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Economic Sustainability in a Wider Context: Case Study of Considerable ICT Sector Sub-Divisions

Emilia Madudova [1,*], Tatiana Čorejova [1] and Marek Valica [2]

[1] The Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215, 010 026 Žilina, Slovakia; tatiana.corejova@fpedas.uniza.sk

[2] Institute of Continuing Education, University of Žilina, Ulica 1.mája 32, 010 26 Žilina Slovakia; marek.valica@uniza.sk

* Correspondence: emilia.madudova@fpedas.uniza.sk; Tel.: +421-41-513-3116

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Abstract: This paper situates the process of economic sustainability in the wider context of regional specialization and geographic concentration. The main object is to analyze the implications of increasing importance of sustainable development. In this context, the ICT (Information and Communication Technology) is at the same time a part of the problem and solution. The focus of this paper is also the ICT firms themselves. This research aimed to explore the ICT firms operating in the ICT sector and focused more on the ICT firms' sustainability in connection with industry geographic concentration and regional specialization. The economic sustainability (evaluated by sustainability sub-index) and geographical and regional analysis were studied for 62 Computer Programming and 63 Information Services sub-divisions of the ICT sector. The results confirm a strong correlation between economic sustainability and firm geographic concentration. Results show that a worsening value of economic sustainability does not always lead to the worsening conditions in the industry and there is a strong relationship between the economic sustainability and regional analysis.

Keywords: Computer Programming; Information Services; economic sustainability; regional disparities; knowledge dissemination; ICT sector

1. Introduction

Within the last years, sustainability has passed from an ambiguous concept promoted by public bodies in developed countries to a daily concern of a majority of people, organizations, and companies across the world. In that context, ICT (Information and Communication Technology) is at the same time part of the problem and of the solution [1].

There is clear evidence that ICT may positively influence enterprise competitiveness but also social and environmental issues [2] and the impact of ICT on sustainability is ambiguous: whether ICT constitutes a threat or a cure to environmental degradation is controversially discussed [3].

One thing is for sure, ICT has offered many new opportunities to address and improve sustainability topics from the local level up to global concepts such as the EU's emission trading system. Targeted improvements in the industry can only be effective and efficient when company sustainability management is available [1].

Many enterprises adopt and use information and communication technologies (ICTs) to achieve their social mission. ICT has the potential to address the three main aspects of sustainability (people, planet, and profit, known as the Triple Bottom Line [4]), therefore several organizations have initiated sustainable development by integrating ICT with their business activities [5]. Some organizations have planned sustainable strategies that not only minimize the environmental impact but also increase their business competitiveness [6].

The ICT firms find the innovative ways how to integrate ICT into the business processes when at the same time try to deliver sustainable benefits [5]. ICT has the potential to support and enhance significantly the collection and management of innovation-related knowledge, the innovation production, and the external innovation collaborations, increasing the productivity of firms' innovation creation processes [7,8]. Finally, there is another more recent theoretical research stream dealing with the potential of ICT to increase the productivity of firms' research and development (R&D) and innovation creation processes, which can result in higher innovation performance [8–11]. This theoretical literature concludes that ICT can significantly help improve the collection, management, and exchange of innovation-related knowledge [7].

Over the years, ICT has provided organizations with capabilities to improve their profitability, efficiency, productivity and increase their competitive advantage. Thus, ICT has become a major supporter of business innovation and important tool for organizations to develop sustainability capabilities [12]. Consequently, ICT can play significant roles in addressing sustainability [13,14]. Research on the possible roles of ICT in supporting sustainability initiatives has been reported in the available sustainability literature [15,16].

The ICT market depends far more on technological innovation than non-ICT markets [17,18]. In the ICT market, existing firms' defense strategies and newcomers' entry strategies coexist. A saturated ICT market is characterized by an intense competition and few existing firms that dominate the market in terms of their market share. This characteristic of the ICT market can be explained by the swing effect. On the other hand, because of shorter product life cycles and the inability of dominant firms to cover various needs of consumers, newcomers offering innovative products and services have better opportunities to succeed in the ICT market than in non-ICT markets [19,20].

Even the best-run companies may not be sustainable if their business models or technologies are not sustainable for the long haul. In such cases, economists need to focus on the prospects for incubation, considering how more sustainable technologies, business models and industries can be incubated in today's world [21].

However, the roles of ICT in supporting sustainability initiatives have already been discussed [15] and there are theories and findings available describing and assuming the importance, interlacing the sustainability and the ICT in a corporate environment [22,23], it is very important to pay attention to the possibilities of promoting ICT sustainability, but it is also very important to pay attention to the ICT firms themselves whose main product is the provision of such important ICT product.

The OECD (2018) defines the ICT product of a candidate that must fulfill the function of information processing and communication including transmission and display, or use electronic processing to detect, measure and/or record physical phenomena or control a physical process. Service must be intended to enable the function of information processing and communication by electronic means. Good must be intended to primarily fulfill the function of electronic information processing and communication (including transmission, recording, storage, and display). This also includes the production of electronic components [24].

Lee et al. (2016) highlighted the importance of achieving a balanced industrial development to enhance the overall competitiveness of the ICT industry [25]. Therefore, this research aimed to explore the ICT economic sustainability in a wider context.

It is not only important for the industry in the country to achieve a certain level of sustainability, but it is also important to address the impact of the industry on the national economy [26,27].

Partial findings have led the authors to explore not only the sustainability of the ICT sector in terms of economic sustainability, but also to explore the implications of the measures described in [28–31] focused on reducing regional disparities in the ICT sector.

The described context of this paper is put into the context of economic sustainability below with a focus on he regional sustainability, especially regional specialization and geographic concentration.

The importance of monitoring the sustainability of the ICT sector at the European level as well as in the Slovak Republic confirms the statistics of the Business demography of the ICT Sector in Europe [32]. These statistics point to a significant increase in Net business population growth in the ICT sector in the Slovak Republic in comparison to the chosen countries (Appendix A). Net business population growth defines a growth rate between t (time) and $t - 1$ of the population of active enterprises that represent the rate of active enterprises that have employment and/or within a certain period (one year).

