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MEASURING THE TECHNOLOGY READINESS INDEX ON GDP USING A (VAR) MODEL IN EGYPT FOR THE PERIOD (2010-2022)

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Abstract
Technological readiness has become one of the pillars of the growth of the modern economy based on digital technology, the Internet and the rapid and growing digital communication of the economy, as electronic readiness is an attractive and stimulating factor for international economic transactions and investments based on technology, abilities in areas such as financial system development, private sector finance, research and development, and, talents and media, which has become the leader in the development of the economy in any country, especially developed countries and some developing countries seeking to develop their economy and create development in their economies in order to catch up with the global economic and technological development. Hence, this research came as an attempt to measure the total index of border technological readiness on GDP growth using the Vector Auto Regression Estimates (VAR) model in Egypt for the period (2010-2022) and the research found that there is a positive and long term positive correlation between the total e-readiness index and economic growth represented by GDP in Egypt.

Keywords: E-readiness, GDP, AVR model.

Introduction

In recent times, there has been a remarkable leap forward in communication systems and the widespread adoption of information technology. This has brought about a sea change in how we work and what we measure. As a result, we now analyses, process, and exchange economic activities in whole new ways. This has given rise to a new type of economic system called "electronic readiness," which is crucial for meeting the various social and economic challenges that nations face today, particularly in areas like sustainable development, which aims to alleviate poverty and unemployment. To put it simply, e-readiness is a measure of how well an economy is prepared to conduct its day-to-day operations in the digital sphere,

making use of various forms of electronic communication and information technology in order to foster collaboration amongst all stakeholders, increase gross domestic product (GDP), and promote overall economic growth.

The research problem: the lack of technological readiness in developing countries, including Egypt, is a weak factor for economic growth and thus negatively reflects on the GDP.

Importance of the research: It lies in the pioneering and leading role of technology, communication and creativity as a catalyst for economic growth.

Objective of the research: The research aims to clarify the relationship between the total e-readiness index and GDP growth in Egypt.

Research hypothesis: The research hypothesis is that the e-readiness score correlates positively with Egypt's GDP development over the long term.

Research methodology: We relied on economic measurement and time series statistical methods for both research variables.

The structure of the research: We deal with two axes:

The first axis: The conceptual framework of the technology readiness index, its objectives and its developmental role in Egypt.

The second axis: Measuring the border technology readiness index on GDP using a VAR model in Egypt for the period (2010-2022).

Axis I: Theoretical framework (technology readiness index, its objectives, and its role in development)

Firstly: E-readiness index concept :

Multiple regional, international, and multinational approaches to gauging a nation's e-readiness form the basis of the e-readiness index. When we talk about the E-Readiness Index, we're talking about a different way of looking at the capacity of certain global economies to generate transactions that rely heavily on specialized ICTs. (Nazarov & Others, 2019: 51). The concept of the E-Readiness Index is also related to how international transactions are completed and their readiness at the virtual level (Mueller, 2017: 183). The E-Readiness Index is defined as ‘a useful, unique and easy-to-use tool to assess the gap between a state's current state of cybersecurity and the cyber capabilities needed to achieve its economic vision’ (Hathaway et al., 2015: 7).

Secondly: Objectives of e-readiness

The term e-readiness refers to the use of computer technology and the Internet to improve the process of creating economic value more efficiently and effectively, as well as improving organisations through the changes that new technologies bring about in how work is developed and how wealth is created and maximised within this system (Mergel, 2018: 122). The main objective of using e-readiness indicators is to raise awareness about the fundamental changes that occur between the value creation chain of an organisation or its internal structure with a sustainable cyber domain and the GDP growth of each country when digitising the country (Muehlburger et al., 2019:3).

Third: The structure of the e-readiness index in the Arab countries

Public and private institutions adopt the e-readiness model that merges with the model of managing institutional financial, human, technical and knowledge capacities, here it is necessary to focus the attention of these institutions on innovation by focusing on the strategic dimensions of the Arab vision of the e-readiness index, namely: (Arab Federation for Digital Economy, 2022: 9).

