* is a fixed capital stock; *GDPC* stands for GDP per capita; *EDU* is the education rate; *OPEN* is the total exports and imports as a percent of GDP; *LP* is the labour productivity, and μ is the error term.

Estimation result is summarised in Table 6:

In Table 6, digitisation has a negative a significant effect on unemployment (model 1). It is significant that an increase of the level of KICT of 1% reduces the unemployment rate by 2.61%. However, in model 2, digitisation has no effect on unemployment.

3.3. Relationship between Digitisation and Transparency

Many studies have demonstrated that digitisation reduces corruption and allows governments to operate with greater transparency and efficiency (Merhi and Ahluwalia (2018), Haafst (2017), Sabbagh et al. (2013)). Referring to the models used by Ylmaz and Arvas, (2011), we analyse the relationship between digitisation and transparency in Saudi Arabia by considering the following models:

Model 1: $$TI_t = c + \beta_1 IDI_t + \beta_2 GDPC_t + \beta_3 GR_t + \beta_4 INFR_t + \beta_5 EF_t + \beta_6 GINI_t + \text{ and} \quad (6)$$

Model 2: $$TI_t = \beta_1 K_{ICTt} + \beta_2 K_{NICTt} + \beta_3 GDPC_t + \beta_4 GR_t + \beta_5 INFR_t + \beta_6 EF_t + \beta_7 GINI_t + \eta_t \quad (7)$$

Where TI is the transparency international measured by a corruption perception index (CPI); DI is the digitisation index; *GDPC* stands for GDP per capita; *GR* is the GGDP; *IR* is the inflation rate; *EF* is an economic freedom index; *GINI* is a Gini coefficient; c is a constant; and η is the error term. The definitions of K_{ICT} and K_{NICT} were aforementioned.

Table 6: Estimation results of the impact of digitization on unemployment

Dependent variable: Unemployment (U)					
Method: Fully modified least squares (FMOLS)					
Model 1			Model 2		
	Coefficient	Prob.		Coefficient	Prob.
KICT	−2.616904***	0.0000	IDI	0.089326	0.6773
KNICT	−0.199262*	0.1485	LNK	−0.693535	0.1949
GDPC	0.000298***	0.0000	GDPC	0.000333	0.0146
EDU	0.187908**	0.0282	EDU	−0.162725	0.2380
OPEN	0.089066***	0.0028	OPEN	−0.034872	0.0683
LP	−3.807396***	0.0002	LP	−7.18E−05	0.0193
C	187.3170***	0.0002	LNLP	45.51396	0.1653
@TREND	−0.269294	0.0000	C	−37.79223	0.2501
			@TREND	−0.466758	0.0320
R^2	0.630222		R^2	0.453511	
Long-run variance	0.074958		Long-run variance	0.017684	
Included observations:	20 after adjustments		Included observations	Included observations: 15 after adjustments	

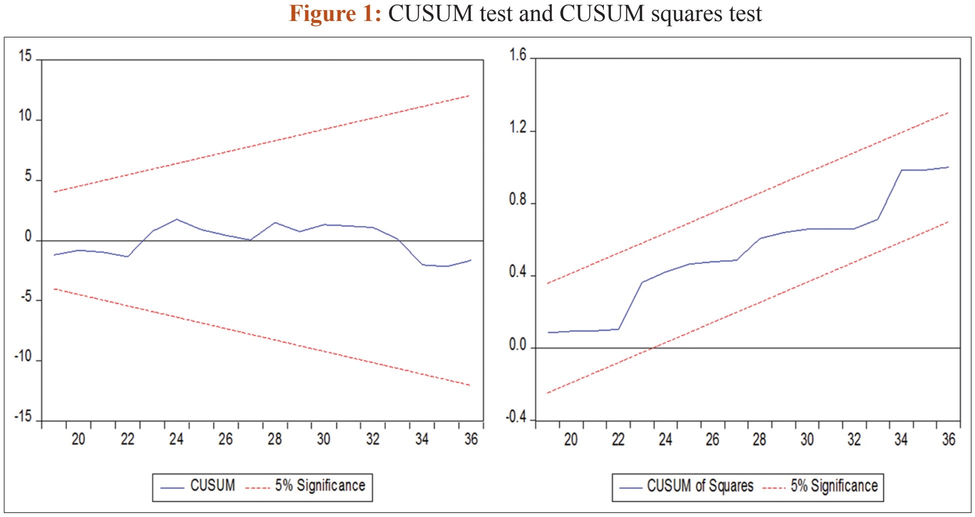
Source: Eviews10 estimation output

Table 7: Estimation results of the impact of digitization on transparency

Dependent variable: Transparency international (TI)					
Method: Fully modified least squares (FMOLS)					
Model 1			Model2		
Independent Variables	Coefficient	Prob.	Independent Variables	Coefficient	Prob.
KICT	0.189270	0.0002	IDI	10.21066	0.0000
KNICT	−0.042458	0.0001	GDPC	−8.26E-05	0.0331
GDPC	−0.000244	0.0004	GR	0.673259	0.0029
INFR	0.001558	0.2637	INFR	−0.505538	0.0149
EF	−0.006745	0.0184	EF	0.049690	0.8601
GR	0.002848	0.2493	GINI	−0.003580	0.0001
GINI	0.000238	0.0003	C	162.5539	0.0011
C	0.501395	0.0526			
R^2	0.881703		R^2	0.954541	
Long-run variance	0.000960		Long-run variance	1.554614	
Included observations:	13 after adjustments		Included observations	14 after adjustments	

Source: Eviews10 estimation output, authors estimations

Figure 1: CUSUM test and CUSUM squares test



Source: Eviews10 output, by authors

The result estimation summarised in Table 7 demonstrates that in model 1 and model 2, digitisation has a positive sign and is statistically significant. In model 1, we observe that a 1% increase in KICT increases transparency by 0.19%. In model 2, a 1% increase in digitisation increases transparency by 10.21%. This result confirms the theoretical and empirical predictions that digitisation allows governments to operate with greater transparency and efficiency.

4. CONCLUSION

In this paper, we study the positive effects of digitisation on GDP, unemployment, and transparency in Saudi Arabia. Empirical results indicate that digitisation supports global development in Saudi Arabia. We observe that digitisation leads to economic and social benefits. Therefore, digitisation has various socioeconomic returns such us economic growth, job creation, transparency. The results also indicate that digitisation contributes to GDP, reduces unemployment, and enhances transparency in the Saudi economy.

In Saudi Arabia, the use of digitisation can constitute a catalyst for sustainable development in the post-oil area and become a key pillar of Saudi Arabia's Vision 2030. Therefore, policymakers who seek to accelerate economic diversification have different challenges to realise a significant benefit of digitisation in terms of job creation, transparency, welfare, and improving citizens' access to public services. To accomplish digital transformation, Saudi Arabia must develop its digital infrastructure and require improvements in its ICT readiness. Furthermore, mechanisms and tools must be developed to measure the effects of digitisation in the Saudi economy and reallocated to the most productive sectors to increase economic efficiency. Additionally, to facilitate the transition to a knowledge-based economy, education must be recognised as playing a key role in this phase, and the Saudi government should make greater investments in human capital to enhance skills among the youth.

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