Madudova and Kolarovszki (2016), Madudova (2016; 2018), and Stalmasekova, Genzorova and Corejova (2017) confirmed that this primacy is largely influenced by the progressing of sub-divisions 62 Computer Programming and 63 Information Services. Sub-divisions 62 and 63 of the ICT sector have also been evaluated because they showed the highest increase and sustainability potential in the future [28–31].

2. Materials and Methods

In advance, it is important to describe sub-divisions 62 and 63 in more detail and define the activities this sub-divisions include.

2.1. ICT Sub-Divisions Classification

The ICT sector according to the Statistical Office of the Slovak Republic [33] categorization (SK NACE rev.2) is defined as the sector including Publishing Activities, Film, Video, TV Production, Broadcasting, Telecommunications, Computer Programming, and Information Services. ICT Sector in the Slovak Republic is defined as the sector including: 62, Computer Programming; and 63, Information Services (Table 1); and Telecommunications, which are excluded from the research.

Table 1. SK NACE Rev 2 Classification (Selected ICT sub-divisions).

62. Computer Programming	63. Information Services
- Computer programming, consultancy, and related activities - Computer programming activities - Computer facilities management activities - Other information technology and computer service activities	- Data processing, hosting and related activities, Web portals - Other information service activities - New agency activities

When the statistics for the 62 and 63 sub-divisions were unavailable (at the European Level), the authors used the categorization of ICT services (ICT manufacturing was excluded).

2.2. Economics Sustainability

The methodology of calculating the individual indicators of economic sustainability is based on the methodology of sustainability performance [34–37], more precisely Composite Sustainable Development Index. Within this methodology [37,38], deeply described in [37], the relative corporate contribution to sustainability can be measured in absolute monetary terms. It does not show whether the use of the resource by this entity is sustainable in absolute terms, but it indicates how much more sustainable the use of the resource is in comparison with other entities.

Grajnc and Glavic (2005) introduced this method as the assessment of products, services, and technologies. This method can be used for assessing the sustainability performance of a company, too. They calculated economic sustainability by the sustainability sub-index. Moore deeply described this sustainability sub-index; the detailed calculation methodology can be found in [35–37].

The procedure for calculating the index is divided into selection, grouping and judging the indicators, weighting, normalizing and calculating sub-indices [35,36].

Selection, grouping and judging the indicators: First, proper performance indicators are selected covering different aspects of sustainability. Then, the indicators are grouped into dimensions of sustainable development.

Weighting: Pair-wise comparison technique is used to derive relative weights of each indicator. This method is based on the analytic hierarchy process (AHP) [39,40].

Normalizing: Indicators used for the composite sustainable development index can be expressed in different units. Therefore, they have to be normalized according to Equation (1), where $I^{+}{}_{A,ijt}$ is an indicator of positive performance, $I^{-}{}_{A,ijt}$ is an indicator of negative performance, A is the actual indicator, N is the normalized indicator, and t is time.

$$I^{+}_{N,ijt} = \frac{I^{+}_{A\ ijt} - I^{+}_{min,jt}}{I^{+}_{max,jt} - I^{+}_{min,\ jt}} I^{-}_{N,ijt} = \frac{I^{-}_{A,ijt} - I^{-}_{min,jt}}{I^{-}_{max,jt} - I^{-}_{min,\ jt}} \quad (1)$$

Calculating sub-indices: The sub-indices are calculated by multiplying each normalized indicator value with its weight and summing up all multiplications (Equation (2)), where I_{Sjt} is Sustainability sub-index and W_{ji} is the weight of indicators i for the group of sustainability indicators j.

$$I_{S,jt} = \sum_{jit}^{n} W_{ji} I^{+}_{N,ijt} + \sum_{jit}^{n} W_{ji} I^{-}_{N,ijt} \quad (2)$$

The sub-indices were calculated by multiplying each normalized indicator value with its weight and summing up all multiplications. The weight of each dimension is estimated.

2.3. Regional Sustainability: Regional Specialization and Geographic Concentration

The main objective of this methodological approach is monitoring the concentration of economic activity in sub-divisions 62 and 63 and examining whether the concentration of these sub-divisions is higher than the concentration of all the economic sectors randomly or this concentration is not random (happening by chance). Brülhart and Traeger (2005) distinguished between absolute and relative concentration (or specialization measures) [41]. Absolute concentration measures the spread of industrial activities across countries. An industry is said to be absolutely concentrated if its output is generated in only one or a few regions. Relative concentration measures the difference between an industry's spread of phenomenon and the average spread of phenomenon. Thus, an industry is relatively concentrated if its output is more concentrated than total economic output in the area [42].

The spatial effects have been calculated using exploratory data analysis [41–43] by means of descriptive statistics that have been extended to the spatial domain with the Location Index, Coefficient of Concentration, and Lorenz Curve. This study approached the issue of both 62 and 63 sub-divisions of ICT specialization of regions and geographic concentration of these sub-divisions. Regional specialization is usually analyzed in connection with geographic concentration and its distribution in the regional dimension.

Location index (LI) measures a region's industrial specialization relative to a larger geographic unit. The LI is calculated as an industry's share of a regional total for some economic statistic divided by the industry's share of the national total for the same statistics, where, X_{ij} means number of employees of the i-th sector in the selected region, Y_i is the number of employees of the i-th sector in the relevant country, S_i is the population in the selected region and S is the population in the relevant country [43].

$$LI = \frac{\frac{X_{ij}}{Y_i}}{\frac{S_i}{S}} \quad (3)$$

Hoover Coefficient of Concentration (CC) compares the intensity of regional employment with the intensity of the national employment. Coefficient shows the proportion of all income which would have to be redistributed to achieve a state of perfect equality.

$$CC = \frac{X_{ij}}{X_i} - \frac{\sum_{k=1}^{n} X_{kj}}{\sum_{k=1}^{n} X_k} \quad (4)$$

where X_{ij} is sectoral (i) employment in region j, X_{kj} is total employment in region j, X_i is sectoral employment at the national level, and X_k is total employment at the national level [43].

