ISSN 1648-0627 / eISSN 1822-4202

VILNIUS TECH
Vilnius Gediminas Technical University

BUSINESS: THEORY & PRACTICE

2025
Volume 26
Issue 1
Pages 176–181
https://doi.org/10.3846/btp.2025.18665

R&D IMPACT IN THE CHANGES OF ECONOMIC STRUCTURE OF POPULATION

Luljeta ALIU MULAJ, But DEDAJ ✉

Faculty of Economics, University of Prishtina "Hasan Prishtina", Prishtina, Kosovo

Article History:
- received 19 February 2023
- accepted 19 February 2025

Abstract. Research and Development (R&D) plays crucial role in the technological progress, and thus it can be seen as facilitator of the economic development. It is widely known that the importance of the research is not only in economic aspect but also in the technologic aspect. On the other hand, not all of countries have possibility to develop such researches, as it requires huge financial support, and professional human capital. As a result of these investments and technological developments, changes on the employment rate in each sector are evident. The study is focused on measuring the impact of R&D in the changes of the economic structure of population. In the study are included thirty world countries divided in three groups: ten countries with largest GDP, ten with largest GDP per capita and ten Balkan countries. Structural Equation Model is used to measure the impact of almost three decades until pandemic COVID-19. From the analysis conducted, the results show that, investments in research and development and innovation have positive impact on the economic structural of population.

Keywords: research and development, investments, innovation, economic structure of population, economic transformation, structural equation model.

JEL Classification: O10, O32, O33, J24.

✉Corresponding author. E-mail: ***but.dedaj@uni-pr.edu***

1. Introduction

The economic development in general is seen as focused and dedicated to the interrelation of structural changes that in one way fosters the economical capacity of the country to enhance economic growth (Dudzevičiūtė et al., 2014) which progress is due to the technology development.

Economic Structure of Population, meaning the employment rate/number at the main economic sectors. The perspective of discussion and analysis of this paper is done on the basis of the main economic sectors: primary (agriculture) sector, secondary (manufacturing) sector and tertiary (service) sector (Griffith & Wall, 2004). With term structural changes is understood the composition of the economic activity structure, in this study will be referred:

Economic Structure – the output that each sector is contributing to the total GDP of the country;

Economic Structure of Population – meaning the employment rate/number at the main economic sectors;

The interrelation of the R&D investments, as a starting point to the changes by innovation and technological development – ICT, follows the changes in the economic structure and economical structure of population. Furthermore, the study provides evidence from the trends on structural changes – changes in the share of employment of each sector – from ten worlds' countries with largest GDP.

Investments on R&D can lead to wide network of the innovations such as: processes or design of the new products. These are protected by the IP rights Industrial Property (Rights). Top R&D investors in the ICT industries present relatively more concentrated IP portfolios in terms of both technologies (patents) and products (trademarks and designs)" (Daiko et al., 2017).

There exist different phases from R&D investments to technological innovation and diffusion. In fact, it is considered quite easy to define each phase in theory, but in practical way, it is very difficult to distinguish among phases and realize the whole process. Beside the financial and human recourses, the time distance is very long. Depending on the type of invention, sometimes it takes some years, and sometimes it can even take hundred years to employ in practice the invention. Due to the complexity of the new products/processes, it is depended on countries investments whether they can close the circle of all phases of the researches and development (Dedaj, 1998). Usually, it is dependent on the level of investments in each phase.

Meaning, less investments or not, the probability to finalize researches is low, and the opposite, more investments, country can succeed to even diffuse the invention at the broader level. Initiatives for increasing R&D investments by European Union countries, were also based on good examples of in order of USA – 2.5% and Japan 3%. Low level of participation in R&D by the EU countries, is mainly as a result of the lack of private investments. Productivity of R&D must be increased. The proportion of structural funds spent on research and innovation should be trebled" (Aho et al., 2006) since the R&D spending by the European Union countries since the level of investments was under 3% of the country's GDP. Therefore, Europe policies for were being focused on improving conditions for investments in R&D by private sector (European Commission, 2010). The productivity gains among other could result on structural change from innovation, technical change, capital accumulation through reallocation of factors of production to high productivity sectors from those low-productivity sectors which implies economic transformation by heavy and sophisticated technologies to technology-intensive services (El-Haddad, 2013, Mouelhi & Ghazalli, 2018).