1. **Digital governance:** Digital governance is the systematic use of ICTs to meet the needs of society by providing public services in a seamless, fast and accessible way 24/7. Here, the digitalisation index will improve the efficiency and effectiveness of the government sector (Al-tarawneh & Al-tarawneh, 2023: 4).
2. **Digital Foundations:** From infrastructure to rules and regulations to digital skills and funding, this dimension aims to create the groundwork for a robust digital ecosystem. On a global, national, and even organizational scale, these domains are crucial to the advancement of digital systems.
3. **Digital readiness of individuals:** To guarantee that digital technologies enhance the quality of life of civil society overall, including disadvantaged groups and minorities, this component aims to make the person the central focus of any system that aspires to digital transformation.
4. **Digital innovation:** One component, vector, or growth path out of crises is digital innovation. Many initiatives in local industries receive funding from the innovation environment, which can be viewed as a driving force behind digitalisation. This includes the economical and adaptable use of new digital technologies like 3D printing, AI, big data, and cloud computing, which result in a revolution of ideas and the production of new sources of value. (Darm et al., 2020: 14) to revolutionise concepts, create new sources of added value and support many projects within local industries (Darm et al., 2020: 14).
5. **Digital business:** This aspect seeks to ensure that businesses reap the most benefits from digital transformation processes. This includes digitising work flows, increasing future consumer value, improving cost efficiency, and expanding customer base through opportunities to enter new markets. Seven indicators can be relied upon in the design of the Arab e-Readiness Index, such as the World Bank and the World Economic Forum, published annually by reliable sources: (Council of Arab Economic Unity, 2021: 18)

1. E-Government Development Index 2018 prepared by the United Nations E-Government Survey 2018
2. Ease of Doing Business Index 2018 prepared by the World Bank Group for Doing Business 2019.
3. Global Competitiveness Index 2018 prepared by the World Economic Forum.
4. Global Innovation Index 2018 prepared by the Cornell SC Johnson School of Business in 2018.
5. Sustainable Development Goals Indicators and Dashboards Report 2018 co-authored by the Bertelsmann Foundation and the Sustainable Development Solutions Network
6. Global Entrepreneurship Index 2018 prepared by the Global Institute for Entrepreneurship and Development.
7. Global Competitiveness Report 2017-2018.

Fourth: The developmental role of the e-readiness index in Egypt

Internet penetration in Arab countries varied from country to country, but on average it rose by more than 50% between 2018 and 2010. This marked a dramatic shift in the Arab world's reliance on ICT. 2010), with a disparity in usage between Arab countries. Although the infrastructure in these countries is not digitally advanced in terms of internet speed, number of users, and prices are still high by international standards (Nazarov & Other, M. A., 2019: 22). It can be seen that the issue of investing in people in line with the National Project for the Development of the Egyptian Family has received the attention of successive governments in Egypt. From trying to introduce multiple improvements in the structure of institutions and the health, education and housing sectors in providing the right to decent housing, as well as expanding the availability of all services to citizens in a digital way, to introducing more radical reforms and real breakthroughs in strategies to invest in human capital increasingly to diversify economic activity, with much emphasis on the dimensions of quality, transparency and competitiveness (Hassouna, 2008: 117). Present policies seek to enhance the execution of the PoA, which stands for the Programme of Action to Eliminate All Forms of Discrimination Against Women. and finally succeed in our mission to eradicate all dangerous places and informal settlements, as seen through the eyes of the people who now reside there (Al-Shehhi, 2017, p. 37).

It turns out that the Egyptian government is planning to launch a reform program to raise people's standard of living in the near future. which seeks to enhance the quality of the organization's services by implementing a comprehensive reform of the organisation at its foundational level, with the ultimate goal of enhancing the organization's structure and functioning. in order to achieve growth, employment, and production possibilities that are both inclusive and sustainable, in conformity with the SDGs set out by the World Bank. and ecological systems to promote long-term, equitable, and sustainable economic growth (Shawky et al., 2022: 29).

