مجلة البحوث المالية والتجارية
المجلد (22) – العدد الثالث – يوليو 2021

The Effect of Digital Transformation on Egyptian Competitiveness Using the ARDL Model

أثر التحول الرقمي على تنافسية الاقتصاد المصري باستخدام نموذج ARDL

Dr. Sally Mohamed Farid Mahmoud
Associate Professor of Economics, Department of Politics and Economics,
Faculty of African postgraduate Studies, Cairo University
Tel. :(002) 01222944442
Email: sallyfarid2000@yahoo.com,

الملخص

تهدف الدراسة إلى تقييم "التحول الرقمي" في مصر وقياس تأثيره على القدرة التنافسية خلال الفترة (1996–2019) باستخدام نموذج الانحدار الذاتي الموزع (ARDL). وقد أظهرت النتائج وجود علاقة إيجابية بين متغير الأداء التنافسي والقيمة المبطأة لنفس المتغير، حيث أدى ارتفاع القيمة المبطأة للأداء التنافسي بمقدار وحدة واحدة إلى زيادة قدرها 0.72 وحدة في الأداء التنافسي للعام الحالي. وقد أثرت نفقات البحث والتطوير بشكل إيجابي على الأداء التنافسي حيث أدت زيادتها بمقدار وحدة واحدة إلى زيادة قدرها 0.41 وحدة في الأداء التنافسي. كما أثر عدد براءات الاختراع المسجلة بشكل إيجابي على الأداء التنافسي، حيث أدت زيادته بمقدار وحدة واحدة إلى زيادة قدرها 0.01 وحدة في الأداء التنافسي. علاوة على ذلك، أثر صافي الاستثمار الأجنبي المباشر بشكل إيجابي على الأداء التنافسي، حيث أدت زيادته بمقدار وحدة واحدة إلى زيادة قدرها 0.05 وحدة على الأداء التنافسي، وأدت زيادة وحدة واحدة في الصادرات عالية التكنولوجيا إلى زيادة قدرها 0.25 وحدة في الأداء التنافسي. كما أثر عدد المشتركين في خطوط الهاتف المحمول والهاتف الثابت بشكل إيجابي على الأداء التنافسي، حيث أدت زيادة وحدة واحدة في عدد مشتركي الهاتف المحمول لكل 100 شخص، وأدى عدد مشتركي الخطوط الثابتة لكل 100 شخص إلى

حدوث زيادة قدرها 0.03 و 0.94 وحدة في الأداء التنافسي على التوالي. لذا فإنه لزيادة الأداء التنافسي في مصر لابد من زيادة كفاءة استخدام الموارد ورفع الإنتاجية، ويجب تحسين المستوى التكنولوجي في الإنتاج المصري.

الكلمات المفتاحية: التكنولوجيا الرقمية، الابتكار، التنافسية، نموذج ARDL.

Abstract

This study aimed at assessing the "digital transformation" of Egypt and measured its effect on the country's competitiveness during the period 1996–2019 using the autoregressive distributed lag (ARDL) model. Results showed positive relationship between the competitive performance variable (MVA) and the lag value of the same variable, as an increase in competitive performance during last year by one point led to an increase of 0.72 point in competitive performance during current year. The research and development expenditure positively affected competitive performance as one-point increase led to an increase of 0.41 point in competitive performance. The number of patents registered by individuals positively affected MVA as one-point increase led to an increase of 0.01 point in MVA. Moreover, the net foreign direct investment positively affected MVA as one-point increase led to an increase of 0.05 point in MVA, and one-point increase in the high technology exports led to an increase of 0.25 point in competitive performance. Also, the number of mobile and fixed phone lines subscribers positively affected MVA as one-point increase in the number of mobile phone subscribers per 100 people (MOB), and the number of fixed-line subscribers per 100 people (FTS) led to an increase of 0.03, 0.94 point in competitive performance, respectively. In conclusion, to achieve competitive performance in Egypt by increasing efficiency in both resources' usage and technical productivity, the technological level in Egyptian production must be improved.

Keywords: Digital Technology; Innovation; Competitively; ARDL Model; implications.

Contribution/Originality: This study contributes to the existing literature on the digital transformation and competitiveness phenomenon. The study uses new estimation methodology to fill the research gap regarding the effect of the digital transformation on competitiveness; this study is one of few that have investigated the digital transformation and competitiveness in Egypt using econometrics methodology.

1. Introduction

UNIDO (2013) defined competitiveness as the ability of states to increase their presence in the international and domestic markets in conjunction with the development in sectors and activities with high-value and technological content.

Digital technology offers countries around the world a unique opportunity to accelerate socio-economic development and build a better future. Digital innovations are currently transforming almost all sectors of the economy by introducing new business models, new products, new services, and new ways of creating value and jobs. The results of this transformation are already beginning to emerge; the global digital economy is currently worth 11.5 trillion Dollars, or 15.5% of global GDP (Henry, 2018). Technology also has a profound impact on the way governments work and interact with their citizens, as it opens the door to increased transparency and efficiency in service delivery. The innovation can remove any obstacles that prevent people and opportunities, especially the poorest and most vulnerable groups. Thanks to digital platforms, people can access unprecedented amounts of information, work online jobs, enroll in e-courses, and even access life-saving care via a telemedicine service (Tsoukatos 2018). Mobile financial services also provide an easy and safe alternative to the traditional banking system. Digital identification systems have allowed millions of marginalized people to prove their identity, exercise their rights, and benefit from essential services such as health or education (Garrone, et al. 2018). The Egyptian government tried to strengthen its efforts for ensuring universal access to broadband services, and to give people the skills and resources they need to participate fully in the digital economy.

The objective of the study is identifying the effect of digital transformation on competitiveness in Egypt using ARDL model. The study is structured as follows. The second section reviews the literature reviews, and analyzes indicators of digital transformation and competitiveness in Egypt. The third section presents the methodology and the fourth section discusses the results, provides some implications, and concludes.

2. Literature Review and Analysis of Digital Transformation and Competitiveness indicators in Egypt

The competitiveness depends on input supply factors (production factors), demand in the local market, company structure, competitive strategy, and finally related companies and support (Mukadasi 2018), as well as supportive associations, which lead to the creation and strengthening of capacity. That capacity increases Competitiveness of countries (Kleynhans 2016). the shift to high-productivity activities to achieve rapid, high and sustainable economic growth rates was assessed by Dogan (2016) and explained how the increase in the proportion of commodity exports from the manufacturing industry, and increase their growth rates help to achieve high economic growth, and that change is not only necessary to achieve sustainable economic growth, but also to reduce the level of poverty and provide job opportunities as a result of achieving integration between productivity growth in all economic sectors, and the provision of job opportunities in a sector.

The pillars of the competitiveness indicators are related to each other, so that each pillar leads to strengthening the other, and the weakness of one of them often leads to the weakness of other pillars. For example, it is difficult to advance the field of innovation, without the availability of a workforce with health, good education, high training, high skills in absorbing new technologies, with sufficient funding for scientific research, and an effective commodity market that enables new innovations to be directed to the market (WEF 2018). Considering global technological and scientific developments, developing countries should achieve competitive successes in global markets, which poses several challenges. These are mainly represented in changing the traditional comparative advantages in addition to creating and acquiring new ones (Wurlod and Noailly 2018).

In Egypt, there is a high degree of concentration in the country exports, as oil plus several other traditional exports occupy the largest portion of the export proceeds, and as a result, it is necessary to search for more promising export proceeds with comparative advantages in favor of the country. They can be developed over time to be a specific competitive advantage for the country. The patents were confirmed by Akpotaire (2013) as a measure indicative of innovations resulting from scientific research. Patent and technology indicators reflect the innovative performance of scientific research outputs and are used to assess the dissemination of knowledge as patents are important indicators for measuring the results of scientific research that led to innovations.

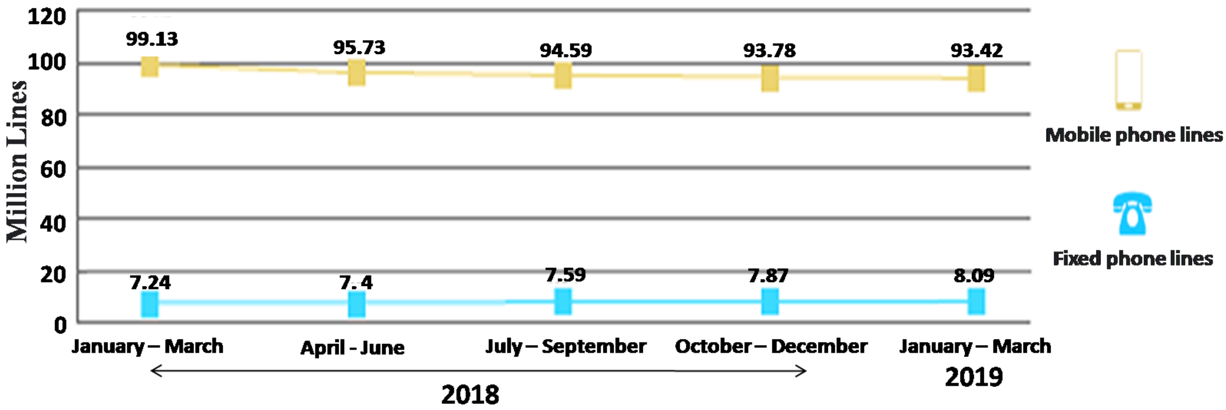
The index of high-tech exports is one of the indicators indicatives of the outputs of technological innovation driven by scientific research and the academic community. The extent of applications of scientific research and its results in the productive sectors on economic progress, and the extent of their effectiveness and ability to accomplish business and their industrial applications that lead to an increase in the return of foreign currencies. Productive scientific research achieves economic growth and keeps pace with global scientific and technological progress (Suryanto, et al. 2018).

The information sources in companies were emphasized by Vassakis and Tsoukatos (2016) as an important mechanism to enhance the absorptive capacity of innovation and the internal and external performance of innovation in the manufacturing sector. The competitiveness of the manufacturing sector depends on its ability to access information and create knowledge accumulation, which leads to the achievement of performance effective innovation for economic institutions. These information sources are a decisive factor in promoting innovation in industry and knowledge or information management. Economic institutions represent a driving force for innovation, thus achieve competitiveness and presence in the markets then achieve the highest possible return.

