TEME, Vol. XLVI, Nº 3, July – September 2022, pp. 789–809

Original Scientific Paper https://doi.org/10.22190/TEME211122042S
Received: November 22, 2021 UDC 004:330.34.014(4-01)
Revised: September 7, 2022
Accepted: October 1, 2022

THE STRUCTURAL RELATIONSHIP BETWEEN ICT AND THE DEVELOPMENT PROFILES OF EUROPEAN COUNTRIES

Jasna Soldić Aleksić*, Biljana Jovanović Gavrilović, Rade Stankić

University of Belgrade, Faculty of Economics, Belgrade, Serbia

Abstract

The application of information and communications technologies (ICTs) in all spheres of human activities has a significant impact on the development of each country. A better understanding of the relationship between these phenomena can contribute to the policy of a more balanced and long-term sustainable development on the national level. In this regard, the aim of the paper is to investigate the link between ICT and development profiles, taking the European countries as an example. We use several composite indexes (i.e., the ITU ICT development index, the global competitiveness index [GCI], and the Legatum prosperity index [LPI]) to investigate these countries' profiles and find a common structure among their respective relationships. We applied the partial least squares regression (PLS-R) model and included a new welfare index – the prosperity index, which integrates all the key dimensions of country development (economic, social, and environmental). Our main finding is that PLS-R models successfully extract important information on common structure vis-à-vis the observed countries' ICT and development profiles. Certain ICT indicators – namely, *Use of ICT* and *Price of ICT services* – can be considered predominant indicators, given their impact on a set of competitiveness and prosperity features within a country. These ICT indicators influence certain competitiveness attributes - *Technological readiness, Business sophistication, Institutions*, and *Innovation*, and certain prosperity attributes - *Governance, Economic quality,* and *Personal freedom* of the observed countries. These observations may be of great importance, as policy-makers can leverage them when designing the appropriate ICT and development strategies at national level.

Key words: ICT country profile, development country profile, European countries, PLS-R Methodology, national development strategy

* Corresponding author: Jasna Soldić Aleksić, Faculty of Economics, University of Belgrade, Kamenička 6, 11000 Belgrade, Serbia, jasna.soldic@ekof.bg.ac.rs

СТРУКТУРНА ВЕЗА ИЗМЕЂУ ИКТ И РАЗВОЈНОГ ПРОФИЛА ЕВРОПСКИХ ЗЕМАЉА

Апстракт

Примена информационо-комуникационих технологија (ИКТ) у свим сферама човекових активности има значајан утицај на развој сваке земље. Боље разумевање везе између ова два феномена може допринети вођењу уравнотежене политике дугорочног одрживог развоја на националном нивоу. У том смислу, циљ овог рада јесте да истражи везу између ИКТ и развојних профила на примеру низа европских земаља. У раду смо користили неколико композитних индекса (ИКТ развојни индекс Уједињених нација, глобални индекс конкурентности и Легатум индекс просперитета) са циљем да истражимо односне профиле посматраних земаља и пронађемо заједничку структуру у њиховим везама. Применили смо методологију парцијалне регресије најмањих квадрата (PLS-R) и укључили нови индекс, индекс просперитета, који интегрише све кључне димензије националног развоја (економску, социјалну и димензију окружења). Најважнији резултат јесте да PLS-R методологија успешно открива заједничку структуру у ИКТ и развојном профилу посматраних земаља. Одређени ИКТ индикатори – *Употреба ИКТ* и *Цена ИКТ* услуга – показали су се као доминантни индикатори, имајући у виду њихов утицај на конкурентност и просперитет земаља. Ови индикатори посебно имају утицај на следеће атрибуте конкурентности – *Технолошка спремност, Пословно окружење, Институције* и *Иновације*, као и на атрибуте просперитета – *Управљање, Квалитет економије* и *Личне слободе грађана* посматраних земаља. Добијени резултати могу бити од великог значаја, с обзиром на чињеницу да их креатори националних политика могу употребити за дизајнирање националних ИКТ и развојних стратегија.

Кључне речи: ИКТ профил земље, развојни профил земље, европске земље, PLS-R методологија, национална развојна стратегија

INTRODUCTION

The topic of the link between information and communications technology (ICT) and national socioeconomic development is widely discussed and elaborated in literature. It is undeniably accepted that in the current digital age, ICT is a powerful driver that not only boosts economic development but also offers many social benefits to developed and developing countries alike. Indeed, as Savulescu notes, "ICT represents a fundamental factor, with several effects on productivity, innovation, competitiveness and economic growth" (2015, p. 515). Although many researchers have discussed the importance and role of ICT in socioeconomic development, this issue has attracted considerably more attention lately, mainly on account of the dynamic changes occurring in the ICT field. Changes in the ICT domain include the widespread use of mobile devices, leading in turn to the explosive growth of mobile applications, cloud computing, the internet of things, 'big data', artificial intelligence, 5G networks, streaming computing and advanced data analytics.

Aside from this aforementioned trend, in the most recent decade we have observed a general tendency to measure phenomena with composite indexes. These are used in diverse branches of science, including ICT and the development field. We opted for the International Telecommunication Union (ITU) development index as a measure of ICT development, and the global competitiveness index (GCI) and the Legatum prosperity index (LPI) as the measures of national socioeconomic development. We consider the relationship between the ICT and the sustainable development profiles of the observed European countries by using the given composite indexes. Thus, the main research question and purpose of this paper is to elucidate the relationships of the aforementioned phenomena and determine the nature of the common structure among these relationships, if one exists. This knowledge can be used to pursue a balanced and long-term policy of the sustainable development of any society.

The literature relating to ICT and development includes a number of studies that focus on statistical data and quantitative analysis. The current study belongs to this strand of research, but underlines some notable specifics. Unlike previous research, it includes a new development dimension (i.e., an environmental dimension) and attempts to explore the inner structure of the relationship between ICT and development, while bearing in mind the complexity of the measurement involved. We apply a specific multidimensional approach that is promising in terms of potentially generating new findings that cannot be detected with conventional techniques.

For empirical analysis purposes, we applied the partial least squares (PLS) methodology. Why did we opt for this methodology? Firstly, this methodology provides a multivariate approach where all variables are analyzed simultaneously. As Haenlein and Kaplan (2004, p. 284) write, citing Jacoby (1978), "We live in a complex, multivariate world [and that] studying the impact of one or two variables in isolation, would seem…relatively artificial and inconsequential" (p. 91). Secondly, our research question corresponds to the PLS objective, which is to analyze multiple relationships between various blocks of variables. In addition, PLS is an appropriate methodology for research characterized by a great number of highly correlated explanatory variables (which may cause the problem of multicollinearity) and a relatively small number of observations, as is the case with our study.

The paper is organized as follows. After the introduction, Section 2 reviews the literature on the relationship between ICT and socioeconomic development, with special emphasis on the quantitative analysis of this relationship. Section 3 describes this study's conceptual framework, data and the applied methodology, while Section 4 discusses the main empirical results. The next section summarizes the results and discusses some possible practical implications. Finally, the paper concludes with a brief description of the limitations of this research and future directions of research.