Today, ICTs have become the driving force for growth and structural changes in the economies of countries, as well as in the lifestyles and relationships of individuals (Schwab, 2016:192). The world is currently living in an era known as the Fourth Industrial Revolution, which has been accompanied by unprecedented technological developments in many fields such as artificial intelligence, machine learning, genetic engineering, cloud computing Technology pertaining to the internet, printing, contemporary finance, and blockchain as it pertains to cryptocurrency. This period is considered the fifth wave in the chain of what the Russian economist (Nikolai D. Kondratiev) called the long cycle, which are cycles triggered by technical innovation, and depend especially on technical transformations and major inventions that change production processes, production relations and the relative shares of production worlds (Arab Monetary Fund, 2020: 192). The e-readiness index is driving the locomotive of development and has proven its ability to revolutionise the economic reality in all its aspects (Arab Federation for the Digital Economy, 2022: 9). The e-Readiness Index will help promote participation in innovative future decision-making and make economic institutions more transparent, effective and accountable, thus the goal of the Border e-Readiness Index aligns with the principles and objectives of the Sustainable Development

Agenda, supports the business environment for the coming years, and contributes to its implementation in the country under study (Soham, 2017: 102).

Fifth: The role of the e-readiness index in improving public service

The e-readiness index provides all ICT devices and means necessary for administrative work and represents a new innovative link in the methods of developing modern administrative work (Duri, 2006: 14), where the adoption of the e-readiness index leads to the introduction of a series of successive changes in the administrative work environment of economic units, with the aim of improving the effectiveness of public service within the programmes of continuous improvement in the quality activities of public institutions that are responsible for providing service activities and tasks. The pioneering role of ICT in achieving qualitative improvement in public service organisations cannot be overlooked (Stephen and Ronald, 1997: 103). In addition to achieving a high degree of comfort and convenience compared to traditional administrative work, while reducing service costs and recording speed in completing tasks in a relatively short time in favour of service seekers, the trend towards electronic public services has increased recently and brought them closer to individuals, customers and companies (Khaldoun, 2005:12). This will enable e-governance to facilitate better delivery of services to the user and establish high-quality economic relations with commercial projects, as well as provide a more efficient and compliant administrative environment for governmental projects. Economic units are also working to integrate sustainable development goals into strategic decisions and this is a prerequisite to ensure the protection of the work environment that adopts agreed international and local standards (Osborne & Gaebler, 1992:23).

Sixth: The contribution of the e-readiness index to growth, productivity and employment

Improving the pace of growth, increasing employment and improving services are the most prominent economic impacts expected when shifting towards e-readiness By stimulating innovation within economic institutions, increasing efficiency and optimisation, as well as the But in the absence of these conditions, economic power is likely to be concentrated in the hands of a few sectors and individuals. Without skills, income and opportunity disparities between those with and without skills will increase, Without question, there is the potential for this technology to be used to control the engines of the economy and the lives of individuals, rather than to maximise their opportunities and capabilities. Rudra argues that the Readiness Index contributes to an increase in the number of investments in digital devices and information technology, i.e. increases in productivity due to more efficient use of production components and innovations, as well as investments in digital hardware, information technology, software, and software (also known as capital deepening) (Rudra, 2018: 92).

The use of information and communication technologies (ICT) has led to increased productivity in industries like finance and research, where most organisations have used supplementary strategies to enhance the quality of their business models and management. (Katz et al, 2017: 7). The impact of the use of ICT systems on the productivity of sectors

depends on their ability to adapt and their degree of flexibility in modifying their business practices. These large enterprises are more capable as they have sufficient resources to access information about market entry, tastes, preferences and behaviours of consumers to attract skilled labour (Brynjolfsson, 2011: 91).

Large companies operate in a competitive environment characterised by easy entry and exit, encouraging highly competitive small and medium-sized enterprises The organisation is based on relational databases, cloud computing and digital platforms and covers local and foreign markets (Joseph, 2019: 31).

Last but not least, the e-readiness index influences employment through a number of pathways, the most crucial of which are the following: making supply and demand side labour market information more accessible; improving matching between them; and making job search efficiency a higher priority (Frey & Osborne, 2013: 14). As a result, more people are choosing to work for themselves, especially those with advanced degrees and familiarity with various technological tools. Consequently, job security has taken a back seat to temporary work arrangements like contracting or freelancing in many global labour markets (Andrews & Criscuolo, 2013: 26).