2.4. Data

The Pearson correlation coefficient was calculated at the European level (Table 2), while the Economic sustainability sub-index, Location Index, and Hoover Coefficient were calculated at the national level (Slovak Republic).

Table 2. Variable used in materials and methods.

Indicator	Variable	Time Period
Pearson Correlation Coefficient	National average monthly wage Percentage of ICT services on GDP ICT services national employment	2015–2016
Location Index (LI) Hoover Coefficient of Concentration (CC) Sustainability sub-index	National and Regional Employment National and Regional Population Sectoral Employment National and Regional Employment Value-added costs, Production Value Gross Operating Surplus Credit Scoring Average monthly wage and employment R&D Full-Time Equivalent R&D Headcount, Researchers FTE Researchers Headcount	2010–2016

The Sustainability sub-index has been calculated separately for the firms operating in the SK NACE Rev 2 Classification in 62 Computer programming and 63 Information services sub-divisions. This method is based on data that are published in annual reports and firm financial databases. All data are reliable due to auditing.

The calculations include all the firms operating in these sub-divisions (62 and 63) in the area of the Slovak Republic in years 2010–2016. All variables used are described in Table 2 and number of firms used in calculations for individual years is described in Table 3. Location Index and Hoover Coefficient of concentration were been calculated separately for sub-divisions 62 and 63.

Table 3. Several firms operating in 62 and 63 divisions in 2010–2016 in the Slovak Republic.

Divisions and Sub-Divisions	Year						
	2010	2011	2012	2013	2014	2015	2016
62. Computer programming							
Computer programming, consultancy and related activities	1186	1307	1146	1200	1405	2295	2195
Computer programming activities	1266	1479	1357	1601	2322	2702	2801
Computer facilities management activities	222	219	222	209	194	185	190
Other information technology and computer service activities	1552	2084	2501	2719	3508	3654	3720
62. Computer programming ∑	4226	5089	5226	5729	7429	8836	8906
63. Information services							
Data processing, hosting and related activities	3057	4244	4279	4282	5077	5217	5170
Web portals	18	20	26	37	20	50	50
News agency activities	7	7	5	4	5	8	8
Other information service activities	10	18	61	59	82	90	92
63. Information services ∑	3092	4289	4371	4382	5184	5365	5320
Sub-divisions 62 and 63 ∑	7318	9378	9597	10,111	12,613	14,201	14,226

3. Results

The primary objective of the authors was to determine the correlation between: (1) National average monthly wage and National Employment; and (2) Percentage of ICT services on GDP and National employment.

It is evident from the histogram (Figure 1) that 11 EU countries account for interval of 3–4% of GDP. An exception is Ireland, where the ICT sector accounts for 9.67% of GDP. The high share of the ICT sector on GDP can also be seen in Luxembourg, Sweden and United Kingdom. On the other hand, Norway, surprisingly, accounts for 3.28% in a part of service of ICT sector.

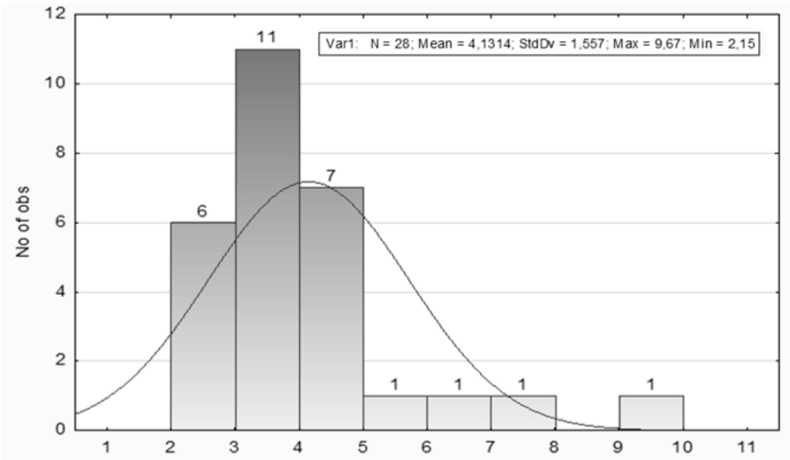

Figure 1. Percentage of ICT services on GDP in EU28 countries 2015.

Based on the correlation of mentioned variables of EU28 and Norway, Turkey, Montenegro, Iceland, Switzerland, Liechtenstein, and Macedonia, the following hypotheses were determined relating to economic sustainability (Table 4):

H0: *There is no significant linear relationship between the ICT sector Employment and the percentage of the ICT services on GDP at the EU level.*

H0: *There is no significant linear relationship between the ICT sector Employment and the ICT sector wage at the EU level.*

Table 4. Regression results.

VALUES	EMPLOYMENT AND GDP CORRELATION		WAGE AND EMPLOYMENT CORRELATION	
N. OBS	35 *	31 After four outliers (Ireland, Malta, Luxembourg, United Kingdom) were removed	35	28 After seven outliers (Germany, Denmark, Italy, Luxembourg, United Kingdom, Austria, Belgium)
R	0.581	0.705	0.440	0.681
R-SQUARE	0.338	0.498	0.194	0.465
T-STAT	4.1	5.36	2.82	4.75
SIG (P-VALUE)	0.00025	9.28×10^{-6}	0.00801	6.51×10^{-5}
F		16.847		7.968
ACCEPTANCE/ REJECTION OF THE H_0	Rejected		Rejected	
ALTERNATIVE HYPOTHESIS H_1	There is a significant linear relationship between the ICT sector employment and the percentage of the ICT services on GDP at the European level.		There is a significant linear relationship between the ICT sector Employment and the ICT sector wage at the European level.	

