Original scientific paper

DIGITALIZATION IMPACT ON TUNISIAN LABOR MARKET

Imtinen Ben Saied[1]

Abstract

This paper investigates the impact of digitalization on the labor market in Tunisia over the period 1972–2021. The study employs the Autoregressive Distributed Lag (ARDL) modeling approach to examine both short- and long-term relationships between digital transformation and employment dynamics. By estimating a cointegration model, the results reveal a statistically significant and positive relationship between digitalization and labor market performance across both time horizons. In particular, digitalization appears to contribute positively to employment creation, suggesting that the adoption and diffusion of digital technologies have fostered economic activities capable of absorbing labor. This study provides empirical support for the argument that digital transformation, when effectively integrated into a national economy, can be a driver of job growth—even in developing countries. It also offers new insights into the Tunisian context, which remains underexplored in the existing literature. The findings have relevant policy implications for promoting inclusive and sustainable employment through technological advancement and digital infrastructure investment.

Keywords: labor market, digitalization, ARDL, cointegrationmodel

JEL classification: J40

INTRODUCTION

Introduction For a long time, there has been a strong incentive for more advanced economies, the creation of innovative companies, or the gradual emergence of start-ups in the digital economy. Moreover, the establishment of an ecosystem conducive to their expansion has become an obligation of competitiveness. In this context, digitalization is an unavoidable paradigm that is affecting the entire economy. Growth, employment and attractiveness depend on it. A new economic vision, which imposes itself on the current market. In this sense, the digital transformation is observed in many sectors such as industry, agri-food, banks and insurance. The issue of the impact of the transformations induced by these mutations on the work factor is among those that cause the most controversy. However, the evaluation of the effects of digitalization on employment is a subject criticized by several economists (GerarldValenduc 2017). Some works consider that digitalization contributes to increasing the productivity by replacing capital with labor, which negatively impacts the quantity of jobs, although it

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contributes to reducing costs, expanding markets and increasing the diversity of products and services, which, on the other hand has a positive impact on growth and employment (Vendramin, and Valenduc, (2016)). Other studies consider that digitalization should focus on the construction of innovations and technological trajectories (Rosenberg 1994, Vendramin, et al (2019), Nedelkoskaet al (OECD, 2018) …). Evolutionary perspective, which focuses on long cycles in economic development and is based on the concept of the techno-economic paradigm (Perez 2010). The deployment of this paradigm is conditioned by the implementation of significant transformations in society, particularly in the job market. Recent studies that assess the impacts of digitalization on employment essentially refer to the employment relationship model built during the previous paradigm and which are based on a short-term vision. We attempt in this research work to focus on the issue of digitalization, the objective of which is to analyze the short and long-term impact of digitalization on the job market in Tunisia. To do so, the first section will be devoted to an inventory of the job market and digital development in Tunisia. The second section concerns the methodology and data of the study. The results and their interpretations will be the subject of the third section. Finally, we end with a conclusion.

1. A BRIEF OVERVIEW OF EMPLOYMENT AND DIGITALIZATION IN TUNISIA:

Tunisia, like other developing countries, is struggling with rising unemployment. Several measures have been implemented, but innovative solutions must be implemented to remedy this national scourge. In this context, digital offers a considerable outcome that creates jobs, which represents an unavoidable challenge in Tunisia. Indeed, unemployment and the increase in regional inequalities generate social and political instability in the country. At the end of 2022, the unemployment rate fell slightly to 15.2%, according to the latest statistics published by the National Institute of Statistics (INS). Despite this slight drop in the unemployment rate, the number of unemployed is estimated at 624.6 thousand at the end of 2022. The active population is on the rise, standing at 4124.2 thousand individuals against 4011.7. In addition, the unemployment rate for higher education graduates will drop to 24% at the end of 2022. This rate is 15.7% for men and 30.8% for women during the same year.