Among others, industrial energy intensity can be lowered by improving technology (technological change) and producing more goods that require less energy (structural change)" (United Nations Industrial Development Organization, 2016).

Therefore, due to such developments the changes in the employment by different sectors are evident. Consequently, analysis below gives an insight of these consequences. The paper is structured into several parts. Introduction which provides the information for the study and sector of the employment, division of the economic sectors of the population and R&D importance and trends by different countries. The study provides overview and analysis by other studies and authors in the section of Literature review. It aims to bring the existing gap of the studies in the field – theoretical and empirical part. Literature is consulted with the new and old studies and comparison of it to bring the niche of the studies in the field by analyzing the impact of research and development in the employment of economic sectors.

2. Literature review

In their stud. Dudzevičiūtė et al. (2014) find out that, according to Karnitis (2011), Smaliukienė et al. (2017), Miškinis et al. (2013), the economic sector changes can be measured based on the share of the output or employment. The proportion result of sector evaluation in terms of the current product or employment remains unchanged (Pasinetti, 1993).

Scientific researches on the topic of economic structural changes have used different approaches. The between-sector component of productivity growth (by sector and for the whole economy) is a measure of structural change contribution (Mouelhi & Ghazalli, 2018). The study of structural changes by these authors take into consideration components of education, R&D investments and innovation.

Large amount of investments goes to ICT sectors, more than 25%, which actually goes in patents and trademarks mainly. Evidence shows that majority of R&D investors, respectively more than 70%, operate in the United States, Japan, Chinese, Chinese Taipei (Daiko et al., 2017).

The technological progress is described by Schumpeter (1943) as the way, where teams of trained specialists can predict what is required. Linear model of innovation was among the first frameworks developed that aimed explain science and technology relation in an economy. It postulated that "innovation starts with basic research and is followed by applied research and development, and ends with production and diffusion" (Lin, 2012).

In the knowledge-based economy era, the role of IT has strengthen the intangible assets for micro-business to compete in an open market.

The large information from the community, and the developed technology infrastructure, will encourage entrepreneurs to absorb and convert into knowledge that stimulate Research and Development process (Hermawan et al., 2021). The record on growth, as the most important measure for the long run success in economy, requires continued innovation in the wide range of products, services as well as advanced methods on the production process and delivery (Blender, 2008; Audretsch et al., 2009).

Among others, Information Technology is considered as a strategic asset on creating and improving the business performance (Hermawan et al., 2021).

Using creativity and innovation methodology and work together, improve the processes and reduce errors (Al-Rjoub & Bassam Fathi Aldiaba, 2023). R&D activities and services should be further analyzed with focus on technology-intensive organization, where organizational structure culture supports innovation (Almeida & Moreira, 2022). Authors Bruijn and Norberg-Bohm (2005), found out that set of policy innovations are necessary for such an industrial transformation, aiming a sustainable industrial society.

With regard to a microlevel, a study by Pusung et al. (2023) shows that innovation contributes to increasing performance of SME, therefore, SMEs who are oriented in process innovation increases performance more easily, compare to those who are oriented on products innovation. Firm performance is affected also by the customer satisfaction (Makhamreh et al., 2022).

Another trend that companies cannot avoid is the distribution and application of AI within the companies strategies. To advance in artificial intelligence maturity, companies must first define their identity, needs, and challenges. Only then can they explore how AI might provide solutions. This requires a thorough understanding of AI applications, available technologies, and, most importantly, successful case studies (Schmiegelow & Melo, 2023).

Great macroeconomic importance is given to the innovation especially by the countries that are highly

industrialized, as innovation is considered to be responsible for half of economic growth (Ignat, 2017; Nyuyfoni, 2016).

In the context of diffusion, authors Cantner and Malerba (2006) states that: "there exist other forms of knowledge diffusion and innovation of higher importance to the relationships between agents than their ability to gather information and knowledge". Therefore, innovation is crucial for "production" of new knowledge and exploitation of existing economic knowledge (Rodríguez-Pose & Crescenzi, 2010; Jalava & Pahjola, 2002).

