The digital divide and its impact on the development of Mediterranean countries

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Abstract

Technology and access to technology is having a significant impact on cultural and economic development throughout the world, as reflected in globalization. The dramatic increase in communications, commercial interaction, and interdependence has made it necessary to implement new metrics to compare the development rate of nations and their economies. In response to this demand, the Human Development Index (HDI) was created in 1990. Nineteen years later in 2009, the ICT Development Index (IDI) also appeared on the scene. The IDI measures the development of information and communication technologies (ICT), and has become a valuable tool that is frequently used by governments, institutions, and researchers. This study analysed the relation between the HDI and IDI with a view to exploring how one index affected the other. The focus area of our study was the Mediterranean basin not only because of its rich historical tradition but also because of the economic and digital divide that separates countries bordering its shores.

Keywords: HDI, IDI, ICT, development, Mediterranean countries, globalization.

1. Introduction

Countries are often compared and classified in terms of their *development*, based on their gross domestic product (GDP) per capita, growth rates, industrial importance, etc.

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Such studies often compare developing "third-world" countries to developed "first-world" countries (Qureshi, 2013). Economic criteria are generally used to measure the status and development of countries, whose economic growth depends to a great extent on technological advances. Such criteria are regarded by politicians, economists, international agencies and the media, as the main indicator of the health and economic well-being of a nation. It was in 1990 that the United Nations Development Program (UNDP) defined a new model to evaluate people's capabilities instead of the economic resources in a territory (OECD, 2013). Instead of economic development, the focus is now on socio-economic development. Since this evaluation model is based on humans and their capabilities, it emphasizes the importance of well-being (e.g. a decent living standard) over means (e.g. income per capita). The goal is for human development to be ultimately more equitable and sustainable. Apart from the annual report of the UNDP, there are numerous studies that have analyzed the Human Development Index (HDI) in relation to different aspects and issues.

Based on theories proposed by Haq (1999) and Nobel-Prize winner, Sen (1981), this new model associates social well-being with people and their capabilities instead of with their satisfaction. In other words, a country's development is measured in terms of the opportunities provided to citizens instead of in terms of the activities that they engage in (PNUD, 2010). This was the idea behind the Human Development Index (HDI), which, thanks to the simplicity of its indicators, is applicable to all countries and regions. This has made it an extremely useful research tool. The HDI is composed of the following key dimensions of human development: (i) health dimension; (ii) education dimension; (iii) economic dimension. The health dimension focuses on whether a population has a long and healthy life. Education signifies their being knowledgeable, and the economic dimension is directly related to their ability to lead a decent human life. The resulting indicator is the average value of these three parameters (OECD, 2013).

Since society is in constant evolution, the measurement of human development should be modified accordingly. The United Nations (UN) is aware of this and envisages the possibility of incorporating more variables into the Human Development Index. For this reason, it has created complementary indexes that provide deeper insights, such as the Gender Development Index and Human Poverty Index, among others (UNDP, 2013). The modified Human Development Index (MHDI) measures the effects of human

development in different countries. This index includes social variables, such as the adult literacy rate, education level, health effects, civil rights, etc. (Gürlük, 2009).

The main objective of the research was to clarify the relationship between the Human Development Index (HDI) and the ICT Development Index (IDI) with a view to exploring how one index influences the other. For this purpose, we focused on Mediterranean countries with a long history of socioeconomic relations. Nevertheless, Syria, Libya and Lebanon were excluded because of the lack of statistical data.

As part of our study, we analyzed the digital divide in this geographic area by comparing countries located on the northern, southern, and eastern shores of the Mediterranean Sea. This was done by studying the evolution of the HDI and IDI in order to obtain evidence of a possible statistical correlation.

2. Theoretical framework

The following sections summarize the main research on indicators of the development, access, use, and implementation of information and communication technology (ICT), and how these indicators help to evaluate the impact of these factors on human development.

2.1. *Relation Between ICT Development and Human Development*

A wide range of studies highlight the considerable influence of technological advances, such as the development of information systems upon social development. Firstly, there are strong indications that the progressive use and expansion of new technologies have allowed countries to modernize their services and have even provided them with a way to bypass the traditional industrialization stages (Nasierowski & Arcelus, 2003, and Barro & Sala-i-Martin, 1995). In this line, Rodríguez and Wilson, (2000) and Sharma & Gani, (2004) review how the size of the development gap between rich and poor countries may be attributed to ICT advances, which in turn stimulate and foster socioeconomic development.

Regarding the concept of ICT within the context of development, Hamelink (1997) affirms that ICT include all technologies that facilitate different forms of communication as well as the handling of information between humans and electronic systems. Soeftestad and Sein (2003) summarize the different conceptualizations of ICT discussed in

Orlikowski and Iacono (2001). For example, ICTs can be regarded as any of the following: (i) algorithms, codes, and models that comprise an information system; (ii) a technical entity and a means to achieve something; and (iii) activities and interactions performed in specific social and cultural contexts.

Interestingly, Soeftestad and Sein (2003) ask if it is possible to prevent the use of ICTs from perpetuating existing economic and social imbalances. They also mention the debate on the Appropriate Technology (AT) and Indigenous Knowledge movements (IK) as part of the answer to this question. They conclude that, the emphasis should be on how ICT is used, and that ICT use should be assessed in terms of human development factors. In this same line, Blunt and Warren (1996) affirm that IK systems constitute a bridge to mutual understanding and communication between the local communities and development professionals.