Table1. Unemployment rate by sex

	Unemployment rate by sex					*Unemployment rate of higher education graduates*				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Total	*15,5*	*15,3*	*16.2*	*16.2*	*15.2*	*28.8*	*27.8*	*30.1*	*24,3*	*24,3*
Men	*12,5*	*12,3*	*13.5*	*13.9*	*12.9*	*17.2*	*15.7*	*17.6*	*15,2*	*15,7*
Women	*22,9*	*22,4*	*22.8*	*21.3*	*20.1*	*38.8*	*38.1*	*40.7*	*32.0*	*30,8*

Source:NIS 2023

Unemployment in Tunisia remains difficult to contain, particularly among graduates. The digital transformation also presents many opportunities, the region marking a clear advance in its digital development, with 15,645 subscribers to mobile telephone networks and an internet access rate of 72%, statistics which hide, however, a strong disparity between regions.

Tunisia is lagging behind in the development of high-speed Internet access. About 72% of the inhabitants have access to the Internet. About 12% have their own broadband Internet connection, which is at least faster than the old ISDN (more than 256 kbit/s). All fixed connections by DSL, cable or satellite have been taken into account, with the exception of mobile connections to the Internet. The mobile ecosystem directly employs 390,000 people in Tunisia, more than half of them in distribution and retail, and indirectly generates another 650,000 jobs. In addition, digitalization offers opportunities for unemployed people, insofar as it opens up new perspectives. Indeed, finding a serious job and earning money online is now possible thanks to freelance platforms that allow you to find offers from all over the world. In the Tunisian context, digitalization is seen as an inclusive alternative for all young people. Indeed, as a result of technological advancement, digital platforms for remote work allow young Tunisians to find jobs, regardless of their nationality, place of residence, gender, or even gender.ethnic group. In addition, they facilitate the access of people with disabilities to employment and give them the opportunity to work and excel in their chosen field, without the need to travel. Digital platforms play a key role in transforming the world of work and therefore accessibility to jobs and reducing the unemployment rate. Thanks to a computer and a simple internet connection, the platforms ensure that you meet potential project leaders, companies, organisations, etc

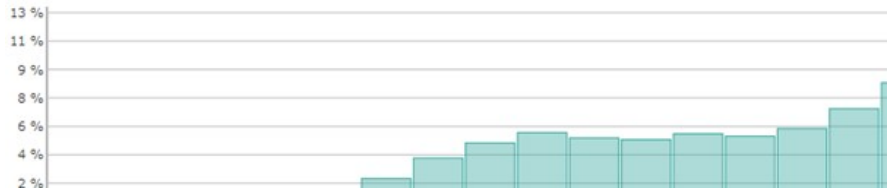

Figure 1. Broadband Internet in 2002-2021
Sources:https://www.donneesmondiales.com/afrique/tunisie/telecommunication

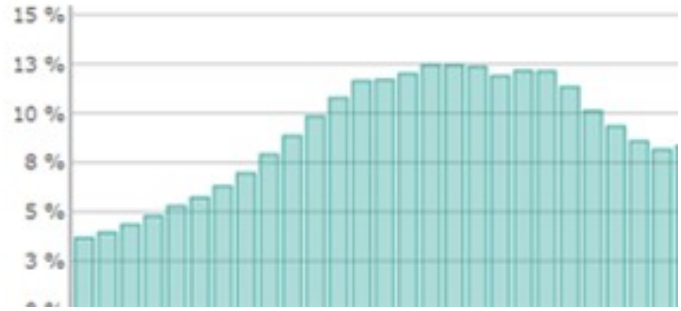

Figure 2. Fixed telephone lines 1990-2021
Sources:https://www.donneesmondiales.com/afrique/tunisie/telecommunication

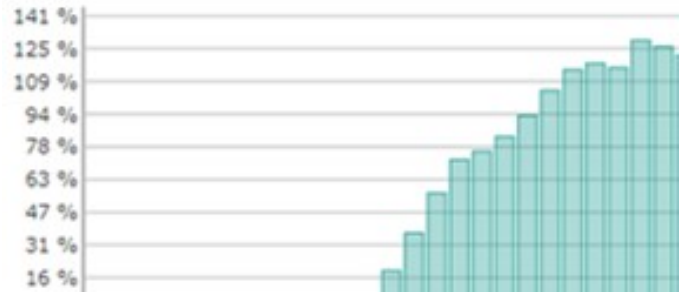

Figure 3. Mobile Phone
Sources:https://www.donneesmondiales.com/afrique/tunisie/telecommunication

In a word, it is the best solution in a context of a marginal increase in unemployment indicators and a major alternative to eliminate borders and boost the Tunisian economy.