* Note: EU28 and Norway, Turkey, Montenegro, Iceland, Switzerland, Liechtenstein, and Macedonia.

When describing the relationship between the variables of the ICT sector employment and the percentage of the ICT services on GDP at the European level, the strength of the correlation is determined by the magnitude of the Pearson correlation coefficient (Table 4). The R = 0.705 suggests a large or a strong correlation. The level of statistical significance (*p*-value) of the correlation coefficient is, in this case, 9.28×10^{-6}, which means, that there is a statistically significant relationship between these two variables. Therefore, the hypothesis H_0 is rejected and the hypothesis H_1 accepted.

When describing the relationship between the variables of the national average monthly wage and ICT services employment, the Pearson correlation coefficient is R = 0.681. This result suggests a large or a strong correlation. The level of statistical significance (*p*-value) of the correlation coefficient is, in this case, 6.58×10^{-5}, which means, that there is a statistically significant relationship between these two variables. Therefore, the hypothesis H_0 is rejected and the hypothesis H_1 accepted.

As written above, there is a significant relationship between: (1) the ICT sector employment and the Percentage of the ICT services on GDP; and (2) the ICT sector employment and the ICT sector average monthly wage. Based on described findings, it can be assumed that the ICT sector greatly affects not only the GDP, but also the national economy. This situation may affect the ubiquity of the ICT services, with respect to sub-divisions 62 and 63.

Relationship of all three variables, ICT sector employment, Percentage of the ICT services on GDP and Average monthly wage in ICT services, is described in Figure 2. Figure 2 presents the related values of Average monthly wage in the selected quadrant.

Employment and wage variables will also be considered in calculating the economic sustainability of the ICT sector. Since the sub-index of economic sustainability is data-intensive, it was calculated at the national level on the example of the Slovak Republic.

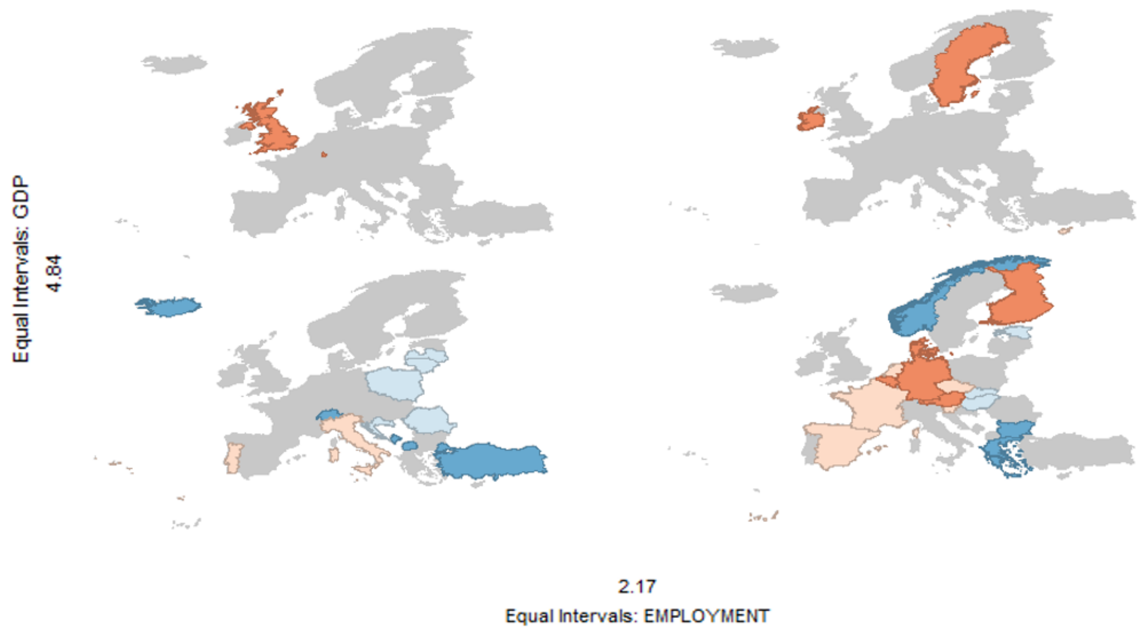

Figure 2. Conditional plot map of the ICT sector employment, Percentage of the ICT services on GDP and Average monthly wage in ICT services.

3.1. Economic Sustainability

Appendix B shows the number of Slovak enterprises in divisions 62 and 63 in the graph. This graph compares the number of firms operating in mentioned divisions in the period 2008–2016. These sub-divisions are relatively stable and a growing number of firms (numeric data) can also be seen in Table 3.

3.2. Sustainability Sub-Index

The sustainable approach determines the indicators (Table 5) in sub-divisions 62 Computer programming and 63 Information services. The considered indicators are divided into three main clusters: Economic, Labor and Research and Development. The Economic cluster consists of six indicators: Total profit, Vale added factor cost, Gross operating surplus, Credit scoring, Production value and Sales revenue. The Labor cluster consists of two indicators: Average monthly wage and Average number of employees. The Research and Development cluster consists of four indicators: Research and Development full-time Equivalent, Research and Development headcount, Researchers Full Time Equivalent and Researchers Headcount. The full-time equivalent (FTE) indicates the ratio of the employees working full-time.

In this case, the social and environmental dimensions are not considered. The sub-divisions 62 and 63 are compared in two main periods: 2010–2013, when these sub-sectors were not stable in the Slovak market, and 2014–2016. Sub-divisions 62 and 63 are relatively sustainable in these two periods. In the Economic cluster, sub-division 62 is sustainable and more stable in comparison with sub-divison 63, which is sustainable as well. The Sustainability sub-index in 63 has increased with a higher index in comparison with 62. Labor Sustainability cluster results (comparing 2010–2013 and 2014–2016) show the positive stable index in 62 and decreasing index in sub-division 63 (Table 6).

Table 5. Values of Sustainability sub-index.

