ORIGINAL SCIENTIFIC PAPER
UDK: 330.341.1(497.11)
330.35:005.591.6
DOI: 10.5937/EKOPRE2204161V
Date of Receipt: December 7, 2021

**Dušan Vujović**
Belgrade Metropolitan University
Faculty of Economics, Finance and Administration

# INNOVATIONS, PRODUCTIVITY AND GROWTH: REFORM AND POLICY CHALLENGES FOR SERBIA

## Inovacije, produktivnost i rast – reformski i ekonomsko-politički izazovi Srbije

## Abstract

The economic annihilation caused by the wars, sanctions and hyperinflation has elevated the issue of restoring previous income and welfare levels to the very top of political and social agenda. Consequently, all efforts during the past two decades were focused on reviving economic growth. Initially the main source of growth was consumer demand financed by external grants and privatization proceeds, followed by industrial revival and new jobs financed by external borrowing and strong FDI flows. In recent years it is becoming increasingly clear that higher sustainable rates of growth needed for income convergence with Europe and improved standards of living can only be achieved with production, organizational and process innovations. This paper reviews the elaborate structure of the present national innovation system in Serbia and concludes that more than 120 academic and almost 80 R&D institutions are competing for very limited resources of around 0.9% of GDP, produce declining innovation output and do not collaborate with the enterprise sector to increase productivity and growth. To have a better impact on productivity, long-run growth and well-being of all citizens, innovation funding must be doubled, innovation priorities must be identified based on empirical evidence and R&D and innovation performance must be evaluated based on results.

**Keywords:** *innovation, productivity, economic growth, research and development, patents*

## Sažetak

Ekonomska katastrofa prouzrokovana ratovima, sankcijama i hiperinflacijom stavila je pitanje vraćanja prethodnog nivoa dohotka i blagostanja na sam vrh političke i društvene agende. Posledično, svi napori u protekle dve decenije bili su usmereni na oživljavanje privrednog rasta. U početku je glavni izvor rasta bila potrošačka tražnja finansirana grantovima i prihodima od privatizacije, nakon čega je to mesto preuzelo oživljavanje industrije i otvaranje novih radnih mesta finansirano spoljnim kreditima i snažnim prilivom SDI. Poslednjih godina postaje sve jasnije da se veće održive stope rasta potrebne za približavanje prihoda s Evropom i poboljšani životni standard mogu postići samo uz pomoć proizvodnih, organizacionih i procesnih inovacija. Ovaj rad daje pregled razuđene strukture sadašnjeg nacionalnog inovacijskog sistema u Srbiji i zaključuje da više od 120 akademskih i gotovo 80 istraživačko-razvojnih institucija konkuriše za vrlo ograničene resurse od oko 0,9% BDP-a, proizvode opadajući inovacioni autput i ne sarađuju sa preduzećima da bi se povećala produktivnost i ekonomski rast. Da bi imale bolji uticaj na produktivnost, dugoročni rast i dobrobit svih građana, potrebno je udvostručiti finansiranje inovacija, prioriteti finansiranja i podržavanja inovacija moraju biti ustanovljeni na empiriji, a performanse istraživanja i razvoja i inovacija moraju se ocenjivati na osnovu rezultata.

**Ključne reči:** *inovacije, produktivnost, ekonomski rast, istraživanje i razvoj, patenti*

## Introduction: Definition of innovations

Innovation is a relatively new term dating back to the beginning of the 17th century[1], although the concept of innovation existed for thousands of years. Innovations have marked the history of human development over the last four millennia. Technological innovations were the basis of critical production and survival knowledge of such importance that the two key periods preceding the new era were named after innovative metal processing technologies: the Bronze Age (from 2200 to 750 BC) and the Iron Age (from 700 BC to the beginning of the new era).

During the time of classical civilizations (Greece, Rome, Persia, Byzantium, China), the field of innovation expanded to the sphere of organization of the state and the army. Technological innovations once again took the center stage during the First and Second Industrial Revolutions, which were the basis for the emergence of a capitalist market economy and, to a large extent, of the competing non-market planned economies. Innovation brought new sources of energy, changed the production technology and organization as well as the concept of management. It enabled unprecedented growth in productivity, income levels and the living standards. More specifically, innovations enabled:

- New energy sources (steam engine, electric motor, internal combustion engine, nuclear power);
- New industrial machines that (partly) replaced human labor;
- New means of transport (train, steam ships, cars, planes);
- New means of communication (telegraph, telephone, radio).

Indirectly, these innovations radically changed not only the way of life (industrialization, urbanization) but also changed political organization and introduced decision-making based on representative democracies (i.e. political parties and elections). Nevertheless, for many decades the definition and common understanding of innovation were limited to a one-way causal link: from invention - to innovation of a product, process or technology.

Today, the meaning and content of INNOVATION have expanded to

- INCLUDE application of inventions, new ideas, novel approaches
- TO create new value
- IN production, application, assimilation, exploitation
- WITHIN enterprise, economy, society, global world
- BY renewing existing or developing
- NEW products, services, processes, technologies, markets, management methods
- RELATING to inputs, outputs and/or results/outcomes.

It should be emphasized that innovations can be:

- Sustaining – when they improve existing products and/or processes (and coexist with them) or
- Disruptive – if they introduce new products and/or processes that substantially change the way a specific need is met and thus displace old technology/organization/management.

In short, innovation always means the direct or indirect application of inventions (i.e. inventions, new ideas, innovations, etc.) to new products, technology, processes, organization, but also a new way of management, communication or decision-making. Application is a key word here, which means confirmation of invention/innovation on the market (through commercialization) or confirmation/acceptance in society. Without implementation, inventions only increase the fund of knowledge but do not represent innovation at the time. It happened many times in history, though, that cumulative effect of many ideas, concepts and inventions eventually leads to quantum leaps in innovations many years later. For example, theoretical breakthroughs and inventions in nuclear physics enabled applied research and innovations based on nuclear power (ranging from atomic arms to nuclear power stations, submarine engines, and use of radiation for medical treatment).

## Source and historical significance of innovation

China had one of the most developed economies in the world before the First and Second Industrial Revolutions.

1 The first formal mention of the term is found in F. Bacon in the book "On Innovations" published in 1625. The book deals with the emergence of new biological species rather than economic and social issues.

Thanks to, among other things, innovations, Western Europe, the United States and Japan have sharply increased productivity, accelerated economic growth and overtaken China in terms of output, income and quality of living standards. This poses many questions: To what extent have innovations contributed to faster economic growth? How can one measure the effectiveness and impact of innovations? What is the role of the market, and the state in the process of creating innovations? What type of companies (enterprises) are likely to become main national and global innovators? How does productivity growth enabled by innovations affect the wages, the level of knowledge and the income inequality within and across countries? What policies encourage innovation, productivity, economic growth and international competitiveness?

Measuring (supply of and demand for) innovation is becoming a central issue today. Patents and IPR (intellectual property rights) are potentially the key to answering the question of encouraging and measuring innovation. In 2019, three Stanford professors Stephen Haber, Edward Lazear and Amit Seru [7] discussed the issue of empirical measurement of innovation levels and effectiveness, the link between innovation and productivity growth (and, hence, economic growth), and the effects of productivity growth on inequality (in income and wealth distribution). Their research confirmed that the new innovation firms founded in the "Silicon Valley" are indeed the main modern source of innovation, but it also showed that existing firms are very innovative and active in registering new quality patents. Their research also showed that both private and public companies contribute to innovation, and that universities and state institutions can be very innovative.

The main objective of their empirical research was to develop an indicator of "high quality innovation". They used "big data analysis" to screen 9 million patents registered in the United States over the past two centuries and identify the occurrence of keywords in the technical description of the patents.

The analysis showed that:

- *Patents with essential innovations* (true novelties) frequently contained *new keywords* and had relatively small presence of older keywords found in previous patents;
- *Important patents* introduced new keywords which were *often repeated* in later (newer) patents;
- *High quality innovations/patents* met both criteria. They introduced new keywords that were often repeated in later patents. In other words, they brought fresh innovations that proved to be important as they affected later patents.

The resulting list of "high quality patents" proved to be quite similar to the list of patents that have already been recognized as significant patents in the economic and business literature. Their research showed that big data analysis can be used to identify and promote high quality patents and innovations, and set priorities in R&D field based on modern empirical research with minimal time lags.

## Source of innovation: Where do innovations come from?

Inventions and ideas and related innovations are created either by individuals (individual research) or organized groups (or networks) of researchers. Innovations are confirmed (or validated) either in the market or outside the market (in social groups or society as a whole, by individual country or a group of countries such as the EU, or by a global society).