Table (1) Indicators of e-readiness and GDP growth in Egypt

Year	Information &Communication Technology	Research and development	Skill	Industrial activity	Access to finance	Overall index	GDP growth (annual %)
2010	0.2	0.3	0.5	0.4	0.7	0.4	5.1
2011	0.2	0.3	0.5	0.4	0.7	0.4	1.8
2012	0.2	0.3	0.5	0.4	0.7	0.3	2.2
2013	0.1	0.4	0.6	0.4	0.6	0.4	2.2
2014	0.5	0.3	0.5	0.5	0.6	0.5	2.9
2015	0.3	0.3	0.5	0.6	0.5	0.4	4.4
2016	0.3	0.4	0.5	0.6	0.5	0.5	4.3
2017	0.3	0.4	0.5	0.5	0.5	0.4	4.2
2018	0.3	0.4	0.5	0.6	0.6	0.4	5.3
2019	0.4	0.4	0.5	0.5	0.6	0.5	5.6
2020	0.5	0.4	0.5	0.6	0.5	0.5	3.6
2021	0.5	0.4	0.5	0.6	0.5	0.5	3.3
2022	0.5	0.4	0.5	0.6	0.5	0.5	6.6

https://ar.knoema.com/atlas

The total technological readiness index can be determined by looking at Table 1. One of the five e-readiness indicators is the ICT indicator, which shows the level of ICT infrastructure. This indicator has been rising and falling since 2013, reaching a low point in 2013. However, after 2020, it continued to rise due to the Coronavirus period, which means that IT services will be needed more often. Skilled individuals are essential for the use, acceptance, and modification of state-of-the-art technology. This indicator remained constant at 0.5 throughout the research period with the exception of 2013, when it rose, indicating a decline in the IT indicator. R&D scores may not reflect the actual volume of activities and fluctuate between 0.3 and 0.4, but after more than half the time they stabilised at 0.5. This is because

R&D activity is essential for the production, adoption, and adaptation of pioneering technologies, as these technologies often require modification for local use. This fundamental indicator pertains to the sector of the economy that deals with the implementation, utilisation, and adaption of state-of-the-art technological systems. The report considers three industries that were quick to embrace new technology: manufacturing (particularly high-tech manufacturing), finance, and information and communication technology (ICT), which often interacts with other sectors. From there, he draws on export statistics pertaining to high-tech manufacturing and digitally deliverable services, which include financial and information and communication technology (https://ar.knoema.com/atlas).

Some businesses also participate in what is known as the "informal sector," which does not participate in official statistics but is prevalent in developing countries. Lifespan improvements in Egypt suggest that these countries' rankings may be understating actual activity. Conversely, access to finance—a measure of the availability of private sector financing—had a negative effect on economic activity. It is believed that if more people had access to capital, they would use, adopt, and adapt cutting-edge technology more quickly. The ratio of domestic credit to the private sector to GDP is one indicator used for this reason. This statistic has been declining since its peak at the beginning of the semester. The overall e-readiness index, which was calculated as the average of the five indicators described earlier, saw its fair share of fluctuations; nonetheless, it stabilised at 0.5 after 2019 and stayed there until the end of the period.

Seventh: Challenges Facing the e-Readiness Index in Egypt

One of the most prominent challenges facing the E-Readiness Index in Egypt is how to develop digitisation plans, as it requires a clear strategy from the Ministry of Communications. Transitioning to a digital economy is costly and difficult when changing the organisational structure of companies. In the long run, companies need to build their organisational capabilities that make the change process simpler and faster by developing a strategy that supports and promotes design principles and continuous change processes and a strategy based on innovation that allows new services to be provided to citizens digitally (Murad, 2010: 80). Organisations are fostering a culture of collaboration where employees must be able to collaborate, innovate and explore new ideas, unlike the culture of some individuals who may support resistance to change and remain stuck in hierarchical levels of work for many years. The high wages in foreign markets compared to Egyptian wages may lead to the flight of Egyptian talent out of the country. In addition, the crisis of financing local projects hinders the progress of companies as well as the high prices, wages and increased costs do not enable local companies to compete with international companies, and thus the demand for local products returns due to the low quality of the Egyptian product and its inability to compete with international products (Lashin, 2023: 51-53).

Second axis: Measuring the Border Technology Readiness Index on GDP using the AVR model in Egypt for the period 2010-2022

First: Description of the model

Vector Autoregression Estimates (VAR) (837-844): 1998, Ghali, Khalifah (is one of the most famous standard methods for analysing the relationship between variables, which needs time

series of time lagged variables, and one of the conditions for its use is that the variables have static I(1) for the unit root and in order to use VAR analysis, we test the extended Dickey Fuller test for the unit root This test shows the stability and staticity of the time series and determine the order of their integration and then the co-integration test and then complete the test Vector Autoregression Estimates for the research variables.