LITERATURE REVIEW

Research into the relationship between the two complex phenomena—ICT and development—has a decades-long tradition. As Walsham (2017) states, “information and communication technology for development (ICT4D) research, has a history going back some 30 years” (p. 18). Walsham provides a broad historical review of the diverse research that has been conducted since the mid-1980s vis-à-vis ICT and development, and discusses future research agendas. Bearing in mind the current pervasive nature of ICT usage in our everyday lives, he concludes “that the future [of the field] lies in a multidisciplinary interaction between researchers, practitioners, and policy-makers” (Walsham, 2017, p. 18). Also, the focus of research has chiefly been on developing countries, as this topic is, undoubtedly, likewise relevant for developed economies. Poverty is a ubiquitous phenomenon with many faces which vary from country to country. A real challenge for development theorists and practitioners is the fact that adequate ICT implementation can improve people’s lives worldwide, regardless of their country’s development level (Qureshi, 2015; Sein, Thapa, Harakka & Saebo, 2019). More about the theoretical foundations of ICT for development research can be found in the works of Avgerou (2017), Sein, et.al. (2019) and Rothe (2020).

The Millennium Development Goals (MDGs), as one of the most successful initiatives for poverty eradication, contributed to a broader view of development, and shaped the international development agenda in the period between 2000 and 2015 (United Nations, 2001, 2015). ICT is recognized as an enabler of MDGs, and a powerful tool which can be used to facilitate and support different aspects of the process of socio-economic development (World Bank, 2003, 2016, 2019, 2020, 2020a).

A new dimension was given to the analysis of the relationship between ICT and sustainable development by a global post-2015 development agenda, aimed at the fulfilment of Sustainable Development Goals (SDGs), which substituted MDGs (United Nations, 2015). Unlike MDGs, the SDGs refer to not only developing but also developed countries, and they completely cover the economic, social and ecological aspects of development (Perović, D. & Radukić, S., 2017; Trlaković, J., Despotović, D. & Ristić, L., 2018). The great potential of ICT for achieving all three aspects of SDGs by 2030, i.e. for achieving economic prosperity for all, social equity and environmental sustainability, was recognized in literature (Krstić, B, Stanojević, J, & Stanišić, T., 2016; Tjoa, A., & Tjoa, S., 2016; Gligorić, M., Jovanović Gavrilović, B. & Savić, Lj., 2018).

The literature related to the subject of ICT and socio-economic development includes a number of papers which treat some aspects of the topic using statistical data and quantitative analysis, such as: Kowal, J., & Roztocki, N. (2013), Skaletsky, M., Soremekun, O. & Galliers, R.D. (2014), Ayanso, A., Cho, D. I. & Lertwachara, K. (2014), Alderete, M. V.

(2017), Kowal, J. & Paliwoda-Pekosz, G. (2017), Cioacă, Cristache, Vuță, Marin, & Vuță, M. (2020). Here we point out the works of Kowal, J., & Roztocki, N. (2013) and Kowal, J. & Paliwoda-Pekosz, G. (2017), as the main idea of these works is quite similar to the idea and concept presented in this paper. However, there are significant differences. We discuss them below.

The first paper addresses the issue of the impact of a few variables, such as proportion of households with computer, proportion of households with internet access, mean years of schooling, expected years of schooling, working hours, self-employment rate, innovation rank on gross national income, well-being, and human development. The authors used the Human Development Index (HDI) and life expectancy as a representative of well-being and human development. They analyzed the differences between four groups of countries (developed, transition, emerging and developing economies) in light of the correlations between the mentioned variables. The results of their analysis showed that HDI and life expectancy at birth are highly correlated with the variables: gross national income, proportion of households with Internet access, proportion of household with computer, innovations, expected years of schooling, and mean years of schooling. While the correlation between the previously enumerated variables was positive and high, the variables self-employment rate and working hours showed a negative correlation with gross national income, HDI and life expectancy at birth. Also, their analysis demonstrated that all four group of countries differ significantly in relation to the examined factors. Finally the authors concluded that "statistical analysis confirms well-known fact that high standards of living in investigated countries are related to computer use, education of the population and the ability to innovate" (Kowal & Roztocki, 2013, p. 9).

The second paper addresses the significance of ICT for Global Competitiveness and Economic Growth in Emerging Economies. The authors examined the relationships between ICT, innovations, competitiveness, human capital and human development, taking into account the following indexes: gross national income (GNI), human capital development index (HDI), ICT infrastructure (ICTDI), human capital index (HCI), global competitiveness index (GCI), global innovation index (GII), psycho-social and economic factors of innovations (GII, GII efficiency), life expectancy (LE) and mean years of schooling (MSCH). They also concentrated on the following four groups of countries (European countries): advanced, advanced in transition, emerging in transitions, and emerging. The study results indicate "strong correlations between global indexes of ICTDI, HCI and HDI, GCI and GNI" for countries in transition (Kowal & Paliwoda-Pekosz, 2017, p. 305).

Compared with the previous two works, this paper has a slightly different approach in terms of the variables covered, the methodology applied, and the focus of research. This paper analyzes the relationship between three composite indexes: ITU ICT Development index, Global Competitiveness Index and Prosperity Index. The focus is not on the relationship between summary measures (which was the case in previous works), but the relationship between their indicators: 14 ICT indicators, 113 GCI indicators (12 pillars) and 33 LPI indicators (9 pillars). In this complex coverage, novel aspects of development are involved as elements of the Prosperity index, such as Safety & Security, Personal Freedom, Social capital and Natural environment. According to our knowledge, the Prosperity Index has not been included in previous studies on the relationship between ICT and development. Also, the proposed methodology is specific, as it is based on the correlation of the observed variables with some latent constructs, which can be extracted from the complex multidimensional space of individual variables. Thus, the focus of this work is on discovering the common structure of the investigated indicators, and, consequently, examining the position of the observed countries in this space. Given the above, we believe this study complements previous research, offering a more detailed picture of the structural relationship between ICT indicators and indicators of the socio-economic development of the chosen countries.

METHODS

The Conceptual Framework of the Research

As explained in the introductory part, we chose three composite indexes for ICT and socioeconomic development, and explored the relationship between them. For ICT data, we opted for the ITU ICT development index. To address national-level socioeconomic profiles, we investigated two composite indexes - the GCI and the LPI respectively.

Our research hypotheses are as follows.

Hypothesis H1: The relationship between ICT and the global competitiveness profiles of the observed countries is characterized by a common structure, which can be explained in terms of some significant latent constructs (components) derived from the original ICT and GCI indicators.

Hypothesis H2: The relationship between ICT and the prosperity profiles of the observed countries is characterized by a common structure, which can be explained in terms of some significant latent constructs (components) derived from the original ICT and LPI indicators.

Description Of Data

The data used in this study relates to 36 European countries (Table 1), each of which is described in terms of their ICT, competitiveness, and prosperity features.