More precisely, based on authorship we have:

- Individual innovations where the authors of inventions, as the basis of innovation, are either an individual or a small team engaged in a scientific research organization or a small company, or an individual researcher (such as Tesla), or
- Network innovations where inventions and innovations are the result of an organized collective effort of coordinated teams working on the same task.

According to the method or place of validation, we have:

- Market innovations where inventions/innovations are validated/confirmed either in the market by selling or assigning copyrights to an invention/innovation, or
- Non-market innovations where inventions, ideas and related inventions are not valorized directly in

the market but represent a public good (part of the knowledge fund or info sphere) which is confirmed by acceptance in social groups or society as a whole.

By combining the two criteria of "authorship" and "place of validation" we get the following classification of innovations (see Table 1).

By mapping all known inventions/innovations since the middle of the 18th century until today, three long-term tendencies have been observed:

- *First,* a dramatic increase in the number of innovations over time;
- *Second,* a growing share of network innovations that are the result of the organized work of a large number of professional research teams (second and fourth quadrant); and
- *Third,* a huge increase in the number of innovations that were not confirmed in the market through sales of products, technologies or organizational solutions, but through widespread acceptance in society (third and fourth quadrant).

On this basis, Johnson [8] concludes that an efficient and healthy modern national innovation system (NIS) must have a dynamic and well-organized fourth quadrant – of non-market network innovations that have a huge positive impact on raising intangible sources of productivity growth at the level of society as a whole and the development of the knowledge society.

Empirical research surveyed by Reamer [12] shows that innovations generate the best effects in an open ecosystem characterized by the free flow of ideas, knowledge and information through unregulated (or minimally regulated) and free market and social channels. Conversely, there is strong evidence that controlled and limited channels stifle ideas and innovations based on them. This is where the principles of free market economy clash with the innovation incentive system based on patents, IPRs and copyrights in general. As Schumpeter and, later, Baumol [3] argued, in an ideal market economy (with full competition), the immediate financial interest of innovators encourages the generation of inventions and innovations at an optimal level. Patents and other forms of protection of copyright and other property rights play a key role. But in practice we rarely find ideal conditions and, hence, the reliance on patents and intellectual property rights can help but also hinder the optimal generation of ideas and the spread of innovations.

Most of the new ideas that changed the paradigm of scientific ideas, applied research and technological innovations in the so-called Third Industrial Revolution have deep roots in academic research - that is, inventions that are in the fourth quadrant. In addition, an open network of academic research (which is confirmed by reviews and published) often creates or is the basis for creating knowledge platforms on which applied individual and group research with market verification is based. In other words, inventions and innovations from the fourth quadrant have a strong positive effect on the performance

**Table 1: Classification of innovations**

| | | |
|---|---|---|
| **MARKET** | Individual researchers or entrepreneurs private SMEs<br>*Use of patents to protect IPRs*<br>Examples: Tesla coil, dynamite, AC motor, transistor, vulcanized rubber<br>**Market – Individual 1** | Research teams or institutes market competition of private firms<br>*Use of patents to protect IPRs*<br>Examples: airplane, refrigerator, telegraph, radio, laser, jet engine, automobile, PC<br>**2 Market – Network** |
| **NONMARKET** | **Non-market – Individual 3**<br>Individual researchers or entrepreneurs philanthropists<br>*Share inventions, ideas free of charge*<br>Examples: nitroglycerine, ecosystem, CT scan, Atomic theory, WWW Internet | **4 Non-market – Network**<br>Academic organizations financed by the budget or grants<br>*Share inventions, ideas free of charge*<br>Examples: radar, computer, Germ theory, GPS, EKG, aspirin, penicillin, DNA, MRI |
| | **INDIVIDUAL** | **NETWORK** |

Source: Reamer [12] and Johnson [8]

of the second quadrant (market-oriented group/network research), but also individual research (i.e. first and third quadrant). This is especially true for the so-called general purpose technologies (GPT) that have wide application and huge potential impact on organizational and managerial efficiency. This accelerates the effect of innovation on productivity and economic growth as it allows earlier diffusion (narrows the coverage and shortens patent protection time) and the effect of innovation on business practices and corporate structure in industrial production[2] and in services[3] (including logistics).

The theoretical question of how to properly integrate innovations into economic growth theory is surveyed in Grossman and Helpman [6]. The practical policy question is how to find the best relationship between the patent and IPR protection and the beneficial development and diffusion of innovations with effects on economic growth and human well-being (i.e. quality of life).

## Effects of innovation on productivity and economic growth

The net effects of innovation on employment, productivity and income growth were positive during the First and much of the Second Industrial Revolution. The result was a dramatic improvement in standards and quality of life (mass introduction of household appliances). In the period 1947-1975, productivity and the real income of families in America grew at almost the same rate, indicating an equal distribution of the effects of economic prosperity based, among other things, largely on innovation (see Figure 1). After 1975, productivity grew noticeably faster than real household income. This shows that capital owners and individuals with special abilities (in management, arts, sports, science, etc.) reap most of the effects of cumulative productivity growth, while the real average income of the population stagnates or even declines.

Consequently, innovation is one of the factors that contributed to much faster growth of income of owners and individuals with special knowledge/abilities, increasing inequality not only due to less favorable income ratio of rich and poor, but also due to stagnation or decline in real middle income (expressed in median) and service families.

To some extent, the statistically recorded decline in real wages and incomes was partially offset by rising purchasing power for consumer goods and services from sectors with fast-innovation, especially information, communications, and computer services. At the same time rising real costs of housing, transportation, health services, higher education, culture and sports, etc. neutralized much of these gains.

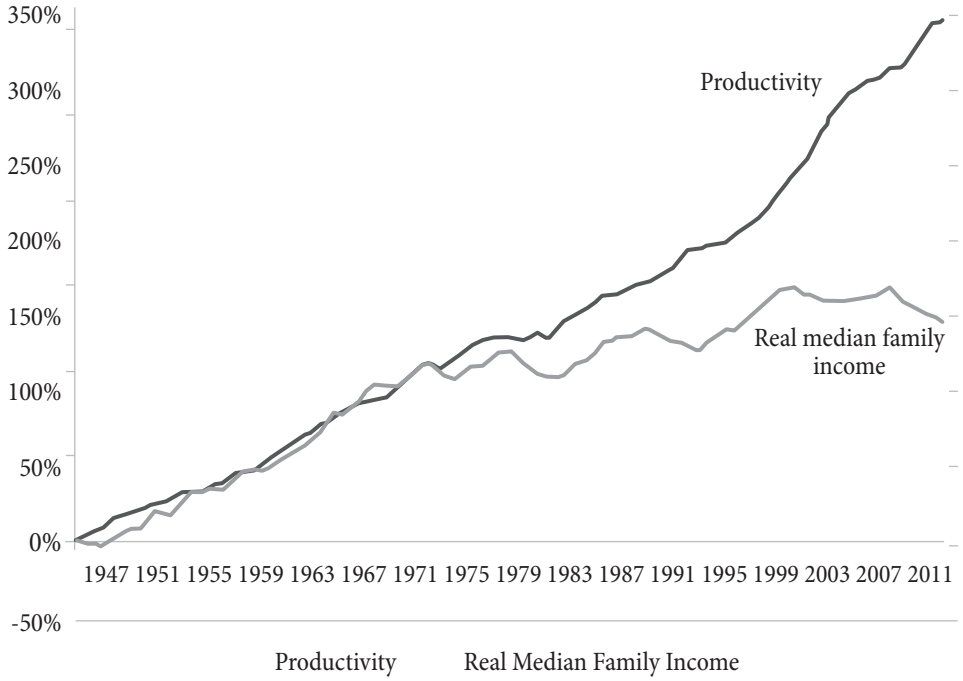
The main reason driving such changes in real prices could be attributed to predictable effects of innovations and new technologies aimed at automation. Coupled with strong globalization processes in trade and production, this has led to increased productivity and reduced employment per unit of GDP, while massively shifting standard high-paying jobs to lower-income countries. Lower and middle management jobs have followed the same trend. Over time, this reduced the demand for this profile of workers and enabled the management to noticeably reduce both the salaries/wages and other benefits provided within employment contract. This has increased inequality and produced far-reaching changes in the structure of labor demand, demand for innovation and investment in general with far reaching effects on economic growth and the well-being of most people.

