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Household and Individual Digitisation and Deprivation: A Comparative Analysis Between Italian and Spanish Regions

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Abstract
Despite the progress of the information society, there are currently still notable differences between the access to, and usage of, information and communication technologies (ICTs) and Internet for a broad range of activities by individuals in the regions of Italy and Spain. These differences could be related to features of material and social deprivation. With 13 variables of the 40 NUTS 2 of Italy and Spain, deriving from EUROSTAT regional statistics for 2018, the aim is to respond to the following questions. Is there a relationship between the variables of ICT access and usage by households and individuals and those of social and material deprivation in the regions analysed? What is the interrelationship? Are there differences between Spanish and Italian regions in the behaviour of spatial and regional factors? Factor analysis was used to discover the relationship between variables; spatial patterns were identified by means of spatial autocorrelation; and a typology of regions has been identified by using cluster analysis. The results show that there is a relationship between the variables of ICT access and usage by households and individuals and those of deprivation in Spanish and Italian regions, and indicate that the advanced and daily use of Internet in households is negatively associated with the variables of social deprivation; and the regions with higher levels of per capita income and daily access to Internet have less employment-linked material deprivation. These results also reveal the existence of a north–south spatial pattern in both countries, and six types of regions with homogeneous characteristics have been identified.

Keywords Information and communication technologies (ICTs) · Social and material deprivation · Digital inequality · Spatial analysis · Regions of Italy and Spain (NUTS 2)

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1 Introduction

The development and diffusion of information and communication technologies (ICTs) in the present digital society has enabled most of the population to establish social, administrative, labour, consumer, political and other relationships via digital devices and platforms. Since the late 2000s, the use of broadband and digital devices has become widespread in the countries of the European Unsion (EU) (Scheerder et al., 2017), with super-fast broadband becoming a basic and necessary infrastructure for economic growth and social development (European Commission, 2020a). However, and despite more than four decades of advances in ICTs, significant differences between individuals in access to, and use of, ICTs and Internet can still be found for a broad range of activities (Van Deursen & Van Dijk, 2019; Gonçalves et al., 2018).

The differences in ICT access and usage between individuals, known as the digital divide, are due to the fact that, in some cases, many digital services are expensive and/or they are offered via smart devices that are likewise not accessible to the entire population. In this respect, although most individuals-households in Europe have a high level of Internet connectivity, and accessibility to ICTs in itself does not cause a digital divide, the fact is that differences in ICT access and usage can be observed that could be related to the material and social deprivation of individuals. Deprivation refers to what certain individuals lack with regard to the basic conditions of living standards within their environment (Mayo, 2008; Walker & Pettigrew, 1984) and its analysis focuses of the limitations and consequences that may mean that these individuals do not enjoy the goods and services that, in theory, society and governments make available in order to achieve an acceptable level of social welfare (Rodero Cosano, 2015). It is necessary to emphasise that there is no unambiguous or unequivocal definition of deprivation and, from a conceptual point of view, there are difficulties to define it, as deprivation is a concept relative to the social context in which it is applied (Ivaldi & Testi, 2011, 2013).

It follows that the penetration of Internet in a territory, at aggregate level, does not necessarily lead to reducing or closing the digital divide between individuals (Buchi et al., 2016). In fact, some authors argue that already existing social differences may even be exacerbated (DiMaggio & Garip, 2012; Witte & Mannon, 2010), depending on the type of use individuals and households make of ICTs and Internet (DiMaggio & Garip, 2012; Longley & Singleton, 2009; Scheerder et al., 2020). Although it is important to get to the bottom of the relationship between ICTs, deprivation and beneficial uses of Internet, research in this respect is still very sparse (Scheerder et al., 2020). The new inequalities created, now termed digital inequality (De Marco, 2017), refer to the uses of Internet—advantageous or otherwise—in everyday life (Hargittai & Hinnant, 2008; Stern, et al., 2009), paying special attention to the groups that are left behind and miss opportunities as a result of not using ICTs for activities such as looking for work or working from home, access to health and e-Government services, etc. (Falch & Henten, 2018). An inability to participate via the formal networks of social institutions that are increasingly digitalised, or access rights related to employment, be connected to the community and establish social ties, and even access links to leisure activities, could lead to the social deprivation of individuals (Barboutidis et al., 2022). Furthermore, in relation to the foregoing, not having the use of a telephone is one of the elements of consumption or indicators related to material deprivation in Europe (Guio et al., 2016). Moreover, if there are differences between individuals in ICT access and usage and deprivation, there will also be differences between territories on the basis of their particular

characteristics, in accordance with the extensively verified regional imbalances within Europe (Iammarino et al., 2019).

The regions of Italy and Spain have been chosen for this study because they face similar challenges, both in social and in economic terms, but at the same time they have come up with very different responses. Both countries were seriously affected by the economic crisis, with common consequences that still persist in relation to employment, wages and the gender gap, among other things (OECD, 2021; World Economic Forum, 2010). Thus, and in this context, it is interesting to acquire more in-depth knowledge of the relationship that exists between the ICT access and usage of individuals and social and material deprivation in the regions of Italy and Spain. In this regard, a number of questions are posed. Is there a relationship between the variables of ICT access and usage by households and individuals and those of social and material deprivation in the regions analysed? What is the interrelationship (what factors)? Are there differences between Spanish and Italian regions in the behaviour of spatial factors (patterns) and regional factors (typologies)? In order to respond to these questions, the general aim of this paper is to study what relationship exists between ICT access and usage by households and individuals and social and material deprivation in the regions of Italy and Spain and to examine the current state of this relationship. This aim entails: (i) Identifying the key factors in the relationships between the variables, (ii) Detecting the existence of different spatial patterns of the regions according to the factors, and (iii) Identifying a hierarchical typology of regions in accordance with the factors.

The paper is structured in such a way that, first, there is a review of the main contributions in this area, and the methodology applied to identify the key variables, their spatial distribution and the typology of Italian and Spanish regions according to the relationship between ICTs and deprivation is explained. Subsequently, the results obtained on the relationship between ICT access and usage and deprivation, the distribution of the spatial patterns of regions and the typology of regions detected are analysed and discussed. Finally conclusions based on the results are presented and their merit for the scientific literature, for public policies on ICTs and social aspects, and also with regard to future lines of research, is appraised.

2 Antecedents and State of the Question

Recent studies continue to indicate the persistence of differences in access to, and use of, Internet and ICTs between individuals for a broad range of everyday life activities (Sala et al., 2022; Van Deursen & Van Dijk, 2019). In this respect, the dual direction of the impact of ICTs should be understood: as a potential for development, but also as a source of threats of digital exclusion or new economic and social differences (Haefner & Sternberg, 2020; Richardson & Bissell, 2019). When individuals do not take advantage of the beneficial uses of Internet in everyday life (searching for jobs or working from home, access to health or e-Government services, etc.), differences are increased because opportunities to take advantage of the uses that ICTs offer are missed (Ruiz-Rodríguez et al., 2020). This is even manifested in the territory since, even when there are high levels of ICT access in certain regions, this does not necessarily lead to the digital and social divide between individuals being closed (Blank et al., 2018; Warren, 2007), and the gap may even be exacerbated.

Thus, the existence of what some authors have called the "third digital divide" becomes evident, related to advanced uses of Internet and ICTs through the adoption of recent

digital applications (Van Deursen & Helsper, 2015; Ragnedda, 2017; Ragnedda & Kreitem, 2018). This third level of analysis reveals the inequalities in the benefits obtained, the social and educational implications, as well as the tangible results deriving from different ways of using Internet (Ruiz-Rodríguez et al., 2022). These inequalities can also be determined by the skills of individuals and by other socio-demographic variables (Blank et al., 2018; Haefner & Sternberg, 2020). In this respect, Helsper (2012) maintains that social inclusion interacts with the domains of digital inclusion. Hence, the continuous diffusion of digitalisation in daily life and non-participation in these processes may be related to the state of disadvantage of an individual in terms of deprivation (Helsper, 2017), that is, the living conditions of the community.

The term deprivation in this sense actually emerged in the United Kingdom to refer to the unfavourable socio-economic characteristics of the population in a specific geographic area (Rodero Cosano, 2015). According to Townsend (1987), deprivation is a term defined by socio-economic indicators that indicate a basic lack of a minimum of welfare of an individual or group of individuals in relation to the society they live in. Thus, difficulties persist from a conceptual point of view, as deprivation is a concept relative to the social context in which it is applied (Ivaldi et al. 2020a, b), and relative to the context of analysis as it refers to aggregate data on a geographic base (Carstairs & Morris, 1991; Testi & Ivaldi, 2009; Landi et al., 2018a).

In this context, the needs of individuals change over time and can be understood as relative deprivations as they depend on the general level of wealth of the society, and therefore, people perceive their level of welfare in accordance with the welfare of the rest (Denis et al., 2010). It should be emphasised that responses to needs do not depend exclusively on the availability of goods and resources, but also, and decisively, on the availability of the capacity to use these goods and resources (Nolan & Whelan, 2010; Sánchez-Cantalejo et al., 2008). In fact, Townsend et al., 1988, indicate that the lack of availability of goods, services, resources and amenities that are normally enjoyed or, at least, widely accepted as primary goods, can be identified with the concept of "material deprivation" (Boarini & d'Ercole, 2006); whereas "social deprivation" implies a non-participation in the roles, relationships, customs, functions, rights and responsibilities entailed in being a member of a society or group (Atkinson et al., 2002). On the other hand, as a substantial part of everyday functions have become digitalised, where individuals have failed to adapt to this fact (Büchi et al., 2018) could be related to deprivation, that is, a state of disadvantage in relation to the living standards of the community (Ivaldi & Testi, 2013).

Specifically, in terms of addressing deprivation, academics have developed several indices and new methods of aggregation and weighting of living conditions that enable a better interpretation of social development from the perspective of material well-being, supplementary to the study of inequality and monetary poverty (Galobardes 2006a, 2006b; Ivaldi et al., 2020a).

The first studies related to deprivation date back to the 1980s in Great Britain with the studies of Jarman (1983, 1984) and) and Townsend (1987) on a person's state of disadvantage in relation to the living conditions of the community to which he or she belongs. (Department of Health and Social Security 1988). In the last four decades, deprivation indexes based upon the characteristics of areas of residence were widely used in epidemiology and public health (Davey Smith et al., 2001). They are also used to measure the correlation between deprivation and mortality (Santana et al., 2015), waiting-time inequalities for health services (Landi et al., 2018b) and the incidence of specific diseases (Andersen et al., 2014; Su et al., 2017). These indexes have emphasized, among other things, the multidimensional aspect of urban deprivation as related to its absolute versus relative nature

and its material versus social content (Alaimo et al., 2022; Bruzzi et al., 2020; Guio, 2018). It was also stressed that purely income-based indicators of poverty and inequality, while essential, are not sufficient to satisfactorily reflect the diversity of living conditions (Guio et al. 2016; Fusco et al., 2010).

