



ANALYSIS AND ASSESSMENT OF STRUCTURAL CHANGES IN RESEARCH AND DEVELOPMENT ACTIVITIES BY REGIONS IN BULGARIA

V. Kertikova¹, Iv. Stoycheva^{2*}

¹Student, Faculty of Economics, Trakia University, Stara Zagora, Bulgaria

²Department of Economics, Trakia University, Faculty of Economics, Stara Zagora, Bulgaria

ABSTRACT

Investments in Research and Development (R&D) are a vital aspect of the modern economy and are regarded as a strategic tool for economic transformation, enhancing competitiveness, and transitioning toward a knowledge and innovation-based economy. The present study aims to identify the structural changes in R&D activities across the regions of Bulgaria and to assess their impact on the formation of the sectoral structure. By analyzing regional R&D investments and their ratio to Gross Domestic Product (GDP), the study outlines development imbalances and, on this basis, derives opportunities for sustainable high-tech growth at both national and regional levels. The results reveal a pronounced concentration of scientific, research, and innovation activity in the Southwestern region where Sofia (the capital) plays a key role. The capital's share of total R&D expenditures significantly exceeds that of the other regions, which compromises the representativeness of the region at the NUTS 2 level and distorts the potential for an objective assessment of regional progress. In this context, the study substantiates the proposal for Sofia (capital) to be designated as a separate territorial unit within the NUTS 2 classification. Such a delineation would enable more precise planning of regional policies, resource allocation, and monitoring of investment effects.

Keywords: Sofia (capital), R&D, structural changes, GDP, regional disparities, innovation, high-tech growth.

INTRODUCTION

In today's global economy, where knowledge and innovation are key drivers of progress, special attention is given to investments in research and development (R&D). These investments are a crucial factor for economic development, value creation and sustainable prosperity at both regional and national levels. Unlike classical models that explain growth through the accumulation of physical capital and labor, endogenous growth theory (1, 2) emphasizes that knowledge and technological advancement generated within the economic system determine long-term economic development. R&D investments play a key role, as they lead to the creation of new products, processes and technologies that enhance productivity and competitiveness. This concept is also reflected in the social visions for the future of industrial societies. In his work "The

Coming of Post-Industrial Society", 1973, Daniel Bell (3) argues that the knowledge economy will replace traditional industrial production, transforming scientific knowledge into a strategic resource for social and economic organization. In "The Third Wave", 1980, Alvin Toffler (4) outlines the transition to a society in which innovation and information replace mass production as the driving force of economic development. Castells, Rifkin and others (5, 6) provide an in-depth theoretical overview of the transformations leading to the replacement of mass production with innovation and information as the main engines of economic development.

In this context, R&D investments should be viewed not only as an integral part of the new economic system but also as a strategic tool for long-term growth and balanced regional development. It should be noted that research activity is a source of scientific capital and serves as the foundation for realizing innovation potential. It provides the necessary knowledge

***Correspondence to:** Ivanka Stoycheva,
Department of Economics, Trakia University,
Faculty of Economics, Stara Zagora, Bulgaria,
e-mail: ivanka.zhekova@trakia-uni.bg

and tools without which sustainable economic growth is unthinkable. Development activity, in turn, is critically important for scientific and technological progress and for the competitiveness of national and regional economies. Moreover, this activity stimulates innovation, increases productivity and contributes to sustainable development.

At this stage in Bulgaria, there is a strong concentration of scientific and innovation potential mainly in Sofia, which is a significant indicator of deepening regional imbalances. Finding solutions for a more equitable distribution of resources in the fields of science and innovation is essential for achieving balanced development and is of utmost importance.