These effects should be taken into account when defining innovation strategy and policy. As Acemoglu [1] and Restrepo [2] have shown convincingly, innovation policy directly affects not only average productivity growth but also the scope and nature of automation, and thus the effects on employment. Obviously, the interest of investors and owners remains profit maximization. Depending on the scope and nature of innovation, productivity growth can be achieved either through automation (i.e. labor replacement by machines) or by using new technology

2 The example of the moving assembly line in the automotive and other branches of industry shows this best. It has been 30 years between the confirmation of innovations and their application in factories. The resulting doubling in productivity could have happened much earlier had this general-purpose technology been supported in the right way.

3 A good example here is the introduction of integrated information systems at the level of production and service value chains that have enabled more efficient management of inventories and production in accordance with the dynamics of sales and demand.

**Figure 1: Productivity and real median family income growth, 1947-2011**




Source: Reamer [12]

and/or processes to increase employee efficiency and productivity. To illustrate this, let us assume that there are two types of product/process innovations with the same combined total net benefits (including R&D cost, investment cost and the reduction in operating costs including labor). In the first case, improved productivity is achieved through innovation that involves higher level of automation which requires higher investment cost which is compensated by a greater reduction in the number of employees. In the second case the same improvement in productivity is achieved through innovation that enhances labor efficiency (and hence wages). In the first case most of the effects of increased productivity are appropriated by the owners, while in the second case the effects of productivity growth are shared more evenly by owners and employees.

That is why we cannot assume that inventions and innovations alone lead to an increase in the well-being of all residents even when they increase economic growth and GDP. In principle, the effects of innovation on increasing inequality can be balanced through tax policy, but this approach is much more complicated politically. It is better to use innovation policy to promote innovations (products, processes, technologies) that have desirable effects on equality, social and environmental sustainability.

In short, Reamer [12] based on a detailed analysis of empirical and applied policy literature concludes that inventions and innovations play a central role in promoting economic growth.

- There is no dilemma for economic historians: accelerating economic growth during the First and Second Industrial Revolutions would not have been possible without key technological and organizational innovations.
- Analysis of the contribution of innovation to economic growth (innovation accounting) indicates the great importance of new (innovated) products and processes enabled by investments in research and development that increase the efficiency of (physical and human) capital and intangible assets.
- Macroeconometric analysis points to strong links between R&D investment and economic growth. The results of this analysis for 19 EU countries confirm strong ties, but show that the direction of these influences is not unambiguously determined.
- Microeconomic empirical (econometric) analysis based on firm data unequivocally shows that firms that innovate not only achieve faster productivity growth, but also create more jobs, earn higher wages for employees and higher profits for owners.

- Schumpeter's theory (and Baumol's reinterpretation) according to which innovations are the basis of the so-called creative destruction that displaces old products, processes and technologies and gives net positive effects on employment and economic growth is valid in ideal conditions of perfect competition and free markets, but not in real conditions.

It is important to understand in more detail how inventions and innovations affect economic growth, and how this impact affects the well-being of all residents/people. It is equally important to know which institutional assumptions and measures of direct support and economic policy optimally help the development of such inventions and innovations.

*Characteristics of a good national innovation system (NSI).* A good national innovation system according to Johnson (2010) has the following characteristics:

- Significant public investment in research and development (provide theoretical and practical arguments);
- Incentive system in which companies develop and/or apply a combination of new products, processes and organizational solutions that give the highest growth rate of companies (measured by production and employment);
- Allocation and mobility (reallocation) of resources in line with innovation in order to achieve optimal results in productivity growth; and
- Meets the following criteria:
  1) has educated/qualified workforce,
  2) demonstrates high level of entrepreneurship,
  3) adopts patent policy that secures balance between the protection of intellectual property and the free availability of innovative information,
  4) follows organizational solutions that support the development of networks,
  5) promotes reliable statistical data on key dimensions of innovation,[4]
  6) pursues principles of inclusive and sustainable economic development, and
  7) favors strong democratic institutions, including freedom of speech, rule of law, civilized relations and decency, and the right to research and experiment in the field of technological, organizational, institutional, business and social inventions and innovations.

## Impact of innovation on GDP: Econometric result for EU countries

An empirical study of the impact of innovation on p/c GDP growth in 19 EU countries during the 1989-2014 period was done by Maradana et al. [10]. The study conducted co-integration tests between the following six independent variables and GDP p/c growth rate:

- The number of resident patents (Case 1) and non-resident patents (Case 2);
- R&D expenditures (Case 3) and the number of R&D researchers (Case 4);
- High-tech exports (Case 5); and
- Scientific and technical journal articles (Case 6).

Granger causality tests were conducted (for all 19 countries and the EU, and for each of the six cases) to establish the direction of causality. In 50, out of 120 regression results, the study found unidirectional causal relationship (UCR) between innovation and economic growth. This supports the supply-leading hypothesis where innovations precede economic growth.

- Expectedly, the UCR occurred most frequently (in 21 out of 40 regressions) in combined cases 3 and 4 estimating the impact of R&D expenditures and the number of researchers on p/c GDP growth rate.
- UCR was confirmed in 18 out of 40 regressions in combined cases 1 and 2, thus confirming that patents have a strong role in promoting innovations which in turn have a positive impact on growth.
- Only 11 out of 40 regressions which passed the UCR granger test were found in cases 5 and 6.

In 38, out of 120 regression results, the study found reverse causal relationship (RCR) between innovation and economic growth. This supports the demand-following hypothesis where p/c GDP growth precedes innovations.

4 Including data on inventions, innovations, R&D, investments in intangible assets, SME development, benefits of digitalization, financing of SMEs and startups, etc.

- The RCR occurrence was distributed more evenly across the six cases with the highest frequency (15 out of 40 regression) found in cases 5 and 6, frequently (in 21 out of 40 regressions) in combined cases 3 and 4 estimating the impact of R&D expenditures and the number of researchers on p/c GDP growth rate.

Finally, in 22 out of 120 regression results, the study found bi-directional causal relationship (BCR) between innovation and economic growth. This supports the hypothesis of mutual interdependence between p/c GDP growth and innovations. This is the dominant form of causal relationship at the level of EU (in 4 out of 6 cases).[5]

In short, the results of the study confirm that the level and structure of innovations measured through patents, R&D inputs, hi-tech export performance and scientific and technical publications, had a decisive role in stimulating economic growth. In nine countries (Belgium, Finland, France, Hungary, Italy, Netherlands, Romania, Sweden, UK), innovation precedes p/c GDP growth and thus supports the hypothesis of the leading role of "innovation supply". In four countries (Denmark, Ireland, Norway, Spain), per capita economic growth precedes innovation and thus supports the reverse causality hypothesis with the leading role being attributed to "demand for innovation". In six remaining countries (Austria, Czech Republic, Germany, Greece, Poland, Portugal), innovation and per capita GDP are either mutually interdependent, confirming the hypothesis of a feedback loop between supply and demand in relation to innovation and growth, or cannot be determined based on the six tested cases.

In line with these results, the study recommends that in designing policies to promote per capita growth, special attention should be given to their impact on innovations. For example, it would be desirable for policies aimed at increasing foreign direct investment (FDI) to also attract production, technological and organizational innovations. In other words, the state should play an active role in supporting and attracting FDIs that bring not only new jobs and GDP growth, but also innovation as the basis for future growth. Based on the experience of the EU countries, this is best achieved by:

First, actively promoting the idea of the importance of innovation for (social, resource and environmental) sustainable long-term growth. This becomes increasingly important if simple policy interventions have already been exhausted (reduction of unemployment and relocation of labor from agriculture and extensive activities to modern industry and services) and future economic growth hinges on achieving a more efficient combination of inputs, productivity growth and better products and services.

Second, the state must support and nurture general innovations both:

- Indirectly, by creating a favorable environment for companies that are willing to invest more (in growth and development) and innovate; and
- Directly:
  - (a) by financing research (and development) in the public sector (in state universities, in public and state-owned enterprises and in state institutes), and
  - (b) by supporting private investment in research and development and innovation through tax incentives, subsidies and grants.

Third, the state should tailor sectoral support for innovations depending on the country's development needs and competitive advantages. This requires finding the right balance between support for improving national innovation system and (direct and indirect) support for innovations targeting specific groups or actors in the innovation process. Veugelers and Schweiger [13] show that this combination can only be found based on country specific empirical studies and frequent updates as it evolves over time.

## Serbia: Innovation system design and performance

Serbia has a very elaborate institutional system in the areas of science, R&D, and innovation. At the highest level are the Government and the responsible ministry (Ministry of Education, Science and Technological

5 To complete the picture it should be noted that in 8 regressions no causal relationship between innovations and growth could be established. For details see Maradana et al. [10].