Likewise, indicators have been obtained, at times partial, of the different dimensions that have made it possible to identify and locate specific geographic areas where the index displays greater or lesser intensity (Rodero Cosano, 2015). Even so, the relationship between deprivation and ICTs has not been analysed. Thus, social exclusion goes beyond matters of unemployment and access to the labour market (Ayllón & Gábos, 2017) because it is manifested through deprivations and obstacles of different types which, alone or in combination, prevent full participation in areas such as education, health, the environment, housing, culture, the exercise of rights and access to family support, as well as training and job opportunities (Booker et al., 2018; Ivaldi & Testi, 2011; Longley & Singleton, 2009; Commission of the European Communities, 2000), which are all increasingly digitalised nowadays. The same is true for the educational level of an individual, which seems to play an essential role in deprivation. Nevertheless, the mentality and lifestyle that accompany the educational level appear to be, to a large extent, decisive for the results they obtain (Reinstadler & Ray, 2010). As the adoption of Internet becomes more and more extensive, ICTs could provide explanations as to why these differences exist in the results of deprivation (Warren, 2007; Silverstone et al., 1996).

The regions of Italy and Spain have been analysed in this research because they have a number of common traits, while at the same time being differentiated with respect to general data. First, long-term unemployment, which affects the younger population with great intensity, and also the degree of inflexibility in wage setting and rigidity in hiring and firing practices, remain high (World Economic Forum, 2010). Likewise, both countries obtain very poor results with respect to the gender gap in terms of the participation of female labour (OECD, 2021). In fact, the wage gap between men and women is evident in both Spain and Italy, although both countries are exceptions from the normally greater difference in salaries at the upper end of the wage distribution (De la Rica et al., 2008; Olivetti & Petrongolo, 2008). These dynamics have an important influence on the scope of deprivation for both countries which, even before the onset of the crisis in 2008–2009, had different percentages of households in conditions of severe material deprivation (Ayala et al., 2021), both far removed from the European average, despite having similar at-risk-of-poverty rates. Today, however, the female share of employment in Spain continues to be below the European average, while in Italy the female employment rate is above the average and almost double that of Spain (Mussida & Parisi, 2021).

In relation to the data, the availability of Eurostat, which gathers appropriate and comparable multidimensional transversal and longitudinal microdata on incomes, poverty, social exclusion and living standards, at Nomenclature of Territorial Units for Statistics (NUTS) level, makes it possible to adopt regions as the geographical scale. Nonetheless, the NUTS 2 regional scale of analysis of deprivation has been quite neglected in Europe (with the exceptions of Callens & Croux, 2009, and Reinstadler & Ray, 2010), because studies have focused on the urban or national dimension. Moreover, the analysis of ICTs at this regional scale has been infrequent, since the use of indices has been at national scale or at other regional scales that are not adequate for measuring regional differences in digital preparation due to having a series of restrictions (González-Relaño, et al., 2021). In this respect, European regional data (at NUTS 2 level) may be seen via Digital Economy and Digital Society Statistics at Regional Level (European Commission, 2020), but these data are adversely affected by a simplification of the complex interrelationships between ICT

variables, an inadequate selection of the variables related to ICT technologies and granting a different weight and importance to the variables in calculating the indices (Bruno et al., 2011; OECD, 2008).

Other previous studies have also demonstrated that spatial autocorrelation analysis is an appropriate technique for analysing the territorial diffusion of ICTs (González-Relaño et al., 2021) and deprivation (Rodero Cosano, 2015; EAPN, 2020), as it helps to identify influences between neighbouring regions. On the one hand, deprivation has been analysed from a geostatistical point of view by means of global and local spatial autocorrelation methods, which has made it possible to identify and locate specific geographic areas where the index manifests greater or lesser intensity (Rodero Cosano, 2015). On the other hand, it has also been applied to European regions, finding that in a centre-periphery European model of digital development, the knowledge of how geographical proximity affects ICT access and usage may help in establishing measures to reduce digital inequalities between regions (González-Relaño et al., 2021).

3 Methodology

3.1 Data and Variables

The data that have been used in this study are taken from the Eurostat survey "ICT usage in households and by individuals" (isoc-i) for 2018. This survey provides data on ICT access and usage by households (all private households having at least one member in the age group 16 to 74 years old) and individuals (people aged 16 to 74). For their part, the variables related to deprivation also come from Eurostat, from Regional Statistics for 2018. Thus, a database of 13 variables has been used in this study, of both ICT access and usage by households and individuals and related to deprivation, for 40 NUTS 2 regions, 19 of which are in Spain and 21 in Italy (Table 1).

3.2 Univariate Analysis

The intention of the univariate analysis is to provide a statistical description of the ICT and deprivation variables of households and individuals analysed for the regions of Italy and Spain. This brief analysis makes it possible to know not only the most relevant aspects of the behaviour of the variables on an individual basis, but it also provides statistical contextualisation that will help to understand the results of the subsequent multivariate analyses. Specifically, each variable is analysed at general level, and by country, to discover the average values, variability or dispersion (measured by the standard deviation) and the differences of these statistics between the regions of Italy and Spain (measured in absolute percentage values).

3.3 Factor Analysis (FA)

The study of the links between ICTs and deprivation for the households and individuals of the regions of Italy and Spain requires the use of multivariate statistical techniques. These kinds of statistical methods make it possible to analyse interdependencies (Cruz-Jesus et al. 2012, 2016) between both types of variables. In order to know how these variables interrelate, an explanatory factor analysis was conducted by the principal component method

Table 1 Variables used in the analysis

Area	Variable	Definición	Studies that used an analogous variable
Deprivation	GDP_EURxh(R)	Gross domestic product at current market prices in euro per inhabitant	Łuczak and Kalinowski (2020a); Lancee & Van de Werfhorst (2012)
	HouseLowWorkInt	Percentage of people living in households with very low work intensity by NUTS regions (population aged 0 to 59 years old)	Ayllón and Gábos (2017)
	GapEmp	Gender employment gap: difference between the employment rates of men and women aged 20 to 64. (Percentage points)	Mena et al., 2018
	Unemployment	Percentage of individuals unemployed (population from 15 to 74 years)	Jarman (1983), Townsend (1987), Baumann (2007)
	DeathTHIVH	Death rate due to tuberculosis, HIV and hepatitis (deaths per 100,000 inhabitants)	Pathak et al (2021), Mc Donald et al. (2009)
ICT- Access and frequency	H_Access	Percentage of households with access to the Internet at home	Lucendo-Monedero et al. (2019), Nie and Erbring (2002), Seybert (2011), Spencer et al (2022)
	I_NorHomeWork	Percentage of individuals who accessed the Internet away from home or work	Horrigan (2009), Lera-López et al (2011), Lucendo-Monedero et al (2019), Prescott (2017), Seybert (2011)
	I_Daily	Percentage of individuals who use the Internet daily	Lucendo-Monedero et al (2019); Seybert (2011), Seifert et al (2017)
	I_Regularly	Percentage Individuals who use the Internet all the time	Chmielarz and Parys (2017); Garcia et al (2019), Lucendo-Monedero et al (2019), Seybert (2011), Selwyn (2008)
ICT-Use of the internet by individuals	I_Bank	Percentage of individuals using Internet banking	Gerrard (2006), Lucendo-Monedero et al. (2019), Seybert (2011), Tan and Teo (2000)
	I_SumitForms	Percentage of individuals submitting completed forms (last 12 months)	Lucendo-Monedero et al (2019), Seybert (2011)
	I_InterPA	Percentage of individuals interacting with public authorities (last 12 months)	Nielsen et al (2021); Castelnovo and Simonetta (2008), Lucendo-Monedero et al (2019), Seybert (2011)
	I_BuyTravel	Percentage of individuals: online purchases travel and holiday accommodation	Lucendo-Monedero et al (2019), Marić et al. (2019) Nevado-Peña et al (2019), Seybert (2011)

using the statistical software IBM SPSS v23. The aim is that via this exploratory analysis an optimal number of factors can be obtained, and also the factor structure that defines this relationship. In general, the principal component method is the most appropriate when the goal is to establish an initial theory or model, as it seeks the smallest number of factors that explain the maximum amount of variance or information possible (Frías-Navarro & Pascual Soler, 2012). With this aim, a rotated factor matrix was obtained using the method of Quartimax normalisation with Kaiser because, as indicated by Hayton et al (2004) and Thompson (2004), Quartimax method produces simple and interpretable factorial structures by identifying the most important variables in the factorial structure and produces results that have a clearer and more meaningful interpretation; while using the normalized Quartimax rotation with Kaiser, as indicated by Kim (2013) or Mundfrom et al (2005), allows identifying the loading patterns of the variables in the factors, reducing the number of factors necessary to explain the observed variance which results in a more significant and interpretable expression of the factors.

3.4 Spatial Analysis

In the foregoing procedures, the data of Internet access and usage and deprivation for the households and individuals of the regions of Italy and Spain were analysed, without taking into consideration their spatial situation in relation to their neighbours. However, bearing in mind that interaction between regions may affect their behaviour, above all those that are the closest, the values of Internet access and usage and deprivation data in a region may be explained not only by its own particular characteristics, but also by taking into account the values of neighbouring regions, due to effects of spatial dependence.

Using the ArcGis Pro GIS software, the data of the values of the Spanish and Italian regions for the factors identified were georeferenced and represented cartographically. An analysis of both maps makes it possible to know the location and spatial distribution of the factors and to intuit the existence of possible spatial patterns, understanding a spatial pattern to be the geographic concentration of regions with similar values, whether they are high or low, in the ICT-deprivation relationship of households and individuals. However, the different spatial concentrations of high and low values of the variables represented could be the result of a random geographical distribution or due to effects of spatial dependence. As Serrano and Vayá (2002) explain, the information obtained in the cartographic analysis, although useful, is subjective and highly dependent on, among other things, the number of intervals chosen to represent the factors, due to the fact that it does not explicitly take into consideration the space in which the regions are located. In order to avoid these inconveniences, it is advisable to apply spatial autocorrelation analysis techniques which make it possible to quantify these patterns, locate them and determine whether they entail concentrated, dispersed and/or atypical spatial association schemes.