It is important to initially focus on the influence of technological advances on the three dimensions of the HDI: (i) health dimension; (ii) education dimension; and (iii) economic dimension. As underlined by Castillo, Bercovich and Fernández (2013), technological evolution is linked to greater efficiency in the means of production. When production is thus increased, this leads to the maximization of returns. This lowers costs, which means lower prices for consumers and mass access to services and products. A direct consequence of this is a substantial improvement in the quality of life of a population (Foladori, 2005).

Similarly, Mokyr (1990) claims that technological progress is synonymous with economic progress. He defines technology as any technical change in the production process that increases efficiency by using fewer resources or by creating better and more innovative products. Porter (1985) states that technology is involved in the production process, and that any technological change has a direct impact it.

In the HDI, health dimension is measured in terms of life expectancy. The equitable provision of healthcare is thus central to achieving development in any society (Braveman & Gruskin, 2003). It goes without saying that health is essential to wellbeing and to overcoming social disadvantage and its effects. Unfortunately, governments tend to have limited resources that can be allocated to ensure an equal distribution of healthcare. In this sense, technological advances can help to increase life expectancy and improve mortality data in adults and children (Foladori, 2012).

For example, the use of ICT helps to fight against the propagation of deadly viruses in the general population by collecting data as well as by sharing, analyzing, and making this data available to facilitate the identification and treatment of victims. Mobile Health (mHealth) is also an emerging concept in healthcare where mobile communications devices are used to provide health services and information (Kahn, Yang & Kahn, 2010). In fact, cell phone usage is transforming healthcare in Africa (Berkey, 2014). Since one in six of the billion inhabitants in Africa now own a cell phone, the surveillance, tracking, and monitoring of communicable diseases has become much easier. More specifically, Nigeria was able to contain Ebola, thanks to the latest Global Positioning System (GPS) technology with the help of the World Health Organization (WHO) (Paddock, 2014). Additional studies have also shown that the use of mHealth applications for patient-centered care significantly reduces the cost of healthcare (Boulos, Wheeler, Tavares & Jones (2011); Payne, Chambers & Kensinger, 2012). Medical applications have transformed smartphones into useful tools that can provide fast, effective solutions. Furthermore, these mobile health applications give people more choices as to how they can lead healthier lives (Mosa, Yoo & Sheets, 2012).

Finally, there have been huge changes in education because of the incorporation of technology in the classroom (interactive electronic whiteboards, personal computers, e-learning, enhanced communication in real time, etc.). All of these tools facilitate interaction between teacher and students, and at the same time, foster greater involvement and lead to better results. Nevertheless, one risk inherent in this new trend is when only the format is changed, and teaching contents are not adapted to the new e-learning context.

Bartolomé (2013), Singer, Golikoff and Hirsh-Pasek (2006), Segal (1985), Kalman and De la Garza (2006) specifically mention ICT, such as the use of computers and Internet for educational purposes. These tools open the door to pedagogical and didactic activities based on the incorporation of ICT as part of the classroom routine. Notwithstanding, even though the use of such tools leads to the greater involvement of both students and teachers in class activities, it does not necessarily improve the learning process or guarantee equal access to the use of technology (Oliveira, 2001).

Chen, Lakshmanan and Castillo (2013) and Cuban, Kirkpatrick and Peck (2001) found that in certain countries, the mere presence of computers was not sufficient to

modify the structure of practice classes. Even though the format changed, the teaching contents remained the same.

In this sense, Internet, mobile telephones, computers, and advances in engineering and biotechnology have had a huge impact on most fields. Over the last 20 years, cultural and social paradigms have been significantly modified. This new panorama is diametrically opposed to former ones because of the exponential growth of technology. Data transmission, reception, and processing, which play a crucial role in today's society, now occur in real time (Chen, Lakshmanan, & Castillo, 2013). For this reason, this period has been called the "Third Industrial Revolution" because of the enormous impact of technological advances on all spheres of society (Rifkin, 2011).

Many studies have related ICT to the education level of a country and its economic progress (Terziyana, Goloviankob, & Shevchenkob, 2015; Samoilenko, 2016; Hanclova, Rozehnal, Ministr, & Tvrdikova, 2015; Harris, 2016; Ministr & Pitner, 2015; Nemer, 2016 and Sahayab, 2016). Other research affirms that bridging the digital divide is not only a question of technology. Barriers that must be overcome are also educational, cultural, and linguistic in nature (Ponelis & Holmner, 2015).

Evidently, without an educated population, high-capacity Internet in itself cannot transform society. Education is thus crucial factor in social development (Oyelaran-Oyeyinka & Gehl-Sampath, 2006). From a somewhat different perspective, Mamtani, Lowenfels, Cheema and Sheikh (2014) affirm that migrant workers negatively affect the educational dimension of the HDI because these workers tend to have fewer years of schooling and a lower education level than other sectors of the population. Mohamed-Mimon, Perez-Castro and Montero-Alonso (2017) evaluated how ICT led to better teaching in field outings.

Differences in the capacity of countries to use ICT will determine patterns of global development and poverty in the 21st century. The emergence of the global marketplace now requires all countries to be technologically connected and harnessed together as a tool for human development (Lee, 2001; Katz & Koutroumpis, 2013; De la Fuente (2009); Valderrama & Castillo, 2011). The International Telecommunications Union (ITU, 2014) performed case studies in various countries, and measured the impact of ICT on the gross national product (GNP) as well as on economic growth, Kiiski and Pohjolab (2002) also studied the ratio between the cost of Internet access and the GNP per capita in OECD countries.