Table 1. Countries included in the analysis

Number	Country	Country code	Number	Country	Country code
1	Albania	Alb	19	Lithuania	Lit
2	Austria	Aus	20	Luxembourg	Lux
3	Belgium	Bel	21	Macedonia	Mac
4	Bulgaria	Bul	22	Malta	Mal
5	Croatia	Cro	23	Montenegro	Mon
6	Cyprus	Cyp	24	Netherlands	Net
7	Czech Republic	Cze	25	Norway	Nor
8	Denmark	Den	26	Poland	Pol
9	Estonia	Est	27	Portugal	Por
10	Finland	Fin	28	Romania	Rom
11	France	Fra	29	Serbia	Ser
12	Germany	Ger	30	Slovakia	Slovak
13	Greece	Gre	31	Slovenia	Sloven
14	Hungary	Hun	32	Spain	Spa
15	Iceland	Ice	33	Sweden	Swe
16	Ireland	Ire	34	Switzerland	Swi
17	Italy	Ita	35	Turkey	Tur
18	Latvia	Lat	36	United Kingdom	UK

Table 2 lists the 14 key ICT indicators, the 12 GCI pillars, and the 9 LPI pillars used herein. Also, 113 competitiveness indicators and 33 prosperity indicators were the subject matter of the analysis. The data used in the analysis refers to the years 2017 and 2018.

Methodology

As noted earlier, we applied the PLS methodology in our analysis. Broadly conceived, PLS is a wide class or family of data analysis methods. It may be described as a broad set of methods aimed at modelling relationships between two sets of observed variables – X and Y sets, by means of extracting some latent components from the structural relationship of these sets. The main idea of the PLS methods is the projection of the observed data onto a derived latent structure (Tenenhaus, M., 2004; Tenenhaus, M., Pagès, J., Ambroisine, L., & Guinot, C., 2005, Maitra, S., & Yan, J., 2008, Abdi, H., Chin, W.W., Vinzi, V.E., Russolillo, G. & Trinchera, L., 2013). The projection is performed on the orthogonal score vectors (PLS components or latent components - LC) by maximizing the covariance between the observed sets of variables.

Table 2. Variables used in the analysis

ICT key indicator (X)	Variable code	GCI pillar (Y)	Variable code
Fixed-telephone subscriptions per 100 inhabitants	ICT_1	*Higher education and training*	GCI_5
Mobile-cellular subscriptions per 100 inhabitants	ICT_2	*Goods market efficiency*	GCI_6
Fixed-broadband subscriptions per 100 inhabitants	ICT_3	*Labor market efficiency*	GCI_7
Active mobile-broadband subscriptions per 100 inhabitants	ICT_4	*Financial market development*	GCI_8
3G coverage (% of population)	ICT_5	*Technological readiness*	GCI_9
LTE/Wimax coverage (% of population)	ICT_6	*Market size*	GCI_10
Mobile-cellular prices (% GNI pc)	ICT_7	*Business sophistication*	GCI_11
Fixed-broadband prices (% GNI pc)	ICT_8	*Innovation*	GCI_12
Mobile-broadband prices 500MB (% GNI pc)	ICT_9	LPI pillar (Y)	
Mobile-broadband prices 1GB (% GNI pc)	ICT_10	*Economic quality*	LPI_1
Percentage of households with computer	ICT_11	*Business environment*	LPI_2
Percentage of households with internet access	ICT_12	*Governance*	LPI_3
Percentage of individuals using the internet	ICT_13	*Education*	LPI_4
International internet bandwidth per internet user (kbit/s)	ICT_14	*Health*	LPI_5
GCI pillar (Y)		*Safety & security*	LPI_6
Institutions	GCI_1	*Personal freedom*	LPI_7
Infrastructure	GCI_2	*Social capital*	LPI_8
Macroeconomic environment	GCI_3	*Natural environment*	LPI_9
Health and primary education	GCI_4		

Source: ITU 2017a, b; World Economic Forum, 2017, 2018; Legatum Institute, 2018a, b

The PLS-R model can be presented in a more formal way, as follows (Bastien, Vinzi, & Tenenhaus, 2005). The PLS regression model for variables $\mathbf{y}$, $\mathbf{x}_1$,...., $\mathbf{x}_j$, ..., $\mathbf{x}_p$, with k components is written as:

$$\mathbf{y} = \sum_{h=1}^{k} c_h \left(\sum_{j=1}^{p} w_{hj}^{*} \mathbf{x}_j \right) + \text{residual} \tag{1}$$

with the constraint that the PLS components $\mathbf{t}_h = \sum_{j=1}^{p} w_{hj}^{*} \mathbf{x}_j$ are orthogonal.

The parameters c_h and w^*_{hj} in the previous model are to be estimated. PLS regression is an algorithm for estimating these parameters and is written as:

$$\hat{\mathbf{y}} = \sum_{h=1}^{k} c_h \left(\sum_{j=1}^{p} w^*_{hj} \mathbf{x}_j \right) = \sum_{j=1}^{p} \left(\sum_{h=1}^{k} c_h w^*_{hj} \right) \mathbf{x}_j = \sum_{j=1}^{p} b_j \mathbf{x}_j. \quad (2)$$

where coefficients c_h are estimated by multiple regression of $\mathbf{y}$ on the PLS components $\mathbf{t}_h$. As previously stated, these components $\mathbf{t}_h = \sum_{j=1}^{p} w^*_{hj} \mathbf{x}_j$ are orthogonal.

The first PLS component $\mathbf{t}_1 = \mathbf{X}\mathbf{w}^*_1$ is defined as:

$$\mathbf{t}_1 = \frac{1}{\sqrt{\sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}, \mathbf{x}_j)^2}} \sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}, \mathbf{x}_j) \mathbf{x}_j \quad (3)$$

It is obvious that the importance of the variable $\mathbf{x}_j$ in the construction of the component $\mathbf{t}_1$ is determined by its correlation with $\mathbf{y}$. In the next step, the second component $\mathbf{t}_2$ is calculated. The following regressions are performed first:

$$\mathbf{y} = c_1 \mathbf{t}_1 + \mathbf{y}_1 \quad (4)$$

$$\mathbf{x}_j = p_{1j} \mathbf{t}_1 + \mathbf{x}_{1j} \quad (5)$$

followed by the calculation of the second component. The second PLS component is defined as:

$$\mathbf{t}_2 = \frac{1}{\sqrt{\sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}_1, \mathbf{x}_{1j})^2}} \sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}_1, \mathbf{x}_{1j}) \mathbf{x}_{1j} \quad (6)$$

where $\mathbf{y}_1$ and $\mathbf{x}_{1j}$ are residuals from formulas (4) and (5).