Spatial autocorrelation is a technique of exploratory spatial data analysis (ESDA) that combines a set of methods that focus explicitly on spatial effects and make it possible to describe spatial distributions, identify atypical locations (spatial outliers), discover spatial association schemes (spatial clusters) and suggest different spatial regimes or other forms of spatial instability (Bohórquez & Ceballos, 2008). The concept of autocorrelation is the concentration or dispersion of the values of a variable in space and is based on the existence of a similarity between what occurs in a region and its neighbours, in accordance with Tobler's first law of geography (Tobler, 2004). Therefore, spatial autocorrelation is the result of an effect of spatial dependence, that is, when the ICT-deprivation factors of

households and individuals in a region depend on those of its neighbouring regions due to its position. Hence, in this comparative study of the behaviour of the ICT-deprivation factors of households and individuals of Italian and Spanish regions, it is intended to identify the role of dependence by studying their spatial autocorrelation.

To conduct the spatial autocorrelation study, a GIS was again used with the ArcGis Pro software from Esri, employing the vector coverage from Eurostat's spatial database GISCO NUTS2 2016 which contains the European NUTS2 shapefile. This GIS was used to analyse whether spatial patterns exist for each factor relevant to this study by means of calculating the following spatial autocorrelation indices:

(i) The Global Moran's I index (Moran, 1948), which compares the value of each region with all neighbouring regions (having previously defined the criterion of neighbourhood) and which varies between − 1 or negative spatial autocorrelation (spatial dispersion, neighbouring regions have different values) and + 1 or positive spatial autocorrelation (spatial concentration, neighbouring regions have similar values); and

(ii) The Anselin local Moran's I index and the Getis-Ord Gi* index. The previous autocorrelation index does not make it possible to distinguish whether there are spatial groups that differ from each other. The local indices make it possible to identify these groups and visualise spatial patterns by drawing up maps that show the location of spatial clusters. The Anselin local Moran's I index (LISA or cluster analysis and outlier value analysis) identifies the spatial clusters or groups that have similar values and the atypical spatial values. This index calculates a value that represents the type of cluster for each entity: high-high (HH), low-low (LL), high-low (HL) and low–high (LH), as well as those that are not significant.

The Getis-Ord Gi* index (or optimised analysis of hot spots) shows where statistically significant spatial clusters may be produced due to the concentration of regions with high (hot spots) or low (cold spots) values. The results of this index reveal details not provided by the HH and LL spatial clusters obtained by using the Anselin local de Moran's I index. The result of the Getis-Ord Gi* index goes further, as it identifies the degree of intensity with which an entity belongs to a spatial cluster in accordance with the statistically significant level of confidence on the basis of z-scores and p-values of probability. In this way, an entity is considered to be a statistically significant hot spot if it has a high value and is surrounded by other entities with high values. The procedure assigns the entities a value of belonging to a cluster (± 0, 1, 2 and 3, respectively) depending on the level of statistical confidence (of 0, 90, 95 and 99%). The higher this value, the greater the level of confidence and the stronger the presence of high values (hot spot) or low values (cold spot) within the spatial clusters. Unlike the local Moran's I index, the Getis-Ord Gi* index does not take atypical spatial values into consideration.

Calculating the spatial autocorrelation indices entails the definition of a value for neighbour distance between entities given that the spatial statistic, unlike the traditional statistic, incorporates the spatial relationships into the operation. The conceptualisation of neighbour imposes a spatial restriction as only the entities included within this area or distance (whether by contiguity, number of nearest neighbours or some kind of threshold distance) are included in the calculation of the spatial autocorrelation indices. In this study, due to the number of entities analysed (40 NUTS 2) and the fact that they are spatially separated, it is not advisable to choose a distance criterion from among the options of neighbourhood, but rather use contiguity. The specific option most recommendable is "polygon

contiguity edges only" (first order), so that only neighbouring regions that share a limit or overlap have an influence on the autocorrelation calculations. However, this option is not completely effective as it is not valid for insular regions (without contiguous regions). The solution adopted has been the "k-nearest neighbours" option (with k being equal to 8) as it obtains the same result as "polygon contiguity edges only" but guarantees that all regions, including islands, have neighbours (ESRI, 2020).

3.5 Cluster Analysis (CA)

The identification of groups of regions, defined by the homogeneity of their common characteristics, implies identifying clusters of regions. A typology of regions has been obtained by means of cluster analysis on the basis of the results obtained in the factor analysis. The use of methods of multivariate analysis of clusters is of great utility in cases that seek to solve problems of identification and classification in homogeneous units on the basis of several variables. The average values of each group (centres of the final clusters) were obtained by conducting a k-means analysis since, as Arthur and Vassilvitskii (2007) point out, it facilitates the interpretation of the results and the extraction of the clusters by calculating the centroids of the groups (the average of each conglomerate) that allow them to be characterized. On the basis of these, the percentages of households and individuals that use ICTs in each region were calculated for the two factors. Each cluster contains a group of regions that have similar percentages in the factors obtained, establishing a typology of regions in accordance with these relationships.

4 Results and Discussion

Two main ideas emerge from the values obtained in the univariate analysis (Table 2) of the ICT and deprivation variables: (a) That there are three levels of ICT variables according to the total percentage of households or individuals that have access to, and use of, Internet; and (b) That there is a clear difference in the values of the ICT and deprivation variables between Italian and Spanish regions.

Thus, with regard to ICTs, at the first level there are two variables related to access and frequency of use of ICTs that have very high percentages and these are: households with Internet access at home (85% of households) and individuals who always use Internet (84%). It can therefore be affirmed that the level of Internet access and its general use in Spanish and Italian regions is high and almost universal (European Commission, 2020a). Likewise, the data show that the levels of access and usage are similar in all the regions in question, as the standard deviation values are low for the aforementioned variables (4.4 and 4.8%, respectively).

At the second level there are another two variables related to access and frequency of use of ICTs that have high percentages (over 50%). These are Internet access away from home or work and daily Internet usage. These are more specific than the first level uses since, of the individuals who access Internet, around 60% of them also do so away from home or work (on the move, with mobile devices); and of those who use Internet, more than 71% do so on a daily basis.

Finally, at the third level there are ICT variables related to Internet usage and which have low percentages (less than 50% of individuals) and, therefore, are less used by part of the population in each region. These variables correspond to very specific uses of Internet

such as "online purchases travel and holiday accommodation" (22.3%) and "submitting completed forms" (26.7%); and, with slightly higher values, "using Internet banking" and "interaction with public authorities" (around 40%).

As noted above, Spanish and Italian regions show a clear difference in the average values of ICT and deprivation variables shown in Table 2. On the one hand, and in relation to the ICT access and usage by households and individuals variables, Spanish regions have higher percentages of households and individuals with access and use of Internet than Italian regions in all the variables of this kind (except in Internet usage which are equal). The greatest differences between the regions of both countries are with respect to the variables that were previously classified as second or third level (Ruiz-Rodriguez et al., 2020). Thus, the percentage of individuals who use Internet for "online purchases travel and holiday accommodation" in Spanish regions is almost double that of Italian regions; and with regard to "interaction with public authorities", "individuals who accessed the Internet away from home or work" and "individuals submitting completed forms", the levels in the Spanish regions are more than double those in the Italian regions. On the country, the same does not occur for the first level variables (access and general use of Internet) where the differences are minimal.

On the other hand, according to the average values of the data of the regions by country in Table 2, an important differentiation between regions of both countries on the basis of the variables of deprivation is also evident. In the case, the Italian regions have better indicators than the Spanish ones for most of the variables analysed: around 40% less for the variable that measures unemployment, a 16% difference with regard to income per capita and 12.5% less households with "people living with very low work intensity". The Spanish regions, meanwhile, have substantially better data for "Gender employment gap difference" (67.5% less than Italian regions) and "Death rate" due to infectious diseases (around 40% less).

The exploratory factor analysis (FA) was conducted with 8 variables of ICT access and usage by households and individuals and with the other 5 related to deprivation in Italian and Spanish regions. The valid FA includes 13 variables and the adequacy measures of the variables introduced (determinant, test de KMO test and Bartlett's sphericity test, Table 3) show that the variables are highly correlated with each other and, therefore, the result of the FA is correct. In fact, Bartlett's test makes it possible to test the null hypothesis of lack of correlation between the variables; and the value of the KMO sampling adequacy index is equal to 0.790. The choice of the number of final factors was made in accordance with total variance explained and the Quartimax normalisation with Kaiser method, as can be seen in Table 3. Two factors were obtained because these accumulate the largest possible amount of information (between the two factors, the accumulated total variance explained is over 80%, specifically 83.56%, complying with Pearson's criterion) and moreover they are the two components with an eigenvalue over 1 (in accordance with the Kaiser method).

Table 4 shows the factor matrix of components rotated by the Quartimax normalisation with Kaiser method in which the correlations between variables and the two factors obtained can be seen. The interpretation of the same is as follows:

Factor 1 accounts for 54.54% of the variance. It is made up of 9 variables related positively to:

(i) ICT usage linked to activities carried out for particular reasons, such as: interaction with public authorities (in the last 12 months), online purchases of holiday accom-

Table 2 Univariate descriptive analysis of ICT access and usage by households and individuals and deprivation *Source* Prepared by the authors

Type	Variable	Average	Standard deviation	Spain	Italy
ICTs	H_Access	84.9	4.4	86.2	83.7
	I_Regularly	84.0	4.8	86.8	81.5
	I_Daily	71.3	4.6	71.3	71.3
	I_NorHomeWork	58.5	20.3	79.6	39.4
	I_Bank	40.0	10.3	47.1	33.5
	I_InterPA	39.1	16.0	55.4	24.4
	I_SumitForms	26.7	12.9	38.8	15.0
	I_BuyTravel	22.3	11.3	32.8	12.7
Deprivation	DeathTHIVH	3.9	2.0	2.5	5.2
	GapEmp	16.0	6.0	12.7	19.0
	GDP_EURxh(R)	26,915.0	7122.7	24,652.6	28,961.9
	Unemploy	13.1	6.1	15.7	10.7
	HouseLowWorkInt	11.1	6.3	11.8	10.4

modation (hotel, apartment, etc.), submitting completed forms to public authorities (in the last 12 months) and conducting transactions via e-banking.

(ii) The availability of Internet, that is, Internet access by households and the frequency of individuals who always use Internet.

And they are related negatively to the variables of deprivation such as the death rate by tuberculosis, AIDS and hepatitis, and the gender gap in employment.

This indicates that, in Italian and Spanish regions, the advanced and daily use of Internet in households is negatively associated with variables of social deprivation. This factor could be called "Advanced Internet usage versus social deprivation".

Factor 2 accounts for only 29.02% of the variance, and establishes a relationship between four variables:

(i) GDP per capita is positively related to daily Internet usage

(ii) And negatively to the percentage of individuals who live in households with low work intensity and the regional unemployment rate

This reveals that incomes and daily access to Internet are contrary to unemployment and low work intensity in the households of Italian and Spanish regions. It can be interpreted that the regions with higher GDP per capita and daily access have less material deprivation linked to employment. This factor could be called "Income and daily Internet access versus unemployment".