Various indexes have been used to measure the impact of ICT on socioeconomic development. Some of these indexes coincide with each other even though they base their evaluations on rather diverse criteria. Those that collect data from many different countries and are used throughout the world are the following: (i) ICT Development Index (IDI); (ii) E-government Development Index (EGDI); (iii) Networked Readiness Index (NRI); (iv) Global Competitiveness Index (GCI); (v) Technology Achievement Index; (vi) Digitalization Index; and (vii) Global Innovation Index.

The IDI is published by the United Nations International Telecommunication Union. It is based on 11 ICT indicators grouped in three clusters: access, use, and skills. The E-Government Development Index (EGDI) is presented twice a year by the United Nations Department of Economic and Social Affairs (UN DESA). It is a composite indicator with three indexes (online service index, telecommunication index, and human capital index), which measure the use of ICT to provide public services to citizens, depending on the state of e-government readiness and the extent of e-participation.

The Networked Readiness Index (NRI), published by the World Economic Forum (WEF), measures the propensity of countries to exploit the opportunities offered by ICT. It is based on a list of 68 analytical variables. Its components are the environment for ICT (market, infrastructure, and regulatory) and the preparation of the country's key stakeholders.

The Global Competitiveness Index (GCI), also published by the WEF since 2005, assesses the ability of countries to provide levels of prosperity to their population, mainly through good public and private institutions, a stable macroeconomic framework, sufficient infrastructure, and good healthcare and primary education.

The Technology Achievement Index (TAI) reflects the capacity of a country to participate in the network age. The TAI assessment is based on a single composite measure. In contrast, the Digitalization Index (DI) is a composite index based on six equally-weighted components, namely, infrastructure investment, network access, accessibility, capacity, usage, and human capital, all of which mark the path towards a digital society. The Global Innovation Index (GII) provides tools to promote output growth, improved productivity, and job growth. The GII is the result of collaboration between Cornell University, INSEAD and the World Intellectual Property Organization (WIPO)

This research study focused on the ICT Development Index (IDI). Since society is in constant evolution, the way to measure human development must also evolve accordingly. The United Nations (UN) was and is aware of this and envisages the possibility of including many more variables in its development index. Furthermore, it has created and published complementary indexes that provide a more in-depth vision, such as the Gender Development Index, the Gender Empowerment Measure, and the Human Poverty Index (UNDP, 2013). In this sense, the International Telecommunication Union (ITU) is a specialized agency of the UN for information and communication technology (ICT), whose mission is the development of technical standards that facilitate interconnection and access to ICT throughout the world. It is committed to connecting all people in the world, wherever they live and whatever their means. In fact, it is the only international organization that includes all of the stakeholders in the communication sector.

One way of quantifying and evaluating this sector is by means of the ICT Development Index (IDI), (ITU, 2015). The IDI was created in 2004 to address the issues raised by the Millennium Development Goals to harmonize and develop telecommunication/ICT indicators. This partnership has led to ICT statistics that are crucial to decision-making. Its members include regional and international organizations involved in the collection of ICT statistics: ITU, OECD, UNE, UNESCO, Institute for Statistics, World Bank, Eurostat, and four regional development branches of the United Nations for Africa, Latin America and the Caribbean, Asia and the Pacific, and Western Asia.

The IDI, published annually since 2009, has a core list of ICT indicators that has evolved over time. It has over 60 indicators (2016), which are used to compare countries, based on the following criteria: (i) ICT infrastructure and access; (ii) access and use of ICT by households and individuals; (iii) ICT access and use by enterprises; (iv) the ICT sector and trade in ICT goods; (v) ICT in education; and (vi) ICT in government. Although the components of the HDI and IDI have different indicators, the classification of countries is very similar. Therefore, the relation between the HDI and IDI values were statistically tested to show the relation between the two. UNDP and ITU data were used for this analysis and assessment.

It should be highlighted that none of the previously cited studies had targeted the relation between the IDI and HDI. It goes without saying that *technology* is a rather vague

term, which cannot be quantified unless it is further specified. Our study used ICT as the unit for technology measurement and the IDI as a way to quantify its development. Our purpose was to ascertain the extent to which technology can have an impact on HDI values, and whether the evolution of technological development was similar to that of human development. We wished to discover whether there was a relationship between human and technological development. Accordingly, during 2010-2015, we examined the IDI and HDI, first separately and then in combination with each other to see whether there was a relation between them.

After this description of the theoretical framework and the main research objective, the following section provides an outline of our model of statistical analysis.

2.2. *Analytical model*

The model in this research was quantitative because it uses a set of manageable, measurable, and sequential data, which were instrumental to achieving the research objective. The method of calculating indexes was based on the maximum and minimum values of the data set. The GNP index was adjusted by using the logarithmic values of maximums and minimums. This allowed us to ascertain where there was a statistically significant relation between the HDI and IDI values.

The conventional HDI index, as proposed by the United Nations Development Program (UNDP), measured the level of human development of a certain region. This index comprises three subindexes. The first subindex is *decent standard of living*, as measured by the gross national income (GNI) per capita ($100-$40,000) adjusted by the purchasing power parity (PPP) with one-third weighting. The second subindex is *long and healthy life*, as measured by life expectancy at birth (25-85 years) with one-third weighting. This value is the result of health, sanitation, hygiene, and nutrition in a society. The third subindex is *knowledge*, measured as a combination of the adult literacy rate and the expected years of schooling at the primary, secondary, and higher education levels for children of school-entering age (values of 0%-100%) with one-third weighting.

