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Utilization of communications network potential: Public practices and effects

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ABSTRACT

Technological adoption, with an emphasis on Information and Communications technology (ICT), is considered as a decisive factor for the overall development of each country. For this, the European Commission (EC) has launched a number of policy frameworks, aiming to enhance the usage and to improve the quality of European citizens' lives. However and so far, the results are still below the initial goals. Thus, the EC recently decided to set some additional targets, in order to facilitate a wider adoption of information services and maximize economical and societal benefits.

In line with this, the present work studies the effect of the driving factors that accelerate the uptake of public e-services, together with the impact of technological adoption on the socio-economic status. A new parameter is introduced, the utilization of communications network potential (UCNP), which echoes the Information Society (IS) maturity level. An analysis, focusing on monitoring the progress of public and European Commission (EC) actions is additionally presented in order to assess the evolution of the IS maturity level in the European area. The impact of two main public depended indexes, i.e. structural and benchmarking indicators, on the UCNP maturity level is evaluated, together with the influence of the latter over socio-economic parameters.

1. Introduction

The development of telecommunications and especially internet technologies is considered to be the basis of economic growth and social development (Roller & Waverman, 2001). For this reason, it is commonly related with the level of competition and comparative advantages in a country. In addition, the internet is considered as a platform for social change (Beard et al., 2009). Therefore, the deployment and adoption of related technologies correspond to important policies. The role of the public sector becomes crucial as there are barriers towards offering internet services, despite the fact that internet access tends to be considered as a fundamental right in developed countries (BBC World Service, 2010). A significant obstacle in this process is the initial investments required for the infrastructures implementation. Public sector's policies should facilitate private investments and also resolve problems regarding internet access exclusion. Subsidization is an acceptable solution, if it can deliver the desired results i.e. infrastructure (Höffler, 2007) or service competition (Foros, 2004). Under the recent economic recession, the public sector should gain a leading role regarding the enhancement of broadband services as a significant restriction of private investments is expected. For this reason, the provision of public e-services should be revised and improvements should be faced as a necessity (Bekkers & Homburg, 2007).

Despite policy decisions and applied strategies, the acceptance and use of a new technology raises a number of issues. Therefore researchers analyzed the process, aiming to capture the explanatory factors of technological diffusion (Rogers, 1962; Silverstone, 1991). In addition to the economic and technical dimensions of adoption, psychological theories have been also used in order to signify technological adoption (LaRose et al., 2001; Rosengren, 1974). Quite recently, the Technology Acceptance Model (TAM) was proposed by Davis et al. (1989) as an extension of the Theory of Reasoned Action (TRA) which in turn was proposed by Fishbein and Ajzen (1975). According to TAM, the perceived usefulness and the ease of use are the driving factors of technological adoption and therefore they can cause actual use of a new technology.

Individuals and enterprises must face the challenges of the emerging economy that depends on new technologies. Business organizations and the public sector develop their strategies, change the internal environment and try to meet the demand for their products or services. These changes are usually proposed to follow a user-centered practice (Burroughs, 2009; Osborne & Gaebler, 1992; Su & Yang, 2010). On the contrary, Tat-Kei Ho (2002) and Shareef et al.

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(2010) proposed the opposite approach, based on the reinvention of the public services.

The European Commission (EC) (2005) launched the i2010 policy framework, embracing the importance of information and communication technologies on the economic and society development, as well as on the improvement of the daily life quality for all European citizens. However and despite the definite strategy, internet adoption and usage are still below the initial target. Therefore, public sector's decisions should be revised focusing more on the achievement of an upgraded usage of telecommunications services. Recently, the European Commission (2010a) decided to set complementary measures in order to facilitate a wider adoption of broadband services, as for example to foster public and private investments regarding the implementation of broadband networks.

In the context of the present work we propose a new metric, the utilization of communications network potential (UCNP), which describes the maturity level of what is called "Information Society" (IS). UCNP is a latent (unobserved) parameter which reflects the output of public and EC-applied practices on the use and adoption of new technologies. Public sector indicators are considered as the most appropriate indexes connecting governmental initiatives, policy decisions, EC practices, etc., with the enhancement of the UCNP. "Structural indicators" and "Benchmarking indicators: Public services E-government" are the most coherent indexes reflecting the results of public interventions and public e-services, respectively.

IS maturity level, usually estimated in terms of broadband penetration rate (fixed or mobile), has a direct relationship with the general socio-economic status of a country. The latter can be described by a number of parameters such as population density, GDP, income inequality, etc. Researchers are commonly interested in the impact of each considered socio-economic factor over the internet penetration rate.

However, the continuous economical, technological and societal development in Europe seems to be threatened by the recent crisis. For this, the EC is seeking to exploit the recent situation by introducing a new initiative called "Digital Agenda" (2010b). It is a long-term strategy, up to year 2020, targeting the preparation of a sustainable Europe, as soon as the economic crisis is over. The core of the new strategy is to embrace the strengthening of the general UCNP maturity as a result of a number of focused practices. The output of previous and ongoing practices should be examined, though, in order to ensure the success of the new strategy. The latter constitutes the main target of the present work, which seeks to identify the factors affecting UCNP. The provided results are expected to specify valuable inputs for the design of the strategic plans and actions, towards meeting the goals set by the EC.