Extraction method: Principal component analysis. Rotation method: Quartimax normalisation with Kaiser.

(a) The rotation converged in 3 iterations.

Figures 1 and 2, resulting from the spatial analysis, show the distribution of the values of the two factors obtained in the factor analysis (measured in z-scores) for the Spanish and

Table 3 KMO and Bartlett's test

Kaiser–Meyer–Olkin measure of sampling adequacy		0.790
Bartlett's sphericity test	Approximate chi-square	871.213
	Gl	78
	Sig	0.000

Table 4 Rotated Loading Matrix* *Source* Prepared by the authors

	Component	
	1	2
I_InterPA	0.978	
I_BuyTravel	0.942	
I_NorHomeWork	0.934	
I_SumitForms	0.931	
I_Bank	0.868	
I_Regularly	0.799	
DeathTHIVIH	− 0.793	
GapEmp	− 0.718	
H_Access	0.579	
GDP_EURxh(R)		0.956
Unemployment		− 0.912
HouseLowWorkInt		− 0.828
I_Daily		0.778
Explained variance	54.54%	29.03%

Italian regions. The maps make it possible to show, intuitively: (a) A differential behaviour of both factors between Spanish and Italian regions; and (b) A possible spatial correlation between neighbouring regions as the presence of some groups of adjacent regions with high or low values in these factors can be observed in both countries (potential spatial clusters).

In effect, Fig. 1 clearly shows a spatial dichotomy for Factor 1 "Advanced Internet usage vs. social deprivation": all the Spanish regions have high values (z-scores over 0) with a gradient of higher to lower values from NE to SW (except Ceuta); while all the Italian regions have low values under 0 and a N-S spatial gradient can also be seen. This means that there is a high level of advanced and daily use of Internet by households and individuals along with low levels of social deprivation in Spanish regions, with very high values (z-scores 1.0) in the regions of Ceuta, the Community of Madrid, Aragón, the Balearic Islands, Catalonia, the Autonomous Community of Navarre and the Basque Country. It is quite the opposite in the Italian regions: there are low percentages of households and individuals with advanced Internet usage and high levels of social deprivation, especially in Molise, Campania, Puglia, Basilicata, Calabria, Sicily and Abruzzo (with z-scores 1.0).

Figure 2 shows similar behaviour in both countries as in each of them there are regions with different levels of Factor 2. Even so, it can be affirmed that, overall, the regions of Italy have higher Factor 2 values than those of Spain and that, therefore, the Italian NUTS 2 have high levels of income and daily Internet access and low levels of

unemployment; whereas the opposite is the case in Spanish regions. In fact, there are only 8 regions with high Factor 2 values (z-scores over 1.0) and all of them are Italian (the Autonomous Province of Bolzano, Emilia-Romagna, Lombardy, the Autonomous Province of Trento, Veneto, Aosta Valley, Tuscany and Friuli-Venezia Giulia). The above-mentioned similarities between regions of both countries are to be found in: (a) An equal number of regions with average Factor 2 values (z-scores between 0.5 and 1.0), with 4 Italian regions (Liguria, Piedmont, Marche and Lazio) and another four in Spain (Madrid, the Balearic Islands, Navarre and the Basque Country); and (b) Once again gradients of decreasing spatial distribution can be seen, SW-NE (for Spanish regions) and N-S (for Italy).

As has already been commented, the analysis of these maps shows the location of a series of spatial concentrations of Spanish and Italian regions with similar values of both factors and therefore, to verify the existence of spatial clusters, a spatial autocorrelation analysis of the two factors obtained was performed. The results of calculating the Global Moran's I index (Fig. 3), obtained with ArcGis Pro, show the existence of spatial autocorrelation for both factors, with a probability of less than 1% that the group pattern could be the result of a random probability. Specifically, the Moran I index is higher for Factor 1 "Advanced Internet usage versus social deprivation" (0.97, with a z of 7.44) than for Factor 2 "Income and daily Internet access versus unemployment" (0.47 and a z of 3.70).

Using the Anselin local Moran's I index, the spatial clusters of regions for both factors have been identified (Figs. 3 and 4) and which correspond to clusters with high (HH) and low (LL) values, with no atypical region (regions with high values surrounded by low values or vice versa). For Factor 1, the HH clusters are regions with high values for advanced Internet usage and low levels of social deprivation, while the LL clusters are the contrary. In the case of Factor 2, the HH clusters are regions with high levels of income and daily Internet access and low levels of unemployment; while the LL clusters are groups of regions with low levels of income and daily Internet access and high levels of unemployment.

These clusters show significant differences between factors and countries. Thus, Factor 1 shows a clear differentiation between countries as the HH clusters only appear for Spanish regions (basically the centre and north-west of the country); whereas the LL clusters

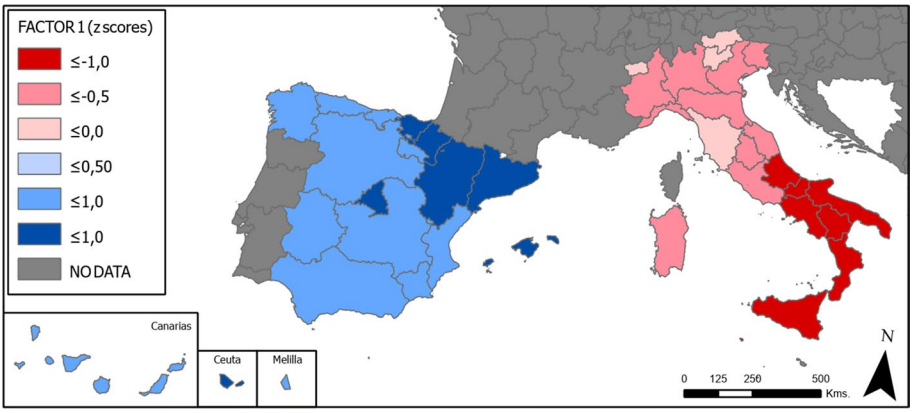

Fig. 1 Regions according to Factor 1 (in z-scores). Source: Prepared by the authors

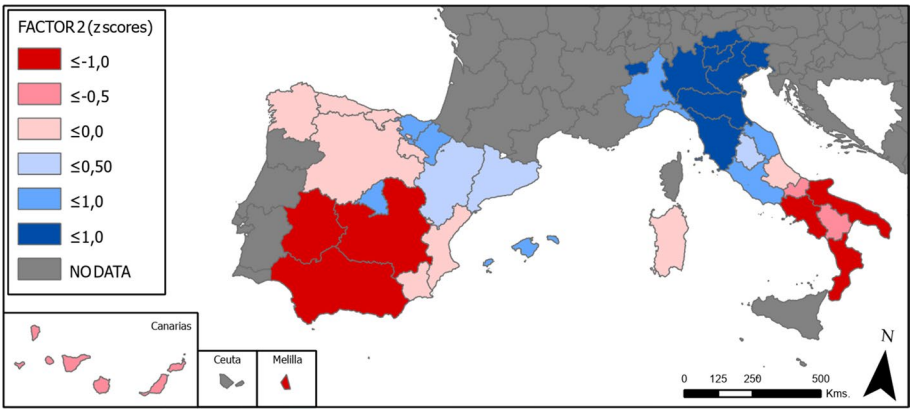

Fig. 2 Regions according to Factor 2 (in z-scores). Source: Prepared by the authors

only involve Italian regions (all southern regions from Lazio and Abruzzo). This means that high levels of ICT access and usage associated with a low value for social deprivation vary notably between Spanish and Italian regions, and one could speak of a "gap" or "divide" between countries with regard to this factor.

Figures 4 and 5 reveals that Factor 2 shows a different spatial behaviour to Factor 1 since: (i) LL spatial clusters form regardless of the country, as they occur in both Italy and Spain; and, (ii) Moreover, the LL clusters have some common traits as they are made up of peripheral regions in the south of Italy (Sicily, Calabria and Puglia) and Spain (Extremadura, Andalusia, the Region of Murcia, Ceuta, Melilla and the Canary Islands). This therefore means that in both countries the southern regions have low levels of income and daily Internet access and high levels of unemployment. By contrast, only one HH cluster has been identified, which is made up exclusively of regions of the north of Italy (Piedmont, Aosta Valley, Liguria, Lombardy, Veneto, Friuli-Venezia, the autonomous provinces of Bolzano and Trento, Tuscany, Umbria and Marche). These regions stand out for having high levels of income and daily Internet access and low levels of unemployment.

Figures 6 and 7 show the spatial clusters obtained by using an analysis of the correlation of hot spots, or the Getis-Ord Gi* index, for Factors 1 and 2, respectively. In relation to Factor 1, large differences are detected between the regions of both countries, since there is a single hot spot comprising the regions of the NE of Spain; and a single cold spot comprising the regions of the centre and south of Italy. The former is made up of a number of regions with high Factor 1 values that create a spatial distribution pattern in the form of a ring of regions around Madrid of greater to lesser intensity of households and individuals with advanced Internet usage and low levels of social deprivation. Castile-La Mancha, Castile and León and Aragón form a first ring of higher Factor 1 values (above the average according to z-score values and with higher levels of confidence, of 99%); with a second ring made up of Navarre, La Rioja, the Valencian Community, the Basque Country and Catalonia (95% level of confidence); and finally the regions of Murcia, Cantabria and the Principality of Asturias with less hot spot intensity (lower confidence level of 90%). The spatial cluster of low Factor 1 values or cold spot of Italian regions describes a S–N gradient: Sicily, Calabria, Basilicata, Puglia, Campania, Molise and Lazio are the regions with the lowest intensity of households and individuals with advanced Internet usage and