The ICT Development Index (IDI) is a composite index combining 11 indicators into one benchmark measure that monitors and compares the level and evolution over time of ICT in developed and developing countries. It also measures the differences between countries in terms of ICT development as reflected in the digital divide. Finally,

it assesses the extent to which countries can potentially make use of ICTs to improve their growth, based on available capabilities and skills.

This assessment is based on the measurements obtained in the following three stages: (Stage 1) level of networked infrastructure and access to ICTs with a weight of 40%; (Stage 2) ICT intensity, reflecting the level of use of ICTs in society with a weight of 40%; (Stage 3) ICT impact, reflecting the results of efficient and effective ICT use through literacy rate and expected years of schooling at the primary, secondary, and higher education levels for children of school-entering age, with a weight of 20%.

In order to guarantee that the data set had the same measurement unit, it was necessary to normalize the data before aggregation. In the case of the IDI, distance from the benchmark or reference value was used as the normalization method. The benchmark was regarded as the ideal value that a variable could reach.

After this description of the HDI and IDI as well as the research on their interrelation, we now focus on ICT as the measurement unit of technology use and, more concretely, on the IDI, which was used to quantify ICT development in the subsequent analysis. The objective was to ascertain the degree to which technology can influence socioeconomic development and whether technological development evolves similarly to human development. For this purpose, the HDI and IDI were analyzed both independently as well as in relation to each other, during the time period 2010-2015. Our research targeted the countries of the Mediterranean basin (except for Syria, Libya, and Lebanon because of the lack of statistical data). The countries in this area are worth studying because despite their geographic proximity, they show striking differences in development. In fact, these differences are greater than those between neighboring countries in other parts of the world. Technological advances in recent years and their implication in the daily life of citizens and businesses are a constant reminder that collaboration between countries should be greater so as not to increase the digital divide, as well as the economic gap between them. An ever increasing number of advances implemented by the Millennial Generation are related to information (big data, the data cloud, etc.) and communications (Internet of things, mobile 5G, connectivity, locators, GIS, etc.).

They also have led to collaborative work (workplace tools), automatization and robotics (automation and robots), and digital innovation (algorithms and quantum computing, business intelligence, blockchain, artificial intelligence, etc.). These advances

have even transformed government and the provision of public services (e-government). Even more important, they have led to a veritable revolution in teaching methods and education (machine learning, virtual reality), in pharmaceuticals and life sciences), as well as in leisure activities (media-entertainment), and marketing (digital and e-commerce).

All of these technological advances highlight the fact that more collaboration initiatives between countries are necessary to halt, among other things, mass migratory movements, which have become increasingly frequent in the world today. The following section analyzes the relation between HDI and IDI values for countries in the Mediterranean basin.

2.3. *Analysis of the situation in the Mediterranean area*

The European Union (EU) has become one of the most important geographic areas in the world in regard to economy as well as social development. This has had a positive impact on the Mediterranean countries within the EU though their development has lagged behind that of countries in Northern and Central Europe. Generally speaking, the Mediterranean zone has a lower level of industrial development, and a large percentage of its economy is based on tourism and agriculture (Makarovič, Šušteršič & Rončević, 2014). The economic benefits accrued from belonging to the European Union signify that the European Mediterranean countries are in a more favourable situation in regard to commerce and are in a privileged position when it comes to establishing supplier and client relations (Rosenthal, 2013). Because of the geo-strategic location of its member states, the EU has association agreements/treaties with southern Mediterranean countries. These agreements are an excellent framework for north-south political dialogue and are the basis for the progressive liberalization of commercial exchanges in the Mediterranean area.

The progress and potential of African economies is also rapidly advancing. Despite the drop in the prices of raw materials throughout the world and the political crises that have significantly slowed global development, Africa continues to expand. In the long term, this growth process is fuelled by three trends. First, the fact that the population of the African continent is relatively young means that it possesses an active and growing workforce, which is an extremely valuable asset in an ageing world. Secondly, urban

expansion of Africa is contributing to consumption growth in homes and businesses with an important development potential. Finally, African economies are well positioned to benefit from the rapid acceleration of technological changes, which can overcome many of the obstacles to their growth, overcome limitations, and lower the costs of physical infrastructures in important economic areas.

For the purpose of this study, we analyzed data from official sources for 2010-2015. Data previous to 2010 were not available because the IDI was not created until 2009. Accordingly, we analyzed the evolution of this index to ascertain whether there was a digital divide between the countries studied, with particular emphasis on the dichotomy between northern and southern Mediterranean countries.

3. Methodology

As previously mentioned, our analysis was based on two indexes endorsed by UN agencies. Each index was first analyzed independently. Values were collected for all countries during the period of study. After calculating the variation rate in order to assess the evolution of the variables, we then performed an econometric analysis to study the HDI, contingent on the IDI and based on the theoretical premises outlined in the previous section. We compared the values to identify relations between the two indexes. For this purpose, a linear estimation was used since there was no significant increase in variability as the complexity of the model increased.

Panel data were used to analyze the model. We then verified the relation between the indexes and their reliability as well as the absence of defects in the model. Both the fixed and random effects were calculated, and it was found that neither autocorrelation nor heterocedasticity was present. Finally, the model was estimated, and an equation was obtained that related the two variables. The statistical analysis was performed with the statistical software package STATA, ver. 14.0.