The analysis performed in this work is twofold and is based on the preceding considerations. On the one hand, the relationship between UCNP maturity and public sector indicators is studied, under the assumption that these variables interact with each other. On the other hand, the impact of UCNP maturity over the main socio-economic parameters is examined. From the first part of the analysis, useful outputs can be derived, regarding the importance of the two key constructs according to public practices. According to the results, policy suggestions and rethinking proposals could arise and new opportunities can be explored by business organizations.

The analysis is conducted in the European area, among a number of countries for years 2007 and 2009. Year 2007 is the time when the EC stated a more focused strategy regarding the development of UCNP and year 2009 corresponds to the most recent available data. Comparison and analysis of the results between these two years are expected to reveal the progress made, due to the strategies policy makers introduced. Despite the fact that, due to the short time period, only slight changes were initially expected, significant differences in the descriptive statistics between these two years indicated that it would be interesting to consider both of them in the analysis. Finally, the analysis was performed based on a well-known multidimensional methodology, structural equation modeling (SEM), which is employed for the development of the proper model and the estimation of the determinants. The use of SEM, together with information of the method, is described in a latter section.

2. UCNP definition background

The new economy described above, which is based on new technologies and especially the internet, forces decision makers on both governmental and entrepreneurial sides, to exploit the opportunity to offer innovative products and services (Gupta & Jana, 2003). The European Commission (2006) stressed the importance of E-government development by setting specific targets and proposing a set of actions for the Member States. Some of these interventions refer to regulation, or the subsidization of infrastructures. Moreover and according to Bourreau and Dogan (2005), competition in infrastructure interacts with service competition, aiming to provide better quality of services. Based on the SEM methodology, Verdegem and Verleye (2009) estimated user satisfaction as an influential factor in the adoption of E-government services. Another analysis based on SEM technique (van Dijk et al., 2008), indicated that acceptance and use of E-government services is a dynamic process which depends on various parameters. For this reason, decision makers should examine both the supply and demand side before deploying their strategies. In addition, a number of analyses were performed, both qualitative and quantitative, suggesting practical approaches focusing on end-users (Burroughs, 2009; Potnis, 2009). These approaches are considered as driving parameters that can boost the uptake of E-government services.

Apart from the factors related to public interventions, differentiations on UCNP maturity are expected to affect the major socio-economic parameters. Researchers have mainly focused on social, economic, demographic, factors that seem to sufficiently describe a country's status. Kum (2008) in her PhD thesis studied the impact of governmental actions, and specifically the availability of E-government services over the broadband penetration rate for both developed and developing countries. She concluded that there is a positive relationship between broadband adoption and E-government availability.

The provision of public e-services can be regarded as a deterrent to the development of digital inequalities due to demographic reasons. Decision makers faced this challenge in the first step of broadband development (OECD, 2004). However, the equal supply of E-government services, regardless of the place of residence, enhances the quality of life in remote areas and eliminates digital exclusion (LaRose et al., 2011; OECD, 2004; Prieger, 2003). However, the key factor that determines UCNP maturity level is the availability of the ICT infrastructures. Moreover, one can expect that a greater ICT adoption would lead to a higher technological diffusion (Chinn & Fairlie, 2007). Apart from the increase of usage, empirical studies showed that the strength of ICT infrastructures could improve organizations' efficiency as well (Wong, 2002). In contrast to the supply of fixed broadband services depending on ICT infrastructures, mobile broadband technology gains an increasing market share. Broadband mobile diffusion is not included in the data published by OECD and ITU describing broadband penetration. However, the estimation of digital divide convergence in terms

of broadband adoption could lead to useful findings regarding the diffusion process and differentiations among countries (Kyriakidou et al., 2009). Thus, it seems that digital divide convergence could rely on mobile technology, not only in developing countries with lower income level but also among developed countries where the digital divide is still evident, despite the public and private interventions (James, 2007; UNCTAD, 2008).

Bouwman et al. (2007) examined actual and future use of mobile services in Finland and found that differences in service attributes should be considered in a process of usage conceptualization. However, despite the fact that the proposed model consists of a number of variables, researchers had not included socio-economic parameters in the analysis.

A common approach to describe the Information Society maturity level is to create a ranking of the countries, according to their broadband penetration level. A number of indexes were developed (Ford et al., 2007, 2008; Giokas & Pentzaropoulos, 2008) in order to present the development of telecommunications around the world. Based on these studies the best practices have been revealed and proposed. Socio-economic parameters are considered either as drivers or as barriers providing policy suggestion to decision makers.

ITU pointed out the importance of regular monitoring and measuring technological development, by introducing "ICT Development Index — IDI" in (2010). According to this report, more than 150 countries worldwide were ranked, based on their estimated IDI. Not surprisingly, the majority of OECD and European countries held the highest position in this classification.

3. Methodology

As already mentioned, a multivariate statistical analysis technique, structural equation modeling (SEM), is used for identifying and quantifying the relationships between observed (or measured) variables and latent (or unobserved) constructs. SEM was initially introduced by Wright (1921, 1934) who applied it to nature science problems; since then it was extensively developed from its original version (Bollen, 1989; Jöreskog & Sörbom, 1982; MacCallum & Austin, 2000).