Indicator	Weight	Unit	Sustainability Sub-Index			
			2010–2013		2014–2016	
			62	63	62	63
Economic						
Total profit	0.122107	EUR	0.399214	0.022263	0.524071	1.224416
Value added factor cost	0.106327	mil. EUR				
Gross operating surplus	0.106327	mil. EUR				
Credit Scoring	0.106327	index				
Production value	0.085065	mil. EUR				
Sales revenue	0.065489	mil. EUR				
Labor						
Average monthly wage	0.063901	EUR	0.045834	0.106327	0.042426	0.042426
Average number of employees	0.042426	Headcount				
Research and Development						
R&D Full Time Equivalent	0.060451	Head count	0.302032	0	0.308032	0
R&D Headcount	0.085461					
Researchers FTE	0.085065					
Researchers Headcount	0.071055					

Considering the evidence that calculations should include not only the number of employees but the wage as well, authors have more deeply analyzed the reason of this unsustainability in 63 sub-divisions in a wide context.

Table 6. Sustainability sub-index results.

CLUSTER	Sustainability Sub-Index Results	
	10/13–14/16	
	62	63
Economic	Sustainable	Sustainable
Labor	Sustainable	Unsustainable
Research and Development	Sustainable	-

This context has been extended with regard to Regional Specialization and Geographic concentration of these sub-divisions. The reason was to find out if specialization and concentration influence the sustainability sub-index results.

3.3. Regional Sustainability: Regional Specialization and Geographic Concentration

In the past, the ICT sector in the Slovak Republic has been notably concentrated in one region of the Slovak Republic (the region where the capital city is located). This has not been a very positive phenomenon in connection with the country's economic sustainability. In addition, the indicators reveal a change in the spatial concentration of the sub-divisions 62 and 63, not excluding the Regional Specialization.

The first step (Table 7) was to find out if there is any correlation of the financial indicators (Net Profit, Sales, Value Added, and Credit Scoring indicators) and the geographic concentration (Region indicator) of 62 and 63 sub-divisions (SK NACE indicator) during 2010–2016.

Table 7. Economic results dependence on sub-sectoral geographic concentration.

	Region	SK NACE	Net Profit	Sales	Value Added	Ownership Type	Credit Scoring
Region	1						
SK NACE	−0.01353	1					
Net Profit	−0.03973	−0.01579	1				
Sales	−0.07433	−0.0308	0,900532	1			
Value Added	−0.06553	−0.02548	0.771026	0.894052	1		
Ownership Type	0.154099	0.058417	−0.00409	−0.05991	−0.08208	1	
Credit Scoring	−0.0293	0.002312	0.002581	−0.00602	−0.01033	−0.05105	1

The correlation analysis shows that character and the nature of mentioned sub-divisions are not dependent on the spatial concentration (localization in larger cities). Tables 7 and 8 present the outcomes resulting in the conclusion that geographic concentration of 62 and 63 sub-divisions did not influence the firm financial indicators in 2010–2016.

Table 8. Regional analysis regression results.

VALUES	REGION/NET PROFIT	REGION/SALES	REGION/SK NACE	REGION/VALUE ADDED
N. OBS	10,256	10,256	10,256	10,256
R	0.069	0.096	0.006	0.064
R-SQUARE	0.004	0.009	3.83e-05	0.004
T-STAT	5.46	8.647	2382	6.13
SIG (P-VALUE)	0.042	0.004	0.855	0.059
F	4.147	8.165	0.033	3.57
ACCEPTANCE/REJECTION OF THE H_0	Rejected	Rejected	Accepted	Accepted
ALTERNATIVE HYPOTHESIS H_1	There is a significant linear relationship	There is a significant linear relationship	There is not a significant linear relationship	There is not a significant linear relationship

When there is no direct correlation between financial indicators and firm geographic concentration and the industry is not heavily concentrated in one or few regions, with respect to administrative centers, this can become ubiquitous.

Sub-divisions 62 and 63 can become ubiquitous, in other words existing or being everywhere, especially at the same time, in all regions. The same is true for the demand of 62 and 63 sub-divisions, because all sectors, industries and firms use them in their own processes.

The following calculations of the regional specialization and geographic concentration in 2010–2016 describes a changing trend in disparities of individual regions of the Slovak Republic in researched sub-divisions (Figures 3 and 4).

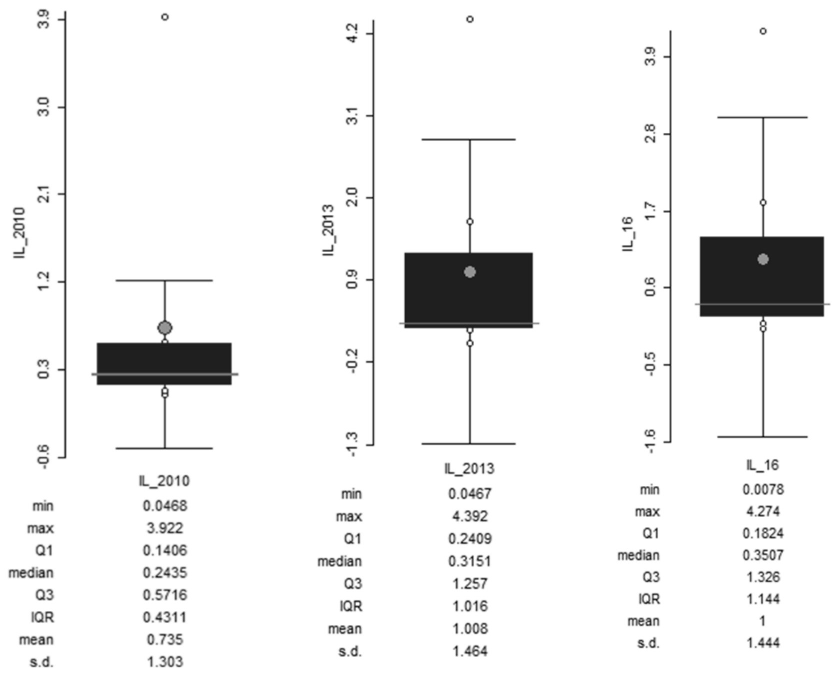

Figure 3. Location Index of ICT sub-divisions 62 and 63 during 2010–2016.