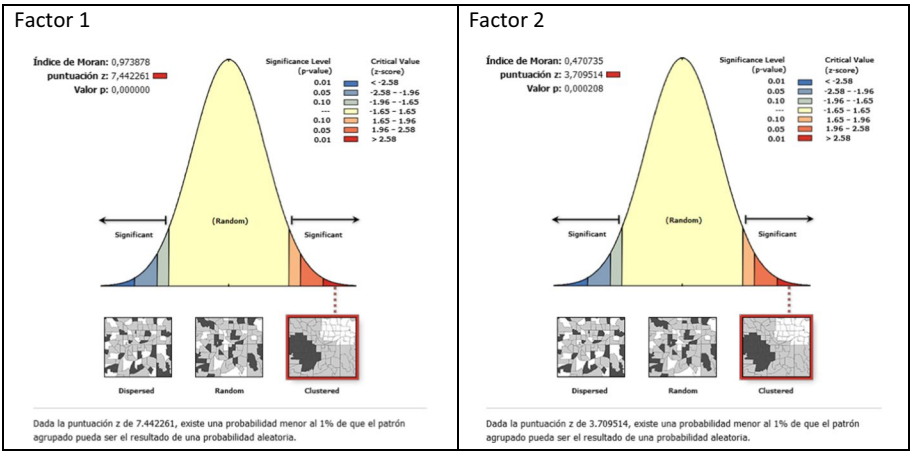

Fig. 3 Spatial autocorrelation (Moran's I). Source: Prepared by the authors

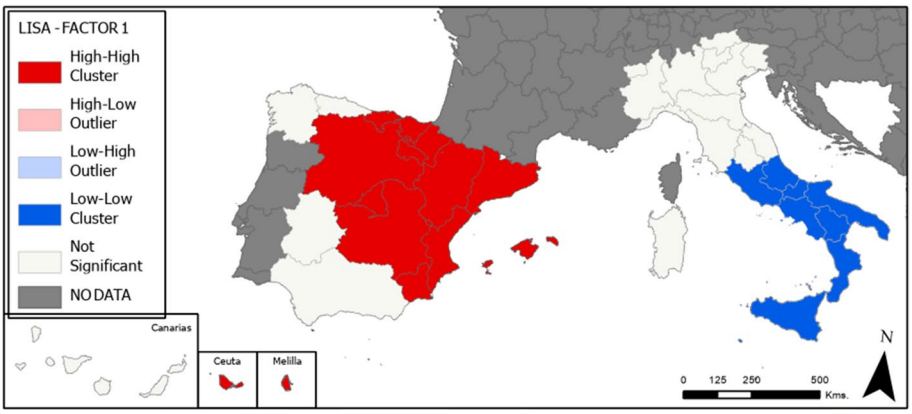

Fig. 4 Anselin local Moran's I index (LISA) for Factor 1. Source: Prepared by the authors

high levels of social deprivation (99% confidence level), followed by Abruzzo (95%) and Umbria and Marché (90%).

In relation to the analysis of hot and cold spots of Factor 2, the spatial distribution patterns shown by the results of the Anselin local Moran's I indices are maintained. In fact, first of all, Fig. 7 makes it possible to observe a peripheral spatial distribution pattern formed by two cold spots. One comprises the regions of southern Spain with Andalusia, Murcia, Ceuta, Melilla and the Canary Islands (with a 99% level of confidence, that is, the lowest levels of income and daily Internet access and the highest levels of unemployment) and Extremadura (with a 95% confidence level). The other is made up of the regions of southern Italy: Sicily, Calabria (with the lowest values for this factor), Basilicata and Puglia (95% confidence level). Second, there is only one hot spot and it comprises only northern Italian regions: Piedmont, Aosta Valley, Liguria, Lombardy, Veneto, Friuli-Venezia and the autonomous provinces of Bolzano and Trento have the highest levels of income and

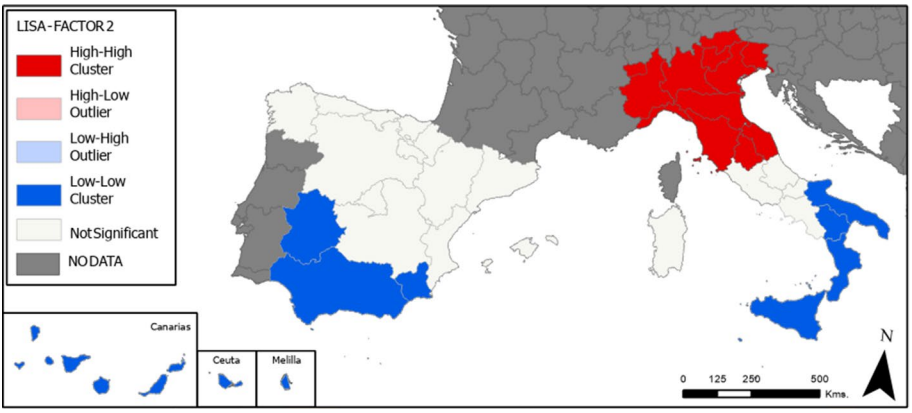

Fig. 5 Anselin local Moran's I index (LISA) for Factor 2 Source: Prepared by the authors

daily Internet access and the lowest levels of unemployment (99% confidence level), followed by Tuscany (intermediate level of confidence of 95%) and Umbria and Marche (with a lower confidence level of 90%).

5 Cluster Analysis

On the basis of the results obtained in the FA, cluster analysis was used following the procedure of furthest neighbour (squared Euclidean distance) and Ward's method with the aim of obtaining groups of Italian and Spanish regions. Each cluster is a group of regions with similar values according to the relationship between the ICT and deprivation variables in the 2 factors. The dendrogram obtained makes it possible to identify 6 differentiated groups of regions. With the k-means cluster analysis, the average descriptive values of each group were obtained (centres of the final clusters, Table 5).

Cluster 1 is made up of seven regions of the north of Italy (17.5% of the total): Aosta Valley, Lombardy; the autonomous provinces of Bolzano and Trento, Veneto, Emilia-Romagna and Tuscany (Fig. 8). These are characterised by being the regions having the highest score in Factor 2 "Income and daily Internet access versus unemployment" (a z-score of 1.3 according to Table 5). This means that they comprise the group of regions with the highest level of income per capita of all those analysed; with the highest average percentage of individuals and households with daily Internet access away from home or work and the lowest average level of unemployment and low work intensity in households. However, they have a below-average Factor 1 value (-0.4) and, therefore, a below-average advanced use of Internet by individuals and households (45.4%).

Cluster 2 is made up of six Italian regions (15%): Piedmont, Liguria, Friuli-Venezia Giulia, Umbria, Marche and Lazio. Geographically, this cluster surrounds the previous one, forming a second level of Italian regions, as this group is also characterised by having above-average values for Factor 2, but below average for Factor 1, and lower than the levels of the regions of Cluster 1 (0.8 for income and daily Internet access; and −0.7 for social deprivation). This indicates that this group contains the regions with the second-highest income level, high percentages of daily Internet access away from home or work

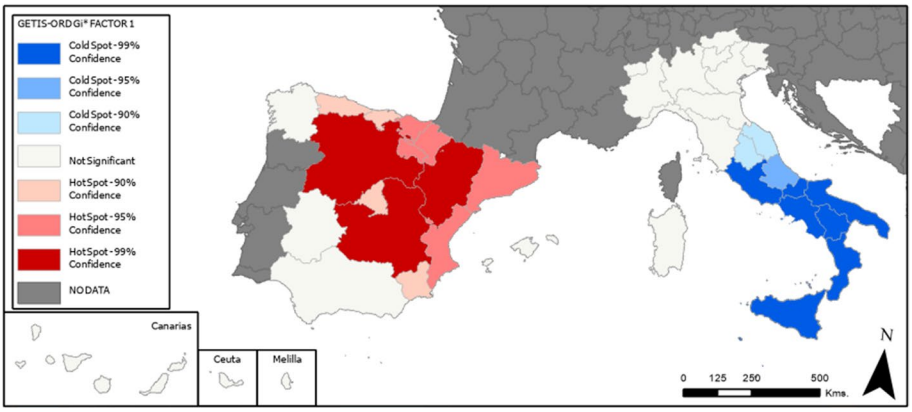

Fig. 6 Getis-Ord Gi* index for Factor 1. Source: Prepared by the authors

(more than 73% of individuals), although barely 43% of individuals participate in advanced Internet usage. This groups is also notable due to the low percentages of unemployment compared with other regions (8.4%) but with a high percentage of gender employment gap (almost 17%).

Cluster 3 is made up of the remaining 8 Italian regions (20% of the total) which are located in the south: Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily and Sardinia. They have the lowest values of all the regions analysed (including the Spanish regions) for Factor 1 (z-score of −1.4); and the second-lowest level for Factor 2 (1 standard deviation below the average), with the exception of Sardinia, which has one of the lowest values for Factor 1, while for Factor 2, related to income, it has positive values. It is in this cluster due to deficiencies related to the variables of advanced ICT usage. This is cluster containing the regions with the lowest advanced ICT usage of all (they do not reach an average of 37% of households and individuals). Furthermore, they are the only regions in the country that have negative values for Factor 2, and consequently these regions have a low GDP per capita and a relatively low daily Internet access away from home or work (66% of individuals), along with high unemployment rates and a high percentage of households with low work intensity (16.4%).

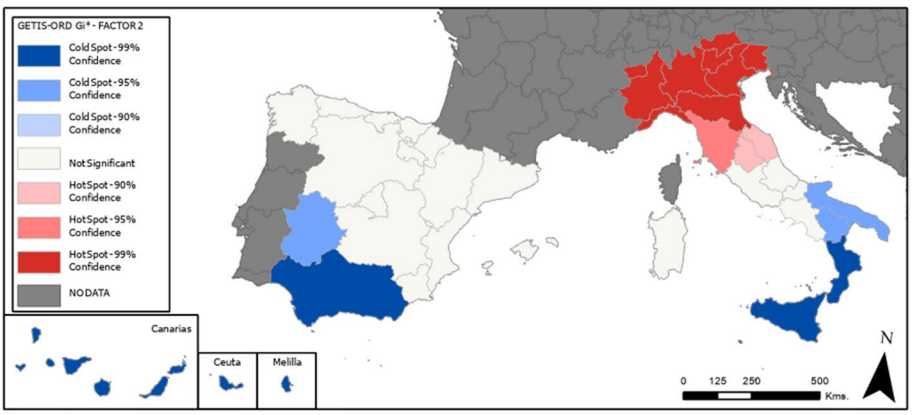

Fig. 7 Getis-Ord Gi* index for Factor 2 Source: Prepared by the authors

Table 5 Typology of regions according to the average values of the factors of ICT and deprivation Prepared by the authors. (Color table online)

CLUSTER	F1	F2	VARIABLES F1			VARIABLES F2			Regions	
			(1)	Gap_Emp	Death	(2)	(3)	Income (4)	No.	%
C1 (It)	−0.40	1.30	45.4	16.7	4.4	5.7	75.4	37614	7	17.5
C2 (It)	−0.70	0.80	43.1	19.00	2.4	8.4	73.5	30366	6	15.0
C3 (It)	−1.40	−1.00	36.7	11.4	2.5	16.4	66	20337	8	20.0
C4 (Es)	1.20	0.60	64.1	9.2	2.7	8.6	75	30983	6	15.0
C5 (Es)	0.90	−1.40	59.7	14.1	3.9	21.6	69.6	19380	5	12.5
C6 (Es)	0.80	−0.40	59.6	25	6.8	12.7	69.5	23200	8	20.0