4. Results

The results obtained in the descriptive analysis and regression analysis are presented and discussed in the following sections.

4.1. *Descriptive analysis*

Table 1 shows the HDI and its variation in all Mediterranean countries. As can be observed, the most developed countries are Israel, France, Slovenia, and Spain with values close to 0.9 (out of 1.0). The least developed countries are Egypt, and Morocco, which are nearer to the equator of the indexes. Initially, it appears that with the exception of Israel, European countries are at the top of the list, whereas African countries are at the bottom. There are also striking differences between the values of the countries in the top and bottom sectors of the list.

Table 1. Human Development Index (HDI) 2010-2015.

Rank	Country	2010	2011	2012	2013	2014	2015	VR* HDI
1	Israel	0.883	0.888	0.890	0.893	0.894	0.899	*1,8%*
2	France	0.881	0.884	0.886	0.887	0.888	0.897	*1,8%*
3	Slovenia	0.876	0.877	0.878	0.878	0.880	0.890	*1,6%*
4	Spain	0.867	0.870	0.874	0.874	0.876	0.884	*1.9%*
5	Italy	0.869	0.873	0.872	0.873	0.873	0.887	*2,1%*
6	Greece	0.866	0.864	0.865	0.863	0.865	0.866	*0,0%*
7	Cyprus	0.848	0.852	0.852	0.850	0.850	0.856	*0,9%*
8	Malta	0.824	0.822	0.830	0.837	0.839	0.856	*3,9%*
9	Croatia	0.807	0.814	0.817	0.817	0.818	0.827	*2,5%*
	MEAN	**0.787**	**0.792**	**0.794**	**0.796**	**0.797**	**0.807**	***2.5%***
10	Serbia	0.757	0.761	0.762	0.771	0.771	0.776	*2,5%*
11	Turkey	0.738	0.751	0.756	0.759	0.761	0.767	*3,9%*
12	Algeria	0.725	0.730	0.732	0.734	0.736	0.736	*1,5%*
13	Bosnia Her.	0.710	0.724	0.726	0.729	0.733	0.750	*5,6%*
14	Albania	0.722	0.728	0.729	0.732	0.733	0.764	*5,8%*
15	Tunisia	0.714	0.715	0.719	0.720	0.721	0.721	*1,0%*
16	Egypt	0.681	0.682	0.688	0.689	0.690	0.691	*1,5%*
17	Morocco	0.611	0.621	0.623	0.626	0.628	0.647	*5,9%*
	*Difference***	*0.272*	*0.267*	*0.267*	*0.267*	*0.266*	*0.252*	*-7.4%*

Sources: UNDP Database. * Variation Rate period 2010-2015. **Difference Rank 1 – Rank 17

As can be observed, the differential between the countries at the top and those at the bottom progressively decreased (-7.4%, from 0.272 to 2.252), approximately one-fourth of a point. As reflected in their variation rates, countries with a high level of human development showed a more moderate growth rate of 0%-2%. As can be observed, the data in the upper part of the table are more homogeneous. In contrast, with only a few exceptions, developing countries showed percentage increases greater than the mean growth (2.5% and 5%-6%) since their potential growth was much greater (Fukuda-Parr & Lopes 2013).

Table 2 shows the IDI values for the period studied as well as their variation rate. To facilitate comparison between the IDI and HDI, the two scales were homogenized. IDI values were thus converted from a scale of 0 to 10 to a scale of 0 to 1 (as in the HDI).

Table 2. ICT Development Index (IDI) 2010-2015.

Rank	Country	2010	2011	2012	2013	2014	2015	VR* IDI
1	France	0.709	0.730	0.773	0.787	0.812	0.805	*13.5%*
2	Israel	0.687	0.662	0.725	0.729	0.719	0.771	*12.2%*
3	Malta	0.643	0.669	0.708	0.725	0.752	0.765	*19.0%*
4	Spain	0.673	0.662	0.714	0.738	0.766	0.761	*13.1%*
5	Cyprus	0.598	0.573	0.609	0.611	0.637	0.730	*22.1%*
6	Slovenia	0.675	0.670	0.696	0.713	0.723	0.720	*6.7%*
7	Greece	0.628	0.614	0.670	0.685	0.709	0.708	*12.7%*
8	Croatia	0.621	0.575	0.670	0.690	0.700	0.696	*12.1%*
9	Italy	0.657	0.628	0.666	0.694	0.712	0.684	*4.1%*
10	Serbia	0.511	0.540	0.607	0.624	0.645	0.651	*27.4%*
	MEAN	**0.525**	**0.527**	**0.580**	**0.597**	**0.616**	**0.629**	***23.4%***
11	Turkey	0.442	0.438	0.512	0.529	0.558	0.566	*28.1%*
12	Bosnia Her.	0.431	0.453	0.489	0.523	0.528	0.525	*21.8%*
13	Albania	0.361	0.378	0.442	0.472	0.473	0.490	*35.7%*
14	Tunisia	0.343	0.358	0.407	0.423	0.473	0.470	*37.0%*
15	Morocco	0.329	0.346	0.409	0.427	0.447	0.457	*38.9%*
16	Algeria	0.282	0.298	0.330	0.342	0.371	0.447	*58.5%*
17	Egypt	0.328	0.366	0.428	0.445	0.440	0.444	*35.4%*
	*Difference***	*0.381*	*0.364*	*0.345*	*0.342*	*0.372*	*0.361*	-5.2%

