

Iot – the Keypoint for the Future Economic Growth of the States

Meral Kagitci¹

¹⁾ *The Bucharest University of Economic Studies, Bucharest, Romania.*

E-mail: meral.kagitci@ase.ro

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Abstract

This study aims to make a comparison of economic growth within European countries entered in the EU together with Romania (Bulgaria), a group of three states (Poland, Slovenia, Slovakia) that entered EU before Romania's accession immediately before and Croatia, the state entered EU after Romania joined EU, by analyzing the impact of impact led by some innovation measures on population well being, proxied by the GDP per capita, based on a panel analysis. The results indicate that GDPc is sensitive to Information and communication technology goods exports (the higher the exports, the higher the GDP per capita). The same conclusion can be drowned for gross domestic expenditures on research and development while the exports of aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery are diminishing the GDP per capita.

Keywords

economic growth, innovation, technology, ICT, IoT.

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Introduction

It is hard to imagine a world challenging the opportunities offered by technology. Nowadays, the Internet seems to be a need for all individuals in all fields of their lives. Devices such as smart phones, sensors, mobile computers, and more other smart devices can be considered examples of things we are dealing with every day. Not only these, but also other IoT related technologies have an essential impact on the new Information and Communication Technology (ICT) and systems technologies. At the beginning, it was known as "Internet of Computers"; then it became "Internet of People"; and at present, due to the evolution of ICT, everybody calls it "Internet of Things".

The "Internet of Things" (IoT) is about the connection that may appear among certain objects and internet infrastructure through embedded computing devices, like radio frequency identification (RFID) chips and sensors. IoT products are divided into five main categories: wearable devices, smart homes, smart cities, environmental sensors and business applications. It is said that at the end of 2020, more than 50 billion devices will have been connected to the Internet.

Moreover, not only different devices, but also smart objects are created in order to give accessibility, so that people can connect to the Internet whenever they need or feel so. The Internet connection is related to everything that starts with "any", that is "anyone", "anytime", "anywhere", "anything". In a society, the ICT innovations and economy developments, a significant focus has shifted to the IoT related technologies where it is widely considered as one of the most important infrastructures of their promotion and one of the future promise strategies. The main goal is to enable the real world and cyber space to communicate and integrate.

Review of the scientific literature

An overview of IoT implications

The IoT is considered to be a cornerstone of the future Internet and is expected to allow computers, smart objects, systems, and services to be intelligently controlled and advanced. Indeed, it is a modern communication technology revolution that implies that everything will be assigned a unique identifier, from tires to hairbrush, so that it can be addressed, linked to other items and exchanged information. In the eye of the hurricane, the COVID-19 pandemic cycle can be seen and has forced companies to reconsider the way they function and operate. Many workers have been advised to operate from home and use facilities for video conferencing and online collaboration. The influence of the pandemic on the global economic crisis is leading CIOs to prioritize spending on "mission-critical" technologies and services over development or change initiatives. It is no longer a luxury to invest in connected technology, but a requirement and a must for survival and business continuity. While we were already witnessing businesses investing in proof of concepts and smaller connected technology deployments as a huge motivation to boost efficiencies and minimize downtime, mass adoption rates were never very remarkable. The pandemic leads to global company shutdowns, delays in the supply chain, social distancing and remote working processes (a new normal). We are experiencing a huge increase in the number of deployments, especially in the business and automotive sectors. The Internet of Things (IoT) market is expected to rise to 5.8 billion endpoints in these sectors in 2020, up from 21 percent in 2019, as one of the leading analyst firms predicted. As this technology provides companies and individuals with greater visibility into and influence over artifacts and environments that remain beyond the Internet's reach, the IoT market will further improve. And by doing this, IoT enables organizations and individuals to be more connected to and do more important, higher-level work in the world around them. Last-mile networking upgrades, cheaper sensors, low-power technology availability, and long-lasting batteries make IoT solutions more important and affordable compared to the situation of a decade ago. The IoT is affecting both the consumer and industrial sectors (retail, healthcare and services) such as travel, water, oil and gas, agriculture and manufacturing.

Similarly, an increase in the number of Internet users per capita in the provinces of China has also seen faster export growth, with more companies selling in foreign markets and a higher share of provincial production sold abroad. These examples attest to the ability of ICTs to assist countries in being part of global supply chains (OECD, 2018). Growing access to (and broader use of) broadband Internet and web-enabled devices will also connect more customers and businesses to online markets and business-to-business channels in low-income countries. Digital markets are increasing, encouraging GVC participation and concentration. On the rise are digital markets and online retailers. The interface between global manufacturers and customers is becoming increasingly relevant for platforms such as Alibaba, Amazon, eBay, Taobao, and Mercado Libre. Around the same time, manufacturers and conventional retailers, alongside their standard distribution networks, aim to achieve a stronger online presence. Consumers buying about \$2.86 trillion in products and services online worldwide are less likely to export or import them. In the United States, a typical modal manufacturing company has 45 staff, and larger businesses appear to be more profitable and pay higher salaries and are more likely to export and import.