Development - MESTD). Other ministries are responsible for important areas of science, research and development (energy, infrastructure, environment, agriculture, defense, economy, finance etc.).

According to the Law on Ministries, the Ministry of Education and Science has broad powers in defining and implementing the strategy and policy of scientific research and innovation. The Ministry is assisted in defining and implementing the relevant strategy and policy by the National Council for Scientific and Technological Development.

Within the MESTD ministry, three sectors deal with science, research, development and innovation issues. The division of responsibilities between science, research and development, and innovation is not always clear. Especially on the transition of basic research to applied research and further to innovation.

In the wider field of science, research and development, and innovation, Serbia has the Science Fund, the Development Fund and the Academy of Sciences and Arts (SANU), 38 scientific institutes (8 of them within SANU) and 35 research and development institutes, 22 centers of excellence, 123 faculties and/or universities, and 12,000 researchers.

In addition, according to MESTD official internet site, the Innovation Fund directly deals with 139 innovation organizations, 16 companies to support innovation activities (including 4 science and technology parks and business incubators), as well as 209 registered individual innovators (of which only 87 are active today and 122 have been deleted from the register). The Development Agency of Serbia (RAS) and the Chambers of Commerce also deal with and support R&D and innovation organizations. Innovations are also supported by technology transfer centers, the Intellectual Property Office, the Office of Information Technology and e-Government, and the Institute for Standardization.

During the past ten years, numerous very impressive results have been achieved in scientific and research work. The number of publications in scientific journals has increased significantly. The number of patents as well. Hundreds of scientific and innovation projects have been completed on the basis of funding from domestic and foreign sources through the Science Fund and the Innovation Fund.

## Serbia's performance based on the Global Innovation Index

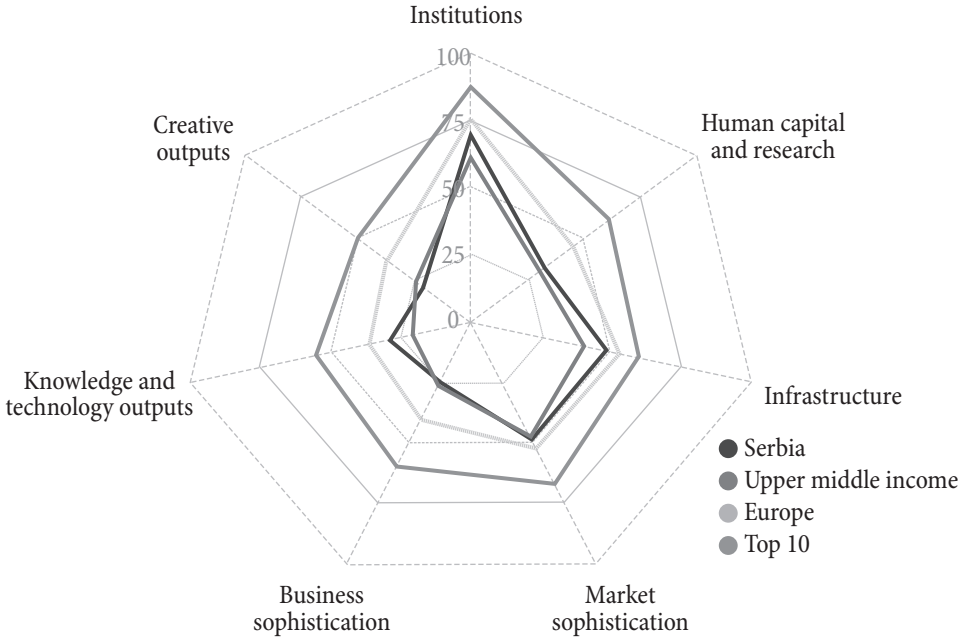
According to the Global Innovation Index (GII) for 2021 (see WIPO [15]), Serbia is slightly above the regression line depicting the effect of innovation on economic development (measured by GDP per capita expressed in purchasing power parity). This positive effect is certainly the result of increased investment in science, research and development, and innovation. Unfortunately, the efficiency of these investments was not as good: In terms of the ratio of innovation inputs and outputs, Serbia is below the regression line. This means that increased innovation investment was not well targeted either due to incorrect choice of priorities or due to muffled redirection of resources in line with recognized priorities. In practice, both factors probably worked.

According to GII estimates for 2021, Serbia ranks 54th in the overall innovation indicator. On the side of providing inputs for innovation, it has a better ranking (50th place) than on the side of innovation output (57th place), which indicates a lower average efficiency of using limited and quite expensive innovation resources. Moreover, there has been a relative deterioration in this aspect of performance compared to the GII 2020 report, indicating a decline in marginal effectiveness which should be taken into account when considering how to allocate innovation resources and measure the achieved innovation results.

It is important to emphasize that Serbia has better relative performance in relation to the group of countries with similar income levels (eighth place among 34 middle-income countries globally) than in relation to its region (Europe) where it ranks 34th from a total of 39 countries. This can be clearly seen in Figure 2, which gives a comparative overview of the score achieved by Serbia in each of the seven pillars of the GII index in relation to the score of countries with comparable middle incomes, Europe and ten countries leaders in innovation.

Compared to the group of middle-income countries, Serbia has better performance in all pillars of the GII

**Figure 2: Serbia's relative performance across seven GII pillars, 2021**




Source: GII 2021 [15]

index except in "business development" (where it lags behind marginally[6]) and "creative outputs" (where the lag is more noticeable).

Out of ten advantages of Serbia identified in the GII index 2021 report, the most significant for the national innovation system are: exports of IT services and creative services, ISO certification, FDI, number of articles in scientific journals, industry diversification, low tariff rates, and a favorable small student-professor ratio. These indicators can represent true advantages in the broad innovation area under a certain set conditions. But these conditions do not always hold.

For example, higher FDIs are beneficial for innovations if they bring new jobs, modern technology and better management practices. But if they bring low paying jobs, inferior technology and organization, and contribute to excessive diversification which lowers competitiveness, higher FDIs may not be well aligned with progress in innovations. Likewise, higher number of papers in scientific and technical journals can be an indicator of progress in creating inventions and innovations. But it can also indicate a weakness (a gap or discontinuity) in the process of developing ideas leading to applied innovations if the growing number of published scientific and technical papers grows in relation to the number of registered patents and (production and process) innovations. The same applies to a good average student-teacher ratio if it is not a result of a planned improvement in the education system but rather a consequence of low birth rates and migration from rural areas. Therefore, the perceived advantages based on better numerical values of selected indicators should be critically evaluated to ensure their effective impact on the quality of innovation system.

Furthermore, some perceived shortcomings should be viewed in the relevant context. For example, out of eleven indicator weaknesses identified in the GII index 2021, as many as eight are strongly connected and, taken together, suggest an unsatisfactory state of innovations at the microeconomic/corporate level. For some dimensions (covered by indicators such as enterprise expenditures on R&D, hiring researchers, spending on software and intangible assets, and brand value) companies bear full responsibility. For other dimensions (such as low capitalization, poor cluster development, and energy

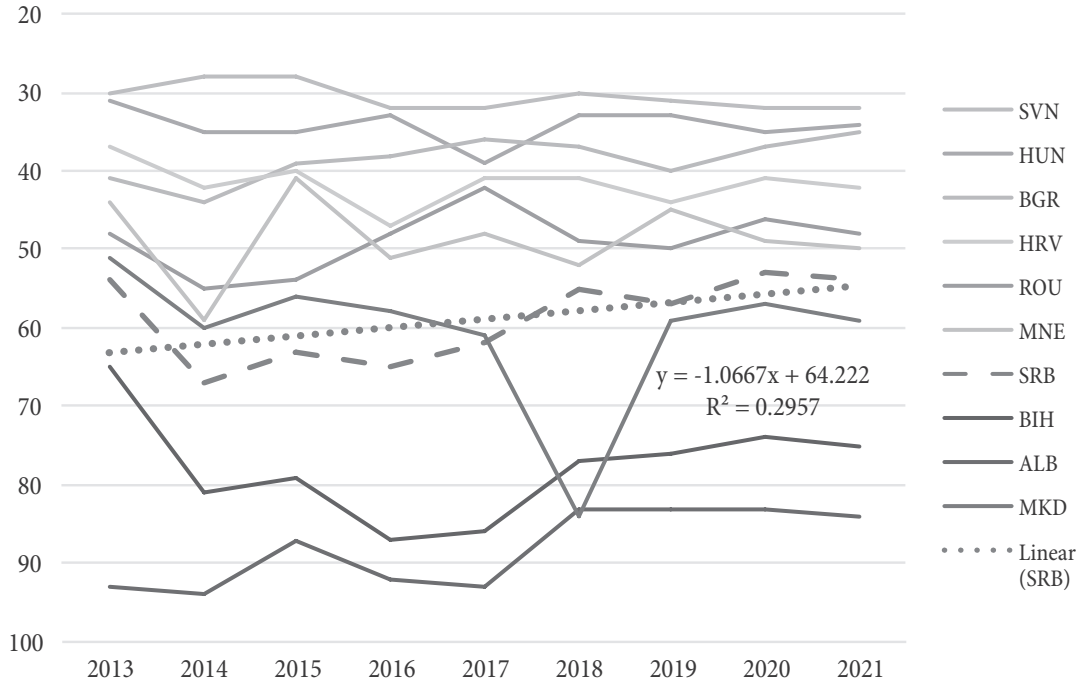
6 Although marginal in the numerical score, the lag in "business development" is serious in substance, as it stems from six strategically important factors: 1. low GERD (gross R&D expenditure) of companies (78th place), 2. weak cooperation between business and universities in R&D (85th place), 3. low level of cluster development (107th place), 4. relatively small number of joint ventures and PPP projects (80th place), 5. low imports of hi-tech equipment and products (75th place), and 6. small number of researchers employed in companies (64th place).