Sources: ITU Database. * Variation Rate period 2010-2015. **Difference Rank 1 – Rank 17

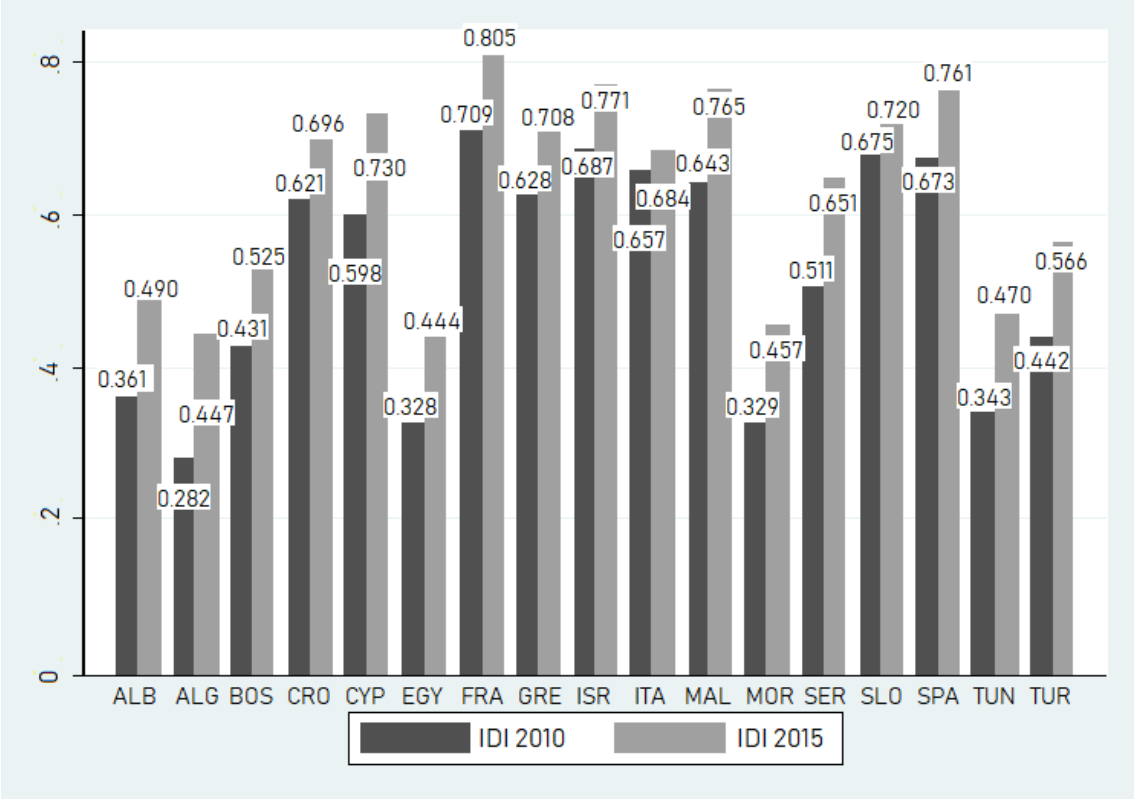
Table 2 shows that there is an average difference of almost 0.3 points between countries with the highest and lowest IDI (a decrease of 0.38 to 0.36). This difference is significantly greater than in the HDI, and its reduction is lower since the percentage is 5.2%. There is also an important increase between the upper and lower halves of the table. The distribution of the countries in the IDI table is similar to the distribution in the HDI table. The same ten countries are above the mean, and accordingly, the same seven countries are below the mean. More specifically, except in the case of Israel, European countries who are EU members occupy the upper positions in the table whereas African countries occupy the lower ones.

Regarding the IDI variation rate, almost all countries showed a two-digit growth rate. Even more important is the fact that this increase was sharper in countries in the lower half of the table, which indicates a slight reduction in the digital divide. Figure 1 shows the IDI data for 2010 and 2014, which indicates increases for all of the countries studied. In fact, the seven countries with the highest growth coincided with the seven countries

with the lowest levels of technological development. The rankings of these countries soared to the point that they managed to overtake countries that were initially higher on the 2010 table.

Furthermore, one of the countries at the top is Israel, surrounded by European countries. In the middle of the table are the Middle Eastern countries along with Bosnia, whereas in the lowest zone of the table are African countries and Albania. As can be observed, the countries with a higher level of technological development have values that are almost twice those of less developed countries.

Figure 1. Variation of IDI in the period 2010-2015



Source: developed by authors, based on ITU data.

4.2. *Regression Analysis*

Presented below is Table 3 that shows the ratio between the HDI and the IDI in 2014. As can be observed, all of the countries obtained a positive correlation except Italy and Greece. This signifies that when the IDI increased, the HDI value also increased with approximately the same intensity (close to +1). At the same time, the determination

coefficient that adjusted the model to the development variable was reliable in a large number of countries.

Table 3. Relationship between HDI and IDI.