A modal business, by comparison, has one employee, the owner, in most developed countries. Among businesses recruiting additional employees, the majority employ less than 10. Companies with less than 10 employees account for more than 99 percent of the total in India, Indonesia, and Nigeria. Developing countries appear to have less exporters and lower export revenue concentrations among their top exporters, indicating that these companies face greater distortions. Investment in reducing market barriers and mitigating friction can therefore be particularly beneficial for developing countries.

Digital Innovation and Agricultural Exchange Distributed Ledger Technologies (DLTs) are decentralized asset transaction recording systems in which transactions and their information are registered at multiple locations simultaneously. By enhancing product traceability and credibility, contract certainty, verification of geographic origin, and compliance with sanitary and phytosanitary requirements, DLTs could improve productivity and accountability in agricultural supply chains. The enforcement and monitoring of provisions of the World Trade.

Organization agreements applicable to agricultural trade could also be strengthened. In the meantime, food losses in food systems could be decreased by up to 30 million tons a year if block chains tracked information in half of the world's supply chains. DLTs would ensure that profits from trade accrue more directly to producers and consumers. Blockchain technology is still in its infancy, but its use is being quickly spread by pilots researching it. The Food Trust consortium, run by IBM, is one of the most successful initiatives. It uses blockchain technology to enhance food traceability and has brought together major corporations from around the world in the retail and food sectors, including Dole, Driscoll's, Golden State Foods, Kroger, and McCormick. Carrefour, a retail chain in France, uses blockchain technology as part of this consortium to provide customers with comprehensive details on purchased poultry, such as veterinary procedures, freshness and other metrics. Likewise, Barilla, an Italian producer of pasta and pesto sauce, uses blockchain technology to boost transparency and technology can be defined as a collection methods, processes and operations performed or applied on raw materials and data for the realization of a particular industrial or commercial product. The importance of technology for economic development is widely recognized, given the impact that technology can have on the success of companies' economic activity, as well as the impact it can have on: inflation; employment and wages.

Andergassen, Nardini and Ricottilli (2017) analyze the conditions under which if certain technologies spread through the economy can generate an increase in productivity. Investments made by innovators to support the search for new technological principles, as well as investments made by companies to develop ways and means to adapt them in areas of similar technological nature. Hong (2017) demonstrates the causal relationship between investment in research and development in the IoT industry and economic growth. When total investment in IoT was classified in the public and private sectors, private investment in IoT had a stronger relationship with economic growth compared to public investment in IoT.

Information and communication technologies have a wide range of effects on key global systems. The rapid use and expansion of these technologies have contributed to increasing productivity and reducing the intensity of energy consumption, stimulating economic growth.

Since the 1970s, there has been a general interest in how to reduce energy consumption and CO₂ emissions in economies by expanding information and communication technologies. Schumpeter argued that it is possible to reduce energy demand, while allowing the economy to grow by expanding information and communication technologies that could contribute to saving energy (Salahuddin and Alam, 2015).

Salahuddin and Alam (2015) suggest that internet use and growth have positive and significant long-term effects on electricity consumption, while these short-term effects are insignificant. The positive relationship between internet use and electricity consumption shows that energy efficiency gains can be achieved through the expansion of internet and communications technologies.

Also, as Qin, Xinqi, et al. (2019) observed, a significant improvement to various fields of life will be brought by the use of the mix of the blockchain, IoT and industrial IoT (IIoT), but we have to consider the privacy risks and security vulnerabilities led by the lack of core security technology.

An overview of economic growth

The construct of the economic method, as a main objective of economic policies, explained by Worldbank (2004), is that the quantitative shift at the GDP level, which results in the positive or negative variance in the economy of an extremely country, transforms over time into a top research topic in the specific field of literature.

The significance of assessing the economic process is better portrayed in the economic and social sense of AN in depicting the vast image of the AN economy; given the actual fact that many countries have achieved rapid growth rates, transforming into wealthier economies, they have raised questions as to why various countries have achieved very little or no growth in any respect.

Why would we like a prospectus for economic growth? Does this square measure the variables that influence growth? Therefore, a good variety of theories have arisen that examine the factors in setting up economic mechanism, several scientists, economists and honor high winners engaged in providing

the empirical explanations of those queries. During this era, a portion of the analysis, few theories regarding the economic process are defined by employment hand in hand.