Using EViews 9, we will test the data in Egypt for the period (2010-2022) according to the vector autoregressive (VAR) test between the two variables total technology readiness index and GDP as follows:

X =Total Technology Readiness Index

Y = GDP

The GDP variable is the dependent variable and the Total Technology Readiness Index variable is the independent variable, and the time series are taken in quarterly format.

Secondly: Test results

1. Unit root test: The time series of the two variables were tested and the results were as shown in Table (1).

Table (2) Unit root test in Egypt for the period 2010-2022

Unit Root Test Results Table (ADF)			
Null Hypothesis: the variable has a unit root			
At Level			
Y	X		
-1.6273	-2.0892	t-Statistic	With Constant
0.4616	***0.2497***	***Prob.***	
n0	n0		
-2.7477	-2.9694	t-Statistic	With Constant & Trend
0.2229	***0.1507***	***Prob.***	
n0	n0		
-0.2734	0.0847	t-Statistic	Without Constant & Trend
0.5826	***0.7052***	***Prob.***	
n0	n0		
At First Difference			
d(Y)	d(X)		
-6.9386	-6.9481	t-Statistic	With Constant
0.0000	***0.0000***	***Prob.***	
***	***		
-7.0849	-6.8782	t-Statistic	With Constant & Trend
0.0000	***0.0000***	***Prob.***	
***	***		
-7	-7	t-Statistic	Without Constant & Trend
0.0000	***0.0000***	***Prob.***	
***	***		

Source: Prepared by the researchers based on the outputs of the EViews 9 programme

From table (2), it can be seen that the original series were unstable at the level of level, whether with a cross-section or with a cross-section and a general trend, and stabilised at the first difference test with a cross-section and for both variables GDP and total technology readiness at Prob. (0.000) for a significance level of (5 %).

2. Co-integration test

It is a test that shows the long-term equilibrium relationship between the variables, and this test is done by the Johansen Method, and the co-integration test was performed and the results were as in Table (3).

Table (3) Johansen co-integration test for Egypt for the period 2010-2022

Critical Value	Statistic Value	Alternative hypothesis	Null hypothesis
Trace test			
15.49471	11.36808	**r>1**	**r=0**
3.841466	1.599391	**r>2**	**r<1**
Maximum Eigen value test			
14.26460	9.768689	**r=1**	**r=0**
3.841466	1.599391	**r=2**	**r=1**

Source: Prepared by the researchers based on the outputs of the EViews 9 programme

In Table (3), the results of the Johansen test show that there is no vector of co-integration according to the Trace test, thus accepting the null hypothesis and rejecting the alternative hypothesis which states that there is no co-integration at a significant level (5%), while the Maximum value test also shows that there is no long-term equilibrium relationship between the two variables.

3. Analysing the results of the autoregressive model

Before analysing the VAR model for the variables of the model, the optimal lag lengths for these variables must be determined, and after the test was performed as in Table 4, and based on the Akaike's criterion (AIC), Squares criterion (SC) and Hannan-Quinn criterion (HQ), the lag length with the lowest value of these criteria was selected:

Table (4) Number of slowdown times for the VAR model

Lag	LR	FPE	AIC	SC	HQ
0	NA	0.007291	0.754579	0.832546	0.784043
1	99.60343*	0.000942*	-1.292164*	-1.058264*	-1.203772*
2	1.529196	0.001075	-1.161060	-0.771226	-1.013741

Source: Prepared by the researchers based on the outputs of the EViews 9 programme

Table 4 shows that the optimal deceleration time is one period, which has the lowest value at the first deceleration time and will therefore be the optimal deceleration time.