The main advantage of SEM over alternative methodologies, like regression, when multiple indicators are considered is its ability to simultaneously assess all pathways of a relationship. The dependent variable may even become the indicator in a subsequent pathway. With regression analysis, such a model would have to be analyzed in separate regression runs where an allocated dependent variable played no other role. Among the most important advantages of SEM are included its ability to make more flexible assumptions, to construct unobservable latent variables and the ability to test models with multiple dependents. The proposed methodology consists of three parts, each one implemented by a corresponding model, a measurement, a computational, and a structural model, respectively. Firstly, the specification of the relationship between latent and measured variables is estimated. Secondly, the specification of the relationship between latent and estimated variables is conducted. The final step is the identification of the relationships among latent constructs. Path graph is the visual representation of these relationships among variables in the three models (Bentler, 1980; Bielby, 1977; Goldberger, 1972).

The SEM methodology is chosen for analyzing the relationship between UCNP maturity and public sector indicators, which are described by structural and benchmarking indicators. Moreover, as the utilization maturity level has a direct impact on society, the effects on a number of socio-economic parameters are analyzed as well. On the contrary to the classical linear regression approaches, SEM includes an error of measurement in the independent variables, reducing estimated bias and distortions (Iriondo et al., 2003; Pugesek & Tomer, 1995). In this case, the null hypothesis of a SEM is described in Eq. 1:

$$H_0 : \Sigma = \Sigma(\theta) \tag{1}$$

where Σ is the sample covariance matrix, $\Sigma(\theta)$ is the model-implied covariance matrix and θ illustrates the model parameters to be estimated.

The path analysis presented in Fig. 1 examines the link between public sector indicators and UCNP maturity, as well as the influential effects of the studied maturity level and a number of socio-economic parameters. Benchmarking indicators reflect the actual use of E-government services, i.e. the level of end-users' interaction with public authorities by using the internet as the most preferable way. In addition, the public sector has already recognized the different end-users' needs and during the last decade it continuously updates offered services (Bertot & Jaeger, 2006). However, benchmarking indicators are directly related with structural ones, reflecting public practices over the sustainable development strategies, which in turn include the development of new technologies. Structural indicators are the most relevant indexes with regard to the implementation of public decisions and the measurement of their success (European Commission, 2007). For instance, policy decisions regarding the liberalization of telecom sector aiming to increase competition can be measured by the market share of telecom operators. In addition, as the new economy is driven by the information society (Castells, 2000), the conceptual model encloses the relationship between UCNP and various socio-economic factors.

A path diagram is used to represent relationships among observed and unobserved variables, based on the analysis of the preceding paragraph. The development of the conceptual model was based on the following assumptions:

- Structural indicators are positively related with UCNP maturity level.
- Benchmarking indicators: Public sector E-government actions are positively associated with UCNP maturity level.
- Structural indicators and benchmarking indicators interact with each other.
- There is a link between UCNP maturity level and socio-economic status.

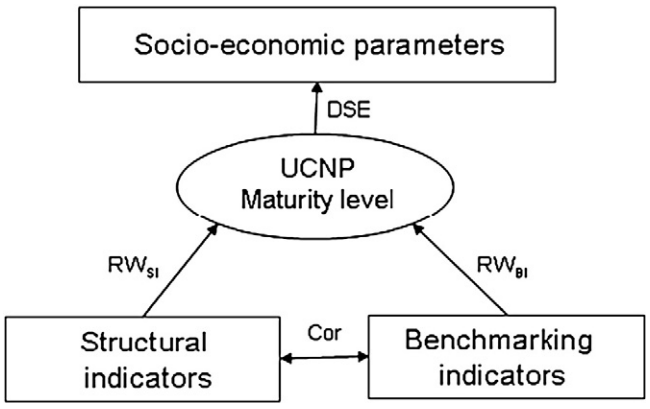

Fig. 1. Conceptual model.

The study of a conceptual model like the one illustrated in Fig. 1 would allow for the identification and the evaluation of the interaction among the different elements of the social system. The groups of structural and benchmarking indicators are expected to reflect the results of public practices regarding the boost of UCNP maturity. Policy and action flaws could emerge by monitoring the relationships between these constructs and the utilization maturity level. For this reason, regression weights for both structural (RW_{SI}) and benchmarking (RW_{BI}) indicators are estimated. The comparison of results referring to different years would show the effects of policies over the utilization maturity level and would probably suggest revised practices to fill the omissions. In addition, the correlation (Cor) between the two constructs is calculated, in order to reveal the importance of the parallel development of the structural and benchmarking indicators.

In the context of this work, the UCNP maturity is assumed to be a key performance factor for socio-economic development. Thus, the relationship between UCNP and socio-economic parameters, for both years 2007 and 2009, is estimated and expressed as the determinants of socio-economic parameters (DSE).

The model was validated by a number of goodness-of-fit statistics (Bagozzi & Yi, 1988), the most commonly used ones being the chi-square test which is sensitive to sample size, the model's degrees of freedom (df), and its probability value (p). The comparative fit index (CFI), the Tucker–Lewis index — TLI, and the Root Mean Square Error of Approximation — RMSEA (Brwone & Cudeck, 1992) are also included for model validation. The threshold of acceptance for CFI and TLI is over 0.90, while values below this indicate the need for revision of the initial model. Finally, RMSEA should not exceed the critical value of 0.08, otherwise the model should be revised, in order to increase the level of goodness of fit. Threshold values of acceptance are the ones usually used in literature and some of them are lower, in comparison, than what is accepted in other scientific fields (Curran & Hussong, 2002). Changing the threshold level would probably lead to different results.