Beginning with Solow's neoclassical theory (1957), the UN agency based its attention on the value of capital accumulation, stating that underdeveloped economies should have the advantage of recording higher growth rates than economies that have been formed, resulting in the disposal of convergence; Specialists are worried with whether a selected number of states or other unique areas do not comply with his neoclassical theory. Even so, in the past century and thus the times, the model was therefore in style and arguable that the discussions relating to economic process hypothesis still remember the neoclassical model of the Solow.

The theory of endogenous development, conducted by Romer (1986) and film writer (1988), holds that its internal efforts are owned by a high proportion of the credit for the expansion level of a rustic; that means the endogenous determinants, during which time the eye shifts to the level of education, human resources and the potential for innovation.

Sharipov (2016) also targeted endogenous and exogenous growth by separating in the specialized literature the determinants in different 2 groups, now betting on the supply of economic process impact: endogenous (quantifying the dynamics of a country's internal economic landscape) and exogenous (quantifying the dynamics of external economic landscape of a country).

The growth accounting methodology (Romer, 1990) focuses on what proportion of growth is often processed by an increase in several inputs, so it is often carried out on an independent basis for all economies with correct recorded information inflows and outflows, after splitting the complete real production growth into multiple items: "Capital input growth, input growth and overall output productivity growth" leads to the inference that the rise in output can not be explained by input growth, so economists estimate the shares as below.:

-the share to growth capital input as $(\alpha_k (\check{K}/k))$

-the share because of labor as (L/L)

-the share derived from growth in total issue productivity (TFP) as

$$(\hat{Y}/Y) - \alpha_k (\check{K}/k) - \alpha_L (L/L)^*.$$

The expansion theory disappeared as a middle of studies for almost 20 years after the innovative quality of exogenous growth models, from the sum of the Nineteen Fifties to Sixties, relinquishing an unanswered issue of raising economic process inside the 'Pandora's box' of recent technologies.

'Proximate' or economic factors, such as public spending, accumulation of resources, labor, job rates, exchange rates, private and public investment, etc., have similar but yet distinct impacts on the economic process, and it should be considered that these factors have a completely different effect on developing economies as compared to developed economies. Of course, it should recognize the presence of "ultimate" or non-economic influences; there are square measures of socio-political sections of growth and a few different conditions that have a robust effect on a country's economic development: government control, level of corruption, infrastructure, political and body structures, cultural and social factors, earth science and sociology (Acemoglu, 2009)

Dollar (1992) investigated that for the 1976-1985 amount, square measures the sources of growth in ninety-five nascent countries.

By applying a cross-sectional analysis of the political economy, he found that the positive and substantially correlative variable is the investment rate for a semi-permanent economic operation, while the exchange rate index is negative and substantially correlative.

Moreover, he showed that there's AN indirect relation between the amounts of rate of exchange instability and therefore the level of technological distribution at intervals advanced economies.

* Shares estimated by grown accountants starting with Romer's equation (1990, 1.34)

Since economic expert brought into discussion within the economy world the speculation of trade and the way people and economies square measure allowed to leap outside the assembly borders that, beneath independence regimes, would strictly certain them to underdeveloped standards of life (Myinth, 1977), varied papers targeted on this link between FDI and trade parts (exports, imports resilience, trade boundaries) versus growth.

A number of papers have shown that countries with open economies linked to trade expect GDP/capita to increase and rise faster than closed regimes (Romer, 1990), evidence jointly checked by Tekin (2012) to find correlational statistics between exports and development. Simuț and Meșter (2014), pioneering the study specializing in jap Europe and that they find an immediate linkage and convergence between exports, openness to trade and economic process, also mention a long and positive evidence between many sections of trade on the economic process. For a sample of 87 highly developed and lowly developed countries for the period 1965-1995, Barro (2003) investigated the determinants of development.

He adopted 3 different cross-sectional regression models for 1965-1975, 1975-1985 and 1985-1995 in his research, each spanning a span of 10 years. He found that variables such as expenditure, democracy, average years of education, square trade flexibility measure fully and significantly correlated with growth, while variables such as anticipation, public consumption, birth rate, square rate measure negatively and significantly correlated with the economic phase.

There are a number of arguable discussions on the effect of public spending on development. Benos (2009), Gregoriu and Gosh (2008) obtained completely different results even by mistreating the "generalized method of moments" with an analogous information technique. Gosh and Gregoriu (2008) showed that, for fifteen developing countries, this part of the public outlay includes a major trend and a positive effect on development. On the other hand, Benos (2009) pointed out that human resources and infrastructure had a better effect on the semi-permanent economic process in a study of 14 EU countries.