2. LITERATURE REVIEW:

The world is today experiencing strong technological progress,known as the fourth industrial revolution. Although digitalization affects the economy as a whole, it is unclear to what extent technological improvement affects the job market. In this context, various works focused on the question of digitalization and employment such as the work of Frey and Osborne (2017), Bloom et al. (2018),and Yantong Zhao (2023).

The work of Febry et al (2020)aimed to analyze and identify the impact of digitalization on the labor market in Indonesia while trying to understand the state of readiness of Indonesia in the digital age. However, using panel data from Statistics on Indonesia 2012-2017, the results indicate that the era of digitalization can replace labor

in Indonesia despite having a profound influence. Furthermore, digitalization has a greater effect in reducing labor productivity in Indonesia. Therefore, to avoid the big wave of a new technological era, the Indonesian government should renew the education system according to the era of digitalization and the change of work structure.

MasahinaSarabdeen and Hind Alofaysan (2023), examined the relationship between digitalization, labor productivity, and unemployment using the ARDL error correction methodbased on time series data obtained from the World Bank database. The results of the study illustrate that digital variables such as fixed broadband subscriptions, mobile phone subscriptions, and communication do not significantly affect the labor market in the agricultural sector. Interestingly, these numerical variables significantly reduce long-term unemployment in Saudi Arabia. However, in the short term, digitalization does not have a positive impact on the economy. This study aims to help policymakers think about how to reorganize the socio-economic infrastructure to balance economic growth through greater technology and utilization of Saudi Arabia's human resources.

According to Bousrihet al. (2022), the labor market must move towards an inclusive digital transformation that strengthens business systems. In fact in their study, they attempted to explore the effect of digitalization on employment in the Gulf Cooperation Council countries and compare them to some advanced countries. Focusingon the Unit Root Tests and the Auto Regressive Distributed Lagged model, the results show a negative and significant impact of ICT on employment in the industrial and service sectors for the Gulf Cooperation Council countries with a moderate speed of adjustment towards long-term equilibrium. These resultsare explained by the shortage of skilled workers in these countries compared to advanced countries, where the results show a positive and significant effect of ICT technologies on total employment, especially in the industrial sector. The speed of long-term adjustment is significantly faster in advanced countries than in Gulf Cooperation Council countries.Asravor and Sackey (2023)[5] studied the effect of technological change on job creation and destruction in Ghana using longitudinal data from the World Development Index covering the period 1990 to 2018. Running the ARDL model, technology-related summative job destruction is higher in the short run while job creation is higher in the long run. Thus, technology has a compensating effect on job destruction and creation, due to its labor-saving nature. Short- and long-term job destruction is greater with increases in imports, interest rates, and the minimum wage.

3. DATA AND METHODOLOGY

The objective of this section is to study the impact of digitalization onaccess to the Tunisian job market. To do this, we proceeded to the construction of a simple economic model that defines the

relationship between an endogenous variable (working populationLF) and exogenous variables (fixed broadband subscription FIXBROD, fixed telephone subscription FIXTEL, IT communications and other COMP services, GDP and tertiary education (SCHOL). The choice of variables is determined by the economic literature (Sarabdeen et al (2022). All these data are taken from the World Bank website.

After specifying the economic model, it is necessary to transform it into what is called an econometric model defined as follows:

LF= β0 + β1PIB+β2 FIXTEL+β3 FIXBROD+β4 COMP+β5 SCHOL +εt

With :

β0 is a constant, εthe error term, and βj (j = 1…, k) represents the different coefficients of the model to be estimated. To test this model, it will first be necessary to perform unit root tests on each of the variables to examine the stationarity. We will then attempt to verify the short-term and long-term link between the LF and the components of digitalization (FIXBROD fixed broadband subscription, FIXTEL fixed telephone subscription, IT communications and other COMP services, GDP and tertiary educationSCHOL). To do so, we will adopt the Autoregressive DistributedLag (ARDL) model, developed by Persan and Shin (2001). All estimates will be made using Eviews12 software.