It is worth mentioning that the SEM methodology cannot be seen as the ultimate multivariate approach that can be used to solve any modeling problem since there are some noticeable pitfalls. The most important is that SEM is a model-driven methodology. Thus, misleading assumptions will definitely lead to misleading results. Furthermore, a large sample size is required, especially when datasets are extracted from questionnaires. In this case, researchers face several challenges regarding the collection of data, e.g. it is difficult, time consuming, and occasionally expensive. For this reason, they should be very careful in the process of the main assumptions and proceed with a number of statistical validation models.

Table 1
Benchmarking indicators.

	Description
IndividualInternetUse	Individuals using the internet for interaction with public authorities
IndividualFilledForms	Individuals using the internet for returning filled in forms to public authorities
EnterprisesInternetUse	Enterprises using the internet for interaction with public authorities
EnterprisesFilledForms	Enterprises using the internet for returning filled in forms to public authorities
EnterprisesProposals	Enterprises using the internet for submitting a proposal in a public electronic tender system to public authorities

Table 2
Structural indicators.

	Description
EnterprisesEgovernmentUse	E-government usage by enterprises
IndividualEgovernmentUse	E-government usage by individuals
BroadbandPenetration	Broadband penetration rate
EgovernmentAvailability	E-government online availability
InternetAccess	Level of internet access-households
ITExpenditures	Information technology expenditures
CommunicationsExpenditures	Communications expenditures
LocalCallPrice	Price of telecommunications by type of call (local call)
IncumbentShare	Market share of the incumbent in fixed telecommunications by types of call
MobileShare	Market share of the leading operator in mobile telecommunications

4. Model definition

The proposed model consists of three main categories of indexes, which correspond to socio-economic factors, and structural and benchmarking indicators. All of the indicators have been established by the EC, as a means to monitor and capture the progress of applied policies. The dataset we use is extracted from Eurostat's (2010) database and corresponds to statistics from the Member States of the European Union. Eurostat follows a strict regulatory and methodological approach regarding the collection and presentation of statistics (European Parliament and Council, 2007). Since the dataset does not derive from simple questionnaires but from a reliable source and can be consequently considered precise, problems related to the sample size are minimized (Loehlin, 1992; Marsh et al., 1988).

The indexes that describe benchmarking indicators, related with the public services, are presented in Table 1.

The corresponding indexes that describe structural indicators are illustrated in Table 2. However, as there are no available data for the market share of the incumbent in fixed telecommunications by types of call (IncumbentShare), the parameter is excluded from the analysis.

Finally, in Table 3 the considered socio-economic factors are presented.

Table 3
Socio-economic parameters.

	Description
GDP	Gross domestic product
HumanResourcesS&T	Human resources in science and technology as a share of labor force
GraduatesS&T	Tertiary graduates in science and technology per 1000 of population aged 20–29 years
ComputerUse	Persons employed using computers connected to the internet
IncomeInequality	Inequality of income distribution — income quintile share ratio
SchoolExpectancy	School expectancy — expected years of education over a lifetime
IndividualEcommerce	Individuals using the internet for ordering goods or services — percentage of individuals aged 16 to 74
ComputerSkills	Individuals' level of computer skills — percentage of the total number of individuals aged 16 to 74
InternetSkills	Individuals' level of internet skills — percentage of the total number of individuals aged 16 to 74
PopulationDensity	Population density

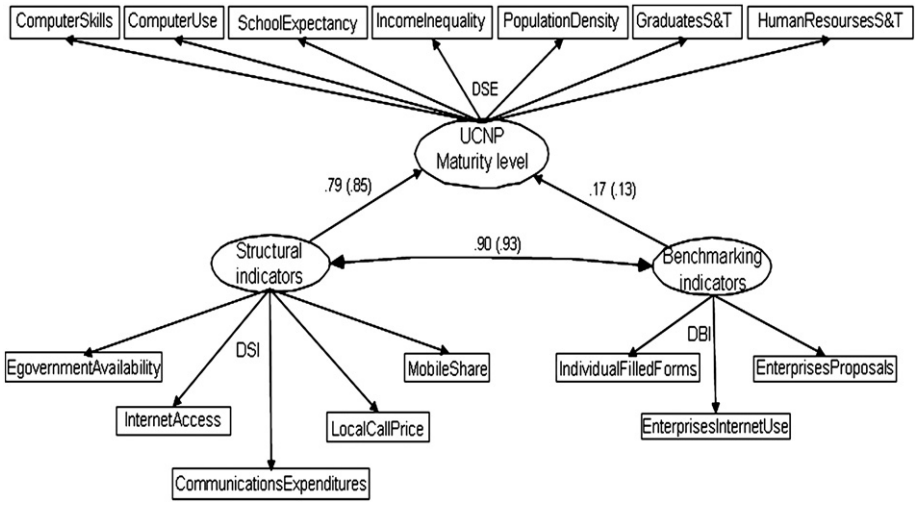

Fig. 2. The proposed structural equation model.

Before conducting the analysis, the Cronbach alpha coefficients are calculated, in order to examine the reliability of each variable (Cronbach, 1951). The internal consistency was 0.802 for benchmarking indicators, 0.737 for structural indicators, and 0.781 for socio-economic parameters. The Cronbach alpha for the whole dataset was 0.693. Since the threshold of this measure is above 0.6 or 0.7, all the obtained values are above acceptance level (Hair et al., 2006).