The present study **aims** to analyze the structural differences in research and development (R&D) investments at the regional level, with a focus on the role of Sofia (capital), and to propose possible solutions for reducing existing imbalances. The research objectives formulated to achieve this goal are as follows: To assess the relative share of R&D expenditures in the Gross Domestic Product (GDP) of the country. To determine the share of R&D expenditures by region in relation to total national spending and to evaluate each region's contribution to the formation of the national R&D potential. To analyze and assess the leading role of Sofia (capital) as a key R&D center in Bulgaria and to determine its impact on the formation and deepening of regional disparities. According to the National Statistical Institute, R&D encompasses four institutional sectors: "Business Enterprises," "Government," "Higher Education," and "Private Non-Profit Organizations" (7). R&D is regarded as a broad and structurally organized process involving creative and systematic efforts aimed at expanding the stock of knowledge in various scientific and social fields. R&D activities include basic and applied research, as well as experimental development focused on innovation and technological advancement. The indicator "R&D Expenditure" covers all financial resources invested in R&D activities, regardless of the source of funding and whether the expenditures refer to current costs or capital investments in fixed assets used for research purposes. In the context of the "Europe 2020" strategy, the European Union member states have committed to investing 3% of their GDP in R&D—a target reflecting innovation progress and economic growth (8). In alignment with these ambitions, and as part of its National

Reform Programme for the period 2010–2013, Bulgaria set a national target of 1.5% of GDP to be invested in R&D by 2022, as stipulated in Council of Ministers Decision No. 803 of 10.11.2010 (9). Bulgaria's national target is linked to accelerating the transfer of knowledge and technologies resulting from R&D activities, with the aim of expanding their practical application in the economy and society while modernizing the national research process. The ultimate objective is to enhance Bulgaria's competitiveness through innovation.

MATERIAL AND METHODS

To achieve the main objective, the study focuses on R&D investments at the regional level in Bulgaria over a ten-year period, covering data from 2014 to 2023. The primary source of information is the National Statistical Institute (NSI), utilizing publicly available statistical datasets. A quantitative approach has been applied, allowing the analysis of the dynamics of R&D investments in the six NUTS 2 level regions through the processing of secondary data. A comparison is made between R&D expenditures and regional GDP in order to assess the relative weight of investments in relation to the economic development of each region.

To examine the structural differences and the dynamics of R&D investments in the six NUTS 2 regions, the following methods were used:

1. Descriptive analysis – this includes graphical and tabular presentation of the data, enabling a visual and summarized characterization of the main indicators and trends.
2. Comparative analysis – this method is used to compare the individual regions in order to identify and quantitatively measure differences in R&D investments and their structure.
3. Time series analysis – the dynamics of R&D investments for the period 2014–2023 are examined, allowing the identification of trends and changes over time.
4. Structural relative indicators – R&D expenditures are calculated as a percentage of regional GDP in order to assess the relative weight of investments in relation to the economic development of each region. This enables a deeper analysis of the effectiveness and contribution of R&D to the regional economy.

In combination, these methods provide the opportunity to conduct an in-depth analysis of the structural differences in R&D investments

and their impact on the sectoral structure of the economy at the regional level.

RESULTS AND DISCUSSION

The transition from an industrial to a post-industrial society, with an economy driven by knowledge, information and innovation, is a key theme in contemporary economic development. The study of the relative share of R&D expenditures makes it possible to assess innovation activity and to analyze its relationship with the economic structure of the country's regions. This share indicates the extent to which an economy is oriented toward innovation and the creation of new knowledge, with a higher percentage reflecting a greater potential of the region to generate technological progress and competitiveness. The indicator

"R&D Expenditures" provides information not only about the total financial resources committed to R&D, but also about the development of long-term capacity and potential for scientific and innovation activity. Capital investments in R&D lay the foundation for generating future innovations.

The share of R&D expenditures as a percentage of Gross Domestic Product is a significant indicator that provides an overview of the country's innovation potential, competitiveness and its ability to achieve sustainable economic development in the global knowledge economy. The present study focuses precisely on this relative share, expressed as a percentage of Bulgaria's Gross Domestic Product. **Figure 1** presents the data for the period 2014–2023.