inefficiency) the responsibility is mostly at the country level.

This, of course, complicates the process of identifying the causes of identified weaknesses, setting priorities, and finding the right set of reforms and practical policy measures to support innovations with the highest impact on productivity, economic growth and sustainable development.

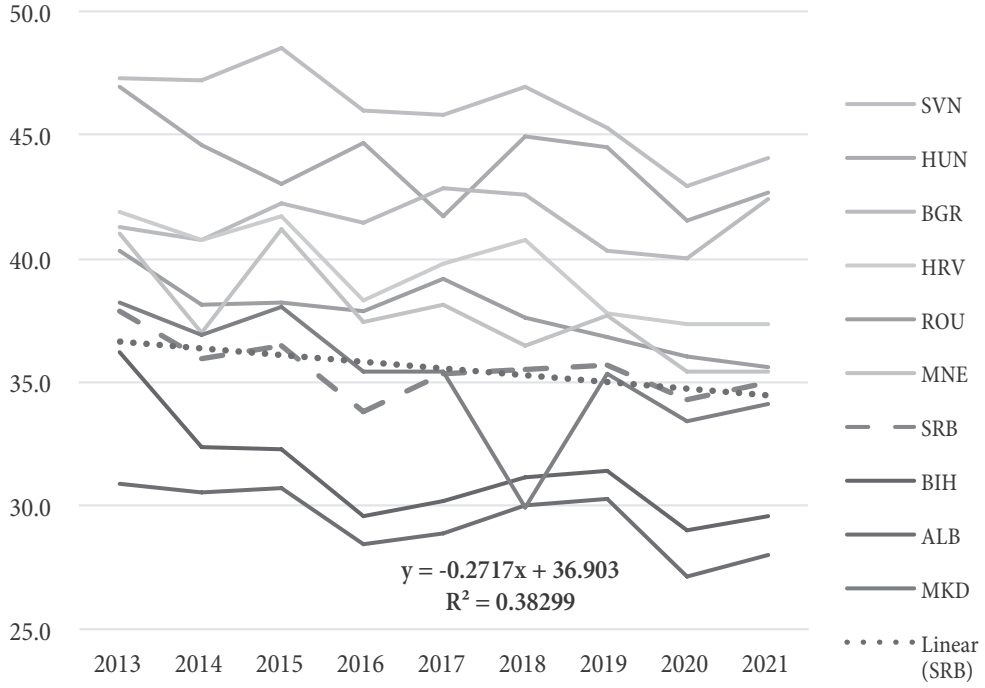
The following figures 3-12 are based on the GII WIPO database for the 2013-2021 period. We selected the following group of nine countries as regional leaders and comparators to Serbia (Slovenia, Hungary, Croatia, Bulgaria,

**Figure 3: GII Rank, 2013-2021**




Source: GII database, author's calculations

**Figure 4: GII Score, 2013-2021**



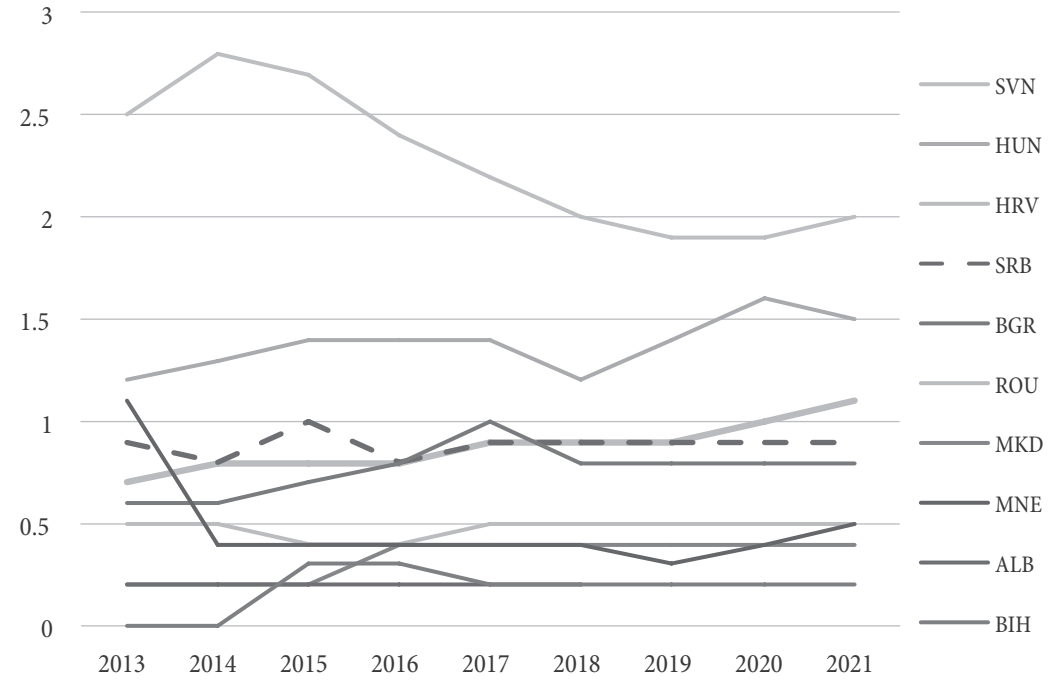

Source: GII database, author's calculations

Romania, North Macedonia, Montenegro, Bosnia and Herzegovina, Albania). The choice of indices was motivated by our primary objective to illustrate Serbia's innovation performance based on GII index, innovation Input and Output subindices, as well as some of the key indicators capturing financing, research potential and output.

In terms of key GII performance indicators Serbia consistently improved its overall GII rank (see Figure 3) despite the less stable and declining trend of the overall GII score (see Figure 4).

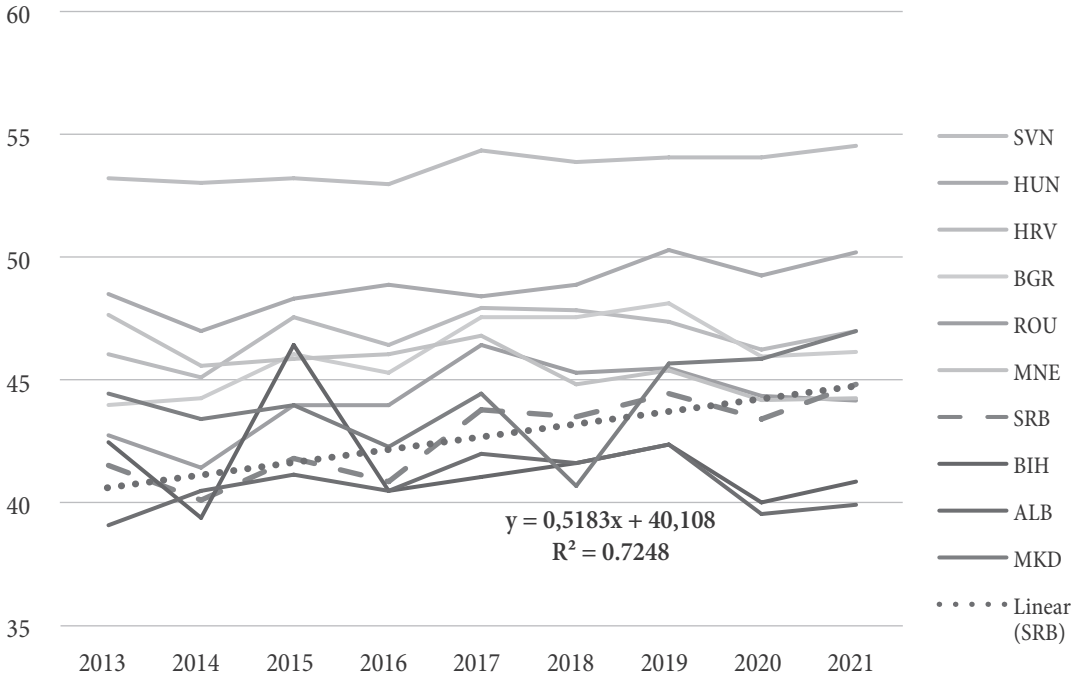
Gross expenditures on R&D (GERD) remained flat at about 0.9 percent of GDP during the entire period (see