In addition, the correlation among the parameters is calculated, aiming to exclude multicollinearity, which is tested by performing bivariate correlations and specifically two-tailed Pearson analysis (Table A.1, Table A.2, Table A.3). Some of the variables are finally excluded from the model as they exceed the threshold of acceptance (0.75). These variables are "EnterprisesEgovenmentUse," "IndividualEgovernmentUse," "BroadbandPenetration," and "ITEexpenditures" corresponding to structural indicators, "IndividualInternetUse" and "EnterprisesFilledForms" for benchmarking indicators, and "GDP," "IndividualEcommerce," and "InternetSkills" representing the socio-economic parameters.

Further analysis of the data includes the provision of descriptive statistics of the data, calculated for each parameter and for each year considered. Results are presented in Appendix B and they provide important information regarding the dispersion and the changes recorded between years 2007 and 2009 on average growth or reduction for all variables. However, the aim of the analysis between these years is not the comparison of the results, especially because of the fact that only marginal differentiations would be revealed in this short period of time. On the contrary, the analysis attempts to outline the relationships among considered inputs, which are not expected to vary significantly. In addition, according to descriptive statistics there are important differences mainly in the mean term, e.g. "EgovernmentAvailability" reached 73.4% in 2009 from 59.7% in 2007. Based on the above considerations, we decided to perform the analysis for both years in order to capture the aforementioned variations.

The proposed model, which is based on the conceptual model and the above correlation analysis, is illustrated in Fig. 2. The correlation (Cor) between structural and benchmarking indicators is estimated for both years, 2007 and 2009, as well as the regression weights (RW_{SI} and RW_{BI}) from the latter indicators to UCNP maturity. Finally, the determinants of structural (DSI), and benchmarking indicators (DBI) and the determinants of socio-economic parameters (DSE) are calculated.

Table 4
Goodness of fit indexes for both 2007 and 2009.

	CFI	TLI	RMSEA
2007	0.944	0.932	0.067
2009	0.921	0.903	0.074

Chi-square$(p)_{2007} = 120.85(0.010)$, Chi-square$(p)_{2009} = 178.11(0.000)$.

5. Results and discussion

The results for the goodness-of-fit indexes are presented in Table 4. According to them, it can be derived that the proposed structural model describes the data with a high level of accuracy. As the parameters are the same for both 2007 and 2009, the estimated degrees of freedom are 87. The comparative fit index and the Tucker–Lewis index are well above the critical value of 0.90. The RMSEA is also below the recommended value for acceptance.

According to the performed calculations, depicted in Fig. 2, the correlation between structural and benchmarking indicators is 0.90 and 0.93 for years 2007 and 2009, respectively. Thus, both constructs regarding public interventions should be taken into account, since it turned out that they strongly interact with each other, enhancing UCNP maturity.

The estimated standardized regression weights among the main variables are presented in Fig. 2. Benchmarking indicators have a smaller effect than the structural indicators, as expected. However, there is an increase in benchmarking coefficients from 0.13 to 0.17. On the contrary, there is a decrease in the corresponding structural, from 0.85 to 0.79. As the availability of E-government services, along with the corresponding usage from both individuals and enterprises is continuously growing, the impact of benchmarking indicators on UCNP maturity is expected to become increasingly important. Hence, the growth of benchmarking indicators' impact reflects the utilization of the available on-line e-services, as a consequence of the effective development of the structural indicators.

Table 5
Determinants of socio-economic parameters, DSE.

	Socio-economic parameters	
	2007	2009
Individuals' level of computer skills	0.49	0.49
Persons employed using computers connected to the internet	0.95	0.94
School expectancy — expected years of education over a lifetime	0.67	0.72
Inequality of income distribution — income quintile share ratio	−0.68	−0.60
Population density	0.14	0.09
Tertiary graduates in science and technology per 1000 of population aged 20–29 years	0.22	0.14
Human resources in science and technology as a share of labor force	0.90	0.89

5.1. Socio-economic parameters and UCNP

According to the socio-economic coefficients shown in Table 5, "ComputerUse" and "HumanResourcesS&T" are the dominant parameters reflecting UCNP maturity. In addition, the descriptive statistics of the socio-economic parameters, which are presented in Table B.1, reveal useful information, regarding the statistical characteristics of the data. Technological development is directly connected to internet usage and therefore the majority of labor force is expected to use a PC at work. Moreover, human resources in science and technology indicate both the necessity of this kind of employment and the attractiveness of the sector. Besides, the average measurements in both variables increased, while the standard deviation measurements were slightly enhanced.

Education level and school expectancy in particular are positively affected by the general utilization maturity level of a society. It seems that modern curriculums are in favor of students becoming familiar with new technologies. Furthermore, school expectancy is related with the development of a social behavior in peer groups that are extremely keen on the adoption and usage of new technologies or services. Despite the marginal increase, on average, the estimated coefficient raise from 0.67 in 2007 to 0.72 in 2009.

According to the calculated determinants regarding income inequality, a negative effect by the level of UCNP maturity is monitored. Furthermore, there is a marginal decrease in the average measurements, which in turn provoked the change in the estimated determinants. As the maturity level of a society increases, the inequalities, in terms of income, are decreased or minimized. Income inequality varies among European countries, specifically in new Member States or in old members characterized by weak economy. Therefore, public practices should be carefully designed, as it seems that UCNP level is related with the overall societal and economical development.

Population density seems to lose part of its importance, albeit the marginal increase of its average measurement. The adoption of e-services, or even broadband, tends to become uncorrelated with high density or urbanization. The digital gap between urban and sub-urban or rural areas is still evident, despite the fact that public or EU initiatives, decision policies, etc. aimed at its elimination.