After selecting the optimal hysteresis, we estimate and analyse the Vector Autoregression Estimates (VAR) model, and the results are shown in Table (5) as follows:

Table 5: Results of analysing the VAR model in Egypt for the period 2010-2022

Dependent variable / Independent variable	X	Y
C **S.E** **t**	0.073677 (0.03572) [2.06251]	-0.292692 (0.75254) [-0.38894]
X(-1) **S.E** **t**	0.795116 (0.08639) [9.20349]	2.189583 (1.82000) [1.20307]
Y(-1) **S.E** **t**	0.004570 (0.00394) [1.15882]	0.837511 (0.08309) [10.0798]
R-squared	0.690675	0.727007
Adj. R-squared	0.677787	0.715632
F-statistic	53.58838	63.91440

Source: Prepared by the researchers based on the outputs of the EViews 9 programme

From table (5), we observe that the results of the VAR test show that there are two autoregressive models for the variables studied in the research when the total technology readiness index X is assumed as a dependent variable and the other time lagged variables are independent variables X (-1), (1-)Y. as a dependent variable and the other time lagged variables are independent variables X (-1), (1-)Y, it can be observed that when X (-1) increases by 100%, it leads to an increase in X in the current year by (0.795116).

The coefficient of determination $\bar{R}^2 = 0.69$, which means that 69% of the changes in the dependent variable X are due to the change in the time lagged independent variables, and 31% of the changes in the dependent variable are due to random factors or variables not included in the estimation.

When we assume that Y is the dependent variable and the time lagged variables are independent variables X(-1), Y(-1), when Y(-1) changes by 100%, Y increases by (0.837511), while the coefficient of determination $\bar{R}^2 = 0.72$, which explains 72% of the changes in the dependent variable Y affected by the time lagged independent variables, and the remaining 28% is due to other factors outside the model.

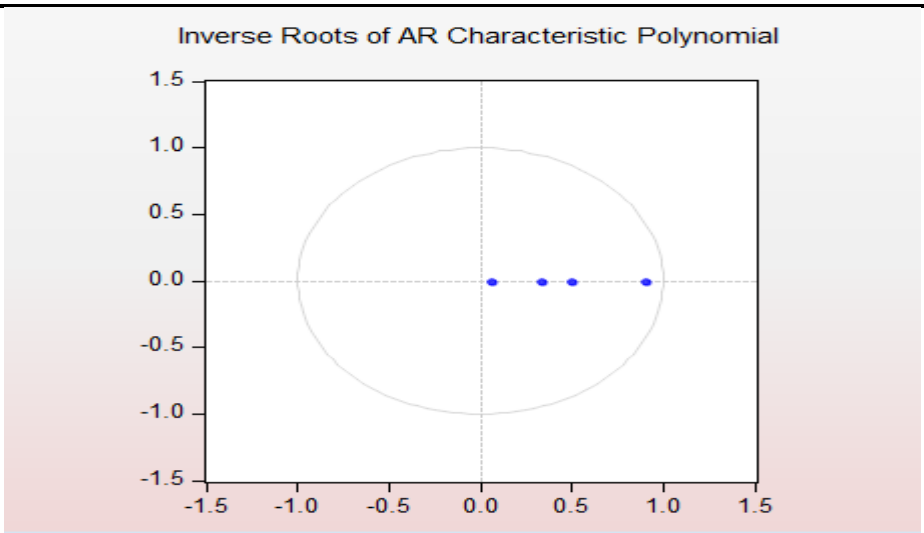

Figure (1) Reverse Roots

Figure (1) shows the inverse roots of the variables and shows that they are inside the unit circle.

Conclusions

1. The e-readiness index has a significant and increasing impact and importance for the accelerating trend towards digitisation globally and on macroeconomic performance.
2. To achieve an increase in GDP, it is necessary to provide a successful digital economic environment, including telecommunications, networks, social media and advanced electronic banking services.
3. When using VAR, it is clear that there is a positive correlation between the total e-readiness index and GDP growth.
4. The decline in the e-readiness index increases the size of the digital divide between developed and developing countries.
5. Achieving development in e-services contributes to raising the e-readiness index and thus reflects positively on economic growth by increasing GDP.

Recommendations

1. Structural structural reform in the Egyptian economy, activating the rest of the sectors, supporting digital transformation and foreign openness, and encouraging talent and creativity.
2. It is necessary to spread the culture of dealing with electronic payments in developing countries, including Egypt, and develop the banking sector and introduce new technologies similar to developed countries.
3. Developing and providing the legal and administrative structure to promote digital transformation in the economy.
4. The importance of training and development programmes for technological competencies for workers, developing strategies to develop electronic infrastructure, encouraging investment in the electronic and digital field to raise the electronic readiness index, and supporting entrepreneurship and companies in the electronic fields.

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