Figure 3 presents the values of the Location Index. The largest increase in the index appears in Košice Region, where the index increased from the 0.59 to 1.81. This means that this region has a higher specialization in mining that the nation. There is an ICT cluster located in this region. This cluster (Košice IT Valley) plays an important (not only regional but also a national) role. In 2015, this cluster was certified as the first in central Europe and is one of three certified clusters in the area of information and communication technologies in central Europe. In the central part of the Slovak Republic the Žilina Region plays an important role. Even when the Location Index is proportional to the population, during the seven-year period, this index has increased, which indicates rising specialization of this region.

This positive trend has also been evaluated in contrast of regional vs. national and sectoral vs. total employment in Hoover coefficient of concentration in 62 and 63 sub-divisions.

As can be seen in Figure 4, the employment concentration has changed (increased) over time. This change can be most seen in the Košice Region. This confirms changing geographic concentration in ICT sector. This shift is presented by decreasing concentration in Bratislava Region, where the capital city is located and strong increase in concentration in the Žilina and Košice Regions. This trend can reflect the job creation in these sub-divisions mainly in Košice and Žilina Regions. Figure 5 refers to the degree to which the intensity of this phenomenon differs between regions. There appear to be significant differences in the degree of geographic concentration with the index increasing from 0.25 to −0.1. The higher is the index of concentration, the more concentrated is the industry of the region. Decreasing negative index means diminishing concentration disparities in regions. As can be seen in Figure 4, the geographic concentration of employment shifts over time with decreases in Bratislava Region and increases in other regions.

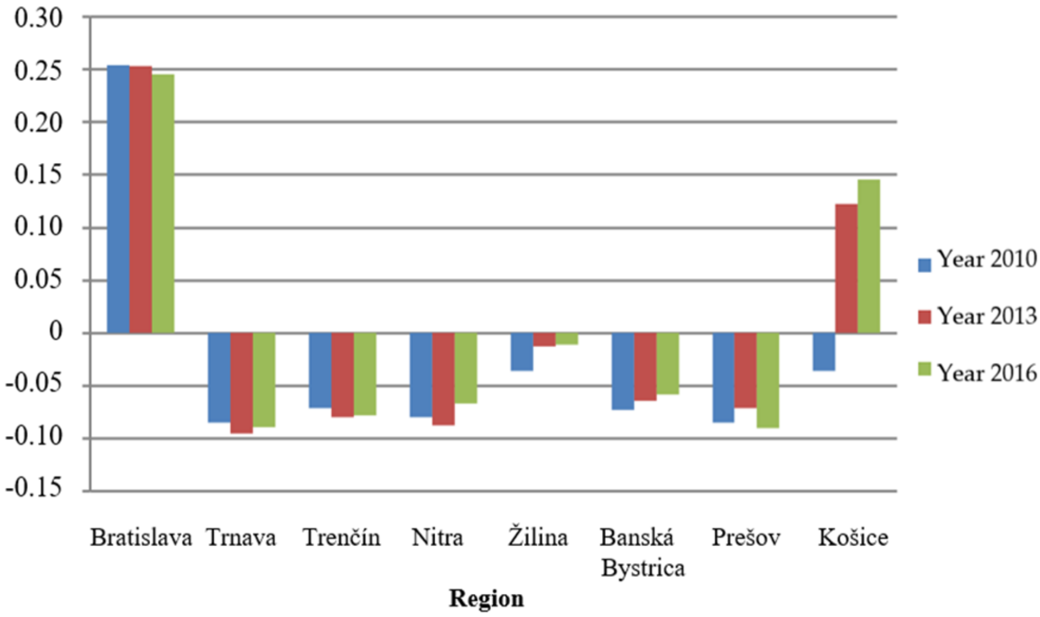

Figure 4. Hoover coefficient of the concentration of ICT sub-divisions 62 and 63 in during 2010-2016.

4. Discussion

The research results show that there is a significant relationship between employment and GDP and between employment and wages as well. When considering economic sustainability, including employment and wage data, the results were not satisfying. Values of sustainability sub-index have not been as positive and sustainable as the authors expected. The value of the labor cluster of this index has decreased by sub-division 63 and not changed in sub-division 62.

The authors researched the economic sustainability in a wider context and found the relationships among geographic concentration, regional specialization, wage and employment in this sector. These conclusions can be explained as a migration of the labor force of the researched sub-divisions from the strongly specialized Bratislava Region to other regions.

Similar to many other countries, in the Slovak Republic, the highest wages are earned in the capital city (situated in Bratislava Region). Significant regional disparities may be recognized in the eastern parts of the country. This situation reflects the lower and unequal wages in comparison with central and west part of the country.

Taking this explanation into account, the stable or decreasing Labor indicators in 62 and 63 sub-divisions may confirm changing the geographic concentration of this sub-division, migration of the labor force from the west to the east and consequently the wage rate change.

Considering the firm sustainability, the increasing wage could lead to bankruptcy or increase the national economy. Regional disparities can be diminished, but it is rarely possible to eliminate regional disparities nationwide. Considering that the wage in each region can differ, it is important to monitor the constancy (steadiness) of wages and the creation of new jobs.

Accordingly, the ICT sector in the Slovak Republic is sustainable. The values of Labor indicators in Sustainability sub-index can be considered positive with regard to regional analysis.

It is important to link changing regional specialization and geographic concentration with the economic sustainability indicators. A worsening value of economic sustainability does not always confirm worsening conditions in the industry. On the contrary, these results can settle diminishing regional disparities contributing to better national economic stability (Figure 5).