Bearing in mind that the partial covariance between $\mathbf{y}$ and $\mathbf{x}_j$, given $\mathbf{t}_1$, is defined as the covariance between residuals $\mathbf{y}_1$ and $\mathbf{x}_{1j}$, that is,

$$\operatorname{cov}(\mathbf{y}, \mathbf{x}_j | \mathrm{t}_1) = \operatorname{cov}(\mathbf{y}_1, \mathbf{x}_{1j}) \quad (7)$$

the second PLS component $\mathbf{t}_2 = \mathbf{X}\mathbf{w}^*_2$ is written as:

$$\mathbf{t}_2 = \frac{1}{\sqrt{\sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}, \mathbf{x}_j | \mathbf{t}_1)^2}} \sum_{j=1}^{p} \operatorname{cov}(\mathbf{y}, \mathbf{x}_j | \mathbf{t}_1) \mathbf{x}_{1j}. \quad (8)$$

Next, components - $\mathbf{t}_h = \mathbf{X}\mathbf{w}^*_h$ are calculated in a similar way. The procedure stops when all partial covariances are not significant.

EMPIRICAL RESULTS AND DISCUSSION

To investigate the research question and test the proposed hypotheses, we examined two structural relationships.

The first hypothesis, which pertains to the relationship between ICT features and the global competitiveness of the observed countries, was tested with two models, as follows:

- GCI pillars (12 pillars) regressed on ICT indicators (ICT-GCI-1 model), and
- GCI indicators (113 indicators) regressed on ICT indicators (ICT-GCI-2 model).

The second hypothesis, which pertains to the relationship between ICT features and the prosperity of the countries studied, was tested with two additional models, as follows:

- LPI pillars (9 pillars) regressed on ICT indicators (ICT-LPI-1 model), and
- LPI indicators (33 indicators) regressed on ICT indicators (ICT-LPI-2 model).

All models were run with the XLSTAT Addinsoft software package (ver. 2019.1.3; Addisonsoft, Inc., New York, N. Y. USA).

Estimated regression equations for the ICT-GCI-1 and ICT-LPI-1 models are presented in Appendix 1.

First, we present the general quality of the applied PLS method for regression (PLS-R models) as a function of the number of LCs. Table 3 shows the metrics of two indexes: R^2Y cum and R^2X cum indexes.

Table 3. PLS-R model quality: basic statistics

Summary statistics	LC_1	LC_2	LC_3	LC_4
ICT-GCI-1 model				
R^2Y cum	0.544	0.607	0.646	0.680
R^2X cum	0.483	0.555	0.627	0.688
ICT-GCI-2 model				
R^2Y cum	0.385	0.432	0.470	0.508
R^2X cum	0.497	0.577	0.660	0.730
ICT-LPI-1 model				
R^2Y cum	0.670	0.700	0.729	0.750
R^2X cum	0.483	0.565	0.627	0.687
ICT-LPI-2 model				
R^2Y cum	0.461	0.493	0.537	0.564
R^2X cum	0.483	0.570	0.628	0.702

Note: PLS component $\mathbf{t}_1$ - Latent Component1: LC_1, PLS component $\mathbf{t}_2$ - Latent Component2: LC_2, PLS component $\mathbf{t}_3$ - Latent Component3: LC_3, PLS component $\mathbf{t}_4$ - Latent Component4: LC_4.

Source: Authors' calculations, based on the data in Table 2.

For the purpose of our analysis, two indexes are especially important – namely, R^2X cum and R^2Y cum, which show the correlation of the ICT and GCI (LPI) indicators, respectively, with LCs. Generally, the values of the R^2Y cum and R^2X cum indexes increase with an increased number of LCs, and approach 1. In the case of the ICT-GCI-1 model, the explanatory power of the first four LCs is higher for the ICT variables, relative to the GCI variables (ICT-GCI-1: 0.688 vs. 0.680; ICT-GCI-2: 0.730 vs. 0.508). On the other hand, for the ICT-LPI model, the explanatory power of the first four LCs is higher for the ICT variables when the LPI variables are LPI indicators (ICT-LPI-1: 0.687 vs. 0.750; ICT-LPI-2: 0.702 vs. 0.564). Generally, these values show that the PLS-R models with the four LCs share a common structure among indexes and adequately explain both the ICT as an independent variable, and the GCI and LPI as dependent variables. Thus, these results support our research hypotheses H1 and H2.

Figures 1 and 2 show the levels of correlation between the observed ICT and development features, and the first two LCs: the former is a correlation map generated by the ICT-GCI-1 model, while the latter is the corresponding map generated by the ICT-LPI-1 model.

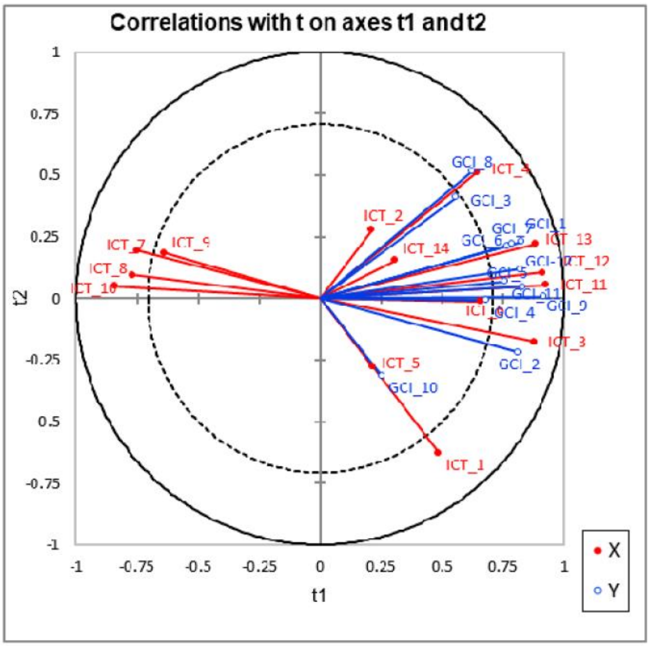

Figure 1. Correlation map generated by the ICT-GCI-1 model: Correlation between ICT indicators (Xs) and GCI pillars (Ys) with two LCs

Note: t1: LC_1; t2: LC_2. X: ICT indicators; Y: GCI pillars

Source: Authors' calculations, based on the data in Table 2.

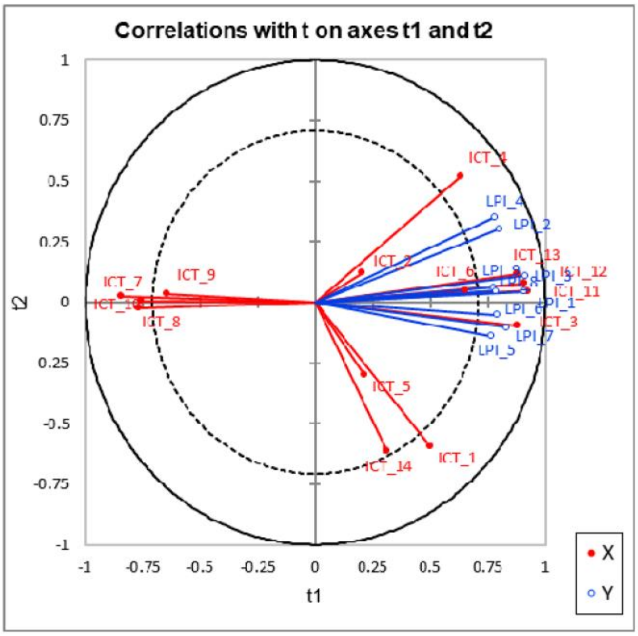

Figure 2. Correlation map generated by the ICT-LPI-1 model: Correlation between ICT indicators (Xs) and LPI pillars (Ys) with two LCs
Note: t1: LC1; t2: LC2. X: ICT indicators; Y: LPI pillars
Source: Authors' calculations, based on the data in Table 2.