5-Estimation results:

The objective of this part is to present and discuss the different estimation results of our model. The preliminary analysis focuses first on the analysis of the descriptive statistics of the different variables

Table1. Descriptive statistics

	COM_COMPUTER	FIXEDBROADSUBS	FIXEDTELESUBSCRI	LABORFORCE	GDP	SCHOOLENROLLMENTTERTIARY
Mean	24.91876	1.794099	6.603144	2267335.	1888 1.70	17.25813
Maximum	48.42028	12.20433	13.52932	4240590.	3716 3.51	35.87718
Minimum	0.000000	0.000000	0.908407	0.000000	0.00 0000	0.000000
Probability	0.161208	0.000000	0.073032	0.030765	0.03 3831	0.044470

The analysis shows that access to the labor market is on average 2267335 during the period from 1992 to 2021.It admits a maximum of 4240590 and a minimum of 0.000000.

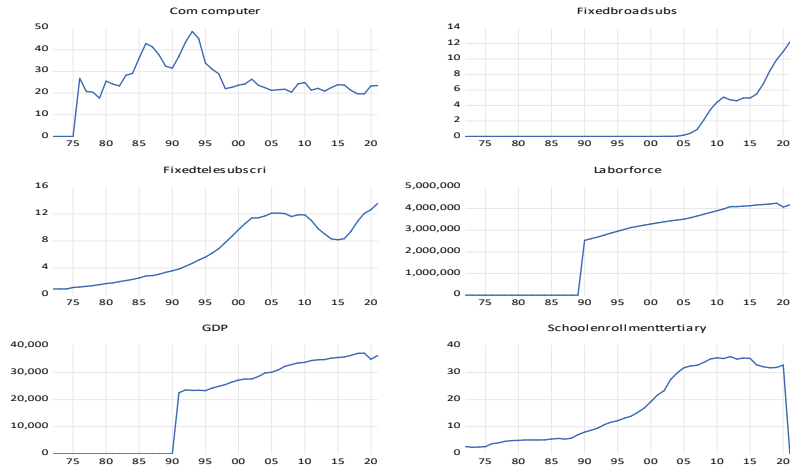

Figure 4. Evolution of digitalisation and employment in Tunisiafrom 1992 to 2021

Conversely, the fixed broadband subscription in Tunisia represents a maximum of 12.20433 with a minimum of 0.000000 in 1992. Then, the fixed telephone subscription variable admits a minimum of 0.908407 and a maximum of 13.52932. As for the schooling variable, it is on average equal to 17.25813. Thisreflects the low participation of graduates in the labor market in Tunisia. The graph belowrecords the evolution of the different variables of the study (digitalization and employment) in Tunisia from 1992 to 2021, where we notice an upward trend in the active population from the nineties in Tunisia. Similarly, the variables that define digitalization have undergone a remarkable increase throughout the study period. Overall all variables follow an upward trend with some fluctuations.

We note again that there is a positive correlation between employment and digitalization, thus reflecting that these variables evolve in the same direction over time, which translates into multicollinearity.

❖ **Unit Root Test**

According to the results from the application of the Augmented Dickey-Fuller and Phillips-Perron tests, there appears to be stationarity in the level of the IT variable, communications, and other services. The other variables (active population, fixed broadband subscription, fixed telephone subscription, GDP, and tertiary education) are stationary in thefirst difference.