Studies of public expenditure, just like the one amongst Lamartina and Zaghini (2008), UN agency conducted AN analysis relating to the correlation between growth and public outlay by mistreatment the Wagner's law, approved the speculation when getting a positive results of physical property constant between the 2 variables, conjointly terminal the actual fact that on an extended run, the constant incorporates a price larger than zero for the countries with smaller GDP, this being explained through the countries' actions of specializing in development.

For few European countries (e.g. Bulgaria, Romania, European country, Slovakia, Hungary), Szarowská (2012) applied an analogous theory, Wagner's rule, to find out the relation between GDP and public outlay in the short and future, and jointly investigated whether public outlay is 'countercyclical.'

The result obtained denied the countercyclical effect of the variables selected.

Based on Wagner's Law too, Chinese S-Y (2010) researched however is that the relationship between real GDP (economic growth) and government expenditures with the assistance of creator relation check, for 182 states for a amount of fifty four years (1950-2004), this model resulting in a two-way relationship between the economic process and therefore the government size, however the underdeveloped countries were excluded from his results due to politics instability of these countries, terminal that government outlay for rising public institutional quality is important for low- financial gain states so as to beat financial condition and cause substantial economic process meantime, Abbott and Jones (2011) conducted a study for Latin America's developing economies and that they have obtained the alternative result, that public outlay is diurnal with GDP (Alesina et al. 2008).

The claims from the class of non-economic forces based on social variables such as sociology and earth science (Rodrik, 2003) that will affect economic efficiency. Considering the social factors mentioned higher than by Rodrik and Acemoglu, earth science and sociology, within the '80s scientists finished the affiliation between economic process and geographic position of states or regions and their population. a lot of exactly, they brought into discussion the high impact of growing returns, traffic, agglomeration, magnitude of developing cities, and site within the men performance of individual

areas, thus, being adopted the model of “the new economic geography” a arguable subject on the time that comes with clear proof of the influence of social factors named higher than, wherever models tend to flow solely between 2 regions (poor and made, urban or rural), planning to multiple varieties of equilibrium, radiating from the fact of state of affairs. The construct was applied to the social sciences of cities, to the disclosure of geographical regions, and thus to the genesis of international disparities. The highly constrictive models did not estimate 'true locations' or provide abstraction size, however (Martin 1999).

In the last decades, a really wise subject relating to economic process has arose into the enduring researches: however will we have a tendency to reach high growth standards while not harming the environment; the unbeatable vary of investments done by building forcefully enterprises and gap new work brunches related to technology and chemistry and plenty of a lot of, are extremely poignant the setting of the earth, resulting in a dangerous global climate change directly proportional with the high level of energy consumption and CO₂ emissions.

Therefore, this subject hasn't been neglected by the EU commission, so once the 2020 Agenda are build, different aspects of growth is noticed within the forecasted vision:

“– sensible growth – developing AN economy supported information and innovation.

– property growth – promoting a a lot of resource economical, greener and a lot of competitive economy.

– comprehensive growth – fostering a high-employment economy delivering economic, social and territorial cohesion.”

Nordhaus and Romer (2018) have won the economic honor for coming up with long-term property economic process approaches and goals. A quantitative analysis model was developed by Nordhaus (1980) to explain the relationship between climate and economy. His model consists of physics, chemistry and social science hypotheses and scientific findings, and various fields of science. The Nordhaus model continues to be prevalent in today's world, however each generates the economy and hence the climate conflict, so economies

Although the economic process debate may be a never ending subject, each in terms of theoretical and empirical study, there is a growing agreement between policymakers and economists on knowledge and education finance in the last decades, being the center of the theory of endogenous growth and additional, the condition for ever-high growth rates. (Doryń, 2017; Kacprzyk, 2017). Although the effect is relatively small, the positive effect of the IoT on productivity is still a step forward, considering that the IoT is still at an initial stage of growth. This outcome applied on the U.S and E.U., areas where, in recent years, the IoT has been supported. Forward estimates indicate that the IoT will account for a much greater share of the growth in labor productivity in about a decade. However, to achieve the full potential, more IoT investment is needed, and many challenges need to be addressed, such as security and measures to protect IoT-generated data, better infrastructure that will further develop the technology, collaboration between stakeholders to encourage effective policies and regulations. Nonetheless, all these challenges cannot outweigh the benefits that IoT will bring into the economy and states. (Malik et al., 2021)

However, the main issue with IoT is that it is human-dependent. What does that mean? The humans are limited in nature, especially time-limited and capacity wise, making them unable in capturing too much from the real world, as for example, collecting all the data about the worldwide GDP. That is why, the Interent is a representation of ideas not acutal things and the next generation of IoT will help us and the economy in becoming more efficient. (Huckle et al., 2016)

Data and Results

We investigate the impact exerted by some Innovation measures on population well being, proxied by the GDP per capita, based on a panel of six EU countries (Bulgaria, Croatia, Poland, Romania, Slovakia and Slovenia) during 19 years (from 2000 to 2019). The variables included in the model are presented in Table no. 1.