Yet, it should be expected that as UCNP maturity increases, the university degrees related to science and technology would increase as well. The average measurement of this variable reached 41% in 2009, as compared to 39% in 2007, while standard deviation is also increased from 7.9 in 2007 to 8.2 in 2009. However, the estimated determinant of this factor seems to decrease, as a result of oversupply of degrees in the labor market.

Finally and according to the results, PC skills are positively affected by the utilization maturity level. Despite the fact that many other parameters include this variable, such as "ComputerUse," "HumanResourcesS&T," "SchoolExpectancy," and "GraduatesS&T," the calculated level of individuals according to their computer skills remains low. Despite the slight increase in the average, the SEM analysis estimated the same determinants for 2007 and 2009. Thus, a number of initiatives, both public and private, could provide fundamental and advanced knowledge regarding the usage of the core instrument of the new technologies, i.e. PC.

5.2. Structural indicators and UCNP

The determinants of structural indicators are presented in Table 6, while descriptive statistics are illustrated in Table B.2. Internet access, as expected, is the primary factor for the upgrade of UCNP maturity. Structural indicators are related with basic infrastructures and investments, which in turn are directly related with the availability of internet access. Thus, the average measurement of this variable is significantly increased, which means that practices aiming at the growth of internet access were successfully applied. More specifically, the level of internet access reached 64% in 2009, from 53% in 2007. Moreover, the dispersion (standard deviation) is also decreased, signifying the development of internet access provision in the considered countries.

The UCNP maturity is positively related with E-government online availability. As the public sector boosts its services with alternative ways of accessibility, i.e. e-services, economies of scales would rise, resulting in shrinking the public sector and increase efficiency. Moreover, if citizens can be served electronically they can minimize the waste of time in queues, increasing by the same time the feeling that transparency and objectivity are ensured. Public and EC practices succeeded in the expansion of E-government online availability captured in average measurement (from 59.7% in 2007 to 73.4% in 2009) and standard deviation (from 21.9 in 2007 to 18.2 in 2009). However, the efficient development was not reflected in the determinants where only a slight positive differentiation was estimated.

The estimated coefficients for Communication expenditures have diminished from −0.74 in 2007 to −0.67 in 2009. These expenditures are strongly related with long-term investments, so the expected performance will be also evident in a long-term period. In 2009, the average measurement was increased together with the dispersion. However, this increase provoked a considerable shrinkage on the estimated determinant.

The determinant of the market share of the leading mobile operator is expected to be negative, as it reflects both the level of competition in the sector and the concentration of the market. According to the statistical analysis there was a marginal decrease in the average measurement as well as in standard deviation.

Table 6
Determinants of structural indicators, DSI.

	Structural indicators	
	2007	2009
E-government online availability	0.50	0.52
Level of internet access-households	0.98	0.97
Communications expenditures	−0.74	−0.67
Market share of the leading operator in mobile telecommunications	−0.14	−0.32
Price of telecommunications by type of call (local call)	0.08	0.02

Table 7
Determinants of benchmarking indicators, DBI.

	Benchmarking indicators	
	2007	2009
Individuals using the internet for returning filled-in forms to public authorities	0.89	0.87
Enterprises using the internet for interaction with public authorities	0.50	0.65
Enterprises using the internet for submitting a proposal in a public electronic tender system to public authorities	0.16	0.15

Finally, it seems that price has very low impact on the utilization maturity level, even though there was a slight increase in the average measurement. The adoption and use of new technologies are not significantly affected by their price, as they tend to become a necessity for daily life.

5.3. Benchmarking indicators and UCNP

The estimated relationships between benchmarking indicators and UCNP maturity are illustrated in Table 7 and the corresponding descriptive statistics are presented in Table B.3. The level of individuals using the internet for returning filled-in forms to public authorities is the dominant parameter in this group of indicators. Thus, this high impact should be maintained but even expanded by offering to individuals more opportunities through additional services. Despite the notable increase in average measurement of this variable (from 13.5% in 2007 to 16.3% in 2009), the corresponding growth of its dispersion was the reason for a marginal reduction of the estimated determinant.

The determinants of the enterprises using the internet for interaction with public authorities are estimated to grow from 0.50 to 0.65, reflecting the corresponding increase in the average measurement. In addition, there was a significant decrease of standard deviation for this variable. The potential growth, resulting from the above analysis, enables decision makers to rethink existing services and offer alternative opportunities to cover a wider range of the actual needs of organizations. As business organizations are assumed to be the leaders in the process of technological adoption, such as broadband services, a continuous increase is expected to derive from this indicator. Finally, according to the submission of proposals in a public tender system to public authorities, a marginal decrease is estimated, contrary to the potential expectations. The average growth, from 71% in 2007 to 77% in 2009, failed to be reflected in the estimated determinants. Hence, it is worth noting that all the parameters are positively related to the benchmarking indicator and consequently to the UCNP maturity.

6. Conclusions

In the context of this work, the impact of public interventions and e-services over utilization of communications network potential maturity is studied based on the structural equation modeling (SEM) methodology. In line with SEM, the maturity level is assumed to be a latent variable, seeking to reveal and quantify the factors that have an influential effect over it. The derived results provide important information regarding the adoption of new technologies and indicate directions for appropriate strategies.

