The Impact of ICT Investments on GDP in Central and South-East Europe

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This paper provides a comparative analysis between Central and Southeastern European (SEE) countries, members of the European Union, based on their investment in the ICT sector over a period of 2008-2019. The countries analyzed are as follows: Austria, Bulgaria, Croatia, Czech Republic, Greece, Hungary, Malta, Poland, Romania, Slovakia. The conclusion of the article is that there is a strong correlation (83%) between the ICT investments indicator and the GDP indicator, and there are negative correlations between the percentage of ICT personnel in total employment, business expenditure on R&D (BERD) in the ICT sector as a percentage of total R&D expenditure by NACE Rev. 2 activity, the R&D personnel in the ICT sector as percent of total R&D personnel by NACE Rev. 2 activity and GDP for the mentioned countries with the 2008-2019. These last three negative correlations were expected due to the focus on the outsourcing activities, inefficient R&D sector for the countries mentioned above from Central and South-East Europe during the 2008-2019 period.
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1 Introduction

The coronavirus crisis transformed our way of living, working, learning, and the digital tools (PCs, mobile phones, laptops, tablets) and software (Zoom, Google Meet, Microsoft Teams, etc.) became the new "normal" in our daily activities. The agile transition was possible due to the existence of previous ICT infrastructure, research and development within the ICT sector, public or private investments, and in the places (schools, universities, small or medium companies, etc.) where these key differentiators were not present, a massive adoption of digital instruments was done in the last two years.

In the context of launching the recovery and resilience facility of European Union countries in 2021 as a response after the coronavirus crisis, an important pillar of these plans is the digital transition/transformation. For example, in the Romanian Recovery and Resilience Facility [1], 21% of the budget is dedicated to investments in public (government cloud, education - development of digital competences for citizens and public services, cybersecurity, connectivity, etc.) and private sectors, after implementation of multiple legislative milestones, reforms.

According to Eurostat's definition, the Information and Communication Technology (ICT) sector "covers all technical means used to handle information and aid communication", computer and network hardware, with the related software [2].

In this article, the objective is to show that there is a correlation between the increase in investments within the ICT sector and the increase in GDP.

Our study is based on data aggregated from Eurostat, with these indicators: annual enterprise statistics for special aggregates of activities (NACE Rev. 2)[sbs_na_sca_r2] (employees - number - thousands euro and investment per person employed) [3], percentage of the ICT personnel on total employment - online data code: TIN00085 [4], business expenditure on R&D (BERD) in the ICT sector as % of total R&D expenditure according to NACE Rev. 2 activity [5], R&D personnel in the ICT sector as % of total R&D personnel by NACE Rev. 2 activity [6], GDP

and main components(output, expenditure and income) [nama_10_gdp] [7].
From the ITU ICT-Eye [8] portal, we can consolidate the ICT infrastructure and market structure details (fixed-telephone subscriptions per 100 inhabitants, mobile-cellular subscriptions per 100 inhabitants, fixed (wired)-broadband subscriptions per 100 inhabitants, percentage of households with Internet) for the same ten countries from Central and SEE.