The following table presents the results of the DickeyFuller and PhillipsPerron tests for each of the variables:

Table 2. Stationarity tests

	Augmented Dickey-Fuller	Phillips-Perron test statistic	Conclusion
			(I0)
COM_COMPUTER(-1)	0.019497 (0.0489)*	0.009303 (0.0861)	
			(I1)
FIXEDBROADSUBS)	0.000004 (0.0005)*	0.147533 (0.5385)	
FIXEDTELESUBSCRI	0.0000 (0.0000)*	0.0000 (0.0000)*	(I1)
GDP	0.0000 (0.0000)*	0.0000 (0.0000)*	(I1)
LABORFORCE	0.0000 (0.0000)*	0.0000 (0.0000)*	(I1)
School	0.003331 (0.00756)	0.016229 (0.0162)	(I1)

Thus, the conditions for applying the ARDL-type cointegration model are verified and thusit becomes possible to test long-term relationships between variables whose integration orders are different (Acikgoz et al 2010). To select the optimal ARDL model, we will use the information criterion of Akaike. The estimation results of the optimal ARDL model retained from Eviews 12 among the various best models, make it possible to select the ARDL(5, 6, 6, 5, 6, 6) model which corresponds to the lowest value of the AIC (fig 2).

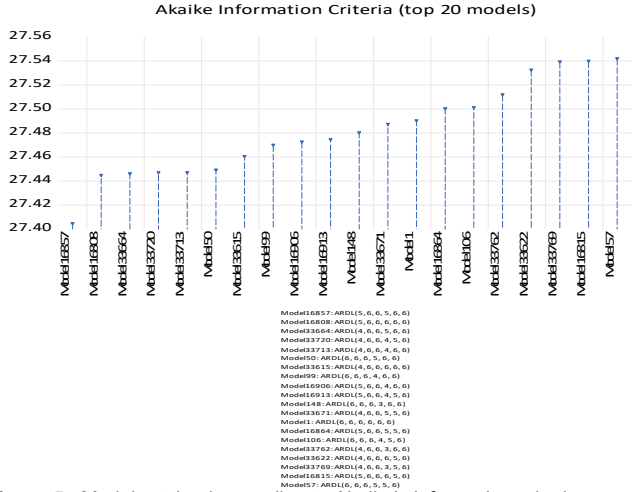

Figure 5. Model retained according to Akaike's information criterion
Source: EViews software estimation results

❖ ARDL model estimation result

The estimation of an error-correction model assumes the existence of a short-term and long-term cointegration relationship between the variables of the study. According to the results of the analysis, in the short term, the estimated coefficients are all significant. Thus, wenotice a negative (-12.75952) and significant impact on total employment in the short term (0.0736). Furthermore, we confirm the existence of a

cointegration between digitalization and employment and that the relationship between these variables is positive. The following table presents the ARDL model,which is equivalent to the number of delays that minimizes the Akaike criterion, it is an ARDL model (5, 6, 6, 5, 6, 6).