**Figure 5: GERD, 2013-2021**




Source: GII database, author's calculations

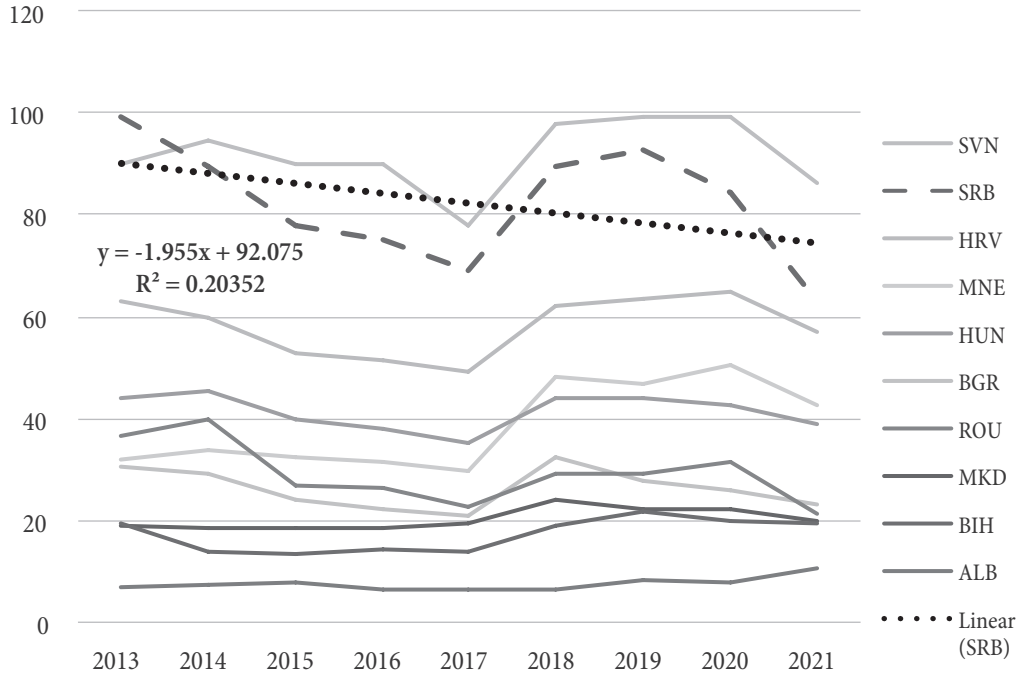
**Figure 6: Innovation inputs GII methodology, 2013-2021**




Source: GII database, author's calculations

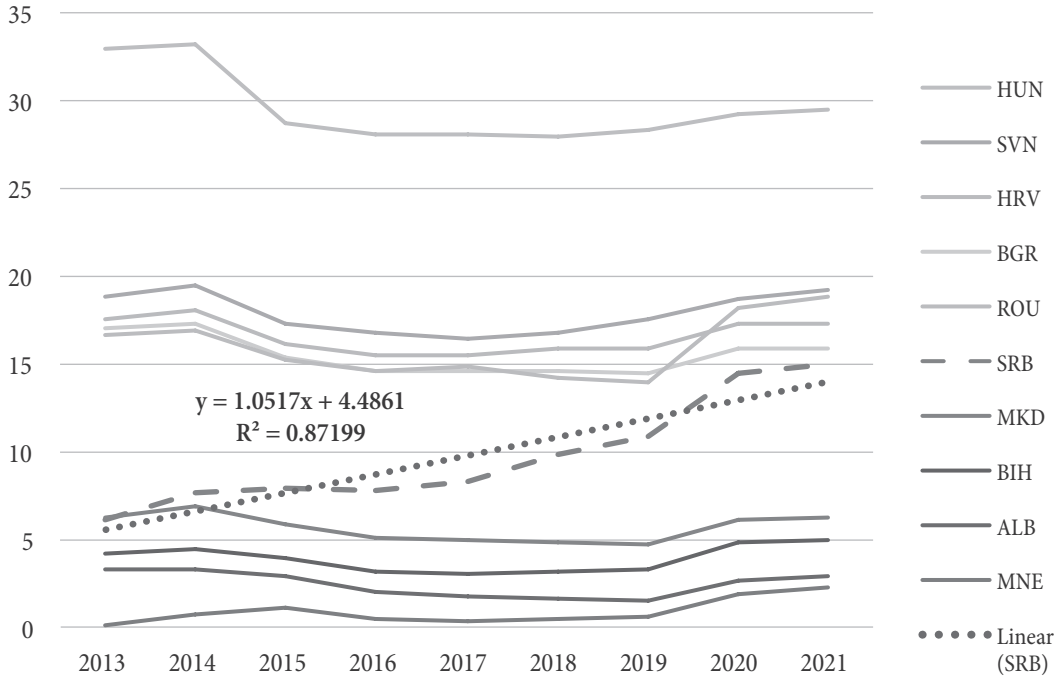
Figure 5), but consolidated innovation inputs (based on the GII methodology) consistently improved (see Figure 6) despite somewhat diverse dynamics in the four most important indicators: (1) the number of STJ publications followed a declining trend but still retained a very high second position among the selected comparator countries (see Figure 7), and (2) had a stronger impact as the H index measuring citations increased sharply (see Figure 8) allowing Serbia to close the gap vis-à-vis regional leaders. The number of researchers also increased (see Figure 9), while the number of registered patents fluctuated around a low and declining trend line (see

**Figure 7: Publications in scientific and technical journals, 2013-2021**




Source: GII database, author's calculations

**Figure 8: Citable documents H index, 2013-2021**

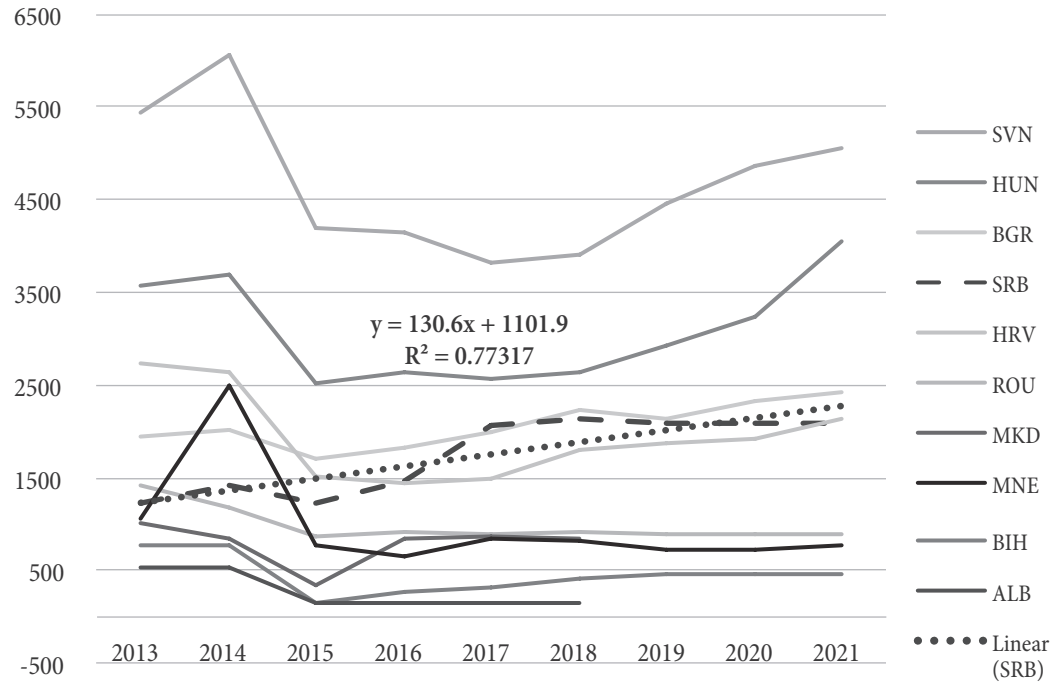



Source: GII database, author's calculations

Figure 10). As a result, consolidated GII output index followed a declining trend thereby confirming the GII 2021 conclusion that the overall national innovation system is faced with declining efficiency in converting a diverse vector of innovation inputs into innovation output (see Figure 11 and Figure 12).

