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THE IMPORTANCE OF DIGITAL TRANSFORMATION. INCIDENCE OF THE DIGITAL ECONOMY AND SOCIETY INDEX (DESI) IN THE GDP OF THE EUROZONE ECONOMIES

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Abstract: In recent years, numerous researches have studied the relationship between the so-called technological indicators and the social development of different countries.

The main motivation of this study has been to find out whether there is a relationship between the variables of the DESI technological indicator and this year's GDP per capita. The existence of such a relationship has been identified and it has been discovered that it is directly related to the use of internet services by citizens and to the implementation of technology in companies.

Keywords: DESI; GDP; technology; digital transformation.

1 Introduction

Over the past few years, companies in almost every industry have carried out a series of initiatives to develop new digital technologies and explore their benefits [1-12]. *Information and Communication Technologies* (ICT) are the merger between new digital technologies and traditional industrial production, leading to the emergence of what we know today as Industry 4.0 [13-20].

The concept of industry 4.0 has allowed to transform factories into intelligent environments where information, objects, and people are connected thanks to the convergence between the physical and the virtual world through cyber-physical systems [21-29].

Advanced economies have experienced significant technological change. The developments that were made since the twentieth century onward eventually led to the emergence of Industry 4.0. The scientific progress that has been made over the years, has allowed for a significant fall in the price of technological capital [30-41].

Unlike the largest economies, such as Germany or the United States, some countries in the European Union have not been able to take advantage of all the benefits offered by the so-called digital revolution. The crisis in 2008 made governments implement austere fiscal policies which reduced spending on research and development [42-50] and business investment. Nevertheless, the situation changed noticeably in 2014. In that year, the digitalization became the driver of several economies [51-56], in the case of Spain, it was responsible for a 30% increase in added value in 2015 [57-60].

In recent years, digital transformation has become an engine of growth for the entire Eurozone. For this reason, the current work focuses on the study of the relationship between the GDP per capita of the Eurozone countries and The Digital Economy and Society Index (DESI) during the period 2015 – 2018.

1.1 Digital transformation. A global concept

Digital native companies are the ones that have best responded to digital transformation, they increased their profits and have been able to implement new business models more efficiently [61]. Despite the fact that technological and digital advances have enabled interconnectivity, digital transformation has not spread uniformly around the world and not all countries benefited from it equally. One of the main reasons for which this inequality exists is the digital divide. This is a term used to describe the unequal opportunity to access technology and it focuses especially on the varying conditions of Internet access [62-68] in different parts of the world.

Given the possibilities offered by digital transformation and the technological inequality between countries, at the last G20 summit, digital transformation has been included in the global agenda. It is hoped that thanks to this, more inclusive and sustainable growth will be achieved for all countries worldwide [69-70].

1.2 The Digital Economy and Society Index (DESI)

The Digital Economy and Society Index, DESI, is a composite indicator that measures the digital performance of Europe. DESI is also responsible for investigating the digital competitiveness of the member states of the European Union. This index is elaborated annually by the European Commission [71].

The indicator of digital competitiveness is broken down into 5 components and their main implications:

- Connectivity: Measures the deployment of broadband infrastructure and its quality. It is measured according to 5 variables: Fixed ADSL, Mobile ADSL, fast broadband, ultra-fast broadband, broadband price index. For example, access to fast and ultrafast broadband services is a necessary condition for competitiveness.
- Human Capital: Measures the skills that are needed in order to take advantage of the possibilities offered by digital technology. It is measured according to 2 variables: Internet users' skills, advanced skills and development.
- Use of internet services by citizens: It represents a variety of online activities, such as the consumption of online content (videos, music, games, etc.), as well as online shopping and banking.
- Integration of digital technology by businesses: Measures the digitalization of companies and e-commerce. By adopting digital technologies, companies can improve efficiency, reduce costs and improve customer and business services.
- Digital public services: Measures the digitalization of public services, focusing on electronic administration and health. The modernization and digitalization of public services can generate efficiency gains for public administration, citizens and businesses alike (such as e-health and e-Government).

2 Methodology

2.1 Population and sample

Data on the GDP per capita and The Digital Economy and Society Index (DESI), have been obtained for 19 countries in the Eurozone, for the following time period 2015-2018.

GDP per capita data comes from Eurostat [72] and is expressed in millions of euros at current prices, for each time period and country separately.

The Digital Economy and Society Index (DESI) data have been obtained from the reports of the European Commission that analyze the ranking of each country according to the DESI index [73-78].