Table no. 1. Data description

Variable	Description
GDPc	Gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Source https://www.theglobaleconomy.com/download-data.php
Innov. Ind.	The Global Innovation Index includes two sub-indices: the Innovation Input Sub-Index and the Innovation Output Sub-Index. The first sub-index is based on five pillars: Institutions, Human capital and research, Infrastructure, Market sophistication, and Business sophistication. The second sub-index is based on two pillars: Knowledge and technology outputs and Creative outputs. Each pillar is divided into sub-pillars and each sub-pillar is composed of individual indicators. Source https://www.theglobaleconomy.com/download-data.php
Info. Tech.	Information and communication technology goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous). https://www.theglobaleconomy.com/download-data.php
Patent. Apl.	Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years. Source https://www.theglobaleconomy.com/download-data.php
Res. and Dev. Exp.	Gross domestic expenditures on research and development (R&D), expressed as a percent of GDP. They include both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development. Source https://www.theglobaleconomy.com/download-data.php
High. Tech. Exports	High-technology exports are products with high R&D intensity, such as aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Source https://www.theglobaleconomy.com/download-data.php

To overcome the issue of a spurious regression, we check the data for some potential unit roots. We apply the test proposed by Levin, Lin & Chu (LLC), which is summarized in Table 2.

Table no. 2. Panel unit root test – Levin, Lin & Chu (LLC)

Variable	LLC Test level	LLC Test first difference
GDPc	-2.8376 (0.0023)	-4.7493 (0.0000)
Innov. Ind.	-1.3676 (0.0857)	-7.9375 (0.0000)
Info. Tech.	-1.6648 (0.0480)	-3.3165 (0.0005)
Patent. Apl.	0.7721 (0.7800)	-5.0291 (0.0000)
Res. and Dev. Exp.	1.5565 (0.9402)	-2.6910 (0.0036)
High. Tech. Exports	-2.3726 (0.0088)	-8.6679 (0.0000)

Source: own calculation

As we can see below, not all the variables are level stationary, so we will estimate a panel Fixed Effects Model in first difference. The results are summarized in Table 3.

Table no. 3. FE model - GDPc as dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Lagged Innov. Ind.	0.0332	0.0996	0.3330	0.7409
Lagged Info. Tech.	1.2974	0.4443	2.9200	0.0059
Lagged Patent. Apl.	-0.1072	0.0994	-1.0782	0.2878
Lagged Res. and Dev. Exp.	0.1319	0.0800	1.6490	0.0922
Lagged High. Tech. Exports	-0.1951	0.1119	-1.7437	0.0893

Source: own calculation

The results summarized in Table 3 indicate that GDPc is sensitive to Information and communication technology goods exports (the higher the exports, the higher the GDP per capita). The same conclusion can be drawn for gross domestic expenditures on research and development while the exports of aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery are diminishing the GDP per capita. The results indicate that, for an emerging country to develop it is crucial to invest in high tech technology, to produce it at lower costs compared to other countries but in the same time to avoid the extensive exports of high-technology products. The R-squared is around 26%, indicating that the GDPc dynamics is explained quite well only by the innovation measures.

Conclusions

In order to maintain a constant pattern of change in real GDP as a measure of the affluent, it is absolutely important, in our view, to concentrate more on investments, not on the spectrum of conventional investments, but on investments demanded by the world of the new economy, where innovation is the key driver of high, low-cost payoffs. As stated in the 2020 Agenda, where sustainable, smart and inclusive growth in all Member States has been the key goal of the past decade, this can only be accomplished by concentrating on all circles, i.e. government spending on jobs and education, and then growing competitiveness and private consumption and the quality of life. These objectives are continued by others from 2030 Agenda for Sustainable Development. Also, innovation is one of the main purposes for this passing decade where to have a sustainable, smart and inclusive growth in all the member states. Once again, the discovery of new optimal and creative solutions will be decided by shifting focus to investments where the costs are low but the payoffs high, in order to maintain a growth that less affects the climate.

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