2.1. Digital Transformation Indicators in Egypt

The number of internet users in Egypt is about 40.9 million users, with a penetration density of 48% in 2018/2019 (MCIT 2019).

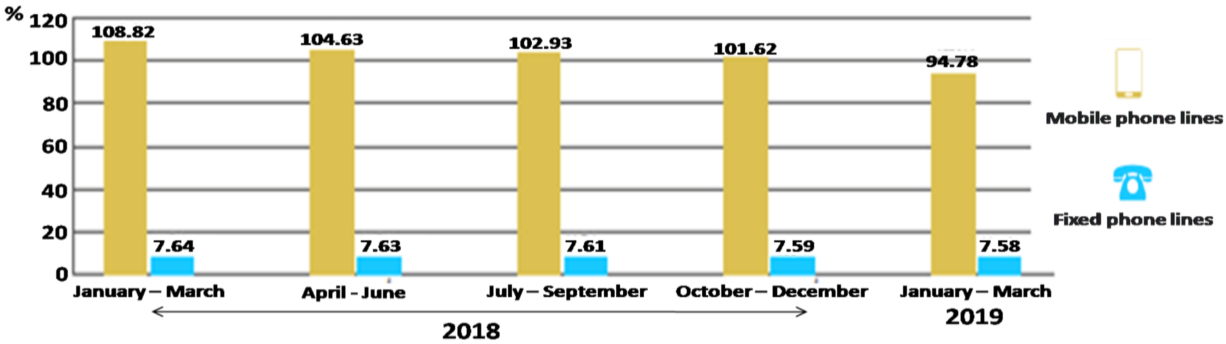
Figure 1. Total fixed and mobile phone subscribers (MCIT 2019)



Source: (Ministry of Communications and Information Technology MCIT 2019)

The total number of mobile and fixed phone subscribers was 101.52 million subscribers in January - March 2019, compared to 106.37 million subscribers in January - March 2018. The total number of mobile phone subscribers reached 93.42 million subscribers in January-March 2019 compared to 99.13 million subscribers in January-March 2018. The number of mobile phone subscribers accounted for about 92% of the total telephone subscribers in January - March 2019 (Figure 1).

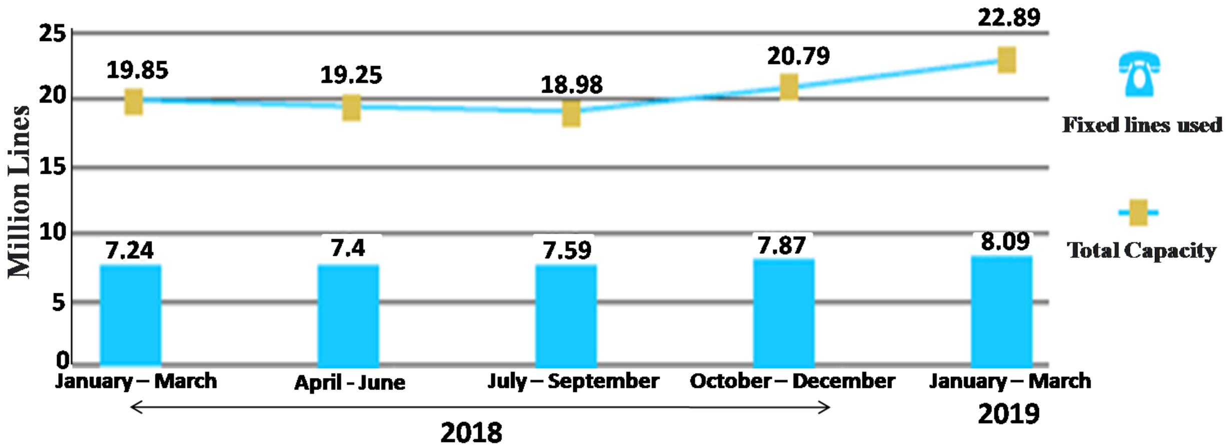
Figure 2. Fixed and mobile phone penetration rate



Source: (MCIT 2019)

The mobile penetration rate was 94.78% in January - March 2019 compared to 108.82% in January - March 2018, with 14.3% annual rate of change. On the other hand, the fixed line penetration rate was about 7.58% in January - March 2019 (Figure 2).

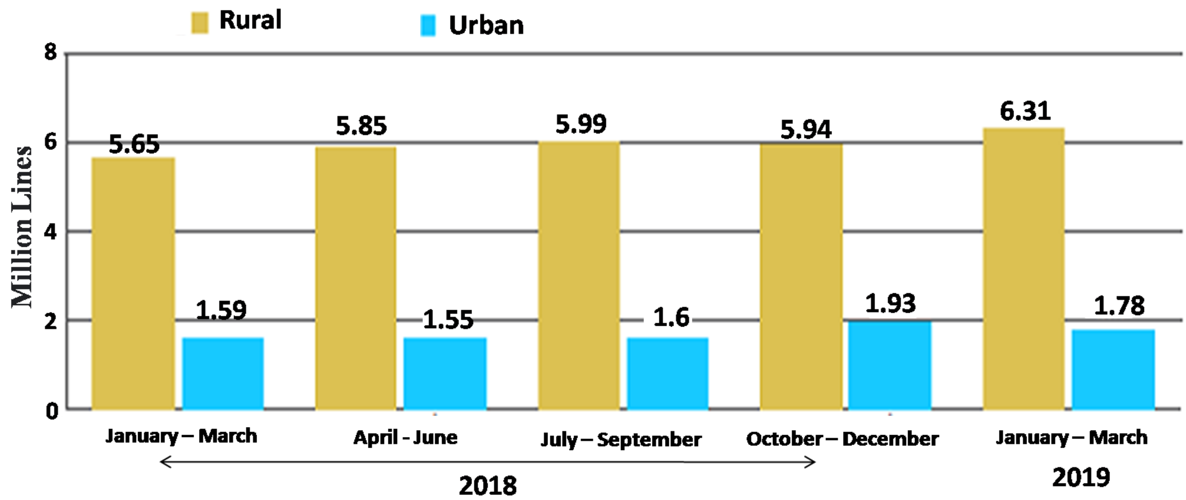
Figure 3. The telephone lines used and the total capacity of the exchanges



Source: (MCIT 2019)

The total number of fixed telephone lines reached about 8.9 million lines in January - March 2019 compared to about 7.24 million lines in January - March 2018, and the capacity of the fixed phone increased to 22.89 million lines in January - March 2019 compared to about 19.85 million lines in January - March 2018 with an annual increase of 3.4 million lines (Figure 3).

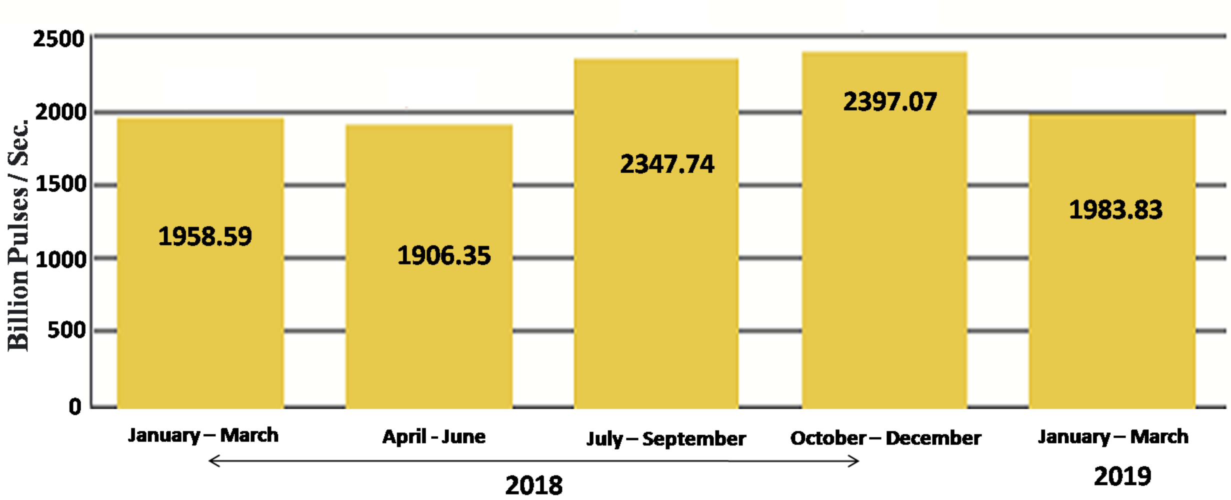
Figure 4. Urban and rural fixed-line subscribers



Source: (MCIT 2019)

The number of fixed line subscribers in rural was about 6.31 million lines in January - March 2019 compared to about 5.65 million lines in January - March 2018, while the number of fixed phone subscribers in urban reached about 1.78 million lines in January - March 2019 Compared to 1.59 million lines in January-March 2018 period (Figure 4).

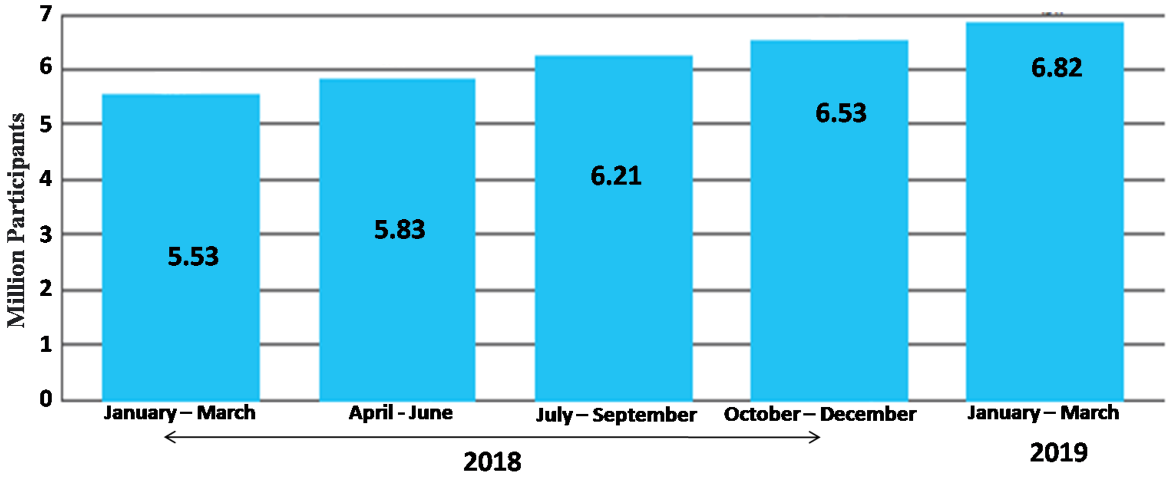
Figure 5. International Capacity of the Internet



Source: (MCIT 2019)

The current capacity of the Internet increased to about 1983 billion pulses / sec in January-March 2019, compared to about 1958 billion pulses / sec in January-March 2018 (Figure 5).