2.2 Variables

The following variables have been selected for the analysis, so it is possible to observe, as anticipated, the incidence of DESI disaggregation in GDP:

PIBPC = GDP per capita
PIBAN = GDP per capita for the previous year
desia = Connectivity
desib = Human Capital
desic = Use of internet services by citizens
desid = Integration of digital technology by businesses
desie = Digital public services

2.3 Estimation techniques

For the estimation of the model we have used panel data, combining cross sections for several periods of time.

Specifically, we have followed the methodology of applying fixed effects, this is the most elementary and consistent methodology and the model to be estimated is:

$$\log(\text{PIBPC}) = \beta_1 \log(\text{PIBAN}) + \beta_2 \log(\text{desia}) + \beta_3 \log(\text{desib}) + \beta_4 \log(\text{desic}) + \beta_5 \log(\text{desid}) + \beta_6 \log(\text{desie}) + u_{i,t}$$

We have elaborated the expression of the model and we have chosen to adopt logarithms because they facilitate the comprehension of results. In the model, we take into account this year's and last year's GDP per capita of each country, considering the 2015-2018 period and all the disaggregated components of the DESI index during this time period.

We have used the R software to estimate the model, a free programming software, oriented to statistical analysis, which allows to design econometric models and analyze them statistically by means of different libraries.

3 Results

Prior to the development of the study, a correlation analysis has been carried out, as shown in Table 1. As it can be seen, there is a clear relationship between last year's GDP per capita and this year's GDP per capita.

The rest of the correlations are not considered to be as strong, nevertheless, the most significant relationship is between this year's GDP per capita and the *desib* variable, which stands at 0.624592.

Strong correlation would imply multicollinearity between the explanatory variables of our model. Given that it is not the case, as the correlation between the chosen set of variables is not strong, it has been possible to continue with the estimation of the proposed model.

Table 2 illustrates the developed model, where it is possible to see that this year, there is a clear implication of the *desic* and *desid* variables in the GDP per capita indicator. In addition, last year's GDP per capita has had a logical impact on this year's GDP per capita, which is positive.

It is important to note that the implication of the variables of the DESI index is positive, and it occurs due to the use of internet services by citizens and due to the implementation of digital technology in businesses.

Table 1. Correlation analysis.

	PIBPC	PIBAN	desia	desib	desic	desid	desie
PIBPC	1.000000	0.994836	0.481729	0.624592	0.299778	0.292481	-0.004682
PIBAN	0.994836	1.000000	0.482999	0.621272	0.298734	0.270716	-0.024390
desia	0.481729	0.482999	1.000000	0.577137	0.714044	0.485058	0.371132
desib	0.624592	0.621272	0.577137	1.000000	0.511841	0.432595	0.438125
desic	0.299778	0.298734	0.714044	0.511841	1.000000	0.259130	0.387760
desid	0.292481	0.270716	0.485058	0.432595	0.259130	1.000000	0.487801
desie	-0.004682	-0.024390	0.371132	0.438125	0.387760	0.487801	1.000000

Table 2. Regression analysis.

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Call:
plm(formula = log(PIBPC) ~ log(PIBAN) + log(desia) + log(desib) +
    log(desic) + log(desid) + log(desie), data = datest)

Balanced Panel: n = 19, T = 4, N = 76

Residuals:
       Min.     1st Qu.      Median     3rd Qu.        Max.
-0.06844738 -0.01367687  0.00052004  0.01000381  0.06409087

Coefficients:
             Estimate  Std. Error t-value  Pr(>|t|)
log(PIBAN)  1.3769e-01  4.8934e-02  2.8138  0.006938 **
log(desia) -2.1885e-02  6.9281e-02 -0.3159  0.753376
log(desib)  4.9375e-02  6.1260e-02  0.8060  0.423989
log(desic)  2.9505e-01  5.7769e-02  5.1073 4.918e-06 ***
log(desid)  2.7161e-01  4.3985e-02  6.1750 1.090e-07 ***
log(desie)  8.1522e-05  3.6255e-02  0.0022  0.998215
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    0.20228
Residual Sum of Squares: 0.038294
R-Squared:      0.81069
Adj. R-Squared: 0.7216
F-statistic: 36.4002 on 6 and 51 DF, p-value: < 2.22e-16
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4 Conclusions

In developed economies, specifically in the economies whose main driver is technology, different studies have aimed to determine the implication that technological development has in the labor market. However, not many studies have associated GDP per capita with technological development indicators.

According to the results of the conducted study, there is a close relationship between technological indicators and the GDP per capita, especially in terms of the use of Internet services by citizens and the digitalization of businesses.

This result makes one think about the importance of technological development for a country, given that an increase in technology in different fields implies growth in GDP per capita.

Future lines of research will focus on determining why developed countries have better technology and it will look at the percentage of technological investment in different countries. In addition, it will be analyzed whether the implementation of high-tech in Europe's less developed countries will foster a process of convergence among all European regions.

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