Figures 1 and 2 reveal the direction and the magnitude of correlation between the ICT and GCI (LPI) indicators with the first two LCs. At first glance, one can see that the correlation pattern is similar for these two models. We see that the majority of the input variables correlate positively with the first LC; for this reason, they are mainly concentrated on the right-hand side of the map. Regarding the ICT indicators, we see in both Figures 1 and 2 that four independent variables related to prices (i.e., *Mobile-cellular prices*, *Fixed-broadband prices*, *Mobile-broadband prices 500MB*, and *Mobile-broadband prices 1GB*) strongly and negatively correlate with t_1. These four variables comprise a block of variables that strongly and positively correlate among themselves, but correlate negatively with all other ICT indicators. At the same time, on the opposite side of the chart, other variables – namely, *Percentage of households with computer*, *Percentage of households with internet access*, and *Percentage of individuals using the internet* – show very strong and positive correlations among themselves, and a very strong and negative correlation with the first block of variables. This holds for both models. Additionally, we note that three ICT indicators, i.e., *Mobile-cellular subscriptions per 100 inhabitants*, *3G coverage*, and *International internet bandwidth per inter-*

net user, near the center of the map, show weak correlation with both PLS components and other ICT indicators.

The development indicators (GCI and LPI indicators) are concentrated on the right-hand edge of the correlation maps. In the case of the ICT-GCI-1 model, all the GCI variables except GCI_3 (*Macroeconomic environment*) and GCI_10 (*Market size*) strongly correlate with the first latent component (t_1) (i.e., correlation coefficient>0.6). The Competitiveness variables GCI_3 (*Macroeconomic environment*), GCI_8 (*Financial market development*), and GCI_10 (*Market size*) correlate more strongly with the second LC (t_2). On the other hand, with the ICT-LPI-1 model, there is a demonstrably strong correlation between all LPI variables and the first LC (i.e., all correlation coefficients >0.765). These results concerning the correlation structure of the observed ICT and development indicators, and derived LCs are significant and 'speak in favor' of our research hypotheses.

Additionally, other maps that show the countries' positions regarding their ICT and development profiles are also very useful. Figures 3 and 4 respectively are observation maps generated by the previous models.

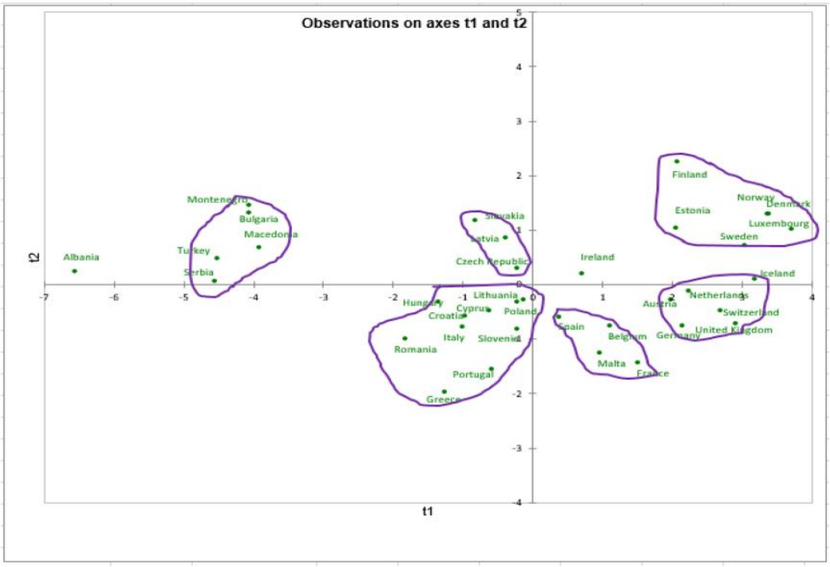

Figure 3. Observation map: GCI pillars regressed on ICT indicators

Note: t1: LC_1; t2: LC_2.

Source: Authors' calculations, based on the data in Table 2.

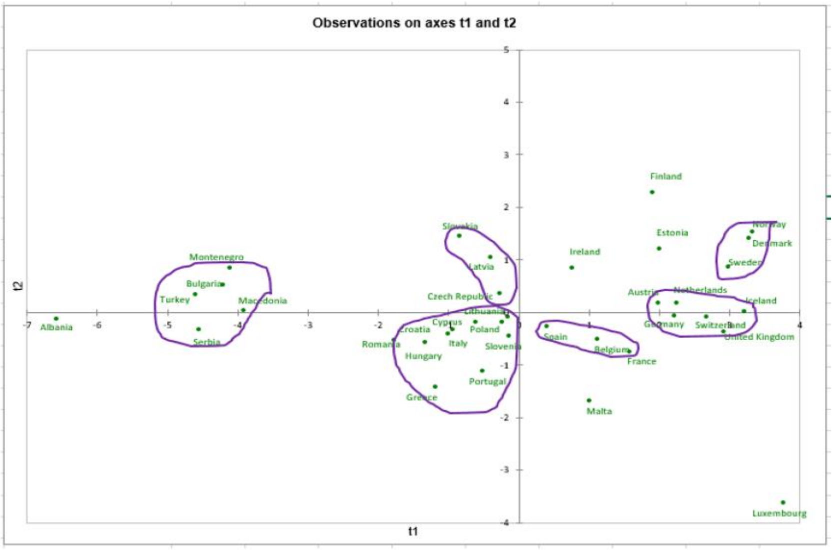

Figure 4. Observation map: LPI pillars regressed on ICT indicators

Note: t1: LC_1; t2: LC_2.

Source: Authors' calculations, based on the data in Table 2.

Interpretations of the observation maps are very intuitive: the more tightly clustered the countries are on the map, the more similar they are in terms of ICT, global competitiveness, and prosperity features. Note that the Scandinavian countries are located along the upper right-hand edge of the map, while the West Balkan countries are located on the opposite side of the map, along the left-hand edge.

Additionally, these observation maps reveal the following findings: a) the two models generate very similar projections for the studied countries, and this indicates that the relationship between ICT and competitiveness profiles is very similar to the relationship between ICT and prosperity profiles (with the exception of Luxembourg); b) it is interesting that the distribution of the observed countries on the map mainly resembles a geographical map; and c) we see a pattern of clustering among the European countries regarding their ICT and development profiles. Based on the visualization, we point to one possible grouping solution (i.e., countries in highlighted circles in Figures 3 and 4).