2 Literature review

The development of the ICT sector at the European or worldwide level is analyzed from multiple perspectives, using different statistical indicators, parameters, etc. In the upcoming statements, we will reveal how the ICT sector influences import and export of goods and services, how the ICT sector has access to knowledge and information, how the ICT sector is impacted by a negative result in economy, how the development of ICT is impacting life satisfaction, how the numbers of households with Internet connections is influencing the ICT adoption, what is the impact of ICT sector in the GDP of the European Union and which is the contribution of EU to the ICT sector through ESIF(European Structural and Investment Funds) programs.
According to these authors [9], the ICT sector is considered a GPT (general purpose technology), and the determinants of investments in ICT are positively related to the development of human capital (higher share of researchers) and the structure of the economy (larger firms have a higher probability of adopting new technologies), while strict regulation will have the opposite effect for firms.
The influence of ICT in terms of import and export of goods and services using gravity models is exposed in [10] with these independent variables considered (GDP, GDP per capita, population, distance, fixed telephone lines, Internet usage, secondary gross enrollment ratio, tertiary gross enrollment ratio, etc.).
Import is positively affected by GDP per capita and Internet usage, and import is correlated with digital infrastructure and digital skills. Not all countries from South-East Europe were considered for ICT usage, Bulgaria, Croatia, Romania are missing from the analysis.
The European ICT sector was analyzed in relation to the diffusion of "information and knowledge across the economic network" [11] using the structural hole theory of Ronald Stuart Burt. The article reveals that the "European ICT sector has a high level of efficiency with low dependences. The presence of structural holes in the network of contacts established by the ICT sector implies that this sector has access to diverse information"[11]. Furthermore, in terms of low constraints, the ICT sector is limited by the negative economy result, compared to other industries.
From the perspective of the Sustainable Development Goals (SDG), the article [12] analyzed the impact of the ICT sector on economic growth and the reduction of inequality. A positive correlation was discovered between access to the Internet and the change in GDP per capita, and a negative relationship between the implementation of a digital society will decrease the inequality of social income. "An increase of 1% of ICT sector share in GDP will lead to a decrease of 0.27% of income inequality distribution".
The ICT sector has an impact on quality of life, and the article [13] evaluated life satisfaction (trust and safety), mobility (culture and sports), integration (sustainability) and public services within 79 European NUTS 2(Nomenclature of territorial units for statistics). Life satisfaction is strongly related to "greater use of technologies and ICT preparedness in the region".
The number of households with Internet connection is a very important aspect for the development of ICT sector in general, people can learn, work outside the regular job schedule, when they have instant access to the network, etc.

For the countries below, the percentage of households with Internet access follows the same trend (**Figure 1**), the differences between countries are minimized over time, and in 2019 the difference between Austria(89.91%) and Bulgaria (70.77%) is 14.84%, according to ITU [8].

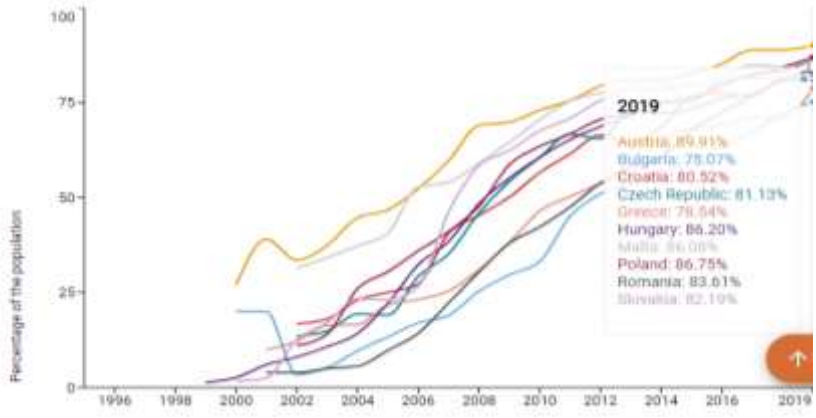

Fig. 1. ITU, Percentage of households with Internet [8]

In the Eurostat analysis [15] and **Figure 2**, the ICT sector is measured by the value-added indicator (ICT manufacturing and ICT services) from 2014-2019, where the percentage of ICT contribution to the GDP of the European Union is evaluated at 3.8% in 2019. The same report [15] consolidated that "the EU's ICT sector employed more than 5.8 million people in 2019", the labor productivity in the ICT sector is an average of €81 200 per person employed (2019), with great discrepancies (€81 200 per person in Belgium, or €35 000 in Bulgaria and Romania).