In the study of "Increasing Returns and Economic Geography", by Krugman (1991), the author used "A Two-Region Model" that assume agriculture and manufactures. The model illustrated the tools drown from industrial organization theory that, in a way can help to formalize the insights of the neglected fields. Authors, McMillan and Rodrik (2011); McMillan et al. (2014) provides analysis from developed and emerging countries on structural changes.

Therefore, to provide a detailed analysis of the structural change over time periods and by sectors, we use the decomposition equation of labor productivity growth suggested by McMillan and Rodrik (2011) to calculate the within and between components:

$$\Delta P_t = \sum_{i=1}^{n} \theta_{it-k} \Delta p_{it} + \sum_{i=1}^{n} p_{it} \Delta \theta_{it}, , \quad (1)$$

where, P_t and p_{it} refer to economy-wide and sectoral labor productivity levels, respectively, and θ_{it} is the share of employment in sector i at time t. Δ refers to changes between $(t - k)$ and t. The between-sector component of productivity growth (by sector and for the whole economy) is a measure of structural change contribution" (Mouelhi & Ghazalli, 2018).

3. Methodology

The study includes group of thirty world countries: ten countries with largest GDP, ten with largest GDP per capita and ten Balkan countries. The period of study includes 1991–2019. According to the model by McMillan and Rodrik (2011) used by Mouelhi and Ghazalli (2018), **R&D and Innovation:** Patents, Hi-tech exports and R&D expenditures; **Economic Structure:** Agriculture share (% of total employment), Manufacture share (% of total employment), Service share (% of total employment).

The between-sector component of productivity growth (by sector and for the whole economy) is a measure of structural change contribution" (Mouelhi & Ghazalli, 2018).

Based on the need to measure the impact of the above-mentioned components on the economic transformation, there is used Structural Equation Model. Description of variables are shown in the Table 1.

Table 1. Description of variables (source: Mouelhi & Ghazalli, 2018, modified by author)

Variable	
R&D expenditures	rde
Patents	pattenth
Hi-tech exports	htex

4. Sample

In this dataset there were 30 states (see Table A1 in the Appendix), for a period of 29 years, the time series are limited to the year of 2019, without including the periods where pandemic COVID-19 can have impact on the priorities for investments in R&D. In order to make comparison of different states and levels of investments, there are included in the study thirty countries divided in three different groups composed by ten: countries with largest GDP, countries with largest GDP per capita and Balkan countries. Thus, this dataset that we took into consideration has around 850 observations. The data were retrieved from the official database of the world bank.

To analyse the data collected was used SPSS v26 and AMOS 21 for all the analysis and models presented in this paper. In the Table 2, are presented descriptive statistics.

Table 2. Descriptive statistics (source: authors own calculation)

Descriptive Statistics for RandDal										
	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic							Std. Error	Statistic	Std. Error
ae	849	0.19	59.7	10.1	11.8	139.7	2.14	0.08	4.44	0.17
ie	850	10.8	46	25.7	5.95	35.35	0.24	0.08	0.01	0.17
se	850	17.9	87.9	55.7	19.5	381.3	–0.5	0.08	–1.15	0.17
rde	659	0.02	4.55	1.68	0.91	0.82	0.26	0.1	–0.53	0.19
pattenth	696	0	140	4.15	12.5	156.7	5.98	0.09	47.74	0.19
htex	736	0.05	98.7	17	12.5	156	1.9	0.09	6.66	0.18
Valid N (listwise)	399									

5. Results

The results from the SEM presented in the Figure 1, shows that the model fit to the purpose of the study. Below are presented details for the impact of R&D in the employment of economic sectors of population.

5.1. Reliability and validity analysis

Correlational and descriptive analyses.