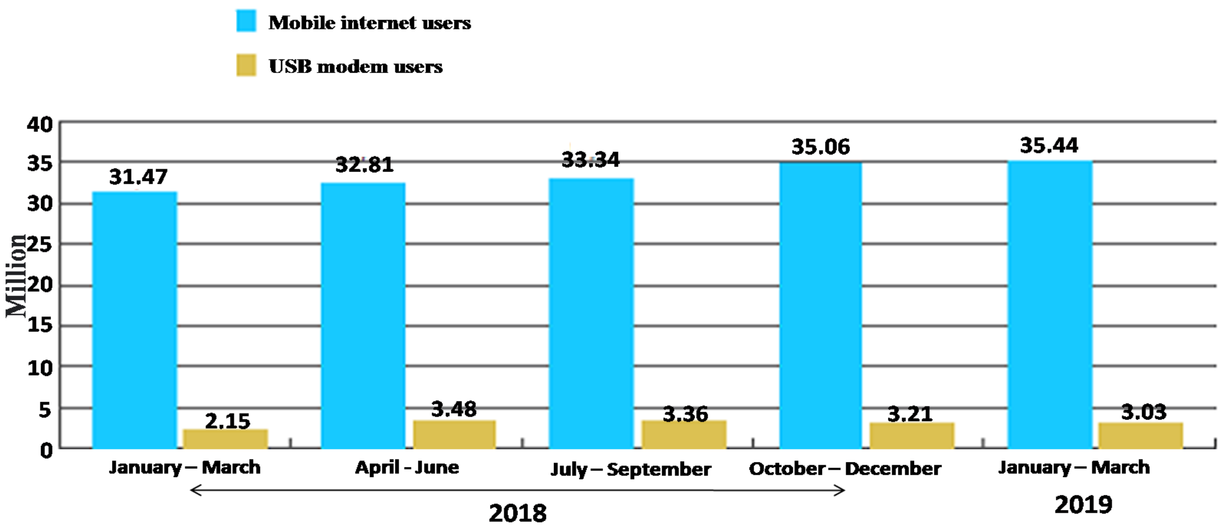
Figure 6. ADSL subscribers



Source: (MCIT 2019)

The total number of ADSL subscribers was 6.82 million subscribers in January-March 2019 compared to 5.53 million subscribers in January-March 2018, with an annual increase of 1.29 million subscribers (Figure 6).

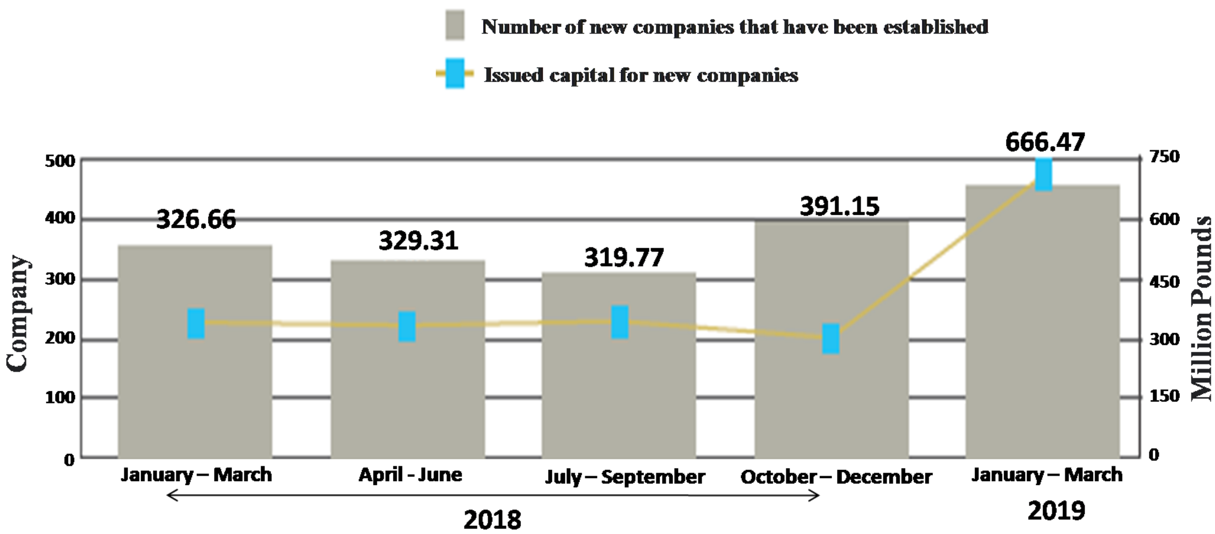
Figure 7. Internet users via mobile and USB modem



Source: (MCIT 2019)

The number of internet users via mobile phone was 35.44 million users in January - March 2019, compared to 31.47 million users during the same period of the previous year. while the number of USB Modem subscribers reached 3.3 million users in January - March 2019, compared to about 2.15 million subscribers during the same period in 2018 (Figure 7).

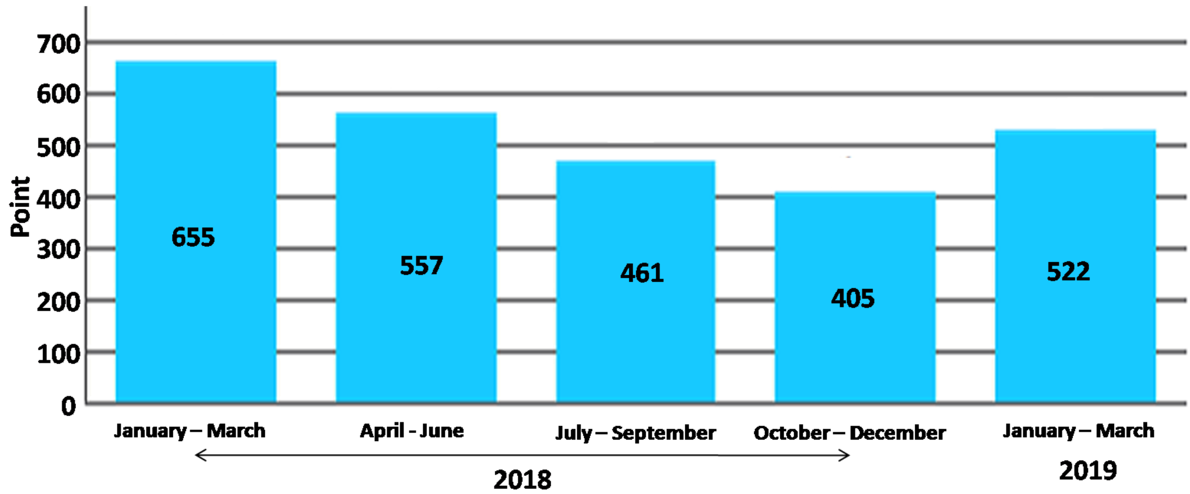
Figure 8. ICT companies that have been established



Source: (MCIT 2019)

The number of information and communication technology companies that were established during the period (January - March 2019) reached 456 compared with 357 companies established during the same period of 2018. The capital of these companies amounted to 666.47 million Egyptian pounds during the period (January - March 2019) compared with 326.66 million pounds during the same period in 2018 (Figure 8).

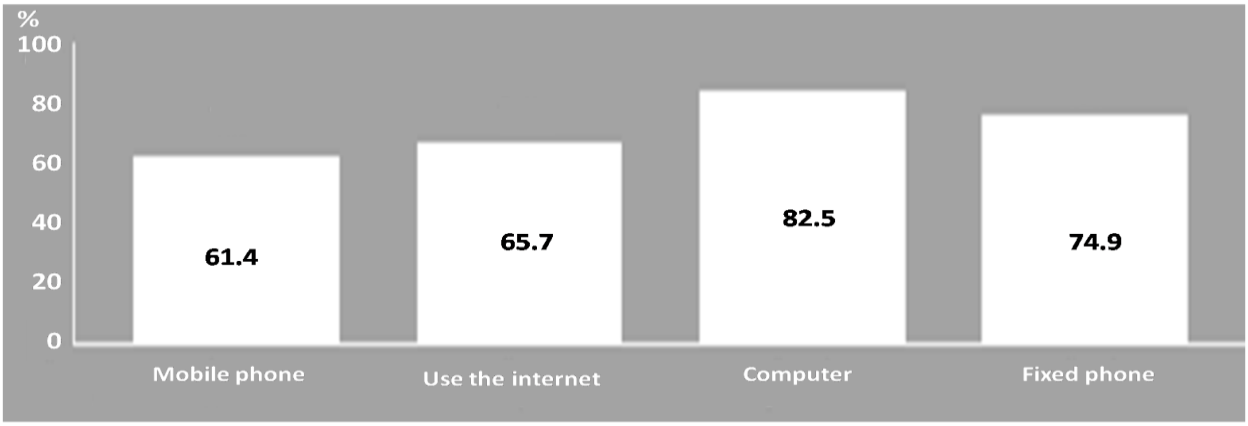
Figure 9. The telecom sector index value in the Egyptian Stock Exchange



Source: (MCIT 2019)

The value of the Telecom Sector Index in the Egyptian Stock Exchange reached 522 points in January – March 2019 compared with 655 points in January - March 2018. The index includes three companies working in the telecommunications field, namely Telecom Egypt, Global Telecom Holding and Orascom Communications and Media (Figure 9).