* (1) Average percentage of the ICT variables of Factor 1

(2) Average percentage of the deprivation variables of Factor 2

(3) Average percentage of the ICT variables of Factor 2

(4) EUR per inhabitant

Source: Prepared by the authors

Blue colors mean values above the mean of each variable. Red colors mean values below the average

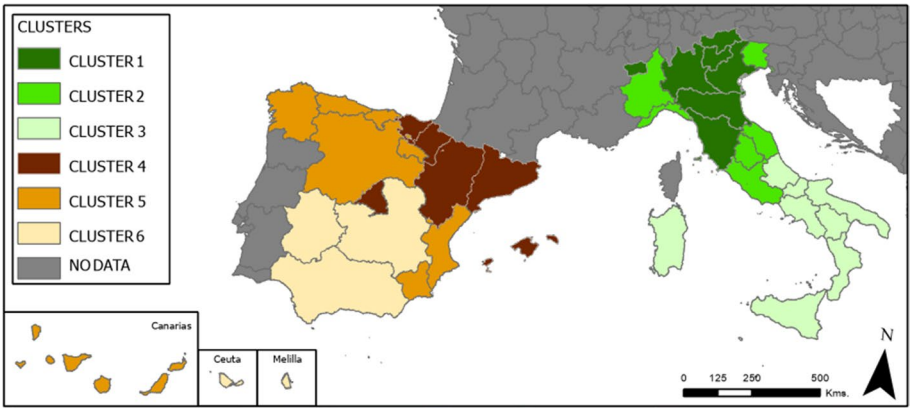

Fig. 8 Italian and Spanish regions according to cluster of belonging. Source: Prepared by the authors

Cluster 4 is made up of 6 Spanish regions (15% of the total): the Basque Country, Navarre, Aragón, Madrid, Catalonia and the Balearic Islands. It is the only cluster with positive and above average values for both factors (z-scores of 1.2 and 0.6, respectively). Thus, these are the regions with the highest average percentage of households and individuals with advanced ICT usage (64.1%), also away from home or work (3 out of every 4 individuals). They also register the lowest levels of social deprivation of the regions studied; a high average income per capita (around 31,000 euros, only below the Italian regions of Cluster 1), and low unemployment rates and low percentages of households with low work intensity (8.6%), the gender gap in employment (9.2%) and deaths due to infectious diseases (less than 3 per hundred thousand).

Cluster 5 is comprised of 8 Spanish regions (20% of the total: Galicia, Asturias, Cantabria, La Rioja, Castile and León, the Valencian Community, Murcia and the Canary Islands). They are characterised by having above-average values for Factor 1 (z-score of

0.8) with an average of around 60% of households and individuals using Internet in an advanced manner along with higher levels of social deprivation (25.5% gender employment gap, and mortality from infectious diseases of almost 7 per hundred thousand). Levels of material deprivation are also high as average income per capita barely exceeds 23,000 euros, and average unemployment rates and percentages of households with low work intensity in excess of 12%. These are therefore Spanish regions with a high level of digital development and advanced usage, but with high indices of unemployment and households with low work intensity.

Finally, Cluster 6 is made up of the 5 remaining Spanish regions (12.5% of the total): Castile-La Mancha, Extremadura, Andalusia and the autonomous cities of Ceuta and Melilla. The average values for the two factors show a great contrast. On the one hand, these regions have high values for Factor 1, with high average percentages of households and individuals using Internet in an advanced manner (including individuals who use Internet away from home and work, with an average figure of almost 70%). On the other hand, they have lower values for Factor 2 (a z-score −1,4 below the average) which correspond to the highest unemployment rates and percentages of households with low work intensity (21.6%), along with the lowest average income of all the NUTS 2 analysed (not reaching 20,000 euros).

6 Concluding Remarks

From the analyses performed, it may be affirmed that there is a relationship between the variables of ICT access and usage by households and individuals and those of deprivation in Spanish and Italian regions, as authors such as Longley and Singleton (2009) had already observed in other areas. Hence, the level of access and frequency of use of Internet is very high in all regions (85% of households and individuals), but differences have been detected in relation to the types of ICT usage and deprivation in the behaviour of the two countries, despite the social and economic similarities. While the differences between both countries are fundamentally based on the values of the ICT variables, where Spanish regions are well ahead in advanced ICT usage, the greater differentiation between regions within each of the countries is observed on the basis of the deprivation variables.

Coinciding with the review of previous studies, such as those of Helsper (2012, 2017) which maintain that social inclusion interacts with the domains of digital inclusion, the interrelationship found via factor analysis indicates that the advanced and daily use of Internet in households is negatively associated with the variables of social deprivation (Warren, 2007). This would explain how the regions with less digital participation to interact with banks, the public authorities, etc., could see the already notable social divide accentuated in the context of some Italian and Spanish regions, above all those that are located on the geographical or socio-economic periphery, that is, the south of both countries, where the territorial level from north to south proves to be a determining factor in both countries (Caranci et al., 2010; Sánchez-Cantalejo et al., 2008). Note that the variables used in this paper are confirmed to be predictors of deprivation status as indicated in the literature (Łuczak, Kalinowski (2020); Ayllón et al. (2017); Mena et al., 2018; Jarman (1983); Townsend (1987); Baumann (2007); Pathak et al (2021), Mc Donald et al. (2009).

Likewise, the existence of a differentiated spatial behaviour (patterns) of the factors between Spanish and Italian regions has been confirmed. A spatial correlation between neighbouring regions in accordance with the factors has been observed. Thus, a spatial

pattern, of high values in all Spanish regions with a NE-SW gradient, has been detected for Factor 1; while the Italian regions have low values with a N-S spatial gradient. Factor 2, meanwhile, follows the same pattern, but the Italian regions have better values. The results indicate that indeed the Italian and Spanish digital society has been heterogeneous and uncohesive, generating spatial imbalances in ICT use. This is in accordance with Ruiz-Rodriguez et al. (2020) who indicated that in Europe, spatial imbalances in ICT use in households/individuals are detected at the regional level, and not only at the national level.

In line with the above, the existence of a typology of regions can be confirmed, and which moreover may be ordered depending on the extent of the relationships between ICTs and deprivation. The NE of Spain (corresponding to Cluster 4) would be in first place, with relatively high average values for both factors: percentage of households and individuals with advanced ICT usage and low values for deprivation. In second place would be the area neighbouring the Cluster described above, and which runs from the NW to the East of Spain (Cluster 5), with a high level of digital development and advanced ICT usage, but with higher rates of unemployment and households with low work intensity. The gradient continues to the South of Spain (Cluster 6), where the average values of the two factors show a great contrast, but the average for Factor 1 is the second highest of all the regional data analysed. The NE of Italy (Cluster 1) would be in fourth place, with the highest level for Factor 2 and a higher than average percentage of individuals and households with daily access to Internet; and a lower than average level of unemployment and low work intensity in households. Around this area, with regions that surround the Cluster 1 of the NE of Italy, there is a second level of Italian regions (Cluster 2) with a high income (according to the data of Factor 2), high percentages of daily access to Internet away from home and work, but with only half of all individuals using Internet in an advanced manner. Lastly, the southern and insular regions of Italy (Cluster 3) have very low values for both factors: income and less daily Internet access away from home or work, high rates of unemployment and households with low work intensity.

Finally, it can be affirmed that the analysis of the relationships between ICTs and deprivation, and their spatial distribution and behaviour, contribute to greater knowledge of the digital development and inequality of households and individuals at regional level (González-Relaño et al., 2021; Rodero Cosano, 2015). Having verified a relationship between ICTs and social and material deprivation in the regional context, this presents a new opportunity to advance conceptually and methodologically with the use of new variables related to social and economic deprivation which are pertinent to European regional contexts. This could be very useful for designing regional policies that really contribute to reducing pre-existing spatial inequalities which, moreover, may increase with the accelerated process of diffusion of the digital society. This should be approached in accordance with The Digital Decade policy programme de la EU which calls on Member States to work together to reach the Digital Decade targets focused on connectivity, digital skills, digital business and digital public services. It is noted that in 2021 was adopted '2030 Digital Compass: the European way for the Digital Decade' (European Commission, 2021) to empower citizens and businesses through digital transformation. The digital transformation of the economy and society in Europe and its regions requires attention to inclusion, accessibility, equality, sustainability, resilience, improved quality of life (European Parliament, 2022).

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Declarations

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article.

References

Alaimo, L. S., Ivaldi, E., Landi, S., & Maggino, F. (2022). Measuring and evaluating socio-economic inequality in small areas: An application to the urban units of the Municipality of Genoa. *Socio-Economic Planning Sciences, 83*, 101170.

Andersen, K. K., Steding-Jessen, M., Oksbjerg Dalton, S., & Skyhøj Olsen, T. (2014). Socioeconomic position and incidence of Ischemic Stroke in Denmark 2003–2012. A nationwide hospital-based study. *Journal of the American Heart Association, 3*(4), e000762. https://doi.org/10.1161/JAHA.113.000762

Arthur, D., & Vassilvitskii, S. (2007). k-means++: The advantages of careful seeding. In: *Proceedings of the Eighteenth Annual ACM-SIAM Symposium on Discrete Algorithms* Society for Industrial and Applied Mathematics, pp. 1027–1035.

Atkinson, T., Cantillon, B., Marlier, E., & Nolan, B. (2002). *Social indicators: The EU and social inclusion*. Oup Oxford.

Ayala, L., Jurado, A., & Pérez-Mayo, J. (2021). Multidimensional deprivation in heterogeneous rural areas: Spain after the economic crisis. *Regional Studies, 55*(5), 883–893. https://doi.org/10.1080/00343404.2020.1813880

Ayllón, S., & Gábos, A. (2017). The Interrelationships between the Europe 2020 Poverty and Social Exclusion Indicators. *Social Indicators Research, 130*(3), 1025–1049.

Ayllón, S., & Gábos, A. (2017). The interrelationships between the Europe 2020 poverty and social exclusion indicators. *Social Indicators Research, 130*, 1025–1049. https://doi.org/10.1007/s11205-015-1212-2

Barboutidis, G., & Stiakakis, E. (2022). Digitization and international development: A descriptive analysis of the networked readiness index in Eight European Union Countries. In N. E. Myridis (Ed.), *Poverty and Quality of Life in the Digital Era: Interdisciplinary Discussions and Solutions* (pp. 53–79). Springer International Publishing. https://doi.org/10.1007/978-3-031-04711-4_3

Baumann, M., Spitz, E., Guillemin, F., et al. (2007). Associations of social and material deprivation with tobacco, alcohol, and psychotropic drug use, and gender: A population-based study. *International Journal of Health Geographics, 6*, 50. https://doi.org/10.1186/1476-072X-6-50

Blank, G., Graham, M., & Calvino, C. (2018). Local geographies of digital inequality. *Social Science Computer Review, 36*, 82–102. https://doi.org/10.1177/0894439317693332

Boarini, R., & d'Ercole, M. M. 2006 Measures of Material Deprivation in OECD Countries. https://doi.org/10.1787/866767270205

Bohórquez, I. A., & Ceballos, H. V. (2008). Algunos conceptos de la econometría espacial y el análisis exploratorio de datos espaciales. *Ecos De Economia: A Latin American Journal of Applied Economics, 12*(27), 9–2.