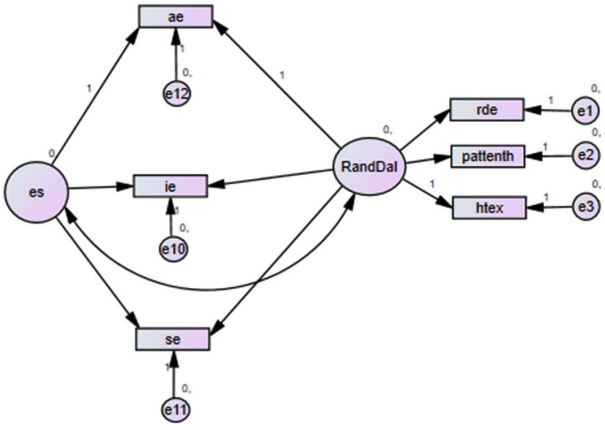

Figure 1. Model of the economic structure RandDal through SEM (source: Mouelhi & Ghazalli, 2018, modified by author)

5.2. Convergent validity and reliability measures

Composite Reliability (CR) analyses has been done as a further model fitness indicator (which is more reliable than Cronbach's alpha), the latent variable RandDal have values are greater than 0.6, which again confirms the strength of the sub-variables in the latent variable. Here also the Convergent Validity (CV) through the Average Variance Extracted (AVE) is presented to measure total amount of the variance of the indicators collected by the latent variable, the results are presented in the table below, and we can see that every latent variable is greater than 0.5 which means the sub-variables are a good representative for the latent variables. Lastly, Discriminant Validity (DV) is to indicate and argue the presence of the latent variables, which is that each value here must be greater than the correlation values, in our case all the variables have greater DV then the correlation factors.

Table 3. Indication factors (source: Mouelhi & Ghazalli, 2018, modified by author)

Constructs	Indicators	CR	AVE	DV
RandDal		0.68	0.5	0.71
	rde			
	pattenth			
	htex			
RandDal		1.58	2.59	1.61
	ae			
	ie			
	se			
es		1.32	2.13	1.46
	ae			
	se			
	ie			

5.3. Structure analysis

Analysing the model fit of our model, from the Table 3, we can see that we have a CFI index of 0.821, and RMSEA of 0.154, all of these indexes presents that this model is fairly fitted model.

When we use the Regression Weights which are presented in the Table 4.

Table 4. Structural equation model regression weights (source: authors own calculations)

			Estimate	S.E.	P-Value
rde	<---	RandDal	0.248	0.037	***
pattenth	<---	RandDal	0.932	0.128	***
htex	<---	RandDal	1		
ae	<---	RandDal	1		
ie	<---	RandDal	0.717	0.2	***
se	<---	RandDal	12.223	5.773	0.034
ae	<---	es	1		
se	<---	es	4.747	2.433	0.051
ie	<---	es	0.392	0.082	***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

From the results presented in the Table 4, we can clearly see that, if the percentage of the rde (R&D spending), pattenth (number of patents issued) and htex (Hi-tech exports) are increased for 1, the RandDal will get higher results and these finding are highly significant, based on the p value.

6. Discussions

Although R&D is considered an important factor for economic development, relatively few studies have been conducted to measure its impact on changes in the economic structure of the population. The theoretical aspect of this topic has been explored extensively; however, there is limited empirical evidence, particularly across different countries. This study aims to bridge the gap between theoretical and empirical research.

Furthermore, it provides evidence of the impact of R&D and innovation in both developed and developing countries. Despite existing research, a significant gap remains between theoretical frameworks and empirical studies on the impact of R&D on employment and economic transformation. Therefore, future research should focus on empirically analyzing this impact. In addition, policies should emphasize capacity building and strategic investments to prepare the labor force and support specific sectors for future economic growth.

7. Conclusions

The purpose of this study was to investigate the importance of R&D investments by analyzing data from 30 countries, divided into three groups of 10 countries each. The results show that investments in R&D have a positive impact on the number of employees in three sectors, leading to an overall increase in employment within each sector.

Although R&D is considered an important factor for economic development, relatively few studies have been conducted to measure its impact on changes in the economic structure of the population. This study provides evidence of the impact of R&D and innovation in developed countries. Consequently, the results confirm the crucial role of R&D in driving employment and economic transformation. In the last three decades, R&D and Innovation have impacted the structure change.

Overall, the findings of this paper improve the existing literature on the impact of R&D in the Economic structural change of population. Regardless of the fact that the used model was significantly supported, this study has a few limitations that should be taken into account.

Research limitations and future research

The results should be interpreted with caution, as the analysis includes a range of countries, which might affect individual countries differently. Specific results may vary for countries.