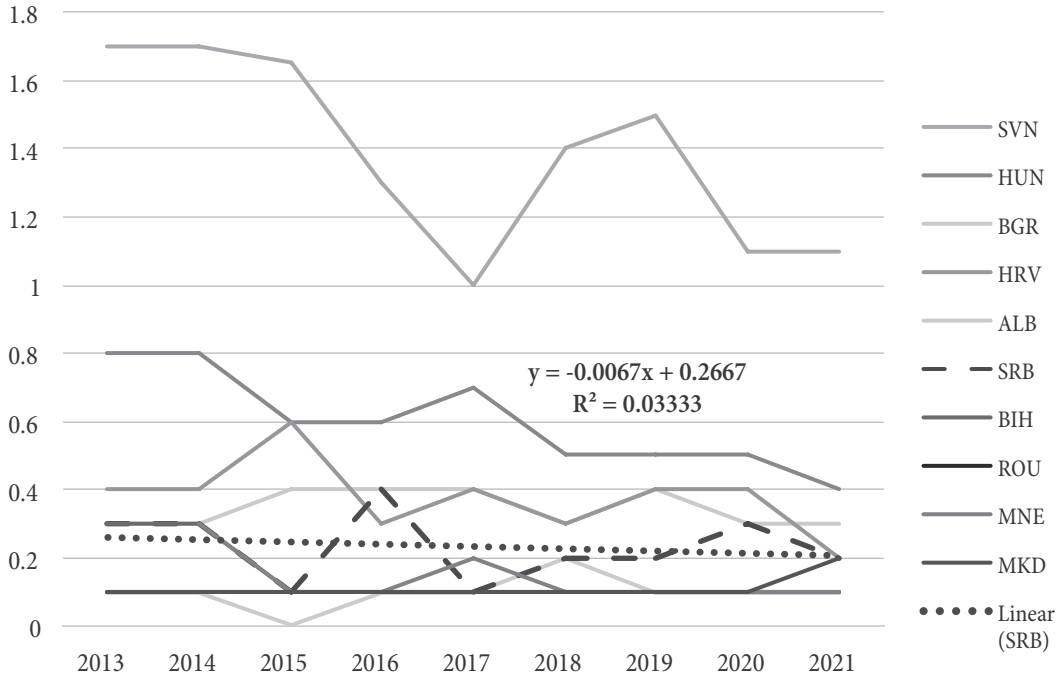
Two important caveats are in order: First, the anemic average performance of the overall national innovation system presented in the above trends does not apply to all innovation subsectors. Second, pouring in more resources without reforming the innovation system and identifying priorities is not likely to produce good overall

**Figure 9: Number of researchers, 2013-2021**




Source: GII database, author's calculations

**Figure 10: Number of registered patents, 2013-2021**



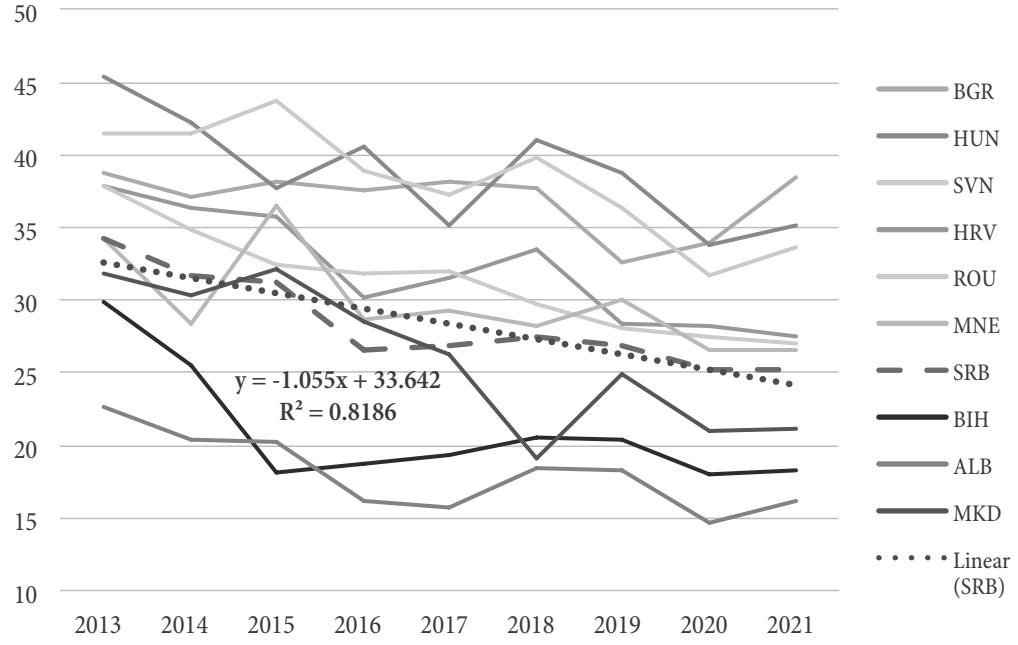

Source: GII database, author's calculations

results and, most importantly, the desired outcomes in increasing productivity and elevating long-term economic growth to the level needed to close the gap with regional leaders and the EU. This is the context in which the summary diagnostics and proposed reform and policy recommendations should be read.

Based on the GII evaluations and performance the following structural and functional weaknesses of Serbian national innovation system are apparent:

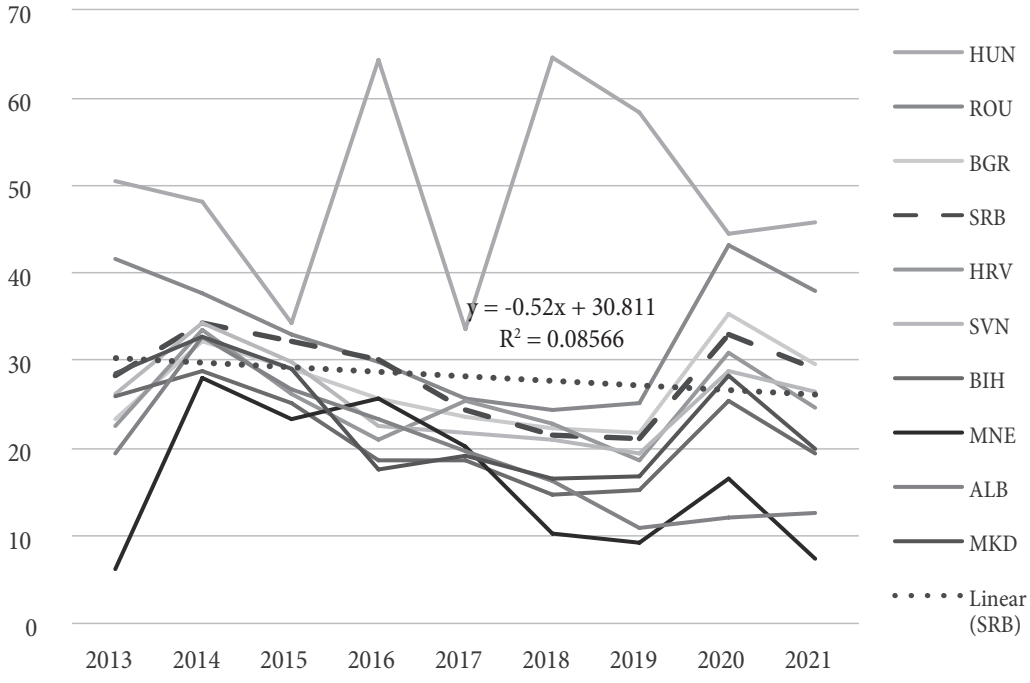
- Political support for "picking innovation winners" and lack of commitment for longer-term reform of the innovation system.