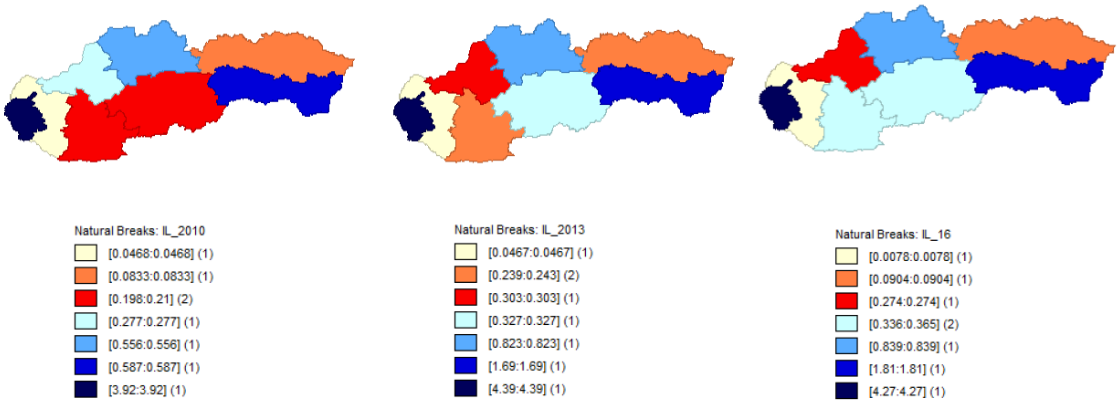

Figure 5. Location index of ICT sub-divisions 62 and 63 during 2010–2016.

Conforming to Regional perspective (Figure 6), research indicators of monthly wage and employment are more equal in sub-divisions 62 and 63 than in the ICT sector overall as 80% of employees in the ICT sector account for 40% of wages, in sub-sectors 62 and 63.

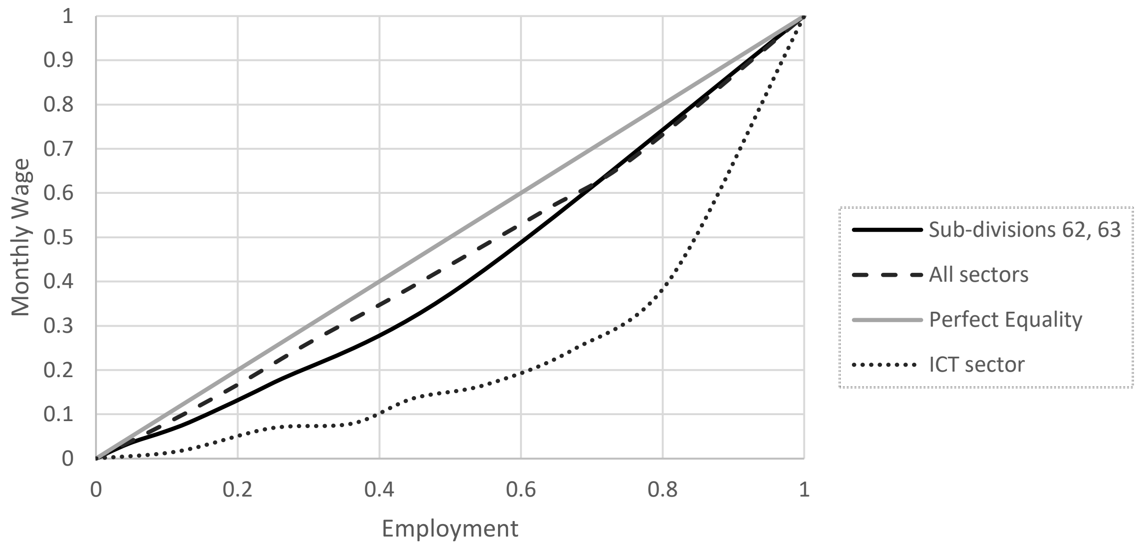

Figure 6. Lorenz curve of concentration of selected quantities.

From the regional perspective, sub-divisions 62 and 63 are not entirely different in the individual regions (with the exception of the Bratislava Region, where the level of wage is not so different from what it was in the past). Large differences can be observed in the regional employment of sub-divisions 62 and 63. These disparities decrease over time.

The national policy objective is not to achieve equal employment in sub-divisions 62 and 63 in all regions. The wage adjustment in individual regions is more substantial for employees working in subsectors 62 and 63.

From the results of the Economic sustainability and spatial analysis of the industry, it can be concluded that the job creation is sustainable and improving economic performance of this sector, declaring the possibility of wage growth in the future nationwide without liquidation or negative impacts and consequences on firms operating in sub-divisions 62 and 63.

5. Conclusions

The first important finding of the research was the relationship between the amount of wage, employment in the ICT sector and the impact of the ICT sector on GDP.

A Pearson's correlation was run to assess the relationship between the ICT sector employment and the percentage of the ICT services on GDP. There is a strong positive correlation between these two variables, R(31) = 0.705, $p < 0.005$. There is also a strong positive correlation between the Average monthly wage and Employment variables, R(28) = 0.681, $p < 0.005$.

Subsequently, the economic sustainability values were calculated. They are described in detail in Section 3.1.

In pursuing the sustainability of the ICT sector, interesting facts were found. The sector sustainability cannot be clearly assessed only by the evaluation of economic data related to economic sustainability; it is also important to take into account the change of regional specialization and geographic concentration of industry.

Consequently, the authors further investigated whether the geographic concentration of industry and regional specialization impact the change in the value of sustainability of sub-divisions 62 and 63 of the ICT sector to confirm the assumption of the change in geographic concentration of industry. In the case of the ICT sector, we confirmed the specificities resulting from the ubiquity of sub-divisions 62 and 63, which is also connected with the portability of the service and a low need to be bound to one physical location.

It can be concluded that unchanging (or decreasing) value of Sustainability sub-index is not always a negative phenomenon. Further, this should be examined more closely in a context of the change in the geographic concentration.