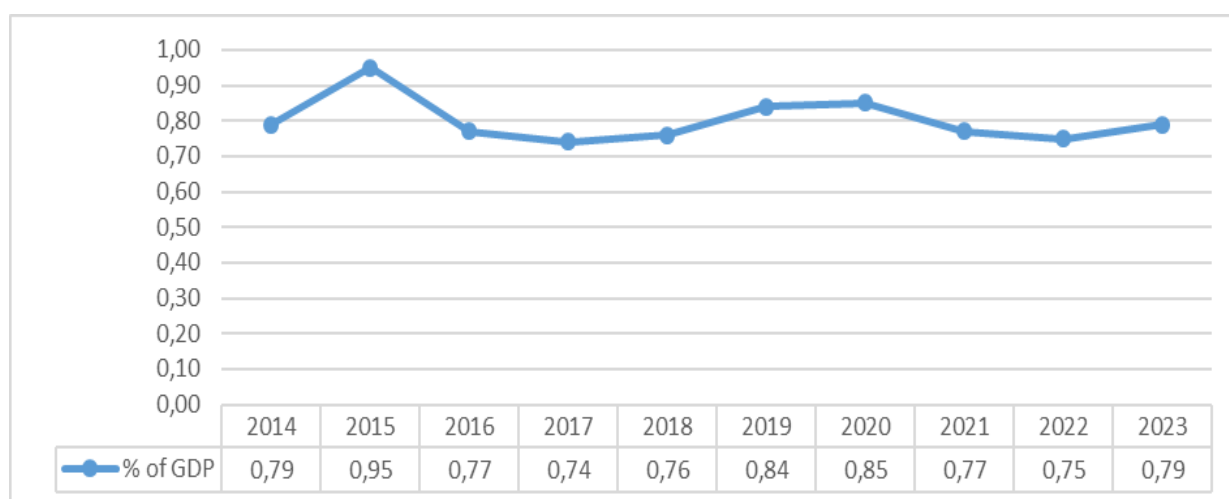


Figure 1. Relative Share of Research and Development Expenditures as a Percentage of Bulgaria's Gross Domestic Product for the Period 2014–2023.

Overall, it can be stated that R&D investments in Bulgaria throughout the entire ten-year period remain significantly below the national target of 1.5% of GDP by 2022. R&D expenditures vary between 0.74% and 0.95%, and in none of the analyzed years do they exceed 1% of GDP. During the reviewed period, no sustained upward trend in the share of R&D expenditures relative to GDP is observed. Compared to EU member states aiming to increase R&D spending to 3% of Gross Domestic Product, Bulgaria is among the countries with the lowest investment in innovation.

The lack of significant and consistent growth indicates that national efforts to stimulate R&D are insufficient or ineffective in achieving the

set goals. This implies that the possibilities for shifting the economy toward a knowledge-based model are unrealistic in the short term.

Calculating the relative share of R&D expenditures in a given region relative to the total national amount provides key information about each region's participation and contribution to the formation of the national research and development potential. Based on this, an assessment of regional opportunities for long-term R&D investments can be made, as well as identification of possible constraints in capacity for future research. The results of the calculated structural shares of the regions in the total national R&D expenditures are presented in **Table 1**.

Table 1. Relative share of R&D expenditures in a given region compared to the total amount of the indicator for the country for the period 2014–2023 (%)

Regions	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NW	1,8	3,9	4,1	4,1	4,5	3,2	3,1	3,3	3,1	2,2
NC	1,6	4,4	4,2	4,0	3,2	3,0	3,1	3,0	3,1	3,1
NE	5,1	4,2	7,0	6,8	6,0	6,4	4,5	4,5	5,2	4,9
SE	4,1	4,3	4,6	5,1	5,1	4,8	4,4	4,2	4,7	4,3
SW	82,9	75,6	71,2	70,9	72,8	73,4	76,0	77,0	75,8	78,6
SC	4,5	7,7	9,0	9,1	8,3	9,2	8,9	8,0	7,9	6,8
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source of information: NSI and own calculations