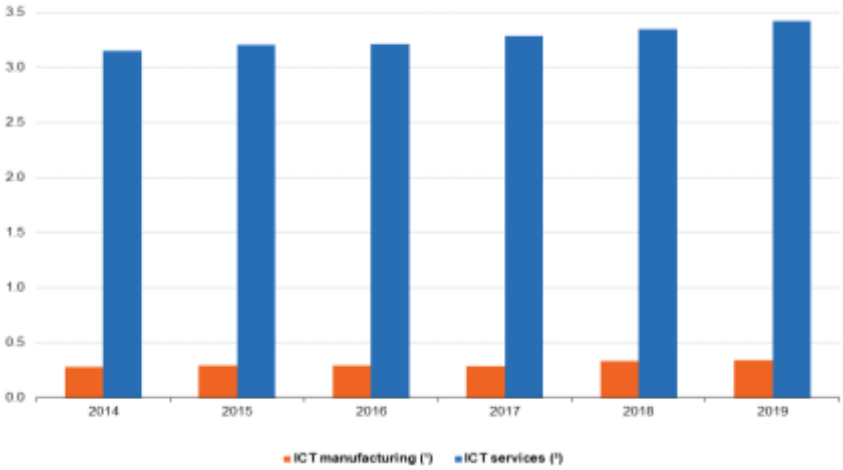

Fig. 2. Eurostat, development of value added for the ICT sector, EU, 2014-2019 (% relative to GDP) [15]

At the European Union level, the total budget allocated for ESIF(European Structural and Investment Funds), through EARDF (European Agricultural Fund for Rural Development) and ERDF (European Regional Development Fund), for the ICT theme was almost € 18 billion in period 2014-2020 [14]. From the report "ESIF 2014-2020: Implementation by country for Information & Communication Technology - Total cost of selection and spending as % of planned (scatter plot, excluding multi-thematic allocations)" [16] we can distinguish that France spent more than € 2 billion (123% spent from planned), Estonia spent € 83 million (89% spent from planned), Malta

spent € 85 million (85% spent from planned), these countries are the largest percent spenders. From the same report [16] we can highlight that Croatia spent € 34 million (13% spent on planned), Slovakia spent € 187 million (23% spent on planned), Greece spent € 133 million (47% spent on planned), Romania spent € 298 million (50% spent on planned), Hungary approximately € 218 million (50% spent on planned), these countries are in the first part of the report measured as % of planned.

3 Research hypotheses

The objective of our research is to prove that there is a correlation between investment in the ICT sector and GDP growth. We will analyze ten countries (Austria, Bulgaria, Croatia, Czech Republic, Greece, Hungary, Malta, Poland, Romania, Slovakia) over a long period of years (2008-2019), taking into consideration the Eurostat indicators from Table 1.

Table 1. Eurostat indicators used in the current paper

Name of the indicator		Code of indicators/relations	Source
Annual enterprise statistics for special aggregates of activities (NACE Rev. 2) [sbs_na_sca_r2] with the next details:	Employees - number - thousands of euros (EMP_NO)	ICT_INV= EMP_NO* INV_PER_EMP	[3]
	Investment per person employed - thousands euro (INV_PER_EMP)		
Percentage of the ICT personnel in total employment		PER_ICT_EMP	[4]
Business expenditure on R&D (BERD) in ICT sector as % of total R&D expenditure by NACE Rev. 2 activity		BERD_ICT	[5]
R&D personnel in ICT sector as % of total R&D personnel by NACE Rev. 2 activity		RD_ICT	[6]
GDP and main components (output, expenditure and income)[nama_10_gdp]		GDP	[7]

4 Statistical data

In our investigation, we employ statistical methods to correlate various sets of data to investigate whether there is a correlation between the indicators of Table 1.

Our study is based on data aggregated from Eurostat, with these indicators: annual enterprise statistics for special aggregates of activities (NACE Rev. 2) - sbs_na_sca_r2, percentage of the ICT personnel on total employment - online data code: TIN00085 [4], GDP and main components (output, expenditure and income) [nama_10_gdp] [7]. From the ICT-Eye [8] portal of ITU, we extracted from the ICT infrastructure and the market structure details the percentage of households with Internet for the same ten countries from Central and SEE.

Results

We have aggregated two indicators, 'employees, number - thousands of euro' (EMP_NO) and 'investment per person employed, thousands of euro' (INV_PER_EMP) to construct the indicator of ICT investments (ICT_INV) as a product between EMP_NO and INV_PER_EMP using Eurostat statistics [3].

We obtained in Excel a strong correlation, over 83% (Table 2) between the ICT Investments indicator and the gross domestic product at market prices of the GDP and the main components (output, expenditure and income)[nama_10_gdp]"(GDP)[7], this will demonstrate that our research hypothesis is

valid, the scatter plot with the trendline (Figure 3) will also visually support our research hypothesis.