Table 3. Short-term ARDL test

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LF(-1)	-12.75952	5.296483	-2.409056	0.0736
LF(-2)	3.898999	5.450295	0.715374	0.5139
LF(-3)	-25.07327	7.158821	-3.502431	0.0248
LF(-4)	-7.123601	3.683092	-1.934136	0.1252
LF(-5)	-2.885364	4.787531	-0.602683	0.5792
GDP	1444.496	568.6040	2.540424	0.0640
GDP(-1)	-326.1806	602.5630	-0.541322	0.6170
GDP(-2)	2880.105	829.8861	3.470483	0.0256
GDP(-3)	734.2092	407.3828	1.802258	0.1459
GDP(-4)	474.0081	556.0231	0.852497	0.4420
GDP(-5)	132.9647	47.45939	2.801653	0.0487
GDP(-6)	166.4959	74.35596	2.239173	0.0887
FIXBROSUBS	-669934.0	990814.7	-0.676145	0.5360
FIXBROSUBS(-1)	-2264899.	1291325.	-1.753934	0.1543
FIXBROSUBS(-2)	2381291.	1304956.	1.824806	0.1421
FIXBROSUBS(-3)	-2318158.	1678397.	-1.381174	0.2394
FIXBROSUBS(-4)	6706191.	2041427.	3.285050	0.0304
FIXBROSUBS(-5)	-7163772.	1817505.	-3.941542	0.0169
FIXBROSUBS(-6)	4134725.	1768565.	2.337898	0.0796
FIXTELSUB	-806614.6	1061405.	-0.759950	0.4896
FIXTELSUB(-1)	1063447.	1404392.	0.757229	0.4911
FIXTELSUB(-2)	1435384.	1442537.	0.995041	0.3760
FIXTELSUB(-3)	-2579729.	797875.9	-3.233246	0.0319
FIXTELSUB(-4)	-216532.1	2200561.	-0.098399	0.9263
FIXTELSUB(-5)	929596.7	1341158.	0.693130	0.5264
COM_COM	-9751.237	28720.12	-0.339526	0.7513
COM_COM (-1)	-45201.68	35121.95	-1.286992	0.2675
COM_COM(-2)	25791.85	24621.24	1.047545	0.3540
COM_COM (-3)	47626.40	23404.87	2.034893	0.1116
COM_COM (-4)	-9.431609	18713.23	-0.000504	0.9996
COM_COM (-5)	16190.16	16667.66	0.971351	0.3864
COM_COM (-6)	15481.11	19885.51	0.778512	0.4798
SCHENRTTER	98610.57	81024.01	1.217054	0.2905
SCHENRTTER(-1)	674301.1	282882.2	2.383681	0.0757
SCHENRTTER	-194024.6	444616.0	-0.436387	0.6851
SCHENRTTER(-3)	-1705905.	410023.9	-4.160501	0.0141
SCHENRTTER(-4)	662225.8	520529.9	1.272215	0.2722
SCHENRTTER(-5)	649315.7	504801.5	1.286279	0.2677
SCHENRTTER	-502247.5	396912.5	-1.265386	0.2744
C	948850.0	1264374.	0.750451	0.4947

R-squared = 0.997186F-statistic=36.34028Prob(F-statistic) =0.001529Akaike info criterion=27.40455

Source:Eviews estimation result

It is important in this research work to test the long-term relationship between digitalization and employment. Indeed, according to the estimation results of the "bounds test", the Fisher statistic (F=5.49) is greater than the upper limit of the interval of critical values corresponding to the error level of 1%. This confirms the existence of a long-term relationship for the estimated model.

Table 4. bounds test

F-Bounds Test

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.497310	10%	2.08	3
K	5	5%	2.39	3.38
		1%	3.06	4.15

According to Table 7, the result of the dynamic coefficients associated with long-term relationships shows a positive and significant impact at risk of 5%.This shows the existence of a long-term adjustment mechanism. Indeed, the results confirm that digitalization in Tunisia has an automatic mechanism that reacts to fluctuations in a balanced way. Indeed, the estimated value of (-44.94276) for the coefficients suggests a fast adjustment strategy of around 69%. This means that imbalances from the shock of the previous year converge towards the long-term equilibrium of the current year.

Table 5. Long-term ARDL test

ConditionalError Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	948850.0	1264374.	0.000000	0.0000
LABORFORCE(-1)*	-44.94276	13.83664	-3.248098	0.0314
GDP(-1)	5506.098	1689.615	3.258788	0.0311
FIXEDBROADSUBS(-1)	805443.0	712464.9	1.130502	0.3215
FIXEDTELESUBSCRI(-1)	-174448.4	818656.9	-0.213091	0.8417
COM_COMPUTER(-1)	50127.17	41311.94	1.213382	0.2917
SCHOOLENROLLMENTTERTIARY(-1)	-317723.8	362784.1	-0.875793	0.4306
D(LABORFORCE(-1))	31.18324	9.791942	3.184582	0.0334
D(LABORFORCE(-2))	35.08224	11.63172	3.016084	0.0393
D(LABORFORCE(-3))	10.00896	6.092713	1.642776	0.1758
D(LABORFORCE(-4))	2.885364	4.787531	0.602683	0.5792
D(GDP)	1444.496	568.6040	2.540424	0.0640
D(GDP(-1))	-4387.783	1432.492	-3.063042	0.0375
D(GDP(-2))	-1507.678	749.0448	-2.012801	0.1144
D(GDP(-3))	-773.4687	596.7859	-1.296057	0.2647
D(GDP(-4))	-299.4606	96.24085	-3.111575	0.0358