The presented information shows that during the examined period there has been growth in the relative share of R&D expenditures in most regions of the country. Nevertheless, the values remain low, which can be explained by the lack of developed research infrastructure. The insignificant concentration of innovative industries likely accounts for the limited attraction of investments in the regions. It should be noted that the Southwest Region holds a leading position in R&D expenditures, mainly due to the economic and scientific weight of Sofia, the capital. The data show that the Southwest Region plays an exceptionally dominant role in forming the total sum of expenditures. Throughout the entire ten-year period, this region's relative share ranges between 70.9% and 82.9% of all R&D expenditures in the country. It can be stated with certainty that there is a strongly pronounced concentration of scientific and innovation potential primarily in the Southwest Region. This trend is unfavorable, as directing R&D investments toward a single major region leads to deep regional imbalances and uneven development.

The other regions have an extremely low share in the formation of the total expenditures, and

although some fluctuations are observed over the years, this share remains in single digits. The fluctuations by region over the years are as follows: for the Northwest Region between 1.8% and 4.5%, for the North-Central Region between 1.6% and 4.4%, for the Northeast Region between 4.2% and 7.0%, for the Southeast Region between 4.1% and 5.1%, and for the South-Central Region between 4.5% and 9.2%. The low shares of these regions indicate limited innovation capacity and fewer investments in scientific infrastructure, which adversely affects the development of a knowledge-based economy outside the Southwest Region.

In dynamic terms, some fluctuation is noted for the other regions, but none of them show significant growth in their share that would approach the dominant Southwest Region. **Table 2** presents a ranking of the regions, where the region with the largest relative share is assigned rank 1, and the region with the smallest relative share of R&D expenditures is assigned rank 6. The ranking is done by year, and the total sum of ranks for the entire period is also calculated.

Table 2. Ranking of regions in Bulgaria by relative share of R&D expenditures for the period 2014–2023

Region	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Sum of ranks
NW	5	6	6	5	5	5	5	5	6	6	54
NC	6	3	5	6	6	6	6	6	5	5	54
NE	2	5	3	3	3	3	3	3	3	3	31
SE	4	4	4	4	4	4	4	4	4	4	40
SW	1	1	1	1	1	1	1	1	1	1	10
SC	3	2	2	2	2	2	2	2	2	2	21

Source of information: NSI and own ranking

The sum of ranks confirms the leading role of the Southwest region, which maintains its top position and has the lowest sum of ranks throughout the entire study period. The Southern Central region ranks second, showing some growth in expenses, reaching 9.2% in 2019, but then declining again to 6.8% in 2023. The Northeast region holds third place; however, its contribution remains significantly lower compared to the dominant region. The Southeast region ranks fourth, characterized by a relatively stable, though modest, contribution to the total national R&D expenditures. It is worth noting that this region shows no significant fluctuations or trends toward substantial growth that could reduce the overall regional concentration.

The Northern Central and Northwest regions rank fifth and sixth, respectively, with equal sums of ranks. These two regions have the smallest contribution to national R&D expenditures throughout the entire period. Their extremely low shares indicate a serious shortage of scientific and innovation potential, which is a clear indicator of structural disparities in their economic development.

These findings call for targeted policies to stimulate R&D activities in the mentioned regions in order to overcome deep regional imbalances. **Figure 2** presents the dynamics of the relative shares of R&D expenditures by region over the entire observation period.