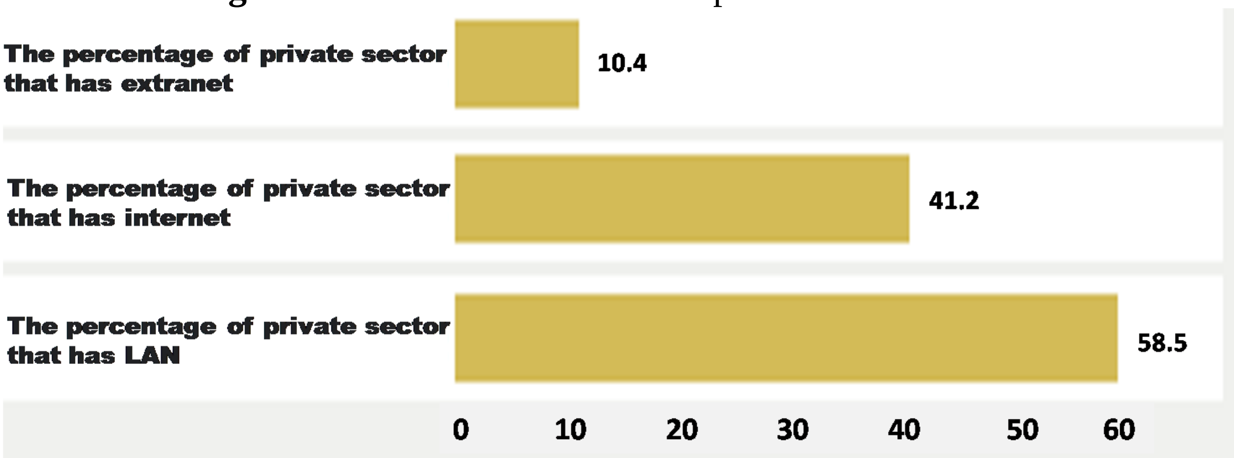
Figure 10. The infrastructure of communications and information technology in the private sector



Source: (MCIT 2019)

Private sector establishments that have a fixed phone reached 74.9% of the total establishments, while those have a computer reached 82.5% of the total. Establishments that use the Internet reached 65.7%, and the percentage of private sector establishments that have a mobile was 61.4% (Figure 10).

Figure 11. Use of networks in the private sector



Source: (MCIT 2019)

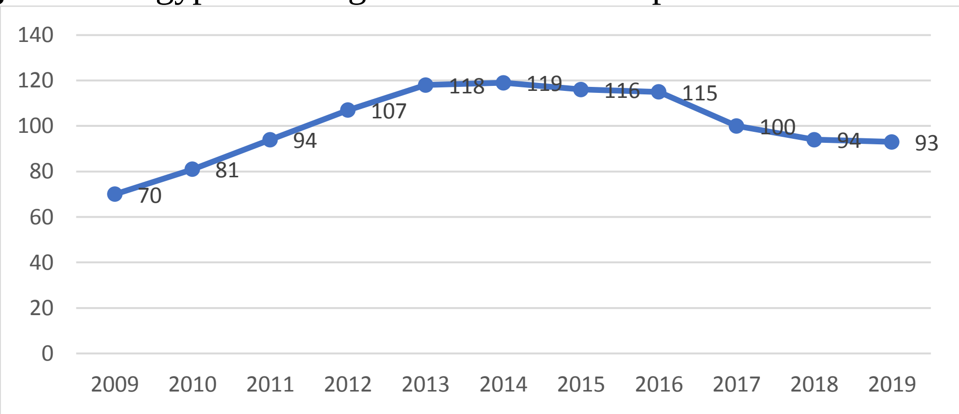
In the private sector, establishments that have a local network is estimated as 85.5% of the total while the percentage of those with Internet is 41.2%. The percentage of establishments that have Extranet is estimated to be 10.4% (Figure 11).

Egypt was ranked 8th in Africa in the field of artificial intelligence, and 111st out of 194 countries, in the government readiness report for artificial intelligence in 2019 (Oxford Insights 2019).

2.2. Competitiveness Indicators in Egypt

Egypt Vision 2030 aimed at making the Egyptian economy a disciplined market economy. Such type of economy is characterized by the stability in macroeconomic conditions, the capability of achieving sustainable inclusive growth, the ability of competitiveness, diversity, and the dependence on knowledge. Achieving that type of economy makes the country an active player in the global economy by adapting to global changes and maximizing the added value. In addition to increasing the competitiveness of the Egyptian economy internationally, the contribution of services to the GDP, especially production services will increase.

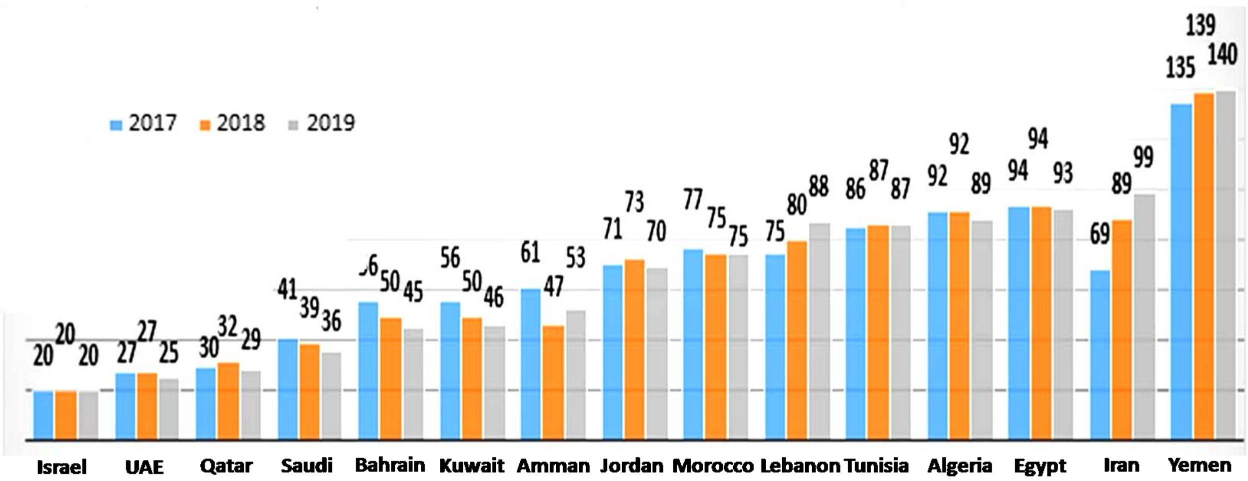
Figure 12. Egypt's ranking in the Global Competitiveness Index



Source: (World Economic Forum WEF 2019)

In 2019 Egypt was ranked 93rd globally compared to the 94th and achieved improvement in eight pillars of the competitiveness index and stability compared with those of 2018 (Figure 12).

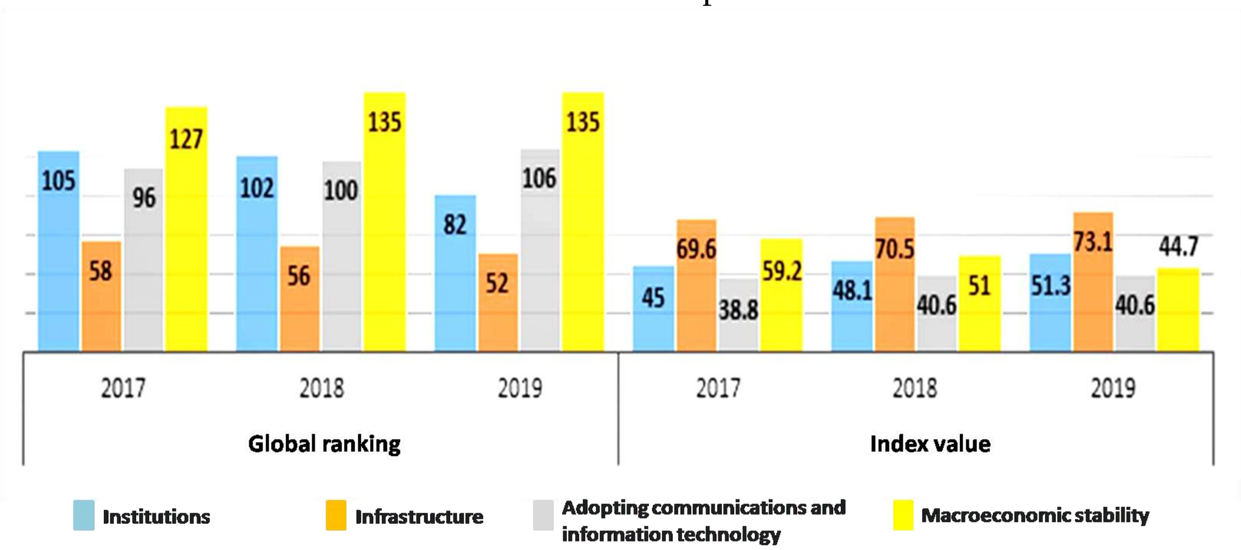
Figure 13. A comparison of Egypt's ranking in the Global Competitiveness Index among the countries of the Middle East and North Africa



Source: (WEF 2019)

Egypt was ranked the 13th among the countries of the Middle East and North Africa in 2019 instead of the 14th in 2018 in the Global Competitiveness Index (Figure 13).