The model used in this study can be expanded to include additional indicators influencing economic transformation. Moreover, generalizing the results of this study to other groups needs to be done cautiously, since the group of countries included in the study are countries with large GDP, and there could be countries with lower GDP, but they spend large amount of countries' GDP in R&D and thus reaching the level of the states taken into study. Consequently, these findings serve as good guidelines for targeting certain level of investments in R&D, as well as including more factors that might impacts the economic structural change.

Taking that into consideration, future research could improve on the limitations and also, adding other factors to this model could further increase its explanatory power.

Furthermore, extending the analysis to compare the period before and after COVID-19 could be of particular interest to academics and policymakers.

References

Aho, E., Cornu, J., Georghiou, L., & Subirá, A. (2006). *Creating an innovative Europe*. European Commission.

Al-Rjoub, S. R., Aldiabat, B. F., & Ait Yassine, F. L. Y. (2023). The impact of employee empowerment on continuous improvement of health care: An empirical and comparative study between hospitals. *Business: Theory and Practice*, *24*(1), 13–23. https://doi.org/10.3846/btp.2023.16667

Almeida, L., & Moreira, A. (2022). Workplace innovation: A search for its determinants through a systematic literature review. *Business: Theory and Practice, 23*(2), 502–524. https://doi.org/10.3846/btp.2022.14928

Audretsch, D. B., Litan, R. E., & Strom, R. J. (2009). *Entrepreneurship and openness: Theory and evidence*. Edward Elgar Publishing Limited. https://doi.org/10.4337/9781848449046

Blender, G. (2008). Chapter 2: How to grasp innovativeness of organizations: Outline of a conceptual tool. In *Innovation in low-tech firms and industries*. Hartmut Hirsch-Kreinsen and David Jacobson. https://doi.org/10.4337/9781848445055.00010

Bruijn, T. d., & Norberg-Bohm, V. (2005). *Industrial transformation: Environmental policy innovation in the United States and Europe*. The MIT Press. https://doi.org/10.7551/mitpress/3746.001.0001

Cantner, U., & Malerba, F. (2006). *Innovation, industrial dynamics and structural transformation*. Schumpeterian Legacies. Springer. https://doi.org/10.1007/978-3-540-49465-2

Daiko, T., Dernis, H., Dosso, M., Gkotsis, P., Squicciarini, M., & Vezzani, A. (2017). *World top R&D investors: Industrial property strategies in the digital economy.* European Commission's Joint Research Centre; Organisation for Economic Co-operation and Development.

Dedaj, B. (1998). *Roli i shkences dhe teknologjise ne zhvillimin ekonomik – analiza e disa aspekteve te pergjithshme* [The role of technology and high-tech economics – analysis of some general aspects]. Fakulteti Ekonomik, Universiteti i Prishtines.

Dudzevičiūtė, G., Mačiulis, A., & Tvaronavičienė, M. (2014). Structural changes of economies: Lithuania in the global context. *Technological and Economic Development of Economy, 20*(2), 353–370. https://doi.org/10.3846/20294913.2014.915597

European Commission. (2010). Europe 2020. *A strategy for smart, sustainable and inclusive growth*. European Commission.

El-Haddad, A. (2013). *Political patronage and economic opportunity: The case of vertical integration in the Egyptian clothing industry* (Working Paper 797). ResearchGate.

Griffith, A., & Wall, S. (2004). *Applied economics* (10th ed.). Financial Times-Person Education. https://cdi.mecon.gob.ar/bases/docelec/az2428.pdf

Hermawan, I., Suharnomo, S., & Perdhana, M. S. (2021). Inimitable-based innovative entrepreneurship as mediation concepts of information technology roles on organizational performance. *Business: Theory and Practice, 2*(22), 380–391. https://doi.org/10.3846/btp.2021.13036

Ignat, V. (2017). *Digitalization and the global technology trends*. IOP Publishing. https://doi.org/10.1088/1757-899X/227/1/012062

Jalava, J., & Pahjola, M. (2002). Economic growth in new economy: Evidence from advanced economies. *Information Economics and Policy, 14*(2), 189–210. https://doi.org/10.1016/S0167-6245(01)00066-X