**Figure 11: Innovation output GII methodology, 2013-2021**




Source: GII database, author's calculations

**Figure 12: Knowledge diffusion, 2013-2021**




Source: GII database, author's calculations

- Weak linkages between innovation organizations and the economy due to:
  - Weak orientation of academia and R&D institutions towards business and technological innovations,
  - Low enterprise investment in R&D,
  - Lack of researchers in the enterprise sector.
- Weak SMEs role as innovation base due to their:
  - Short term commercial opportunistic orientation, and
  - Weak capacity (human capital) and financial base.
- Limited research potential in academia and R&D institutions due to prolonged transition, low investment in R&D, inadequate financial and career incentives, and brain drain.
- Outdated management systems and low quality of management in R&D institutions.
- Limited ability (flexibility and adaptability) and low motivation of R&D institutions to cooperate with the economy in general (and especially with SMEs) due to engagement in long-term projects (4-8 years) financed by the state budget.
- Lack of trust due to low transparency, betrayed expectations and lack of feedback on investment effects and results achieved.
- Slow progress of reforms due to inertia and resistance to change (i.e. the Innovation Law was passed in 2005 and has not been implemented in its important parts yet).
- Lack of reform and policy coordination and weak implementation of innovation strategies and policies.

NB One of the reasons for slow performance of the NIS is the excessive number of strategies (eight valid and three expired strategies), multiple policies and laws, poor policy coordination and the lack of dynamic prioritization - an imperative under tight budget constraints. This limitation is exacerbated by the large share of multi-year projects in scientific and research institutes at universities, or the small relative share of funds that the ministry can allocate or reallocate according to priorities using effective methods of motivating researchers, research teams and organizations.

## Concluding remarks and recommendations

The first priority is to align the structure and size of the innovation supply (academic and R&D institutes) with the possibilities and needs of the country. A large number of fragmented entities engaged in science and applied R&D must be scaled down to realistic magnitudes based on academic and research capacity. The rules of accreditation could reduce the number of scientific and R&D entities to a reasonable level, without eroding scientific-research potential. A country with 7 million people and estimated GDP p/c of about USD $8,100 in 2021 cannot sustain 123 faculties or universities (albeit many of them private), 38 research institutes, and 35 R&D institutes.

Second, at the same time, it is necessary to significantly raise the quality of scientific research, R&D and innovation. To achieve this, it is necessary to raise the level of R&D funding from the budget from existing 0.9% of GDP in 2020 closer to 2% by 2025. Fiscal incentives should be used to adjust the structure of the supply of patents and innovations to the needs of companies, as well as to increase corporate investment in R&D from 0.4% of GDP in 2020 to 0.8% by 2025.

Third, in addition to raising the number and quality of production, organizational, technological and process innovations, it is necessary to significantly raise the level of innovation in society and the state. This includes:

- Advances in area of eGovernment at national and local level which will save time and increase productivity and quality of life of all citizens.
- Improved budget preparation process both regarding investment and current expenditures – especially in health, education and all sectors that significantly affect the quality of life of the population. This would largely coincide with already confirmed trends in the world, where the number and quality of innovations produced by research teams are growing rapidly, and valorization is done outside the market through population-state interactions or through social interactions.

Fourth, it is necessary to either adjust and empower the department within the MESTD dealing with basic

science, R&D and innovations or form a separate ministry for Science and R&D with a mandate to:

- Raise awareness of the need for innovation to achieve the desired higher growth rates;
- Establish innovation policies at the government level;
- Strengthen ongoing political support for innovation;
- Strengthen the efficiency of the implementation of the innovation policy strategy, accountability, continuity and coordination of policies and actors;
- Ensure more efficient spending on R&D;
- Incorporate innovation into sectoral policies (information technology, agriculture, energy, transport);
- Preserve and develop scientific and research potential as a precondition for innovation progress;
- Ensure the necessary degree of openness and involvement in international innovation flows;
- Strengthen the contribution of research to economic and social development;
- Equally evaluate the results of applied research and innovation with academic results measured by published scientific papers and participation in conferences;
- Evaluate not only the number but also the quality of scientific papers and innovations (impact);
- Enable researchers to engage outside the academic sphere;
- It is necessary to set clear rules for financing from domestic sources and structural EU funds;
- Propose topics for scientific and research projects on an equal footing (50:50 researchers and countries);
- Each research organization must have its own vision and research mission.

Special effort will be needed to implement a practical innovation support agenda by coordinating multiple innovation strategies and policies, mobilizing financial resources, identifying R&D and innovation priorities, and adopting a results based approach in evaluating performance of all stakeholders. Over time (3-4 years) key elements of performance based budgeting should be expanded from evaluating past budget achievements to guiding allocation of resources in future budgets.

## References


1. Acemoglu, D. (2021). Remaking the Post-COVID World: To reverse widening inequality, keep a tight rein on automation. *Finance and Development.* Washington, DC: IMF.
2. Acemoglu, D., & Restrepo, P. (2019). Automation and new Tasks: How technology changes labor demand. *Journal of Economic Perspectives 33*(2), 3-30.
3. Baumol, W. J. (2002). *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism*. Princeton, NJ: Princeton University Press.
4. Deleidi, M., & Mazzucato, M. (2018). *Putting austerity to bed: Technical progress, aggregate demand and the supermultiplier* (Working Paper Series IIPP WP 2018-02). London: UCL Institute for Innovation and Public Purpose.
5. Deleidi, M., De Lipsis, V., Mazzucato, M., Ryan-Collins, J., & Agnolucci, P. (2019). *The macroeconomic impact of government innovation policies: A quantitative assessment* (UCL Institute for Innovation and Public Purpose, Policy Report, Working Paper Series IIPP 2019-06). Retrieved from https://www.ucl.ac.uk/bartlett/public-purpose/wp2019-06
6. Grossman, G. M., & Helpman, E. (1994). Endogenous innovation in the theory of growth. *Journal of Economic Perspectives, 8*(1), 23-44.
7. Haber, S., Lazear, E. & Seru, A. (2019, June 24). *How Innovation Drives Economic Growth.* Insights from Stanford Business. Retrieved from https://www.gsb.stanford.edu/insights/how-innovation-drives-economic-growth
8. Johnson S. (2010). *Where Good Ideas Come From: The Natural History of Innovation.* New York: Riverhead Books. Cited by Reamer (2014).
9. Kattel, R., Mazzucato, M., Ryan-Collins, J., & Sharpe, S. (2018). *The economics of change: Policy appraisal for missions, market shaping and public purpose* (UCL Institute for Innovation and Public Purpose, Working Paper Series IIPP WP 2018-06). Retrieved from https://www.ucl.ac.uk/bartlett/public-purpose/wp2018-06
10. Maradana, R. P. et al. (2017). Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, *6*(1), 1-23. Retrieved from http://dx.doi.org/10.1186/s13731-016-0061-9
11. Popovic, V. (2019). *Research and Innovation Capacity of the Republic of Serbia.* Belgrade: Ministry of Education, Science and Technological Development of the Republic of Serbia.
12. Reamer, A. (2014). *The Impacts of Technological Invention on Economic Growth - A Review of Literature*. Washington, DC: The George Washington Institute of Public Policy, The George Washington University.
13. Veugelers, R., & Schweiger, H. (2016). Innovation policies in transition countries: one size fits all? *Economic Change and Restructuring*, *49*, 241-267.
14. WIPO (2020). *The Global Innovation Index 2020: Who Will Finance Innovation?* Geneva: World Intellectual Property Organization.
15. WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis*. Geneva: World Intellectual Property Organization.

**Dušan Vujović**

Professor of Economics at FEFA (Faculty of Economics, Finance and Administration), Belgrade, and a World Bank consultant in the areas of macroeconomic policy, fiscal and governance reform, and innovation for growth. Dr Vujović chairs NALED (National Alliance for Local Economic Development) Research Council and provides consulting services to various Serbian and international research and policy institutes. From April 27, 2014 – May 16, 2018 Dr. Vujović held three ministerial positions in the Government of Serbia: Economy April 2014 - September 2014, Finance August 2014 - May 2018, and Defence February - March 2016. He received the best Minister of Finance in Eastern and Central Europe award for 2017. He was a USAID consultant on budget and fiscal reform issues, and a research fellow at CASE Institute, Warsaw. Dr Vujovic past career includes various positions at the World Bank, such as Country Manager for Ukraine, and Co-Director of the Joint Vienna Comprehensive program for government officials from the transition economies, Lead Economist in the World Bank ECA region and in the Independent Evaluation Group. He authored and co-authored a number of publications on macroeconomic policy, development, and institutional reform and transition issues published as papers in domestic and international journals, and chapters in books published by The World Bank, Oxford University Press, North Holland, Edward Elgar, etc.