Figure 14. The global ranking of Egypt’s competitiveness in the environment axis and its pillars

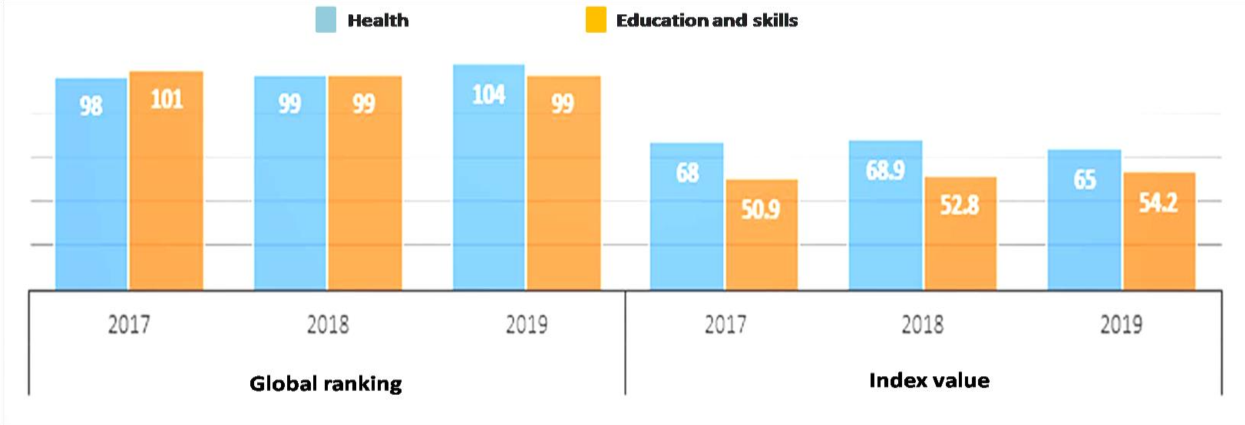


Source: (WEF 2019)

Egypt's ranking in the institutions pillar improved in 2019 from 105th in 2017, to 102nd in 2018 and to 82nd in 2019. The ranking in infrastructure pillar advanced from 58th in 2017, to 56th in 2018 and to 52nd in 2019. Egypt's ranking was declined in the ICT and Macroeconomic stability pillars. In the ICT pillar, ranking was reduced from 96th in 2017 to 100th in

2018 and to 106th in 2019. Macroeconomic stability pillar ranking was declined from 127th in 2017 to 135th in both 2018 and 2019 (Figure 14).

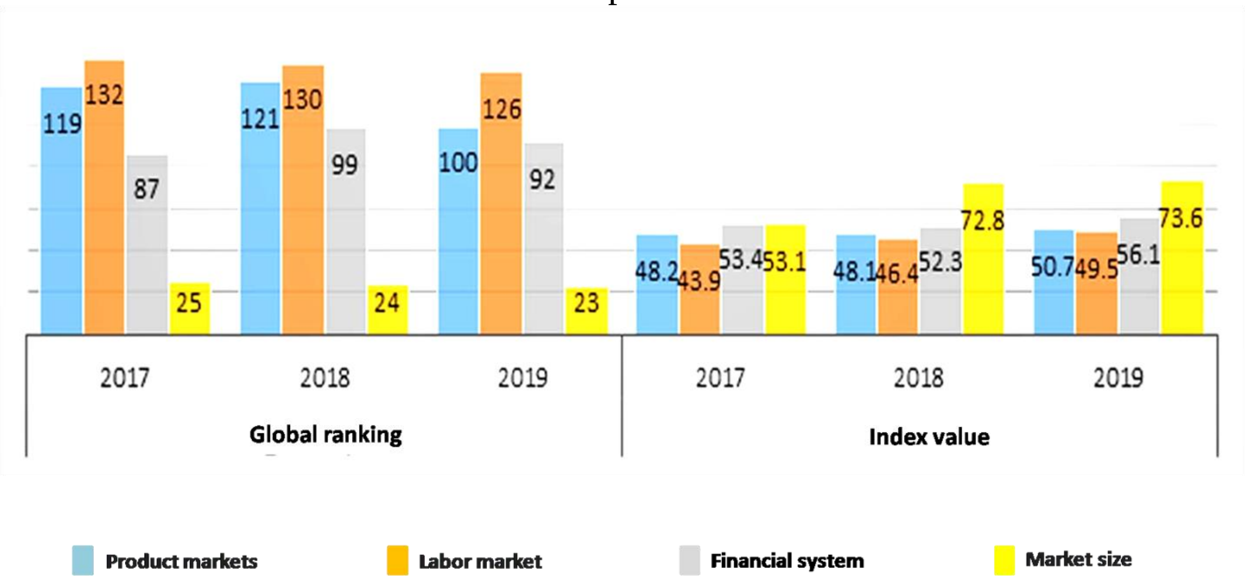
Figure 15. The global ranking of Egypt's competitiveness in the human capital axis and its pillars



Source: (WEF 2019)

Egypt's ranking in the education and skills pillar has remained stable in 2018, 2019 at 99th globally, while ranking in the health was lowered from 98th in 2017, to 99th in 2018 and to 104th in 2019 (Figure 15).

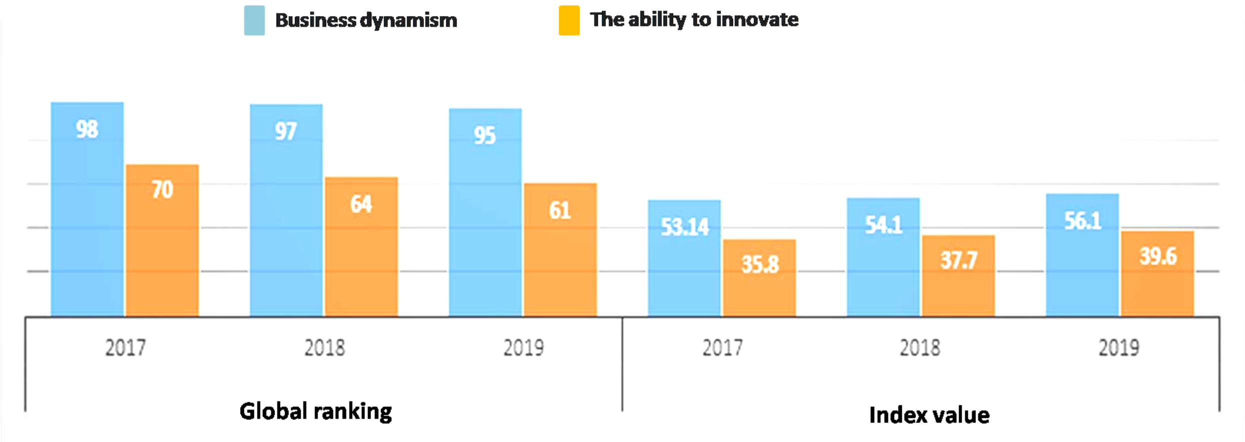
Figure 16. The global ranking of Egypt's competitiveness in the market axis and its pillars



Source: (WEF 2019)

Egypt's ranking in all the pillars of the market axis achieved an improvement in 2019. The market size pillar is one of the most important pillars in the global competitiveness index in which Egypt occupies a very advanced position, which is 23th (Figure 16).

Figure 17. The global ranking of Egypt's competitiveness in the innovation environment axis and its pillars



Source: (WEF 2019)

Egypt's ranking in the business dynamics pillar advanced from 98th in 2017 to 97th in 2018 and to 95th in 2019. The innovation capacity pillar was advanced as well from 70th in 2017, to 64th in 2018 and to 61st in 2019 (Figure 17).

3. Methodology

The effect of digital transformation on competitiveness in Egypt, during the period (1996 – 2019) was discussed as quadratic data, using ARDL model to measure the short and long run effect between digital transformation and competitiveness. Competitive performance was expressed as a dependent variable, and high technology exports, research and development expenditures, the number of mobile phone subscribers per 100 people, and the number of fixed-line subscribers per 100 people were expressed as independent variables in this model.

The study used the dynamic relation between competitive performance and digital transformation, as follows:

$$MVA = \beta 0 + \beta 1\ (MHTEC) + \beta 2\ (RDGDP) + \beta 3\ (PAT) + \beta 4\ (NFDI\_GDP) + \beta 5\ (MOB) + \beta 6\ (FTS) + \varepsilon$$

Where,

MVA: competitive performance.

MHTEC: the high technology exports measured in constant US Dollars.

RDGDP: the research and development expenditure measured in constant US Dollars.

PAT: the number of patents registered by the individual.

NFDI_GDP: net foreign direct investment.

MOB: the number of mobile phone subscribers per 100 people.

FTS: the number of fixed-line subscribers per 100 people.
ε: the error term

The quadratic annual sample data covered the period of 1996 Q1 to 2019 Q4, and was collected from the World Bank Data Base (2020).

3.1. The Unit Root Test

A unit root test was performed using the augmented Dickey–Fuller (ADF) method to examine the stability of the time series, as the first step to analyze the data and examine the properties of the time series to avoid the false regression problem (Behera, 2015). The null hypothesis was: the time series has a unit root problem (the time series is not static), and the alternative hypothesis was: the time series does not have a unit root problem (the time series is static). Also, the Perron-Phillip Test (PP test) was used to ensure the safety of the results from the Extended Dickey Fuller test (Afshan et al. 2018).

3.1.1. Perron-Phillip Test (PP)

Table 1. Results of Perron-Phillip Test

At Level		**MVA**	**NFDI_GDP**	**RDGDP**	**PAT**	**HTEC**	**FTS**	**MOB**
With Constant	t-Statistic	-1.1592	-1.5953	-0.7273	-1.1333	-3.1842	-2.1344	-9.3633
	Prob.	0.6893	0.4811	0.8340	0.7000	0.0240	0.2319	0.0000
With Constant & Trend	t-Statistic	-1.5197	-1.5785	-1.8672	-2.1342	-3.7331	-1.5814	-1.0764
	Prob.	0.8161	0.7943	0.6637	0.5201	0.0248	0.7932	0.9270
Without Constant & Trend	t-Statistic	2.8295	-0.8856	-1.0898	0.9498	-0.9820	0.7272	-0.4621
	Prob.	0.9988	0.3299	0.2482	0.9081	0.2900	0.8702	0.5126
At First Difference		**d(MVA)**	**d(NFDI_GDP)**	**d(RDGDP)**	**d(PAT)**	**d(HTEC)**	**d(FTS)**	**d(MOB)**
With Constant	t-Statistic	-10.3497	-9.6008	-9.6958	-9.6944	-9.5959	-9.7105	-10.4966
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
With Constant & Trend	t-Statistic	-10.3847	-9.5533	-9.6499	-9.6657	-9.5466	-10.4632	-24.3864
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Without Constant & Trend	t-Statistic	-9.6437	-9.6437	-9.6437	-9.6437	-9.6437	-9.6437	-9.6437
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: by Author using Eviews

The Perron-Phillip Test results showed the time series for HTEC and Mob variables only are static at the level, but the other variables aren't static. After taking the first differences, the time series of all variables for the first differences are static with a confidence degree of 99% without constant and trend (Table 1).