Booker, C. L., Kelly, Y. J., & Sacker, A. (2018). Gender differences in the associations between age trends of social media interaction and well-being among 10–15 year olds in the UK. *BMC Public Health, 18*(1), 1–12. https://doi.org/10.1186/s12889-018-5220-4

Bruno, G., Esposito, E., Genovese, A., & Gwebu, K. L. (2011). A critical analysis of current indexes for digital divide measurement. *The Information Society, 27*(1), 16–28. https://doi.org/10.1080/01972243.2010.534364

Bruzzi, C., Ivaldi, E., & Landi, S. (2020). Non-compensatory aggregation method to measure social and material deprivation in an urban area: Relationship with premature mortality. *The European Journal of Health Economics, 21*(3), 381–396.

Büchi, M., Festic, N., & Latzer, M. (2018). How social well-being is affected by digital inequalities. *International Journal of Communication, 12*, 3686–3706.

Büchi, M., Just, N., & Latzer, M. (2016). Modeling the second-level digital divide: A five-country study of social differences in Internet use. *New Media & Society, 18*(11), 2703–2722. https://doi.org/10.1177/1461444815604154

Callens, M., & Croux, C. (2009). Poverty dynamics in Europe: A multilevel recurrent discrete-time hazard analysis. *International Sociology, 24*(3), 368–396. https://doi.org/10.1177/0268580909010291

Caranci, N., Biggeri, A., Grisotto, L., Pacelli, B., Spadea, T., & Costa, G. (2010). The Italian deprivation index at census block level: Definition, description and association with general mortality. *Epidemiologia e Prevenzione, 34*(4), 167–176.

Carstairs, V., Morris, R. (1991). Deprivation and health in Scotland. Aberdeen University Press.

Castelnovo, W., & Simonetta, M. (2008). A public value evaluation of e-Government policies. *Electronic Journal of Information Systems Evaluation, 11*(2), 61–72.

Chmielarz, W., & Parys, T. (2017). The use of mobile technologies in e-commerce. In ICERI2017 Proceedings (pp. 4008–4016). IATED

Comisión de las Comunidades Europeas (2000): Construir una Europa que fomente la integración COM(2000) 79 final

Cruz-Jesus, F., Oliveira, T., & Bacao, F. (2012). Digital divide across the European Union. *Information & Management, 49*(6), 278–291. https://doi.org/10.1016/j.im.2012.09.003

Cruz-Jesus, F., Vicente, M. R., Bacao, F., & Oliverira, T. (2016). The education-related digital divide: An analysis for the EU-28. *Computers in Human Behavior, 56*, 2–82.

Davey Smith, G., Whitley, E., Dorling, D., & Gunnell, D. (2001). Area based measures of social and economic circumstances: Cause specific mortality patterns depend on the choice of index. *Journal of Epidemiology and Community Health, 55*(2), 149–150.

De la Rica, S., Dolado, J. J., & Llorens, V. (2008). Ceilings or floors? Gender wage gaps by education in Spain. *Journal of Population Economics, 21*(3), 751–776.

De Marco, S. (2017). La revolución de internet. Los usos beneficiosos y avanzados dinternet como la nueva frontera de la desigualdad digital. *Panorama Social, 25*, 99–116.

Denis, Á., Gallegos, F., & Sanhueza, C. (2010). *Medición de pobreza multidimensional en Chile*. Universidad Alberto Hurtado.

DiMaggio, P., & Garip, F. (2012). Network effects and social inequality. *Annual Review of Sociology, 38*, 93–118.

ESRI (2020). Analyzing Patterns toolset. Retrieved from https://desktop.arcgis.com/es/arcmap/10.3/tools/spatial-statistics-toolbox/modeling-spatial-relationships.htm#GUID-DDDFA1EE-4ED2-4126-9BB0-3E57E01D7885

European Anti-Poverty Network- EAPN- (2020). *EL ESTADO DE LA POBREZA. Seguimiento del indicador de pobreza y exclusión social en España 2008–2019*. https://www.eapn.es/estadodepobreza/ARCHIVO/documentos/Informe_AROPE_2020_Xg35pbM.pdf

European Commission (2020a). Broadband coverage in Europe 2019: mapping progress towards the coverage objectives of the Digital Agenda: final report. Directorate-General for Communications Networks, Content and Technology European Commission. https://data.europa.eu/doi/https://doi.org/10.2759/375483

European Commission (2020b). Digital Economy and Society Index- desi.https://ec.europa.eu/digital-single-market/en/digital-economy-and-society.

European Commission (2021): 2030 Digital Compass: the European way for the Digital Decade. COM(2021) 118 final. Brussels, 9.3.2021.

European Parliament (2022) Digital decade policy programme 2030. Official Journal of the European Union DECISION (EU) 2022/2481 of The European Parliament and of The Council.

Falch, M., & Henten, A. (2018). Dimensions of broadband policies and developments. *Telecommunications Policy, 42*(9), 715–725. https://doi.org/10.1016/j.telpol.2017.11.004

Frías-Navarro, D., & Pascual Soler, M. (2012). Exploratory factor analysis (EFA) in consumer behavior and marketing research. *Suma Psicológica, 19*(1), 47–58.

Fusco A. Guio A.C. Marlier E. (2010) Risk factors of income poverty and material deprivation in Belgium and Regions Working Paper No 2011–04 CEPS/INSTEAD, Luxembourg IWEPS, Belgium

Galobardes, B., Shaw, M., Lawlor, D. A., & Lynch, J. W. (2006a). Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health, 60*, 7–12.

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Smith, G. D. (2006b). Indicators of socioeconomic position (part 2). *Journal of Epidemiology and Community Health, 60*, 95–101.

Garcia, A., Abrego, J., & Jauregui, J. (2019). Technologies frequently used by elementary principals. *Universal Journal of Educational Research, 7*(1), 95–105.

Gerrard, P., Barton Cunningham, J., & Devlin, J. F. (2006). Why consumers are not using internet banking: A qualitative study. *Journal of Services Marketing, 20*(3), 160–168.

Goncalves, G., Oliveira, T., & Cruz-Jesus, F. (2018). Understanding individual-level digital divide: Evidence of an African country. *Computers in Human Behavior, 87*, 276–291. https://doi.org/10.1016/j.chb.2018.05.039

González-Relaño, R., Lucendo-Monedero, Á. L., & Ruiz-Rodríguez, F. (2021). Information and Communication Technologies of households and individuals, geographical proximity and regional competitiveness: distribution, clusters and spatial patterns of technological capacity in Europe. *Boletín De La Asociación De Geógrafos Españoles*. https://doi.org/10.21138/bage.3118

Guio, A. C. (2018). "Multidimensional poverty and material deprivation: Empirical findings," Chapters. In C. D'Ambrosio (Ed.), *Handbook of Research on Economic and Social Well-Being, chapter 6* (pp. 171–192). Edward Elgar Publishing.

Guio, A. C., Marlier, E., Gordon, D., Fahmy, E., Nandy, S., & Pomati, M. (2016). Improving the measurement of material deprivation at the European Union level. *Journal of European Social Policy, 26*(3), 219–333. https://doi.org/10.1177/0958928716642947

Haefner, L., & Sternberg, R. (2020). Spatial implications of digitization: State of the field and research agenda. *Geography Compass, 14*(12), 12544. https://doi.org/10.1111/gec3.12544

Hargittai, E., & Hinnant, A. (2008). Digital inequality: Differences in young adults' use of the Internet. *Communication Research, 35*(5), 602–621. https://doi.org/10.1177/009365020832178

Hayton, J. C., Allen, D. G., & Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis. *Organizational Research Methods, 7*(2), 191–205.

Helsper, E. J. (2012). A corresponding fields model for the links between social and digital exclusion. *Communication Theory, 22*(4), 403–426. https://doi.org/10.1111/j.1468-2885.2012.01416.x

Helsper, E. J. (2017). The social relativity of digital exclusion: Applying relative deprivation theory to digital inequalities. *Communication Theory, 27*(3), 223–242. https://doi.org/10.1111/comt.12110

Horrigan, J. (2009). *Wireless internet use* (pp. 1–48). Pew Internet & American Life Project.

Iammarino, S., Rodríguez-Pose, A., & Storper, M. (2019). Regional inequality in Europe: Evidence, theory and policy implications. *Journal of Economic Geography, 19*(2), 273–298. https://doi.org/10.1093/jeg/lby021

Ivaldi, E., & Testi, A. (2011). Genoa Index of Deprivation (GDI): An Index of Material Deprivation for Geographical Areas. In C. M. Baird (Ed.), *Social Indicators: Statistics, Trends and Policy Development Chapter 4* (pp. 75–98). Nova Publisher Hauppauge.

Ivaldi, E., & Testi, A. (2013). Socio-Economic Conditions and Health in Europe: A Comparison among the 27 EU Countries. In J. D. Rowsen & P. Amanda (Eds.), *Social Inequalities Eliot chapter 5* (pp. 127–150). Nova Publisher.

Ivaldi, E., Ciacci, A., & Soliani, R. (2020a). Urban deprivation in Argentina: A POSET analysis. *Papers in Regional Science, 99*(6), 1723–1747.

Ivaldi, E., Parra Saiani, P., Primosich, J.J. Bruzzi., & C. (2020). Health and deprivation: A new approach applied to 32 Argentinian urban areas. *Soc Indic Res, 151*, 155–179. https://doi.org/10.1007/s11205-020-02369-w

Jarman, B. (1983). Identification of underprivileged areas. *British Medical Journal, 286*(6379), 1705–1709. https://doi.org/10.1136/bmj.286.6379.1705

Jarman, B. (1984). Underprivileged areas: Validation and distribution of scores. *British Medical Journal (clinical Research Ed.), 289*(6458), 1587–1592. https://doi.org/10.1136/bmj.289.6458.1587

Kim, H. Y. (2013). Statistical notes for clinical researchers: Factors to consider when selecting the appropriate number of factors in exploratory factor analysis. *Journal of the Korean Academy of Nursing, 43*(2), 155–160.

Lancee, B., & Van de Werfhorst, H. G. (2012). Income inequality and participation: A comparison of 24 European countries. *Social Science Research, 41*(5), 1166–1178.