Table 2. Correlation matrix between ICT_INV and GDP indicators, authors' calculations

	GDP
ICT investments (ICT_INV)	0,839157654

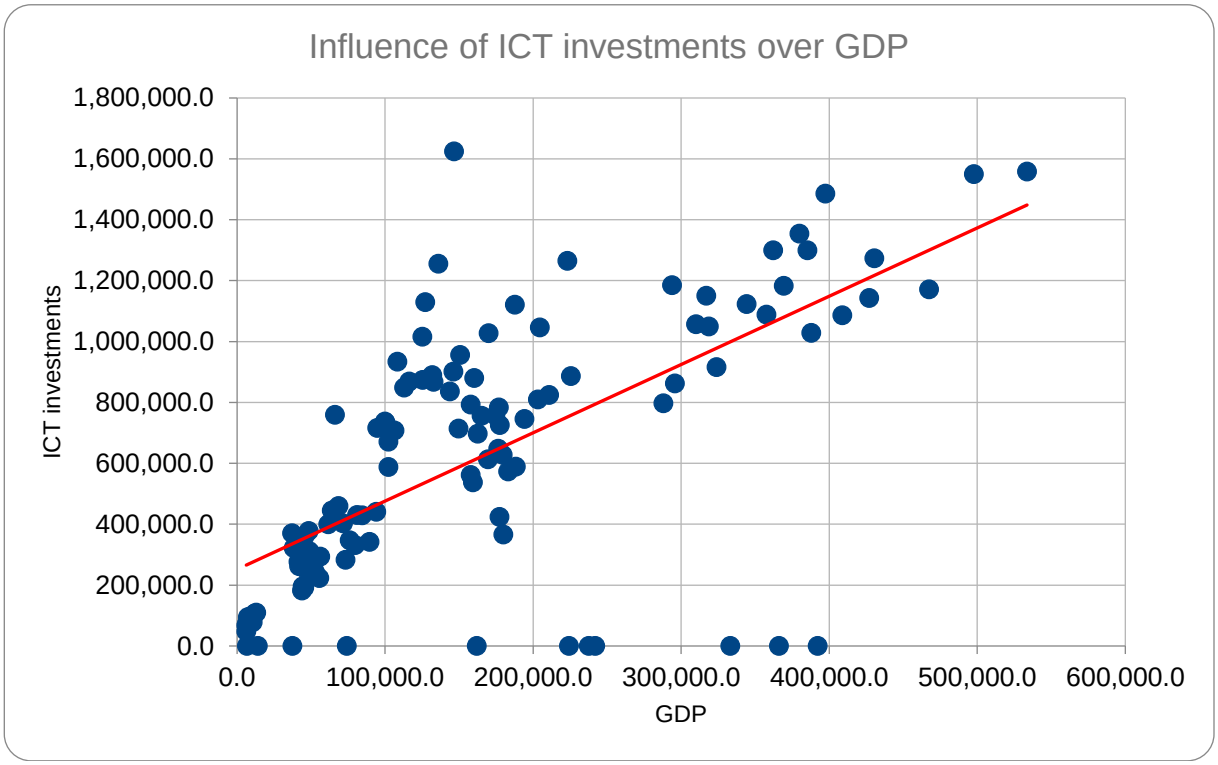

Fig. 3. Scatter plot with ICT_INV and GDP indicators

In the second phase of our study, we have analyzed the relationship between the "percentage of the ICT personnel on total employment" (PER_ICT_EMP) and the "gross domestic product at market prices of GDP and main components (output, expenditure, and income)[nama_10_gdp]"(GDP) [7], and we have obtained a negative correlation -33% (Table 3 and Figure 4), which means that the PER_ICT_EMP indicator does not influence the GDP indicator. This is expected because the selected ten countries focus on outsourcing activities where the scope is cost reduction, financial optimization, implicitly the salaries, taxes, and the contribution to GDP is lower.