3.1.2. The Augmented Dickey–Fuller Test (ADF)

Table 2. Results of the Augmented Dickey–Fuller Test (ADF)

At Level		**MVA**	**NFDI_GDP**	**RDGDP**	**PAT**	**HTEC**	**FTS**	**MOB**
With Constant	t-Statistic	-1.1489	-2.7497	-0.7273	-1.1204	-2.9293	-1.8962	-2.0464
	Prob.	0.6936	0.0698	0.8340	0.7052	0.0457	0.3328	0.2669
With Constant & Trend	t-Statistic	-1.5612	-2.7557	-1.8559	-2.0603	-3.4316	-1.8700	-1.9018
	Prob.	0.8009	0.2176	0.6694	0.5607	0.0533	0.6618	0.6451
Without Constant & Trend	t-Statistic	2.6353	-1.6941	-1.0854	0.9438	-0.9724	0.1621	-0.7599
	Prob.	0.9979	0.0853	0.2499	0.9072	0.2939	0.7309	0.3844
At First Difference		**d(MVA)**	**d(NFDI_GDP)**	**d(RDGDP)**	**d(PAT)**	**d(HTEC)**	**d(FTS)**	**d(MOB)**
With Constant	t-Statistic	-10.3482	-2.7238	-9.6958	-9.6944	-9.5959	-2.5224	-2.8981
	Prob.	0.0000	0.0739	0.0000	0.0000	0.0000	0.1135	0.0496
With Constant & Trend	t-Statistic	-10.3622	-2.7130	-9.6499	-7.1069	-9.5466	-2.6430	-1.8976
	Prob.	0.0000	0.2340	0.0000	0.0000	0.0000	0.2628	0.6473
Without Constant & Trend	t-Statistic	-3.1365	-2.7328	-9.6437	-9.6437	-9.6437	-2.4972	-4.4505
	Prob.	0.0020	0.0067	0.0000	0.0000	0.0000	0.0129	0.0000

Source: by Author using Eviews

The augmented Dickey–Fuller (ADF) test results showed the time series for HTEC and NFDI_GDP variables only are static at the level, but the other variables aren't static. And after taking the first differences, the time series of all variables for the first differences are static with a confidence degree of 99% without constant and trend. So all variables are being stationary at the first difference and no variable is static at the second difference which is a necessary condition for applying ARDL methodology (Table 2).

4. Results, Discussion and Conclusions

4.1. Result of the Model

The autoregressive distributed lag ARDL model was used to measure the impact of digital transformation on competitiveness in Egypt during short and long runs, in addition to the ARDL error correction model ECM to ensure the possibility of return to equilibrium, and correction of short run errors in the long run (Afshan and Khan 2018).

4.1.1. The Result of the ARDL Model

The ARDL model result was performed by the following Estimation Equation:

MVA = C (1)*MVA (-1) + C (2)*RDGDP + C (3)*PAT + C (4)*PAT (-1) + C (5)*NFDI_GDP + C (6)*MHTEC + C (7)*MHTEC (-1) + C (8)*MHTEC (-2) + C (9)*MHTEC (-3) + C (10)*MHTEC (-4) + C (11)*MOB + C (12)*MOB (-1) + C (13)*MOB (-2) + C (14)*MOB (-3) + C (15)*MOB (-4) + C (16)*FTS + C (17)*FTS (-1) + C (18)

Table 3. Results of the *ARDL* Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.894601	2.338074	0.382623	0.0103
MVA(-1)	0.726867	0.055610	13.07080	0.0000
RDGDP	0.407126	0.499690	-0.814758	0.0178
PAT	0.01023	0.001619	-0.631812	0.0295
PAT(-1)	0.002310	0.001496	1.543749	0.0269
NFDI_GDP	0.049584	0.053290	0.930465	0.0552
MHTEC	0.251221	0.039612	6.342079	0.0000
MHTEC(-1)	-0.169718	0.049143	-3.453592	0.0009
MHTEC(-2)	1.77E-14	0.045758	3.87E-13	0.0000
MHTEC(-3)	-2.35E-14	0.045758	-5.14E-13	0.0000
MHTEC(-4)	0.115310	0.038884	2.965519	0.0041
MOB	0.03845	0.022034	-0.174519	0.0619
MOB(-1)	-0.043397	0.021927	-1.979109	0.0515
MOB(-2)	-2.20E-14	0.021523	-1.02E-12	0.0000
MOB(-3)	3.33E-14	0.021523	1.55E-12	0.0000
MOB(-4)	0.051913	0.020796	2.496298	0.0148
FTS	0.947438	0.145067	6.531037	0.0000
FTS(-1)	-0.550182	0.134932	-4.077462	0.0001
R-squared	0.995071	**Mean dependent var**		28.93813
Adjusted R-squared	0.993939	**S.D. dependent var**		8.561606
S.E. of regression	0.666559	**Akaike info criterion**		2.200205

Sum squared resid	32.87826	**Schwarz criterion**	2.693598
Log likelihood	-83.20941	**Hannan-Quinn criter.**	2.399342
F-statistic	878.7795	**Durbin-Watson stat**	2.172118
Prob(F-statistic)	0.000000		

Source: by Author using Eviews

The Substituted Coefficients are as follows (Table 3):
MVA = 0.726866906721*MVA (-1) + 0.40712618941*RDGDP + 0.0102279605463*PAT + 0.0023099387979*PAT (-1) + 0.0495841477353*NFDI_GDP + 0.251221414636*MHTEC - 0.169718476122*MHTEC (-1) + 1.76938060013e-14*MHTEC (-2) - 2.35344969263e-14*MHTEC (-3) + 0.115310158008*MHTEC (-4) + 0. 0384536633724*MOB - 0.0433965282909*MOB (-1) - 2.20045098398e-14*MOB (-2) + 3.3265443984e-14*MOB (-3) + 0.0519134826421*MOB (-4) + 0.947437690197*FTS - 0.55018178565*FTS (-1) + 0.894601399239

Results indicated that the explanatory level of the model, R-squared, was equal to 0.955, which means that the independent variables can explain about 95.5% of variation in the competitive performance, and the rest were due to other factors, including random errors. Also, the overall significance of the model, F-statistic, was significant (878.77), which means that the estimated model is significant (accepting alternative hypothesis). This indicated that the independent variables have a significant effect on the competitive performance in Egypt. Moreover, results indicated partial significance of the model where parameters were statistically significant. These parameters differed substantially from zero and as a result the importance of the independent variables was reflected.

Given that the value of the Durbin–Watson coefficient was 2.17, the corresponding tabular value indicated that there was no false slope and the estimated model was free of a linear correlation problem between the independent variables. These estimated coefficients were consistent with the economic theory. There was a positive relationship between the competitive performance variable MVA and the lag value of the same variable, as an increase in competitive performance in last year by one point led to a 0.72-point increase in competitive performance in current year. The research and development expenditure positively affected competitive performance as one-point increase led to an increase of 0.41-point in competitive performance, and the number of patents registered by the individual positively affected MVA as one-point increase led to an increase of 0.01-point in MVA. Moreover, the net foreign direct investment positively affected MVA as one-point increase led to an increase of 0.05-point in MVA, and one-point increase in the high technology exports led to an increase of 0.25-point in competitive performance. Also, the number of mobile phone and fixed-line subscribers positively affected MVA as one-point increase in MOB, FTS led to an increase of 0.03, 0.94-point in competitive performance respectively.

4.1.2. Results of the Model in the Long Term

The ARDL Long run form and Test Bounds were conducted to ascertain whether there is a long-term relationship between the dependent variable and the independent variables (Table 4).

Table 4. ARDL Long Run Form and Bounds Test (Conditional Error Correction Regression)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.894601	2.606972	0.343157	0.07325
MVA(-1)*	0.273133	0.062006	-4.404976	0.00000
RDGDP**	0.407126	0.557158	-0.730719	0.04673
PAT(-1)	0.001287	0.001082	1.190094	0.02378
NFDI_GDP**	0.049584	0.059418	0.834491	0.04067
MHTEC(-1)	0.196813	0.045875	4.290185	0.00001
MOB(-1)	0.004672	0.008867	0.526858	0.05999
FTS(-1)	0.397256	0.102678	3.868962	0.00002
D(PAT)	-0.001023	0.001805	-0.566644	0.05727
D(MHTEC)	0.251221	0.044168	5.687921	0.00000
D(MHTEC(-1))	-0.115310	0.043356	-2.659639	0.00096
D(MHTEC(-2))	-0.115310	0.043356	-2.659639	0.00096
D(MHTEC(-3))	-0.115310	0.043356	-2.659639	0.00096
D(MOB)	-0.003845	0.024568	-0.156518	0.08761
D(MOB(-1))	-0.051913	0.023188	-2.238815	0.00282
D(MOB(-2))	-0.051913	0.023188	-2.238815	0.00282
D(MOB(-3))	-0.051913	0.023188	-2.238815	0.00282
D(FTS)	0.947438	0.161751	5.857389	0.00000

Source: by Author using Eviews

Table 5. F-Bounds Test Results

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.700417	10%	2.12	3.23
K	6	5%	2.45	3.61
		2.5%	2.75	3.99
		1%	3.15	4.43

Source: by Author using Eviews

Table 6. T-Bounds Test Results

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.404976	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.5%	-3.13	-4.66
		1%	-3.43	-4.99

Source: by Author using Eviews

It was evident that the calculated values of F and T (Tables 5 and 6) were greater than the upper and lower limits of the tabular critical values of Pesaran et al. (2000), and as a result, the null hypothesis can be rejected, and we can conclude that there was not co-integration or long run relationships among the variables. The alternative hypothesis can be accepted, and we can conclude that there were co-integration or long run relationships among the model variables.

4.1.3. Results of the Model in the Short Term

ARDL Error Correction Model (ECM) was performed to ensure that there was a short-term relationship between the dependent variable and the independent variables, as well as to identify the rate of correction of short-term deviations over the long term (Cheon and Urpelainen 2012). In other words, the speed at which correction of the short-term deviations and return to the long-term equilibrium position was performed (Tables 7, 8, and 9).