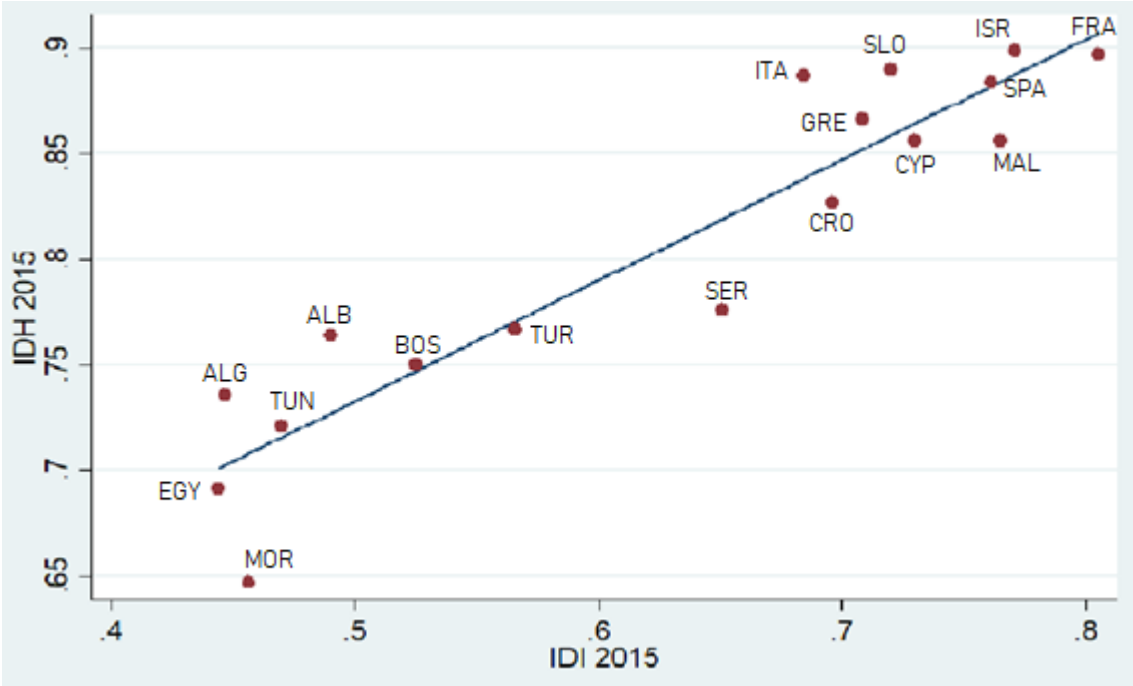
Country	Correlation coefficient	Determination coefficient R^2
Egypt	0.97117	0.94317
Tunisia	0.96586	0.93289
Serbia	0.90941	0.82702
Malta	0.89424	0.79966
Turkey	0.89000	0.79211
Algeria	0.83511	0.69741
Israel	0.83509	0.69737
Spain	0.83040	0.68957
Morocco	0.82237	0.67629
Bosnia H	0.81290	0.66081
France	0.77901	0.60686
Cyprus	0.71701	0.51410
Albania	0.67858	0.46047
Croatia	0.64101	0.41089
Slovenia	0.62764	0.39393
Italy	0.23504	0.05524
Greece	0.08935	0.00798

Sources: ITU Database

Based on these results, the Mediterranean countries can be divided into two groups. The first group, composed of Greece, Italy, Slovenia, Croatia, Albania, has a value lower than 0.7. In Greece and Italy, there is a weak correlation between the two variables. In contrast, the correlation of Cyprus, France, Bosnia Herzegovina, Morocco, Spain, Israel, Algeria, Turkey and Malta is stronger, though not very high (0.7-0.9). The remaining countries were found to have a strong or very strong correlation coefficients with values ranging from 0.91 to 0.97. This indicates that there is a high concordance between both indexes.

Finally, in order to see whether there was a relation between the two indexes and, more concretely, to ascertain whether the HDI varied in function of the IDI, a scatter plot was used (see Figure 2).

Figure 2. Relationship between HDI and IDI.



Source: developed by authors, based on UNDP and ITU data.

In Figure 2, the points are clearly distributed around the regression line except in the case of Morocco, which is farther away from the line because of its low human development value. Moreover, this relation is direct, and thus the increase in the IDI was accompanied by a corresponding increase in the HDI. Most of the countries did not show divergences between their human development values and their technological development values. It is worth mentioning that the HDI-IDI correlation for the last year studied was found to be quite high (R-squared=0.8721).

Table 4. Linear Regression (2015)

Source	SS	df	MS	Number of obs	17
Model	.090362716	1	0.090362716	F (1,15)	102.28
Residual	.01325281	15	0.000883521	Prob > F	0.0000
Total	.103615527	16	.00647597	R-squared	0.8721
				Adj R-squared	0.8636
				Root MSE	.02972

IDH15	Coef.	Std.Err.	t	p> t	(95% Coef. Interval)	
Idi15	.5720856	.0565685	10.11	0.000	.4515127	.6926586
-cons	.446965	.0362948	12.31	0.000	.3696045	.5243255

Source: developed by authors, based on UNDP and ITU data.

Moreover, the linear model estimation is significant as reflected in the model below:

$$IDH = 0.5720856\ IDI + 0.446965$$

The model is statistically significant (see Table 4), which proves that both variables should be part of the model and that they are representative. Furthermore, as can be observed, there is a positive relation since the HDI varies, depending on the IDI. However, in 2015, the tendency changed, and for this reason, the estimation may not deliver values that are applicable to other periods.

Once the analysis for 2015 was found to be significant, the same relation was analyzed for the entire time period in order to complete the study. The analysis of the HDI panel data in regard to the IDI for the 17 countries for 2010-2015 (see Table 5) affirmed the relation between the two variables and that this could be expressed by the following equation:

$$IDH = 0.1159323\ IDI + 0.728341$$

The same as in the regression analyzed for 2015, the test was significant, and the relation between the two variables was found to be positive. More specifically, the proportion to which HDI varied in function of the IDI was approximately 11%. This indicates that if the IDI increased by one unit, with the rest of the factors remaining constant, the HDI would increase 0.11 points. However, it should be highlighted that because of the characteristics of both indexes, it is impossible for them to experience changes equal to or greater than one unit since both range from 0 to 1. This explains the low percentage of variation. Consequently, if technological development increased 0.1 points, human development would increase by 0.011 points.