Table 3. Correlation matrix between PER_ICT_EMP and GDP indicators, authors' calculations

	GDP
PER_ICT_EMP	-0,334546947

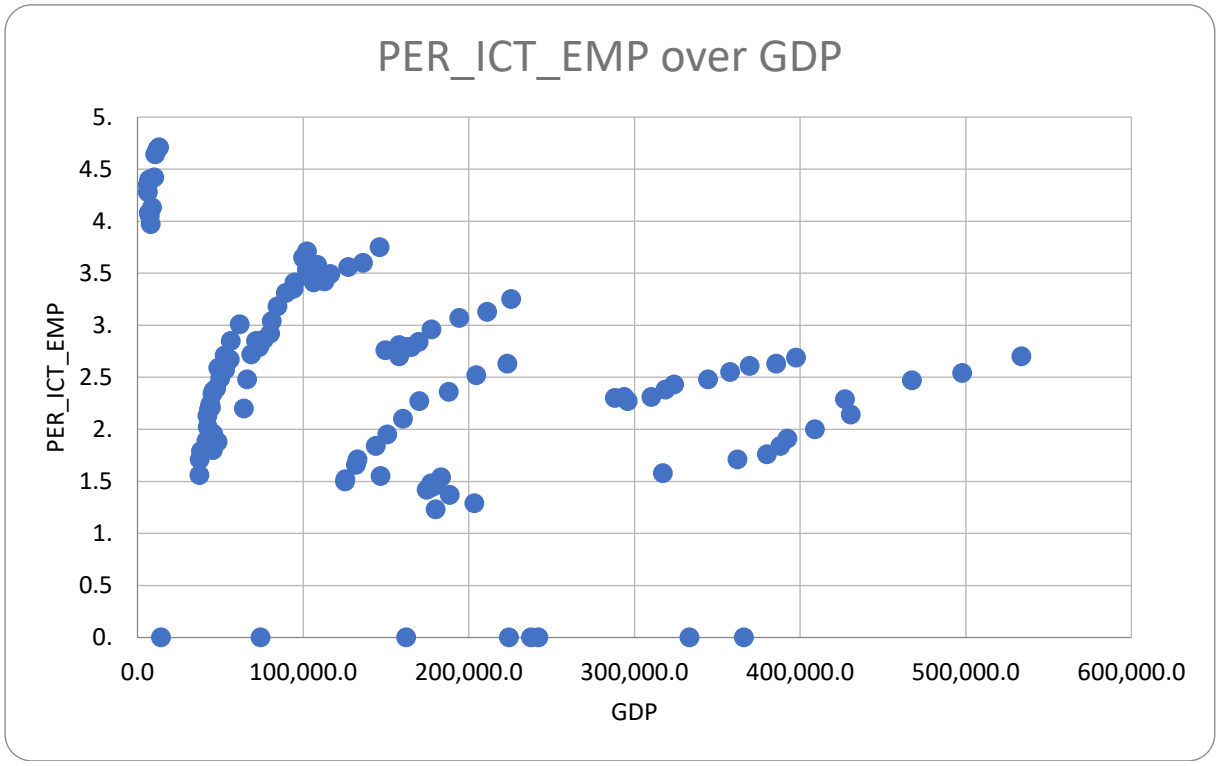

Fig. 4. Scatter plot with PER_ICT_EMP over GDP indicators

In the third phase of our study, we have interpreted the relationship between the "Business expenditure on R&D (BERD) in the ICT sector as % of the total R&D expenditure by NACE Rev. 2 activity" [5] (BERD_ICT) and "gross domestic product at market prices from GDP and main components (output, expenditure and income)[nama_10_gdp]"(GDP) [7], and it resulted a negative correlation -16% (Table 4). It means that BERD_ICT did not impact the GDP indicator. This was to be expected because the selected ten countries focus on outsourcing activities where the scope was cost reduction, financial optimization, implicitly the salaries, taxes, and the contribution to GDP is lower.

Table 4. Correlation matrix between BERD_ICT and GDP indicators, authors' calculations

	GDP
BERD_ICT	-0,165649882

In the fourth phase of our study, we have interpreted the relationship between the "R&D personnel in the ICT sector as % of total R&D personnel by NACE Rev. 2 activity" [6](RD_ICT) and "gross domestic product at market prices from GDP and main components (output, expenditure, and income)[nama_10_gdp]"(GDP) [7], and there was a negative correlation -21% (Table 5 and Figure 5). This can be interpreted as saying that the percentage of research personnel in ICT cannot influence the GDP indicator. This result tends to indicate a limited efficiency of the R&D sector from the area.