CONCLUSION

Bearing in mind the previously mentioned empirical results, we can summarize the principal findings of our study as follows:

- Exploring the relationship between ICT and the development profiles of the European countries, we found that there is a significant common structure among these profiles. By applying the PLS methodology, the common structures of the observed variables (i.e. all ICT, competitiveness and prosperity country features) were extracted and analyzed in the domain of latent components (LCs). It is shown that the correlation between ICT and socioeconomic variables (through the use of LCs) exhibited large values. The appropriate model statistics R^2X cum index values were in the range of [0.687, 0.730] and R^2Y cum index values were in the range of [0.508, 0.750]. As such, these results support our research hypotheses, H1 and H2;

- It is interesting that the correlation 'pattern' between ICT and competitiveness features, as well as between ICT and prosperity features, was similar across the applied models (as seen in the correlation maps). For this reason, we can say that the structure of the relationship between ICT and competitiveness profiles, and the relationship between ICT and the prosperity profiles of the European countries are very similar. This conclusion is additionally supported by the use of observation maps, wherein we can see very similar projections for virtually all the European countries. This indicates that the ICT features of the observed countries are similarly reflected on their competitiveness and prosperity;
- It is remarkable that the observation maps generated in the course of the current study, which reflected the location of the countries in the ICT and development environment, resemble a geographical map of the countries. Additionally, these maps provide an indicative picture of the 'natural' groupings of the countries studied, based on their ICT and competitiveness (prosperity) profiles. We proposed one grouping solution for each observation map.

Based on these findings, we can put forward some practical implications of the study. Our results may be of practical importance to creators of national-level ICT and development policies; they may be particularly salient to policy-makers and executives in developing countries and transition economies. Here, we refer specifically to the fact that certain ICT indicators - namely, *Use of ICT* and *Price of ICT services* - can be considered predominant indicators, given their impact on the set of competitiveness and prosperity features of the observed countries. In particular, these ICT indicators generally share a common structure and influence the following competitiveness features of the observed countries: *Technological readiness*, *Business sophistication*, *Institutions*, and *Innovation*. Also, they are closely correlated and have an impact on certain prosperity country features: *Governance, Economic quality*, and *Personal freedom*. For this reason, this observation can help inform policy-makers which ICT indicators to pay special attention to, and where they can expect significant results. They can also benefit from the proposed correlation maps, which provide an intuitive understanding of the relationships among a large number of indicators and the related countries in a complex ICT and development environment. Using these maps, one can monitor the location and grouping of a particular country, and compare them to those of other countries.

LIMITATIONS AND FUTURE RESEARCH

The main limitation of this study lies in the fact that it included only European countries as a whole. It would be interesting to conduct a similar analysis on multiple groups of countries which are at different stages of socio-economic development. In doing so, the focus would be on developing countries and countries in transition. As a starting point, this research can serve groups of countries that are represented on the observation maps in this paper, but the data sample may be extended to non-European countries. We believe that a comparative analysis of the results would be worthy of attention.

Also, for some future work, the wider context of the ICT and development country profiles can be analyzed applying an extended variant of the methodology applied in this study - PLS Path Modelling (PLS-PM). For that purpose, in addition to the phenomena analyzed, some new concepts may be included.

REFERENCES

Abdi, H., Chin, W.W., Vinzi, V.E., Russolillo, G. & Trinchera, L. (Eds.) (2013). New Perspectives in Partial Least Squares and Related Methods, *Springer Proceedings in Mathematics & Statistics Book 56*, New York: Springer Science+Business Media.

Alderete, M. V. (2017). Examining the ICT access effect on socioeconomic development: the moderating role of ICT use and skills, *Information Technology for Development,* 23(1), 42-48. https://doi.org/10.1080/02681102.2016.1238807

Ayanso, A., Cho, D. I., & Lertwachara, K. (2014). Information and communications technology development and the digital divide: A global and regional assessment. *Information Technology for Development,* 20(1), 60–77. https://doi.org/10.1080/02681102.2013.797378.

Avgerou, C. (2017). Theoretical framing of ICT4D research. In J. Choudrie & S. Islam (Eds.), *Information and communication technologies for development* (pp. 10–23). New York: Springer.

Bastien, P., Vinzi, E.V, Tenenhaus, M., (2005). PLS generalized linear regression, *Computational Statistics & Data Analysis,* 48, 17-46. https://doi.org/10.1016/j.csda.2004.02.005.

Cioacă, S.I., Cristache, S.E., Vuță, M., Marin, E., Vuță, M. (2020). Assessing the Impact of ICT Sector on Sustainable Development in the European Union:

An Empirical Analysis Using Panel Data. *Sustainability* 12, 592. https://doi.org/10.3390/su12020592.

Gligorić, M., Jovanović Gavrilović, B., Savić, Lj. (2018). Prosperity index as a measure of wellbeing in European union and Western Balkan countries, *Teme,* XLII(4), 1253-1275. https://doi.org/10.22190/TEME190401001E.

Haenlein, M., & Kaplan, A. M. (2004). A beginner's guide to partial least squares analysis. *Understanding Statistics,* 3(4), 283–297.

International Telecommunication Union (ITU) (2017a). *Measuring the information society report 2017,* Vol. 1. ICT country profiles. Geneva: ITU International Telecommunication Union.

International Telecommunication Union (ITU) (2017b). Measuring the information society report 2017, volume 2. ICT country profiles. Geneva: ITU International Telecommunication Union.

Kowal, J., & Paliwoda-Pękosz, G. (2017). ICT for global competitiveness and economic growth in emerging economies: Economic, cultural, and social innovations for human capital in transition economies. *Information Systems Management,* 34(4), 304–307. htps://doi.org/10.1080/10580530.2017.1366215.

Kowal, J., & Roztocki, N. (2013). Information and communication technology management for global competitiveness and economic growth in emerging economies. *The Electronic Journal of Information Systems in Developing Countries,* 57, 1–12.

Krstić, B, Stanojević, J, & Stanišić, T., (2016). Innovations as a determinant of competitiveness of Serbia: a comparative analysis with Western Balkan countries and the European union, *Teme,* XL(3), 1035-1050.

Legatum Institute (2018a). The Legatum prosperity index 2018: Methodology report. Creating pathways from poverty to prosperity. London, UK: Legatum Institute.

Legatum Institute (2018b). The Legatum prosperity index 2018: Country profiles, 12th edition. London, UK: Legatum Institute.

Maitra, S., & Yan, J. (2008). Principle component analysis and partial least squares: Two dimension reduction techniques for regression [Discussion paper]. CAS Spring Meeting of the Casualty Actuarial Society (pp. 79–90). Retrieved from: https://www.casact.org/pubs/dpp/dpp08/08dpp76.pdf

Perović, D. & Radukić, S., (2017). Comparative analysis of sustainable development components for the Republic of Serbia and neighbouring countries, *Teme,* XLI(3), 747-765. https://doi.org/ 10.22190/TEME1703747P.

Qureshi, S. (2015). Are we making a better world with information and communication technology for development (ICT4D) research? Findings from the field and theory building. *Information Technology for Development,* 21(4), 511–522. https://doi.org/10.1080/02681102.2015.1080428

Rothe, F. (2020). Rethinking positive and negative impacts of 'ICT for Development' through the holistic lens of the sustainable development goals, *Information Technology for Development,* 26(4), 653-669. https://doi.org/10.1080/02681102.2020.1756728.