D(GDP(-5))	-166.4959	74.35596	-2.239173	0.0887
D(FIXEDBROADSUBS)	-669934.0	990814.7	-0.676145	0.5360
D(FIXEDBROADSUBS(-1))	-3740276.	1085473.	0.000000	0.0000
D(FIXEDBROADSUBS(-2))	-1358985.	836187.7	-1.625215	0.1794
D(FIXEDBROADSUBS(-3))	-3677143.	1157473.	0.000000	0.0000
D(FIXEDBROADSUBS(-4))	3029048.	1152681.	0.000000	0.0000
D(FIXEDBROADSUBS(-5))	-4134725.	1768565.	0.000000	0.0000
D(FIXEDTELESUBSCRI)	-806614.6	1061405.	0.000000	0.0000
D(FIXEDTELESUBSCRI(-1))	431281.0	627771.0	0.687004	0.5298
D(FIXEDTELESUBSCRI(-2))	1866665.	1491834.	0.000000	0.0000
D(FIXEDTELESUBSCRI(-3))	-713064.5	1387904.	0.000000	0.0000
D(FIXEDTELESUBSCRI(-4))	-929596.7	1341158.	0.000000	0.0000
D(COM_COMPUTER)	-9751.237	28720.12	-0.339526	0.7513
D(COM_COMPUTER(-1))	-105080.1	41954.20	-2.504638	0.0664
D(COM_COMPUTER(-2))	-79288.23	39091.90	-2.028252	0.1124
D(COM_COMPUTER(-3))	-31661.83	26685.72	-1.186471	0.3011
D(COM_COMPUTER(-4))	-31671.26	20432.23	-1.550064	0.1961
D(COM_COMPUTER(-5))	-15481.11	19885.51	-0.778512	0.4798
D(SCHOOLENROLLMENTTERTIARY)	98610.57	81024.01	1.217054	0.2905
D(SCHOOLENROLLMENTTERTIARY(-1))	1090635.	335191.3	3.253770	0.0313
D(SCHOOLENROLLMENTTERTIARY(-2))	896610.8	475637.1	1.885073	0.1325
D(SCHOOLENROLLMENTTERTIARY(-3))	-809294.0	332875.9	-2.431218	0.0719
D(SCHOOLENROLLMENTTERTIARY(-4))	-147068.2	413529.1	-0.355642	0.7401
D(SCHOOLENROLLMENTTERTIARY(-5))	502247.5	396912.5	1.265386	0.2744

EC = LABORFORCE - (122.5136*GDP + 17921.5296*FIXEDBROADSUBS
-3881.5689*FIXEDTELESUBSCRI + 1115.3558*COM_COMPUTER
-7069.5204*SCHOOLENROLLMENTTERTIARY + 21112.4106)

Given these results, it can be noted that digitalization has a positive impact on the job market andimproves the Tunisian working population'saccess to the job market. This assertion is supported by Bigot and Raymond (1991).

CONCLUSION

This research work aimed to analyze the relationship between digitalization and the job market.It is a question of determining the short-term and long-term impacts of the components of digitalization on access to employment in Tunisia.

To establish these impacts, we applied the ARDL approach. The results of the used model show the existence of a positive and significant long-term relationship. Furthermore, we can note that the introduction of digitalization had a considerable impact on jobs. It is therefore considered an opportunity to access the job market.Digitalization essentially makes it possible to create new activities and revitalize the economy.

In this context, the Tunisian government must invest in digitalization to position itself as an international benchmark for digital development as well as an important lever for socio-economic development byprovidingthe necessary technological infrastructure in line with a modern economy.

Through this vision, different strategies must be implemented, in particular the guarantee of social inclusion and reduction in the digital dividethrough better access to information and knowledge.

Strengthening digital culture by generalizing the use of ICTs in companiesleads to the reduction of unemployment and the creation of jobs in the digital and offshore sectors. In addition, we should support the creation of added value, the key to sustainable business and employment, by supporting entrepreneurship, stimulating innovation, and improving the competitiveness of companies in all sectors through investing in ICT and positioning them in the digital economy.

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