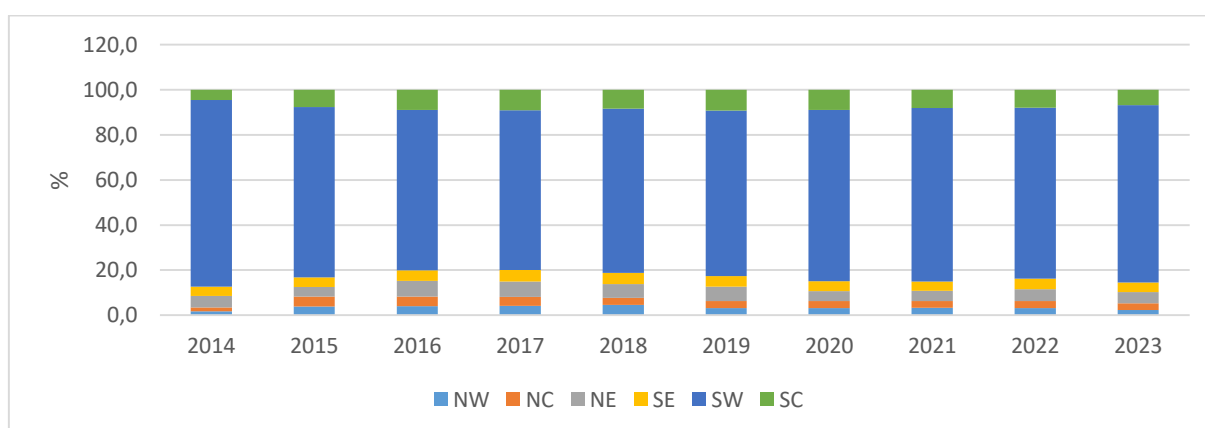


Figure 2. Dynamics of the Relative Shares of R&D Expenditures by Region for the Period 2014–2023.

Another objective of the present study is to determine the role of Sofia (capital) as a leading center for R&D in the Southwest Region and in the country as a whole, and to assess its impact on the formation and deepening of regional disparities. To achieve this objective, **Table 3** presents the relative shares of R&D

expenditures for the individual districts within the Southwest Region. For the period 2015–2017, data for Kyustendil and Pernik districts are classified as confidential in Infostat, and therefore their relative shares are not calculated for the specified time interval.

Table 3. Relative Share of R&D Expenditures by District as a Percentage of the Total in the Southwest Region for the Period 2014–2023 (%)

Districts	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Blagoevgrad	0,6	0,6	1,0	0,9	0,8	0,6	0,8	0,5	0,5	0,4
Kyustendil	0,1	..	..	..	0,5	0,4	0,4	0,4	0,4	0,4
Pernik	0,0	..	..	..	0,1	0,2	0,1	0,2	0,2	0,1
Sofia	1,3	2,5	1,8	1,8	1,5	1,0	1,2	1,4	1,2	0,7
Sofia (capital)	97,9	96,5	96,3	96,6	97,1	97,8	97,5	97,6	97,7	98,3
SW	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source of information: Infostat and own calculations

The table clearly shows that the majority of R&D expenditures within the Southwest Region are concentrated almost entirely in Sofia (capital), ranging from 96.3% to 98.3%. **Figure 3**

clearly illustrates that throughout the entire analyzed period, the scientific and innovation potential of the Southwest Region is heavily concentrated in the capital.

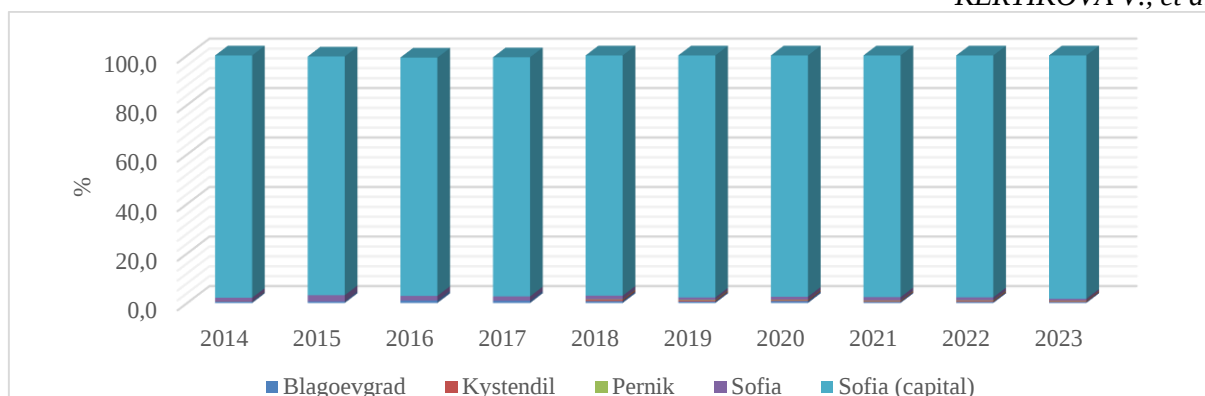


Figure 3. Distribution of R&D Expenditures by District in the Southwest Region for the Period 2014–2023.