The results were described in the example of the case study of the considerable ICT sector sub-divisions. Conclusions may also be applicable in any sector based on reasons mentioned several times above and graphically depicted in Figure 7.

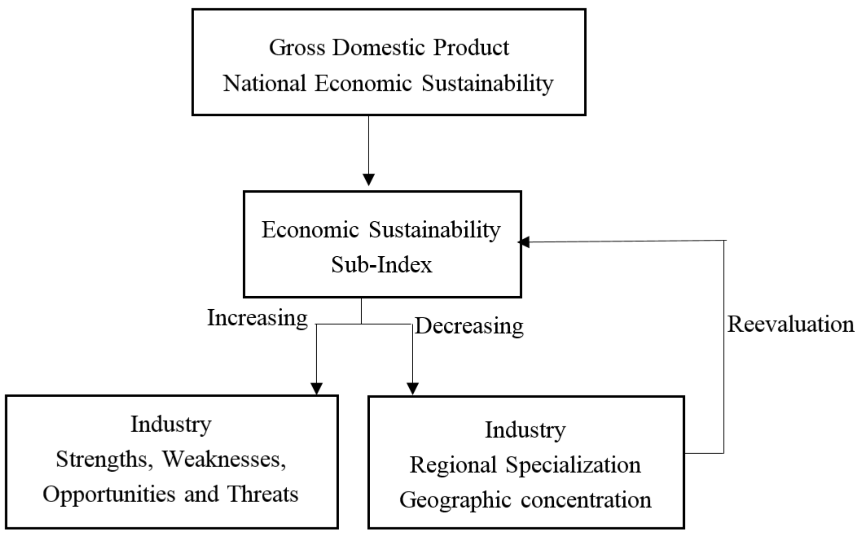

Figure 7. Graphical Interpretation of research results.

In conclusion, the authors recommend calculating the economic sustainability in relation to geographic concentration and regional specialization in terms of the correct evaluation of the economic sustainability of the sector, since several previous studies assess these two views (regional specialization with geographic concentration) separately. The paper methodically provides a guide for measuring and assessing sustainability not only for the ICT sector but also for other sectors.

Author Contributions: E.M. and T.C. conceived and designed the experiments; E.M. performed the experiments; T.C. and E.M. analyzed the data; T.C. and E.M. contributed reagents/materials/analysis tools; E.M. wrote the paper; T.C. made main corrections; E.M. process the main corrections and made minor corrections; and M.V. process the main English corrections.

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Appendix A

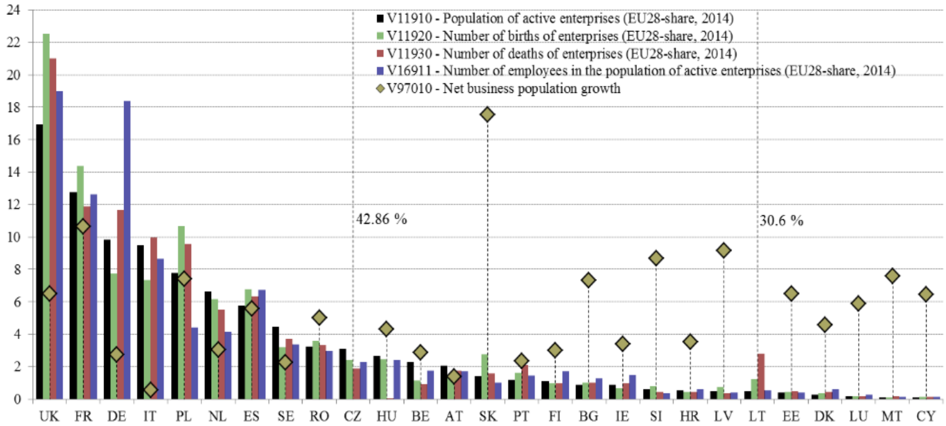

Figure A1. European Union Member States by their shares (%) of EU's active ICT enterprises in 2014 [32].

Appendix B

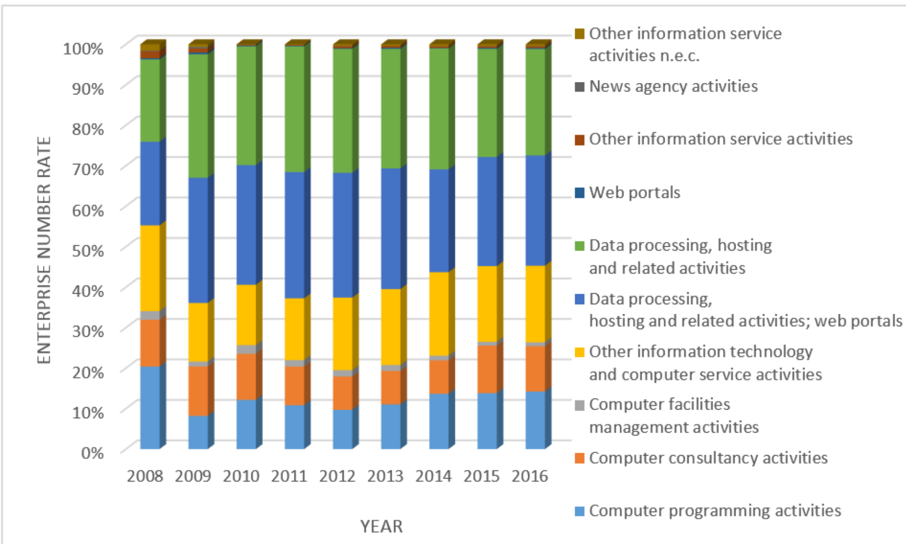

Figure A2. Number of firms operating in sub-divisions 62 and 63 in 2008–2016 (62 refers to Computer Programming (Computer programming, consultancy and related activities, Computer programming activities, Computer facilities management activities, Other information technology and computer service activities) and 63 refers to Information Services (Data processing, hosting and related activities, Web portals, News agency activities, Other information service activities)).

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