Landi, S., Ivaldi, E., & Testi, A. (2018a). Measuring change over time in socio-economic deprivation and health in an Urban Context: The case study of Genoa. *Social Indicator Research, 139*(2), 745–785. https://doi.org/10.1007/s11205-017-1720-3

Landi, S., Ivaldi, E., & Testi, A. (2018b). Socioeconomic status and waiting times for health services: An international literature review and evidence from the Italian National Health System. *Health Policy, 122*(4), 334–351.

Lera-López, F., Billon, M., & Gil, M. (2011). Determinants of Internet use in Spain. *Economics of Innovation and New Technology, 20*(2), 127–152.

Longley, P. A., & Singleton, A. D. (2009). Linking social deprivation and digital exclusion in England. *Urban Studies, 46*(7), 1275–1298. https://doi.org/10.1177/0042098009104566

Lucendo-Monedero, A. L., Ruiz-Rodríguez, F., & González-Relaño, R. (2019). Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe. *Telematics and Informatics, 41*, 197–217.

Łuczak, A., & Kalinowski, S. (2020a). Assessing the level of the material deprivation of European Union countries. *PLoS ONE, 15*(9), e0238376. https://doi.org/10.1371/journal.pone.0238376

Marić, A. M., & Zoroja, J. (2019). Travel and accommodation web services: Usage in selected European Countries. *Interdisciplinary Description of Complex Systems: INDECS, 17*(2B), 403–416.

Mayo, J. P. (2008). *La dimensión territorial de la pobreza y la privación en España*. Fundación Alternativas.

McDonald, S. A., Hutchinson, S. J., Bird, S. M., Mills, P. R., Dillon, J., Bloor, M., & Graham, L. (2009). A population-based record linkage study of mortality in hepatitis C-diagnosed persons with or without HIV coinfection in Scotland. *Statistical Methods in Medical Research, 18*(3), 271–283. https://doi.org/10.1177/0962280208094690

Mena, E., Kroll, L. E., Maier, W., et al. (2018). Gender inequalities in the association between area deprivation and perceived social support: a cross-sectional multilevel analysis at the municipality level in Germany. *British Medical Journal Open, 8*, e019973. https://doi.org/10.1136/bmjopen-2017-019973

Mundfrom, D. J., Shaw, D. G., & Ke, T. L. (2005). Minimum sample size for conducting factor analyses. *International Journal of Testing, 5*(2), 159–168. https://doi.org/10.1207/s15327574ijt0502_4

Mussida, C., & Pariso, M. L. (2021). Social exclusion and financial distress: Evidence from Italy and Spain. *Economia Politica*. https://doi.org/10.1007/s40888-021-00228-6

Nevado-Peña, D., López-Ruiz, V. R., & Alfaro-Navarro, J. L. (2019). Improving quality of life perception with ICT use and technological capacity in Europe. *Technological Forecasting and Social Change, 148*, 119734.

Nie, N. H., & Erbring, L. (2002). Internet and society: A preliminary report. *IT & Society, 1*(1), 275–283.

Nielsen, V. L., Nielsen, H. Ø., & Bisgaard, M. (2021). Citizen reactions to bureaucratic encounters: Different ways of coping with public authorities. *Journal of Public Administration Research and Theory, 31*(2), 381–398.

Nolan, B., & Whelan, C. T. (2010). Using non-monetary deprivation indicators to analyze poverty and social exclusion: Lessons from Europe? *Journal of Policy Analysis and Management, 29*(2), 305–325. https://doi.org/10.1002/pam.20493

OECD- Organization for Economic Cooperation and Development (2021), Gender Data Browser, available at www.oecd/gender

OECD-Organization for Economic Cooperation and Development (2008). Handbook on Constructing Composite Indicators: Methodology and User Guide. Paris: JRC European Commission, OECD. Retrieved from https://www.oecd.org/std/42495745.pdf

Olivetti, C., & Petrongolo, B. (2008). Unequal pay or unequal employment? A cross-country analysis of gender gaps. *Journal of Labor Economics, 26*(4), 621–654.

Pathak, D., Vasishtha, G., & Mohanty, S. K. (2021). Association of multidimensional poverty and tuberculosis in India. *BMC Public Health, 21*, 2065. https://doi.org/10.1186/s12889-021-12149-x

Prescott, C. (2017). *Internet access–households and individuals: 2017*. Office for National Statistics.

Ragnedda, M., & Kreitem, H. (2018). The three levels of digital divide in East EU countries. World of Media. *Journal of Russian Media and Journalism Studies, 1*(4), 5–26. https://doi.org/10.30547/worldofmedia.4.2018.1

Ragnedda, M. (2017). *The third digital divide: a weberian approach to digital inequalities*. Routledge. https://doi.org/10.4324/9781315606002

Reinstadler, A., & Ray, J. C. (2010). Macro determinants of individual income poverty in 93 regions of Europe.

Richardson, L., & Bissell, D. (2019). Geographies of digital skill. *Geoforum, 99*, 278–286. https://doi.org/10.1016/j.geoforum.2017.09.014

Rodero Cosano, M.L. (2015). *Reformulación del índice de privación. El caso de la Comunidad Autónoma de Andalucía*. Fundación Pública Andaluza Centro de Estudios Andaluces, Consejería de la Presidencia, Junta de Andalucía. https://centrodeestudiosandaluces.es/datos/publicaciones/tesis12_indiceprivacion.pdf

Rodríguez-Hevía, L. F., Rodríguez-Fernández, L., & Ruiz-Gómez, L. M. (2022). European regional inequalities in citizens' digital interaction with government. Transforming Government: People, Process and Policy, (ahead-of-print).

Ruiz-Rodríguez, F., González-Relaño, R., & Lucendo-Monedero, Á. L. (2020). Comportamiento espacial del uso de las TIC en los hogares e individuos. *Un Análisis Regional Europeo. Investigaciones Geográficas (esp), 73*, 57–74.

Sala, E., Gaia, A., & Cerati, G. (2022). The gray digital divide in social networking site use in Europe: Results from a quantitative study. *Social Science Computer Review, 40*(2), 328–345. https://doi.org/10.1177/0894439320909507

Sánchez-Cantalejo, C., Ocana-Riola, R., & Fernández-Ajuria, A. (2008). Deprivation index for small areas in Spain. *Social Indicators Research, 89*(2), 259–273. https://doi.org/10.1007/s11205-007-9114-6

Santana, P., Costa, C., Marí-Dell'Olmo, M., Gotsens, M., & Borrell, C. (2015). Mortality, material deprivation and urbanization: Exploring the social patterns of a metropolitan area. *International Journal for Equity in Health, 14*(1), 55. https://doi.org/10.1186/s12939-015-0182-y

Scheerder, A. J., Van Deursen, A., & Van Dijk, J. (2020). Taking advantage of the Internet: A qualitative analysis to explain why educational background is decisive in gaining positive outcomes. *Poetics, 80*, 101426.

Scheerder, A., Van Deursen, A., & Van Dijk, J. (2017). Determinants of internet skills uses and outcomes. A systematic review of the second-and third-level digital divide. *Telematics and Informatics, 34*(8), 1607–1624. https://doi.org/10.1016/j.tele.2017.07.007

Seifert, A., Doh, M., & Wahl, H. W. (2017). They also do it: Internet use by older adults living in residential care facilities. *Educational Gerontology, 43*(9), 451–461.

Selwyn, N. (2008). 'Not necessarily a bad thing…': A study of online plagiarism amongst undergraduate students. *Assessment & Evaluation in Higher Education, 33*(5), 465–479.

Serrano, R. M., & Vayá, E. V. (2002). Econometría espacial: nuevas técnicas para el análisis regional. Una aplicación a las regiones europeas. *Investigaciones Regionales-Journal of Regional Research, 1*, 83–106.

Seybert, H. (2011). Internet use in households and by individuals in 2011. *Eurostat Statistics in Focus, 66*, 2011.

Spencer, P., Timpe, Z., Verlenden, J., Rasberry, C. N., Moore, S., Yeargin-Allsopp, M., & Pampati, S. (2022). Challenges experienced by US K-12 public schools in serving students with special education needs or underlying health conditions during the COVID-19 pandemic and strategies for improved accessibility. *Disability and Health Journal, 16*(2), 101428.

Silverstone, R. (1996). Future imperfect: information and communication technologies in everyday life. In W. H. Dutton (Ed.), *Information and communication technologies: Visions and realities.* Oxford: Oxford University Press.

Stern, M. J., Adams, A. E., & Elsasser, S. (2009). Digital inequality and place: The effects of technological diffusion on internet proficiency and usage across rural, suburban, and urban counties. *Sociological Inquiry, 79*(4), 391–417. https://doi.org/10.1111/j.1475-682X.2009.00302.x

Su, S., Gong, Y., Tan, B., Pi, J., Weng, M., & Cai, Z. (2017). Area social deprivation and public health: Analyzing the spatial non-stationary associations using geographically weighed regression. *Social Indicators Research, 133*(3), 819–832. https://doi.org/10.1007/s11205-016-1390-6

Tan, M., & Teo, T. S. (2000). Factors influencing the adoption of Internet banking. *Journal of the Association for Information Systems, 1*(1), 5.

Testi, A., & Ivaldi, E. (2009). Material vs social deprivation and health: A case study of in an Urban Area. *The European Journal of Health Economics:, 10*(3), 323–328.

Thompson, B. (2004). *Exploratory and confirmatory factor analysis: Understanding concepts and applications*. American Psychological Association.

Tobler, W. (2004). On the first law of geography: A reply. *Annals of the Association of American Geographers, 94*(2), 304–310. https://doi.org/10.1111/j.1467-8306.2004.09402009.x

Townsend, P. (1987). Deprivation. *Journal of Social Policy, 16*(2), 125–146. https://doi.org/10.1017/S0047279400020341

Townsend, P., Philimore, P., & Beattie, A. (1988). *Health y Deprivation: Inequality the North*. Routledge.

Van Deursen, A. J., & Helsper, E. J. (2015). *The third-level digital divide: Who benefits most from being online?* Emerald Group Publishing Limited. https://doi.org/10.1108/S2050-206020150000010002

Van Deursen, A. J., & Van Dijk, J. A. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society, 21*(2), 354–375. https://doi.org/10.1177/1461444818797082

Walker, I., & Pettigrew, T. F. (1984). Relative deprivation theory: An overview and conceptual critique. *British Journal of Social Psychology, 23*(4), 301–310.

Warren, M. (2007). The digital vicious cycle: Links between social disadvantage and digital exclusion in rural areas. *Telecommunications Policy, 31*(6–7), 374–388.
Witte, J. C., & Mannon, S. E. (2010). *The Internet and social inequalities*. Routledge. https://doi.org/10.4324/9780203861639
World Economic Forum (2010), The Global Competitiveness Report 2010–2011. Geneva