Savulescu, C. (2015). Dynamics of ICT development in the EU. *Procedia Economics and Finance,* 23, 513–520.

Sein, M. K., Thapa, D., Hatakka, M., & Saebo, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research, *Information Technology for Development*, 25(1), 7-25, https://doi.org/10.1080/02681102.2018.1503589.

Skaletsky, M., Soremekun, O. & Galliers, R.D. (2014). The Changing – and Unchanging – Face of the Digital Divide: an Application of Kohonen Self-Organizing Maps, *Information Technology for Development*, 20(3), 218-250. https://doi.org/10.1080/02681102.2013.804396.

Tenenhaus, M. (2004). PLS Regression and PLS Path Modeling for Multiple Table Analysis, COMPSTAT 2004 *Proceedings in Computational Statistics* (pp. 489-499). Berlin: Physica-Verlag, Springer.
Tenenhaus, M., Pagès, J., Ambroisine, L., & Guinot, C. (2005). PLS methodology for studying relationships between hedonic judgements and product characteristics. *Food Quality and Preference,* 16(4), 315–325. https://doi.org/10.1016/j.foodqual.2004.05.013
Tjoa, A. M. & Tjoa, S. (2016). The Role of ICT to Achieve the UN Sustainable Development Goals (SDG). In: Mata, F.J. & Pont, A. (Eds.) ICT for Promoting Human Development and Protecting the Environmemnt, *WITFOR 2016*, (pp. 3-13), *IFIP Advances in Information and Communication Technology,* Vol. 481, Berlin: Springer, Cham.
Trlaković, J., Despotović, D. & Ristić, L., (2018**).** Comparative analysis of the sustainable development indicators of the Western Balkan countries and certain EU countrie, *Teme,* XLII(2), 485-501. https://doi.org/10.22190/TEME1802485T
United Nations (2001). *Road Map Towards the Implementation of the United Nations Millennium Declaration: Report of the Secretary-General*, New York: UN.
United Nations (2015). Transforming Our World: The 2030 Agenda For Sustainable Development, New York: UN.
Walsham, G. (2017). ICT4D research: Reflections on history and future agenda. *Information Technology for Development,* 23(1), 18–41. https://doi.org/10.1080/02681102.2016.1246406.
World Bank (2003). ICT and MDGs: A world Bank Group Perspective, Washington: DC, World Bank.
World Bank (2016). Digital Dividents, World Development Report, Washington: DC.
World Bank (2019). Information and Communications for Development 2018: Data Driven. Development, World Development Report, Washington: DC.
World Bank (2020). Europe 4.0, Addressing the Digital Dilemma, Washington: DC.
World Bank (2020a). World Development Report 2021, Data for Better Lives, Concept Notes, May 2020.
World Economic Forum (2017). The global competitiveness report 2016–2017. Geneva: WEF.
World Economic Forum (2018). The global competitiveness report 2017–2018. Geneva: WEF.
XLSTAT Addinsoft software, ver. 2019.1.3., Addinsoft Inc., New York, N.Y. USA.

СТРУКТУРНА ВЕЗА ИЗМЕЂУ ИКТ И РАЗВОЈНОГ ПРОФИЛА ЕВРОПСКИХ ЗЕМАЉА

Јасна Солдић Алексић, Биљана Јовановић Гавриловић, Раде Станкић
Универзитет у Београду, Економски факултет, Београд, Србија

Резиме

У овом раду приказани су резултати емпиријског истраживања структурних односа између два битна феномена националних економија: заступљености и примене информационо-комуникационих технологија - ИКТ карактеристика, са једне стране, и развојних карактеристика, са друге стране. У раду је посебан акценат стављен на сагледавање комплетног развојног профила посматраних земаља, који обухвата како

економске, тако и социјалне и еколошке аспекте развоја, што је у складу са Циљевима одрживог развоја предложених од стране УН. Имајући то у виду, изабране су основне метрике на основу којих је спроведено истраживање. То су три композитна индекса – ИКТ развојни индекс, глобални индекс конкурентности и Легатум индекс просперитета земаља. Истраживање је обухватило 36 европских земаља. Основна методологија истраживања јесте методологија Парцијалне регресије најмањих квадрата (PLS-R), која обезбеђује мултидимензионални приступ према коме су све променљиве симултано укључене у анализу. Применом ове методологије истражена је, са једне стране, структурна веза између ИКТ и нивоа конкуретности земаља (постављена су два модела), а са друге стране, структурна веза између ИКТ и нивоа просперитета посматраних земаља (такође применом два модела).

Најважнији резултати овог емпиријског истраживања откривају значајну структурну повезаност између ИКТ и развојних карактеристика земаља, било да се ниво развоја посматра кроз компетитивне карактеристике или карактеристике просперитета националних економија. То указује да се ИКТ карактеристике на сличан начин рефлектују на ниво конкуретности и просперитета. У том погледу приказане су мапе, које откривају позицију сваке од посматраних земаља у погледу ИКТ и развојних карактеристика. Интересантна је чињеница да ове мапе углавном прате географски распоред земаља и пружају могућност за сагледавање њиховог груписања у области ИКТ и развојног домена. Од свих ИКТ индикатора посебно се издваја утицај два индикатора - Употреба ИКТ и Цена ИКТ услуга на следеће развојне карактеристике земаља: Технолошка спремност, Пословно окружење, Институције и Иновације, као и на начин Управљања, Квалитет економије и Личне слободе грађана посматраних земаља. Добијени резултати могу послужити за креирање развојних стратегија земаља, посебно са аспекта утицаја ИКТ индикатора на развојне карактеристике. Такође, од значаја може бити праћење резултата утицаја ИКТ индикатора на ниво реализације Циљева одрживог развоја, које су предложиле Уједињене нације за националне економије.

APPENDIX 1

ICT-GCI-1 model equations:

GCI_1 = 1,051-0,001*ICT_1+0,02 *ICT_2+0,017*ICT_3+0,010*ICT_4-0,015*ICT_5+0,014*ICT_6 +0,007*ICT_7-0,057*ICT_8+0,095*ICT_9-0,233*ICT_10+0,001*ICT_11+0,006*ICT_12+0,021*ICT_13 +0,000005*ICT_14

GCI_2 = -0,372+0,018*ICT_1-0,001*ICT_2+0,021*ICT_3+0,003*ICT_4+0,028*ICT_5+0,012*ICT_6-0,087*ICT_7-0,123*ICT_8+0,031*ICT_9-0,253*ICT_10-0,004*ICT_11- 0,00026 *ICT_12 +0,009*ICT_13-0,000076*ICT_14

GCI_3 = 4,686-0,023*ICT_1+0,002*ICT_2-0,004*ICT_3+0,007*ICT_4-0,032*ICT_5+0,006*ICT_6+0,050*ICT_7-0,057*ICT_8-0,155*ICT_9-0,096*ICT_10+0,014*ICT_11+0,014*ICT_12+0,012*ICT_13+0,000087*ICT_14