According to these results, both indicators have an important influence on UCNP maturity, since they are both positively related with the latent variable of the considered model. More specifically, structural indicators have a greater impact on the maturity level than the benchmarking ones. For this reason, public and EC practices should continue to aim at further expansion of the internet access. Given the general economic crisis, alternative access technologies, such as mobile which requires lower initial investments, should be considered and included into the developing business plans. Moreover, communications expenditures are the second dominant factor in this group of indicators. Thus, as the utilization maturity grows, the necessity for corresponding investments will be minimized. This suggests that, despite the fact that Europe considers telecommunications growth to be very important there are still restrictions in terms of the availability of required infrastructures and investments.

In addition, it seems that mobile telephone operators tend to merge in order to achieve a larger market share. However, market concentration has a negative impact on UCNP maturity, as it is commonly related with higher prices and lower quality of services. Though the development of UCNP maturity seems to boost competition in the mobile market, restraining the market share of the leading operator in this sector. Moreover, it is worth noting that Price does not seem to influence utilization maturity, indicating an inelastic behavior.

On the other hand, e-services show an increase, in terms of their impact on UCNP maturity. Therefore, decisions makers should rethink the content of the offered e-services, as they have to meet the needs of citizens and business organizations.

This paper provides estimations regarding the impact of UCNP maturity over a number of socio-economic parameters. According to them, Income inequality has an inverse relationship with UCNP maturity level. Thus, the growth of the last-mentioned variable reflects the minimization of the technological exclusion derived from economical reasons. Moreover, educational variables, such as graduates in S&T and School expectancy could be enhanced by the utilization maturity level. Finally, factors describing the working environment, such as the required qualifications — Computer Skills, Computer Use, etc. — and the market share of Science and Technology sector in terms of the percentage of the labor force, are heavily influenced by UCNP maturity level.

It is obvious that all the considered parameters are dynamic and the influence derived from the utilization maturity could vary from year to year. Research could provide useful information to the decision makers by monitoring the impact of these variables on UCNP. The growth of UCNP maturity provides a number of social, economic, and educational benefits to countries and it could be the basis for a sustainable development. EC and Member States should in turn align their strategies with research findings, in order to minimize deviations from the initially set targets.

The validity of the results was based on a number of reliability measures. Although fit indexes indicated acceptable levels, there is still room for possible extensions of the model. Towards this direction, an extension of the model could be considered, consisting of data from specific countries, or groups of them, based on technological adoption, i.e. broadband penetration rate. In this way a cluster analysis can be conducted, comparing the results which are expected to reveal limitations and suggestions, in terms of policy decisions, investments, regulation, etc., proposing specific interventions for each country.

Finally, a number of additional variables could be included into the construction of the model, as for example policy and telecommunications services indicators, such as the usage of internet. This would allow for a detailed framework to be constructed, describing the effects of a wide range of variables over UCNP maturity.

Appendix A. Data correlation analysis

The shaded area refers to the estimated correlation from 2007 while the other results are the calculated Pearson correlations from 2009.

Table A.1
Estimated correlations: benchmarking indicators (2007 and 2009).

		IndividualInternetUse	IndividualFilledForms	EnterprisesInternetUse	EnterprisesFilledForms	EnterprisesProposals
IndividualInternetUse	Pearson correlation	1	.908	.563	.492	.022
	Sig. (2-tailed)		.000	.003	.013	.916
IndividualFilledForms	Pearson correlation	.890	1	.545	.550	.179
	Sig. (2-tailed)	.000		.004	.004	.382
EnterprisesInternetUse	Pearson correlation	.479	.417	1	.807	.175
	Sig. (2-tailed)	.013	.034		.000	.394
EnterprisesFilledForms	Pearson correlation	.497	.522	.789	1	.228
	Sig. (2-tailed)	.012	.007	.000		.273
EnterprisesProposals	Pearson correlation	.106	.236	.201	.170	1
	Sig. (2-tailed)	.608	.245	.325	.418	

Table A.2
Estimated correlations: structural indicators (2007 and 2009).

		Enterprises EgovernmentUse	Individual EgovernmentUse	Broadband Penetration	Egovernment Availability	Internet Access	IT Expenditures	Communications Expenditures	LocalCall Price	Mobile Share
Enterprises	Pearson correlation	1	.763	.490	.743	.540	.309	−.490	−.262	.102
EgovernmentUse	Sig.(2-tailed)		.003	.011	.060	.004	.125	.011	.196	.621
Individual	Pearson correlation	.794	1	.886	.754	.900	.635	−.548	−.065	−.200
EgovernmentUse	Sig.(2-tailed)	.013		.000	.020	.000	.000	.004	.754	.327
Broadband	Pearson correlation	.701	.903	1	.542	.881	.727	−.593	−.043	−.300
Penetration	Sig.(2-tailed)	.043	.000		.004	.000	.000	.001	.836	.136
Egovernment	Pearson correlation	.922	.745	.532	1	.520	.514	−.318	−.066	−.169
Availability	Sig.(2-tailed)	.148	.019	.005		.006	.007	.013	.749	.408
InternetAccess	Pearson correlation	.432	.930	.894	.496	1	.744	−.649	−.087	−.327
	Sig.(2-tailed)	.027	.000	.000	.010		.000	.000	.674	.103
ITExpenditures	Pearson correlation	−.464	.791	.796	.512	.783	1	−.814	.352	−.524
	Sig.(2-tailed)	.059	.000	.000	.022	.000		.035	.078	.006
Communications	Pearson correlation	.376	−.670	−.659	−.446	−.716	−.785	1	.606	.279
Expenditures	Sig.(2-tailed)	.017	.000	.000	.007	.000	.002		.000	.168
LocalCallPrice	Pearson correlation	.066	−.115	−.157	−.048	−.020	.179	−.085	1	−.119
	Sig.(2-tailed)	.749	.577	.443	.816	.924	.382	.679		.563
MobileShare	Pearson correlation	.182	−.091	−.148	−.008	−.134	−.245	.244	−.066	1
	Sig.(2-tailed)	.372	.660	.470	.970	.513	.227	.229	.750	

Table A.3
Estimated correlations: socio-economic parameters (2007 and 2009).