Table 7. ARDL Error Correction Regression, ECM Regression (Unrestricted Constant and No Trend)

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.894601	0.148949	6.006100	0.0000
D(PAT)	-0.001023	0.001543	-0.662777	0.0509
D(MHTEC)	0.251221	0.038293	6.560479	0.0000
D(MHTEC(-1))	-0.115310	0.040479	-2.848628	0.0057
D(MHTEC(-2))	-0.115310	0.040479	-2.848628	0.0057
D(MHTEC(-3))	-0.115310	0.040479	-2.848628	0.0057
D(MOB)	-0.003845	0.019496	-0.197237	0.0442
D(MOB(-1))	-0.051913	0.018462	-2.811900	0.0063
D(MOB(-2))	-0.051913	0.018462	-2.811900	0.0063
D(MOB(-3))	-0.051913	0.018462	-2.811900	0.0063
D(FTS)	0.947438	0.142574	6.645231	0.0000
CointEq(-1)*	-0.273133	0.051614	-5.291801	0.0000

Source: by Author using Eviews

Table 8. F-Bounds Test Results

Test Statistic	Value	Signif.	I (0)	I (1)
F-statistic	3.700417	10%	2.12	3.23
K	6	5%	2.45	3.61
		2.5%	2.75	3.99
		1%	3.15	4.43

Source: by Author using Eviews

Table 9. T-Bounds Test Results

Test Statistic	Value	Signif.	I (0)	I (1)
t-statistic	-5.291801	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.5%	-3.13	-4.66
		1%	-3.43	-4.99

Source: by Author using Eviews

The calculated values of F and T (Tables 8 and 9) are greater than the upper and lower limits of the tabular critical values of Pesaran et al. (2000), and as a result, the null hypothesis can be rejected and the alternative hypothesis that confirms the existence of a short-term relationship between dependent variable and independent variables in the model can be accepted. This confirmed the significance of the short-term relationship.

Accordingly, the Cointegrating Equation can be stated as:

D (MVA) = 0.894601399225 -0.273133093279*MVA (-1) - 0.407126189407*RDGDP** + 0.001287142743*PAT (-1) + 0.049584147736*NFDI_GDP** + 0.196813096522*MHTEC (-1) + 0.004671588014*MOB (-1) + 0.397255904547*FTS (-1) - 0.001022796055*D (PAT) + 0.251221414636*D (MHTEC) - 0.115310158008*D(MHTEC (-1)) -0.115310158008*D (MHTEC(-2)) - 0.115310158008*D (MHTEC (-3)) -0.003845366337*D (MOB) - 0.051913482642*D (MOB (-1)) -0.051913482642*D (MOB (-2)) - 0.051913482642*(MVA - (-1.49057803*RDGDP (-1) + 0.00471251*PAT (-1) + 0.18153841*NFDI_GDP (-1) + 0.72057580*MHTEC (-1) + 0.01710371*MOB (-1) + 1.45444076*FTS (-1)) + 0.947437690197*D (FTS))

4.1.4. Results of the Model Quality Tests

The following tests were performed to examine the quality of the model output (Tables 10 and 11 and Figures 18, 19, and 20):

4.1.4.1. Breusch - Godfrey Serial Correlation LM Test

Table 10. Results of Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.327508	Prob. F (4,70)	0.2683
Obs* R-squared	6.486825	Prob. Chi-Square (4)	0.1656

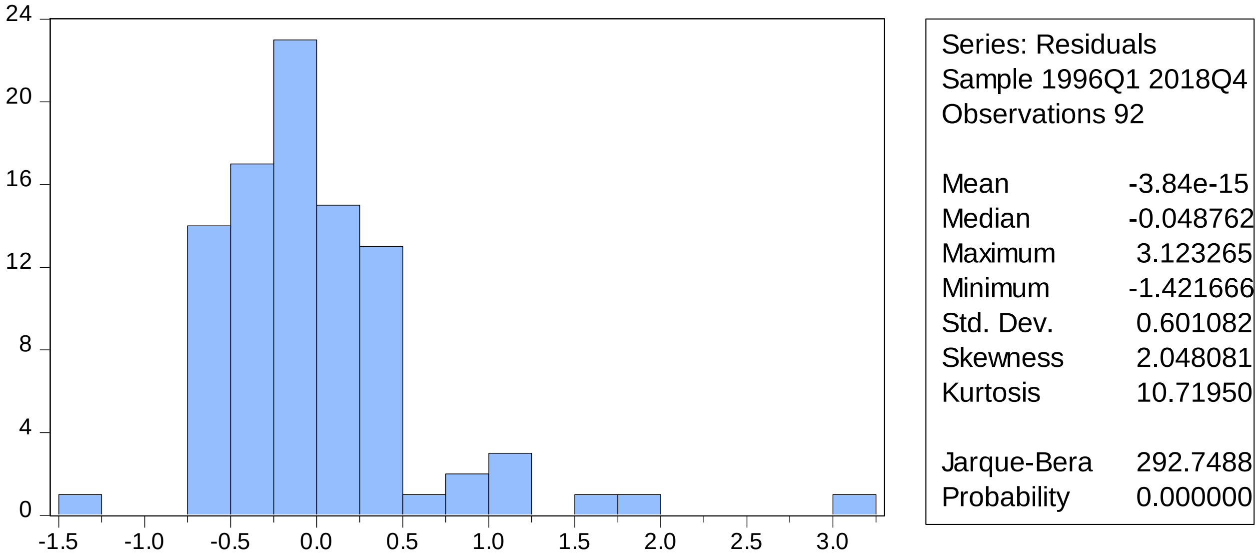
Source: by Author using Eviews

There was a good indicator for the model quality since P-value was greater than 5%, which meant accepting the null hypothesis since the residuals have no serial self-correlation and rejecting the alternative hypothesis since the residuals are self-correlated (Table 10).

4.1.4.2. Histogram Normality Test

Histogram Normality test was performed to ensure that residuals had a normal distribution (Figure 18).

Figure 18. Residuals normal distribution and statistical parameters



Source: by Author using Eviews

Values of (Jarque - Bera) and (P-value) were greater than 5% (Probability is 0.000000), accordingly, the null hypothesis can be accepted since residuals had a normal distribution, and the alternative hypothesis can be rejected because residuals did not have a normal distribution (Figure 18). This is a good indicator of the model quality.

4.1.4.3. The Heteroscedasticity Test

Table 11. Heteroskedasticity Test ARCH Results

F-statistic	0.046034	Prob. F (4,83)	0.9959
Obs*R-squared	0.194794	Prob. Chi-Square (4)	0.9956

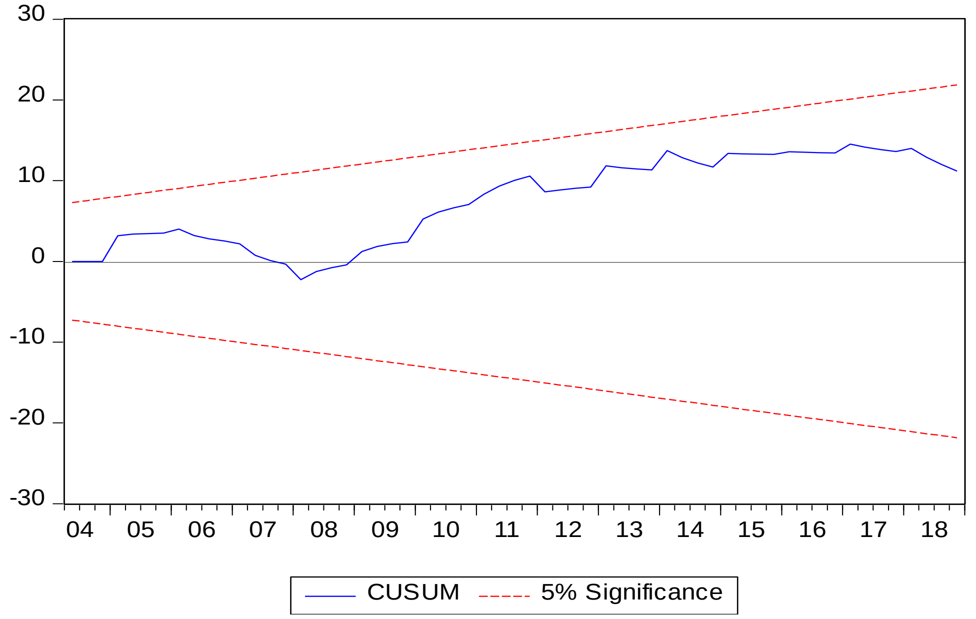
Source: by Author using Eviews

Heteroscedasticity test for residues indicated that there is no variation in the residuals, and the null hypothesis can be accepted which is another good indication of the model quality (Table 11).

4.1.4.4. The Stability Diagnostic Test

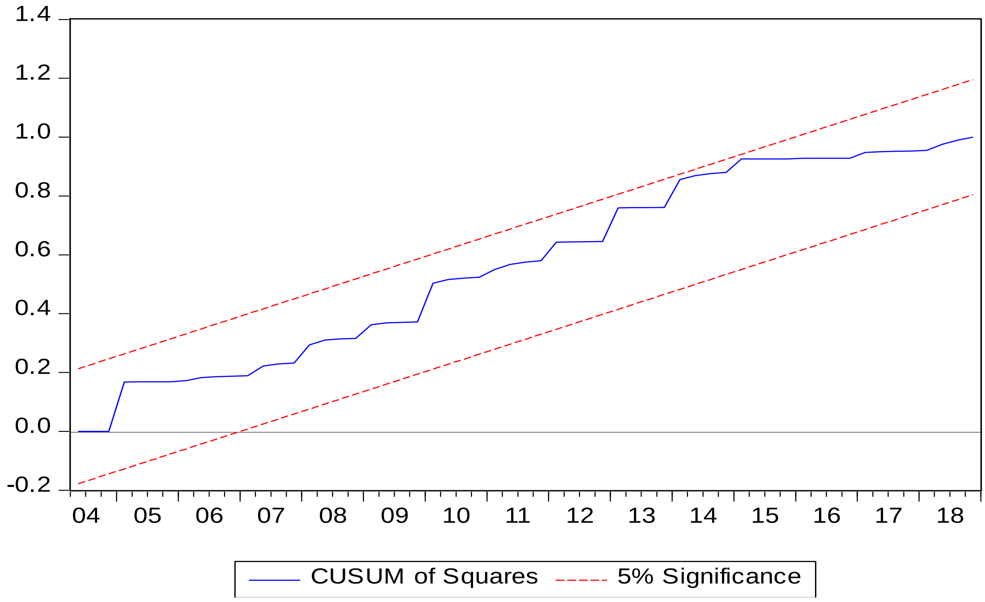
The Sum Cumulative test (Cusum test) and the CUSUM of Squares test were performed to ensure that there were no structural changes in the data used in the study and that it is stable over time. The extent of consistency in the model between short-term correction results with long-term parameters, and the structural stability of the parameters (Figure 19).