Tabel 5. Correlation matrix between RD_ICT and GDP indicators, authors' calculations

	GDP
RD_ICT	-0,217981909

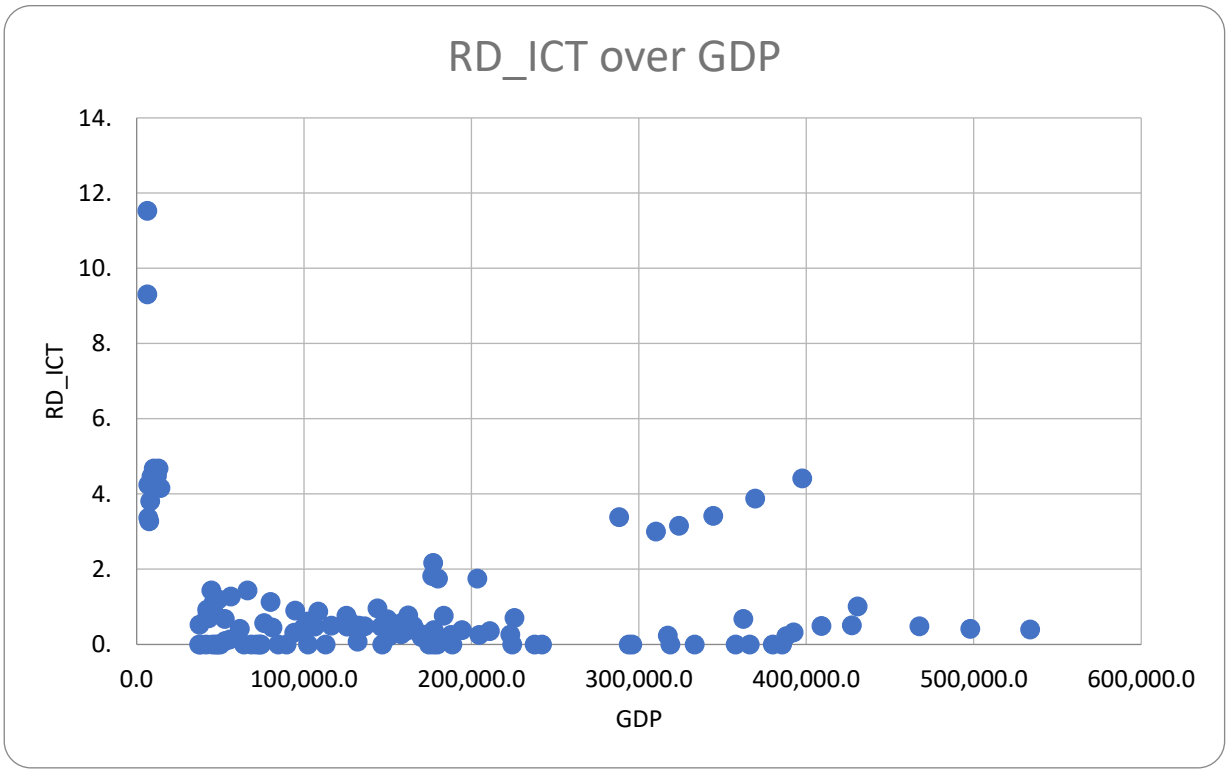

Fig. 5. Scatter plot with RD_ICT on GDP indicators, authors' contributions

5 Conclusions

We have concluded in our paper a strong correlation (83%) between ICT investments and GDP, but we did not extract a positive correlation between PER_ICT_EMP and GDP, BERD_ICT and GDP, and RD_ICT and GDP. We did not find a correlation between PER_ICT_EMP, BERD_ICT, RD_ICT and GDP because the architecture of ICT sector from selected ten countries (Austria, Bulgaria, Croatia, Czech Republic, Greece, Hungary, Malta, Poland, Romania, Slovakia) is based on outsourcing, this is well known that outsourcing cannot contribute significantly to the increase of GDP, also the R&D(research and development) sector from Central and South-East Europe less efficient and additional investments into a not so efficient R&D sector are unlikely to produce a substantial GDP growth.

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