		GDP	Human ResourcesS&T	Graduates S&T	Computer Use	Income Inequality	School Expectancy	Individual Ecommerce	Computer Skills	Internet Skills	Population Density
GDP	Pearson correlation	1	.726	.029	.781	−.542	.364	.822	.337	.745	.212
	Sig. (2-tailed)		.001	.888	.000	.004	.068	.000	.093	.000	.298
Human	Pearson correlation	.742	1	.030	.827	−.452	.655	.774	.262	.675	.099
ResourcesS&T	Sig. (2-tailed)	.000		.884	.000	.020	.000	.000	.197	.000	.629
GraduatesS&T	Pearson correlation	.156	.184	1	.172	.033	.181	.147	.012	.074	−.052
	Sig. (2-tailed)	.446	.368		.401	.873	.376	.473	.955	.719	.801
ComputerUse	Pearson correlation	.842	.846	.230	1	−.581	.701	.856	.513	.756	.070
	Sig. (2-tailed)	.000	.000	.259		.002	.000	.000	.007	.000	.734
IncomeInequality	Pearson correlation	−.569	−.604	−.023	−.659	1	−.487	−.524	−.414	−.522	−.088
	Sig. (2-tailed)	.002	.001	.913	.000		.012	.006	.035	.006	.669
SchoolExpectancy	Pearson correlation	.413	.661	.121	.625	−.512	1	.429	.515	.448	−.086
	Sig. (2-tailed)	.036	.000	.556	.001	.008		.029	.007	.022	.675
Individual	Pearson correlation	.830	.779	.203	.912	−.566	.442	1	.526	.893	.245
Ecommerce	Sig. (2-tailed)	.000	.000	.320	.000	.003	.024		.006	.000	.228
ComputerSkills	Pearson correlation	.331	.401	.138	.480	−.418	.356	.518	1	.665	.016
	Sig. (2-tailed)	.099	.042	.501	.013	.033	.074	.007		.000	.940
InternetSkills	Pearson correlation	.767	.713	.247	.833	−.632	.443	.843	.709	1	.197
	Sig. (2-tailed)	.000	.000	.224	.000	.001	.023	.000	.000		.334
Population	Pearson correlation	.168	.152	−.096	.120	−.089	−.119	.175	.097	.262	1
Density	Sig. (2-tailed)	.413	.458	.639	.561	.665	.562	.392	.636	.195	

Appendix B. Descriptive statistics analysis

Table B.1
Descriptive statistics for socio-economic parameters.

	Years	Mean	Median	Standard deviation	Max	Min
ComputerSkills	2007	13.538	14.50	3.165	18	8
	2009	19.808	13.50	3.464	23	8
ComputerUse	2007	37.192	36.50	12.878	62	16
	2009	40.346	37.00	12.943	68	20
SchoolExpectancy	2007	17.685	17.60	1.240	20.5	15.7
	2009	17.746	17.75	1.234	20.8	15.9
IncomeInequality	2007	4.781	4.45	1.263	7.8	3.3
	2009	4.671	4.35	1.191	7.8	3.35
PopulationDensity	2007	119.727	99.85	108.930	485.3	3.1
	2009	120.735	100.05	110.005	488.3	3.3
GraduatesS&T	2007	12.738	11.90	3.954	20.5	6.4
	2009	14.088	13.75	5.207	29.1	7.6
HumanResourcesS&T	2007	39.319	40.15	7.913	49.8	22.1
	2009	41.050	42.35	8.286	55.8	24.1

Table B.2
Descriptive statistics for structural indicators.

	Years	Mean	Median	Standard deviation	Max	Min
EgovernmentAvailability	2007	59.769	63.00	21.933	100	15
	2009	73.462	76.50	18.248	100	40
InternetAccess	2007	53.654	52.00	18.727	84	19
	2009	64.308	63.00	16.213	90	30
CommunicationsExpenditures	2007	3.269	2.90	1.062	66	17
	2009	3.400	3.15	1.107	62	15
MobileShare	2007	43.000	42.50	7.403	67	24
	2009	42.019	42.50	7.352	57	21
LocalCallPrice	2007	0.373	0.35	0.133	0.74	0.16
	2009	0.392	0.37	0.142	0.75	0.16

Table B.3
Descriptive statistics for benchmarking indicators.

	Years	Mean	Median	Standard deviation	Max	Min
IndividualFilledForms	2007	13.577	13.00	8.882	33	2
	2009	16.385	12.50	12.093	50	3
EnterprisesInternetUse	2007	71.000	74.50	15.697	94	42
	2009	77.038	80.00	13.037	96	41
EnterprisesProposals	2007	9.115	8.50	4.581	22	0
	2009	11.962	11.00	5.831	29	0

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