Figure 19. Cusum test showing the extent of consistency in the model between short-term correction results with long-term parameters



Source: by Author using Eviews

Figure 20. CUSUM of Squares test showing the stability of the parameters over time



Source: by Author using Eviews

CUSUM statistics were within the critical limits at 5% level of significance, and it was evident that the estimated parameters were structurally stable over time during the study period.

4.2. Discussion

The analysis of effect of digital transformation on competitiveness in Egypt indicated a significant positive association from 1996 through 2019. These findings are consistent with the conclusions of Hölzl (2009) who analyzed how innovation affected employment growth in 16 economies. His findings indicated an association between technological innovation and increase of competitiveness. Also, he indicated the significance of technological innovation influence on energy intensity in small and medium enterprises (SMEs). The relationship between innovation and employment growth in the United States was assessed by Coad and Rao (2011). They found a positive correlation between innovation and employment growth for fast growing high-tech firms. No correlation was found in high-tech firms which characterized by a negative employment growth. This indicated the relationship between technological innovation and the increase in competitiveness. Similarly, Bogliacino (2012) applied employment empirical analysis on 677 European large publicly traded companies over the period (1990 – 2008) and concluded that there was not a significant effect in low-tech manufacturing sectors, but the effect was evident in high-tech manufacturing. This supports the relationship between technological innovation and competitiveness. As well as Vivarelli (2014) measured a positive correlation between innovation technology and employment.

Voigt (2014) showed increase in trends of the energy intensity at sampled countries was majorly attributed to increase technological transformation. Van Roy (2015) applied patent data on a sample of European firms over the period (2003-2012), to investigate the innovation and employment nexus. They indicated a positive effect of patenting activities on employment, and the result was significant only in high-tech manufacturing sector. This indicated the relationship between technological innovation and the increase of competitiveness. Wurlod and Noailly (2018) found a negative association between innovation utilizing the proxy of green patents and energy intensity which supports the association between technological innovation and competitiveness. Also, Herrerias (2016) found a positive relation between innovation technology and competitiveness. Kobayashi (2013) indicted that China is progressing towards curtailing rising levels of energy intensive financial systems and the existence of a relationship between technological innovation and increase of competitiveness,

4.3. Conclusion

This research provided an economic analysis through the effect of digital transformation on competitiveness in Egypt, adding to the ongoing debate about the factors affects their current situation. Egypt is working hard to achieve high rates of technological innovation, which reflects the country's vision to be highly competitive globally by transferring technology to all economic activities, achieve economic growth and increase international presence and competitiveness.

References

Afshan, S., Sharif, A., Loganathan, N., Jammazi, R. 2018. Time–frequency Causality between Stock Prices and Exchange Rates: Further Evidences from Co-integration and Wavelet Analysis. Physical Statistical Mechanics and its Applications. https://doi.org/10.1016/j.physa.2017.12.033

Afshan, Sharif, S., Khan. 2018. Does Democracy Embolden Economic Growth in Pakistan? Evidence from ARDL Bound Testing and Rolling Window Analysis. *International Journal of Economics and Business Research*. DOI: 10.1504/IJEBR.2018.089684

Akpotaire, Ufuoma Barbara. 2013. Patent Strategies for Companies Doing

Business in Nigeria, No. 31, pp.40-41.

Behera, J. 2015. Examined the Energy-Led Growth Hypothesis in India, Evidence from Time Series Analysis, Energy Economics Letters. Available at https://www.ipcc.ch/site/assets/uploads/sites/4/2019/11/10_Chapter-7.pdf

Bogliacino, Francesco and Marco Vivarelli. 2012. The Job Creation Effect of R&D Expenditures, *Australian Economic Papers*, June. https://doi.org/10.1111/j.1467-8454.2012.00425.x

Cheon, A., J. Urpelainen. 2012. Oil Prices and Energy Technology Innovation: An Empirical Analysis, Global Environmental Change. https://doi.org/10.1016/j.gloenvcha.2011.12.001

Coad, Alex and Rekha Rao-Nicholson. 2011. The Firm-Level Employment Effects of Innovations in High-Tech US Manufacturing Industries, *Journal of Evolutionary Economics*, vol. 21, issue 2, PP. 255-283. DOI: 10.1007/s00191-010-0209-x

Dogan, Ebru. 2016. The Effect of Innovation on Competitiveness, Turkey, Istanbul, Istanbul University, Faculty of Economics, pp. 60-65. Available at https://dergipark.org.tr/tr/download/article-file/268727

Garrone, P., Grilli, L., Mrkajic, B. 2018. The Role of Institutional Pressures in the Introduction of Energy-Efficiency Innovations. Business Strategy and the Environment. https://doi.org/10.1002/bse.2072

Henry, U. 2018, Globalization and Environmental Issues: A New Framework for Security Analysis, *Humanities and Social Sciences Letters.* Available at http://www.conscientiabeam.com/journal/73/abstract/3073

Hölzl, Werner. 2009. Is the R&D Behaviour of Fast-Growing SMEs Different? Evidence from CIS III Data for 16 Countries. April. *Small Business Economics* 33(1). PP. 59-75. DOI: 10.1007/s11187-009-9182-x

Kleynhans, Ewert P.J. 2013. Factors Determining Industrial ompetitiveness and the Role of Spillovers, *The Journal of Applied Business Research*, South Africa, North-West University, Volume 32, Number 2, p.528. DOI: 10.19030/jabr.v32i2.9594

Kobayashi, T., Kanematsu, H., Hashimoto, R., Morisato, K., Ohashi, N. Yamasaki, H., Takamiya, S. 2013. Study on Environment and Energy Using Belonging Materials. *International Journal of Sustainable Development and World Policy. Available at https://ideas.repec.org/a/pkp/ijsdwp/2013p50-58.html*

Ministry of Communications and Information Technology MCIT. 2019.

ICT Indicators Bulletin, March, Egypt, Cairo. Available at https://www.mcit.gov.eg/Upcont/Documents/Publications_492019000_EN-ICT-Indicators-Quarterly-Bulletin-Q1.pdf

Mukadasi, B. 2018. Mixed Cropping Systems for Sustainable Domestic Food Supply of the Smallholder Farming Communities in Nakasongola District, Central Uganda. Canadian Journal of Agriculture and Crops. DOI:10.20448/803.3.1.42.54

Oxford Insights. 2019. The Government Readiness Report for Artificial Intelligence, Oxford. Available at https://www.oxfordinsights.com/ai-readiness2019

Pesaran, M.H., Shin, Y., Smith, R.J. 2000. Structural Analysis of Vector Error Correction Models with Exogenous I(1) Variables, *Journal of* Econometrics. https://doi.org/10.1016/S0304-4076(99)00073-1

Suryanto, T., Haseeb, M., Hartani, N.H. 2018. The Correlates of Developing Green Supply Chain Management Practices: Firms Level Analysis in Malaysia, *International Journal of Supply Chain Management.* Available at https://www.researchgate.net/publication/329040632_The_Correlates_of_Developing_Green_Supply_Chain_Management_Practices_Firms_Level_Analysis_in_Malaysia

The World Bank Data Base. 2020. Retrieved from: https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT?view=chart.

The World Economic Forum WEF. 2019. The Global Competitiveness Report. Available at http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

The World Economic Forum WEF. 2018.The Arab World Competitiveness Report 2018. Available at http://www3.weforum.org/docs/Arab-World-Competitiveness-Report-2018/AWCR%202018.0724_1342.pdf

Tsoukatos, Evangelos. 2018. Determinants of Technological and Non-Technological Innovation in SMEs: the Case of Crete, *Global Business and Economics Review*, Greece, University of Applied Sciences of Crete, Vol. 20, No. 5/6, pp.544-545. DOI: 10.1504/GBER.2018.10009290

United Nations Industrial Development Organization UNIDO. 2013. The Industrial Competitiveness of Nations, Competitive Industrial Performance Report, Vienna, p.7. Available at https://www.unido.org/sites/default/files/2013-

07/Competitive_Industrial_Performance_Report_UNIDO_2012_2013_0.PDF

Van Roy, Benjamin. 2012. Adaptive Execution: Exploration and Learning of Price Impact, SSRN Electronic Journal 63(5), July. DOI: 10.2139/ssrn.2118111

Vassakis, Konstantinos, Evangelos Tsoukatos. 2016. Knowledge Management and Innovation in Enterprises: a Theoretical A pproach, The 5th Advanced Research in Scientific Areas, Greece, Technological Educational Institute of Crete Heraklion, p.38. DOI: 10.18638/arsa.2016.5.1.842

Vivarelli, Marco. 2014. Innovation, Employment and Skills in Advanced and Developing Countries: A Survey of Economic Literature, December. pp. 123-154. https://doi.org/10.2753/JEI0021-3624480106

Voigt, S., De Cian, E., Schymura, M., Verdolini, E. 2014. Energy Intensity Developments in 40 Major Economies: Structural Change or Technology Improvement? Energy Economics. https://doi.org/10.1016/j.eneco.2013.10.015

Wurlod, J.D., Noailly, J. 2018. The Impact of Green Innovation on Energy Intensity: An Empirical Analysis for 14 Industrial Sectors in OECD Countries, Energy Economics. https://doi.org/10.1016/j.eneco.2017.12.012

رابط المجلة: https://jsst.journals.ekb.eg/