The constant in the formula indicates that even if the IDI were zero, the HDI would have a value of approximately 0.73. This means that even though technology has an impact on human development, there are other factors that also influence it. As previously explained in the individual analysis of each index, the HDI has a slower growth. This is mainly due to the fact that its values are greater than the IDI. In other words, it has arrived at a level of advancement that approximates the values for the countries at the top of the index. For this reason, HDI values have a more limited range of variation than the IDI. For this reason, a variation in the IDI causes less variation in the HDI.

Table 5. Panel Data (2010-2015)

Fixed-effects (within) regression	Number of obs =	102
Group variable: id	Number of groups =	17

R-sq:		Obs per group:	
Within =	0.4741	min =	6
Between =	0.8460	avg =	6.0
Overall =	0.7936	max =	6
		F (1,16) =	45.90
Corr (u_i, Xb)	0.8365	Prob > F =	0.0000

(Std. Err. adjusted for 17 clusters in id)

IDH	Coef.	Robust Std.Err.	t	p> t	(95% Coef.	Interval)
IDI	.1159323	.0171121	6.77	0.000	.0796563	.1522083
_cons	.728341	.0099057	73.53	0.000	.7073418	.7493402
sigma_u	.06770818					
sigma_e	.00586252					
rho	.9925588	(fraction of variance due to u_i)				

Source: developed by authors, based on UNDP and ITU data.

5. Conclusion

The objective of this study was to ascertain whether relating the HDI to the IDI could improve the way of evaluating the development level of different countries. Because of the acknowledged importance of these two indexes in scientific research, we studied a set of Mediterranean countries with a view to analyzing the differences between northern and southern Mediterranean countries and evaluating their respective variation rates.

This study of Mediterranean countries established relations between the HDI and IDI, and also assessed how the behavior of one affected the other. In the descriptive analysis, the behavior of the HDI and the IDI showed that technological development and human development progressed at average growths of 23% and 2.5%, respectively. Increased technological development was found to have a positive impact on human development. Furthermore, because increases in variation rates were greater in less developed countries, this indicated that the digital divide is rapidly decreasing.

However, the differences between the first country in the ranking and the last were lower in the IDI (-5.2%) than in the HDI (-7.4%). When the IDI was converted to the same scale as the HDI, there was a mean difference of 0.2 points between the values of the two indexes. Accordingly, the Mediterranean countries studied were closer to achieving full human development than full technological development, Furthermore, as can be observed in the tables, the increase in the IDI was much greater than in the HDI,

which is hardly surprising, given the current digital revolution (Brynjolfsson & McAfee, 2012).

In terms of geographic development, our results reflected the existence of a digital divide between northern and southern Mediterranean countries. Nonetheless, despite the general improvement in the indicators of all countries, differences decreased slightly because variation rates were greater in less developed countries.

The results showed that in the majority of the countries, there was a direct correlation between indicators, as reflected in the strong linear correlation between the two variables (R-squared=0.8721). Precisely for this reason, it makes sense to relate the IDI and the HDI. In other words, the increase in technological infrastructure, access to ICT, and improvement in their use level improves the quality of life of a population. For this reason, investment and promotion of ICTs is an excellent way to enhance the development of a nation and thus reduce the socioeconomic divide.

One way to attain this objective is through the use of open software, a growing tendency in technology. Such technology makes it possible to create open-access contents for all interested users. Evidently, if this option were not available, the cost of program licenses would be a serious obstacle for people in less advanced countries. When technology can be universally accessed, the educational level of the population can be raised by means of online courses and training, which are considerably less expensive than enrolling in an educational institution.

It should also be highlighted that the objective of technological collaboration projects is usually to share knowledge and foment cooperation between public and private institutions. This type of research initiative fosters innovation, and the results lead to material that is useful for all partners. An excellent example is the tourist sector, in which Spain has a great deal of experience. As such, it could share its knowledge of tourist management with countries in North Africa and contribute to their development.

Particularly in the case of developing countries, the development of ICTs is an extremely attractive path to a better life. The continuous advancement of this type of technology by governments, agencies, and institutions is crucial. In fact, all too often it is left in private hands since it is not regarded as relevant (see Chen, Lakshmanan, & Castillo, 2013).

Thanks to the objectives established by large telecommunications companies with an important investment in I+D+i, these companies are enabling the connection to communication networks in countries where until now this possibility did not exist (e.g. the African Mediterranean countries). This gives the population access to technological improvement as well as healthcare, educational, and economic development options permitted by this technology.

The correspondence between both indicators highlights the fact that ICTs are not isolated from society, nor do they evolve independently. On the contrary, they are now an integral part of people's lives, to the extent that one cannot be understood without the other. Accordingly, the evolution and development of ICTs goes hand in hand with human development.

Recent technological advances and their implications for the daily life of citizens and businesses in an increasingly globalized world signify the need for more collaboration initiatives between nations. As previously mentioned, advances such as cloud computing, the Internet of things, e-commerce, GIS, business intelligence, etc. make it necessary for developed countries to work more closely with developing countries in order to reduce the digital and socioeconomic divide.

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