GCI_4 = 4,569+0,005*ICT_1-0,00028 *ICT_2+0,010*ICT_3+0,004*ICT_4+0,003*ICT_5+0,007*ICT_6+0,001*ICT_7-0,034*ICT_8+0,007*ICT_9-0,093*ICT_10-0,004*ICT_11-0,001*ICT_12+0,007*ICT_13-0,000047*ICT_14

GCI_5 = 2,628+0,002*ICT_1-0,002*ICT_2+0,014*ICT_3+0,007*ICT_4+0,001*ICT_5+0,013*ICT_6+0,036*ICT_7-0,110*ICT_8+0,026*ICT_9 -0,153*ICT_10-004*ICT_11+0,001*ICT_12+0,011*ICT_13-0,00012*ICT_14

GCI_6 = 3,233-0,001*ICT_1+0,002*ICT_2+0,006*ICT_3+0,004*ICT_4-0,006*ICT_5+0,005*ICT_6 -0,007*ICT_7-0,020*ICT_8+0,026*ICT_9-0,099*ICT_10+0,002*ICT_11+0,003*ICT_12+0,009*ICT_13 +0,000022*ICT_14

GCI_7 = 2,223+0,002*ICT_1+0,002*ICT_2+0,014*ICT_3+0,007*ICT_4-0,010*ICT_5+0,009*ICT_6+0,007*ICT_7-0,013*ICT_8+0,134*ICT_9 -0,149*ICT_10-0,003*ICT_11+0,001*ICT_12+0,015*ICT_13-0,0000054*ICT_14

GCI_8 = 3,648-0,014*ICT_1+0,003*ICT_2+0,007*ICT_3+0,011*ICT_4 -0,037*ICT_5+0,009*ICT_6+0,079*ICT_7+0,003*ICT_8+0,097*ICT_9 -0,107*ICT_10+0,002*ICT_11+0,006*ICT_12+0,019*ICT_13+0,000029*ICT_14

GCI_9 = 1,020+0,008*ICT_1+0,001*ICT_2+0,017*ICT_3+0,006*ICT_4+0,008*ICT_5+0,012*ICT_6-0,052*ICT_7-0,084*ICT_8+0,045*ICT_9-0,237*ICT_10- 0,00021*ICT_11+0,003*ICT_12+0,014*ICT_13-0,000015*ICT_14

GCI_10 = 1,061+0,004*ICT_1-0,010*ICT_2+0,003*ICT_3 -0,002*ICT_4+0,047*ICT_5+0,012*ICT_6-0,001*ICT_7-0,319*ICT_80,399*ICT_9 -0,111*ICT_10+0,001*ICT_11+0,004*ICT_12-0,013*ICT_13-0,00026*ICT_14

GCI_11 = 0,737+0,005*ICT_1-0,00005*ICT_2+0,017*ICT_3+0,007*ICT_4 +0,004*ICT_5+0,013*ICT_6-0,014*ICT_7-0,101*ICT_8+0,035*ICT_9 -0,217*ICT_10-0,002*ICT_11+0,003*ICT_12+0,014*ICT_13-0,000057*ICT_14

GCI-12 = -0,111+0,005*ICT_1+0,001*ICT_2+0,021*ICT_3+0,010*ICT_4-0,004*ICT_5 +0,017*ICT_6 +0,005*ICT_7-0,095*ICT_8+0,107*ICT_9-0,256*ICT_10-0,003*ICT_11 +0,003*ICT_12+0,020*ICT_13-0,000064*ICT_14

ICT-LPI-1 model equations:

LPI_1 = 42,211+0,034*ICT_1-0,021*ICT_2+0,118*ICT_3+0,046*ICT_4-0,001*ICT_5+0,064*ICT_6-0,530*ICT_7-1,212*ICT_8-0,906*ICT_9-2,113*ICT_10+0,050*ICT_11+0,078*ICT_12+ 0,109*ICT_13 + 0,0000082 *ICT_14

LPI_2 = 67,658+0,011*ICT_1-0,042*ICT_2+0,148*ICT_3+0,091*ICT_4-0,368*ICT_5+0,039*ICT_6-0,165*ICT_7-0,053*ICT_8+0,740*ICT_9-2,792*ICT_10+0,017*ICT_11+0,055*ICT_12 +0,187*ICT_13-0,001*ICT_14

LPI_3 = 32,874+0,068*ICT_1-0,047*ICT_2+0,231*ICT_3+0,100*ICT_4-0,157*ICT_5+0,098*ICT_6-0,780*ICT_7-1,104*ICT_8-0,325*ICT_9-4,394*ICT_10+0,063*ICT_11+0,114*ICT_12 +0,238*ICT_13-0,001*ICT_14

LPI_4 = 70,258-0,013*ICT_1+0,025*ICT_2+0,092*ICT_3+0,062*ICT_4-0,260*ICT_5+0,074*ICT_6-0,520*ICT_7+0,453*ICT_8+0,736*ICT_9-2,707*ICT_10+0,042*ICT_11+0,037*ICT_12+0,126*ICT_13-0,001*ICT_14

LPI_5 = 62,002+0,060*ICT_1-0,040*ICT_2+0,080*ICT_3+0,017*ICT_4+0,085*ICT_5+0,008*ICT_6-0,145*ICT_7-0,489*ICT_8-0,221*ICT_9-1,123*ICT_10+0,003*ICT_11+0,031*ICT_12 +0,064*ICT_13 +0,00023 *ICT_14

LPI_6 = 39,915+0,089*ICT_1+0,046*ICT_2+0,104*ICT_3+0,011*ICT_4+0,166*ICT_5+0,084*ICT_6-0,954*ICT_7+1,398*ICT_8+1,273*ICT_9 -3,625*ICT_10+0,037*ICT_11+0,007*ICT_12+0,093*ICT_13-0,000081*ICT_14

LPI_7 = 18,974+0,187*ICT_1-0,056*ICT_2+0,240*ICT_3+0,049*ICT_4+0,217*ICT_5+0,061*ICT_6-0,841*ICT_7+0,482*ICT_8+1,052*ICT_9 -4,981*ICT_10+0,017*ICT_11+0,055*ICT_12+0,212*ICT_13 +0,00019*ICT_14

LPI_8 = 49,636+0,066*ICT_1-0,081*ICT_2+0,153*ICT_3+0,065*ICT_4
-0,129*ICT_5+0,007*ICT_6-0,031*ICT_7-0,647*ICT_8+0,133*ICT_9
-2,137*ICT_10-0,002*ICT_11+0,057*ICT_12+0,159*ICT_13-0,00029 *ICT_14

LPI_9 = 49,662+0,015*ICT_1-0,022*ICT_2+0,093*ICT_3+0,040*ICT_4-
0,013*ICT_5+0,055*ICT_6-0,408*ICT_7-1,500*ICT_8-1,237*ICT_9-
1,417*ICT_10+0,048*ICT_11+0,077*ICT_12+0,084*ICT_13 +0,000063 *ICT_14