After the capital, Sofia District ranks second, showing low shares ranging from 0.7% to 2.5%. Similar to the other districts outside the capital, its contribution is also low and shows a declining trend in recent years. Blagoevgrad ranks third in the region but with an extremely low and decreasing contribution, with its share varying from 0.4% to 1.0%. In dynamic terms, a downward trend is observed, reaching 0.4% in 2023. This indicates that the district's capacity in terms of R&D expenditures is shrinking.

Kyustendil District ranks fourth in the region and also shows an insignificant contribution, with its share remaining stable at 0.4% during the period 2018–2023. The contribution of Pernik District is symbolic, ranking last in terms of the relative share of R&D expenditures in the Southwest Region. This negligibly small percentage ranges between 0.0% and 0.2%, demonstrating that Pernik's contribution is practically insignificant, with no positive trend for improvement in this indicator.

In summary, there is a clear concentration of R&D expenditures within the Southwest Region, almost entirely centered in Sofia (capital). The remaining districts in the region—Blagoevgrad, Kyustendil, Pernik, and Sofia District—have insignificant, and in some cases decreasing, shares, which can be explained by the lack of developed research infrastructure. The limited concentration of innovation-driven industries likely explains the weak investment attraction in these areas. As a result, innovation potential, investment in knowledge, and opportunities for developing a high value-added economy are almost entirely concentrated in a single city. This dynamic contributes to the deepening of both intra-regional and national disparities in Bulgaria. The Southwest Region, led by the economic and scientific weight of Sofia, is the only region in the country that holds a significant position in

R&D expenditures. With a reported ratio of 1.2% of GDP, the region approaches the national target of 1.5%. The identified disparities call for urgent measures to stimulate R&D in the other districts of the Southwest Region and across the country to unlock their potential and achieve more balanced regional development.

CONCLUSION

The data clearly confirm the sharp regional disparity in R&D expenditures in Bulgaria. This disparity is due to the near-complete dominance of the Southwest Region, with the main contribution coming from Sofia – the capital, while the other provinces have insignificant participation. This uneven distribution of R&D expenditures has significant consequences for the overall economic development and competitiveness of both the country and its regions. The study demonstrates that there is a serious structural imbalance in investments in research and development activities among the different regions of Bulgaria, favoring the Southwest Region. This concentration calls for an administrative reconsideration of the territorial division by designating Sofia (the capital) as a separate unit at the NUTS 2 level. Separating Sofia (the capital) will allow for a much more precise and detailed analysis of the research, innovation, and economic processes taking place in the capital and will contribute to the adequate planning of regional policy in the rest of the Southwest Region and the country. This measure would facilitate the identification of specific regional needs, priorities, and opportunities for targeted interventions to stimulate R&D development outside the capital. Another positive effect that should be reflected is the improvement of the efficient allocation of funds for science, innovation, and human capital development. Additionally, the separation of the capital will facilitate monitoring the impact of policies promoting

R&D and increase transparency in the management of innovation systems. In the long term, such an administrative change would significantly contribute to more balanced territorial development and reduce the deep regional disparities that currently hinder the overall economic growth of the country.

In conclusion, the recommendation to separate Sofia as an independent NUTS 2 region is not merely an administrative change but a strategic step necessary to create a more adequate framework for measuring, analyzing, planning, and stimulating research and innovation activities, leading to more balanced and sustainable development of Bulgaria.

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