Karnitis, E. (2011). Strategy and efficient mechanisms to improve security and sustainability of the natural gas supply in Baltic States. *Journal of Security and Sustainability Issues, 1*(1), 3–15. https://doi.org/10.9770/jssi.2011.1.1(1)

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, *99*(3), 483–499. https://doi.org/10.1086/261763

Lin, J. Y. (2012). *New structural economics: A framework for rethinking development*. The World Bank. https://doi.org/10.1596/978-0-8213-8955-3

Makhamreh, H. Z., Alsakarneh, A., Enezan, B., & Ngah, A. H. (2022). Employee motivation, job satisfaction, customer satisfaction, and firm performance: The moderating role of employee empowerment. *Business: Theory and Practice, 23*(2), 357–364. https://doi.org/10.3846/btp.2022.15316

McMillan, M. S., & Rodrik, D. (2011). Globalization, structural change and productivity growth. In M. Bacchetta & M. Jense (Eds.), *Making globalization socially sustainable*. International Labour Organization and World Trade Organization. https://doi.org/10.3386/w17143

McMillan, M., & D. Rodrik, & Verduzco-Gallo, I. (2014). Globalization, structural change, and productivity growth: With an update for Africa. *World Development, 63*, 11–32. https://doi.org/10.1016/j.worlddev.2013.10.012

Mouelhi, R., & Ghazalli, M. (2018). Structural transformation in Egypt, Morocco and Tunisia: Patterns, drivers and constraints. *Economics of Transition and Institutional Change, 29*(1), 35–61. https://doi.org/10.1111/ecot.12258

Miškinis, V., Baublys, J., Lekavičius, V., & Morkvėnas, A. (2013). New changes in Lithuanian energy sector. *Journal of Security and Sustainability, 2*(3), 15–28. https://doi.org/10.9770/jssi.2013.2.3(2)

Nyuyfoni, N. M. (2016). *Investments in technology: A growth model for the economic transformation of Cameroon*. NKAFY Policy Institute.

Pasinetti, L. L. (1993). *Structural economic dynamics: A theory of the economic consequences*. Cambridge University Press. https://doi.org/10.1017/CBO9780511551444

Pusung, C. S., Narsa, N. P. D. R. H., & Wardhaningrum, O. A. (2023). Innovation, competitive strategy and MSME performance: A survey study on culinary SMES in Indonesia during the COVID-19 pandemic. *Business: Theory and Practice, 24*(1), 160–172. https://doi.org/10.3846/btp.2023.16676

Rodríguez-Pose, A., & Crescenzi, R. (2010, October 7). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional Studies, 42*(1), 51–67. https://doi.org/10.1080/00343400701654186

Schumpeter, J. A. (1943). *Capitalism, socialism and democracy*. Taylor & Francis.

Schmiegelow, F., & Melo, F. C. L. (2023). A market research on challenges influencing artificial intelligence adoption. *Business: Theory and Practice, 24*(1), 250–257. https://doi.org/10.3846/btp.2023.17655

Smaliukienė, R., Bekešienė, S., Chlivickas, E., & Magyla, M. (2017). Explicating the role of trust in knowledge sharing: A structural equation model test. *Journal of Business Economics and Management, 18*(4), 758–778. https://doi.org/10.3846/16111699.2017.1317019

United Nations Industrial Development Organization. (2016). *The role of technology and innovation in inclusive and sustainable industrial development*. United Nations Industrial Development Organization.

World Bank. (2025, February 26). *The World Bank indicators*. https://databank.worldbank.org/source/world-development-indicators

Appendix

Table A1. List of countries in the study (source: World Bank, 2025)

No.	Country		
	Group I – World Countries with highest GDP	Group II – World Countries with highest GDP per Capita	Group III – Balkan countries
1.	United States	Luxembourg	Kosovo
2.	China	Switzerland	Albania
3.	Japan	Norway	Serbia
4.	Germany	Iceland	North Macedonia
5.	United Kingdom	Ireland	Montenegro
6.	France	Singapore	Bosnia and Herzegovina
7.	Italy	Denmark	Croatia
8.	Canada	Sweden	Bulgaria
9.	Russian Federation	Australia	Greece
10.	Korea Republic	Austria	Slovenia