European Commission

The identification of Smart Specialisation priority domains in Serbia

Mapping exercise

Edited by Radovanovic, N. Matusiak, M. and Kleibrink, A.

2021

SMART SPECIALISATION IN

Serbia

EUR 30811 EN

EU Science Hub
https://ec.europa.eu/jrc

JRC125978

EUR 30811 EN

PDF ISBN 978-92-76-41079-9 ISSN 1831-9424 doi:10.2760/003800

Luxembourg: Publications Office of the European Union, 2021

How to cite this report: Radovanovic, N., Matusiak, M. and Kleibrink, A. editor(s), *The identification of Smart Specialisation priority domains in Serbia. Mapping exercise*, EUR 30811 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-41079-9, doi:10.2760/003800, JRC125978.

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Acknowledgements

We would like to acknowledge the commitment and high-quality work performed by the Fraunhofer ISI and the experts coordinated by Serbia's National Smart Specialisation Team in conducting the quantitative and qualitative analysis of Serbia's economic, innovation and scientific potential. In addition to the authors listed below, special acknowledgement goes to contributing authors Milan Solaja, Jelena Begovic, Jasna Mastilovic, Milica Bozanic and Mirjana Opacic, members of Serbia's Entrepreneurial Discovery Working Group, and to the Statistical Office of the Republic of Serbia, which provided necessary disaggregated datasets which made the analysis possible.

Editors

Radovanovic, Nikola, European Commission – Joint Research Centre (editor)

Matusiak, Monika, European Commission – Joint Research Centre (editor)

Kleibrink, Alexander, Advisory Panel Expert of the European Spatial Planning Observation Network – ESPON (editor)

Authors

Henning Kroll, Fraunhofer ISI

Esther Schnabl, Fraunhofer ISI

Djerdj Horvat, Fraunhofer ISI

Domen Bole, independent expert

Lazar Zivkovic, Institute Mihajlo Pupin

Viktor Nedovic, Ministry of Education, Science and Technological Development of Serbia

Executive summary

Smart Specialisation represents a unique approach to reinforce economic transformation by supporting targeted actions for further development of the most promising areas, aiming at improving competitiveness, innovativeness and responding to societal challenges. It plays an important role in the competitiveness build-up of the Western Balkans region, being used as one of the crucial tools for supporting the economic recovery of the region under the Western Balkans Agenda on Innovation, Research, Education, Culture, Youth and Sport. The aforementioned Agenda supports the development and implementation of Smart Specialisation Strategies through expertise and best practices under the guidance of the Joint Research Centre.

As a candidate country for European Union membership, Serbia is undertaking complex policy reforms, thus facing the challenges of the economic transition process. These challenges have been intensified with the disruptive impact on the country's economy caused by the COVID-19 pandemic. In order to boost its efforts in tackling the above-mentioned issues and to orientate towards unlocking its innovation potential for sustainable economic competitiveness, the country had launched a mapping exercise within the Smart Specialisation process. Such an exercise is based on the thorough analysis of various data sources related to economic, innovation and scientific potential, with the ultimate goal of identifying potential promising areas for investment. It is also a very important process in which stakeholder engagement begins, which advances further during the Entrepreneurial Discovery Process (EDP). The mapping exercise was conducted based entirely on the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region, which has been developed by the Joint Research Centre to provide guidance and assist economies in enhancing policy-making through the joint participation of businesses, academia, civil society and public administration, in a process based on transparency and evidence.

The mapping exercise succeeded in identifying the preliminary priority areas by applying various complementary methods which analysed a variety of data sources and ultimately presented the findings at national level. The availability of data presented a formidable challenge for this exercise, but it was successfully overcome with the participation of a wide range of actors within the National Analytical Team for Smart Specialisation who helped to gather the relevant information. The results of the quantitative mapping were further validated in the qualitative mapping phase, which required the involvement of stakeholders from the business sector, academia, public administration and the civil sector. This step was conducted to justify the findings and provide the list of preliminary priority areas for Serbia by elaborating on potential and critical mass for each priority area.

The mapping exercise – as methodologically described in the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region – proved to be beneficial in profiling preliminary Smart Specialisation priority areas. It captured relevant statistical indicators for determining specialisation areas across three pillars of the exercise, which are represented by economic, innovation and scientific strengths. It further allowed qualitative validation through the engagement of stakeholders, aiming at determining the existence of critical mass in each proposed priority area as well as at understanding both current and potential future trends. Through this cumulative sequence of analytical steps, the mapping exercise succeeded in consolidating the list of preliminary priority areas.

Customised interviews of stakeholders in the qualitative mapping phase represented the first thorough involvement of stakeholders in the Smart Specialisation process and helped design the upcoming EDP in the country. It also provided information about the levels of stakeholder motivation and the capacity for stakeholder dialogue within the EDP. This enabled Serbia's Smart Specialisation Working Group to prepare the rules, procedures and roles of the actors in the EDP workshops, as well as to identify ambassadors of the process, i.e. stakeholders that are likely to promote discussion and facilitate the identification of all relevant elements of the EDP for a particular priority area.

It is important to note that data collection and processing for the purpose of the quantitative mapping exercise was carried out in 2017, while the qualitative mapping was completed in the following year. Accordingly, the results from these analyses were used for identifying priority areas for Serbia's Smart Specialisation Strategy, which was finalised in 2019 and adopted in 2020. It should also be noted that this exercise represents the first and successful application of the Smart Specialisation mapping methodology performed under the guidance of the Joint Research Centre in the EU Enlargement and Neighbourhood Region that later served further developments and applications. Any subsequent mapping exercises in Serbia using the most recent data for the analysis should follow the same methodology applied here.

Abstract

The report documents the findings of the analytical phase of development of the Smart Specialisation Strategy for Serbia, implemented with the methodological and financial support of the Joint Research Centre of the European Commission (JRC). The analysis follows the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region (Matusiak and Kleibrink, 2018) and has two complementary parts: quantitative mapping aims to identify the potential Smart Specialisation priority areas based on the set of indicators, showing critical mass, specialisation and growth rates in the subsectors of economic activity and specialisation in science, technology and innovation outputs. The results of this analysis are verified in a second step through qualitative mapping, based on structured interviews, focus groups and case studies. Both analyses provide a sound base for the following entrepreneurial discovery phase of the strategy development. The findings from both analyses represented key inputs for the upcoming stakeholder dialogue under the Entrepreneurial Discovery Process (EDP).

Serbia decided to introduce the Smart Specialisation approach into the development of its innovation policy in 2016. Guidance and technical support has been provided by the Joint Research Centre ever since, based on the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region. Serbia created its National Smart Specialisation Team to coordinate the Smart Specialisation process and managed the process until the strategy was adopted in February 2020. The Analytical Team within Serbia's National Smart Specialisation Working Group played an important role in providing expert support and developing local capacities for both the quantitative mapping – conducted by the Fraunhofer ISI – and the qualitative mapping. Another major contributor was the National Statistical Office of the Republic of Serbia, which provided necessary disaggregated datasets which made the analysis possible. The quantitative mapping revealed several primary and secondary preliminary priority areas, which were further analysed in the qualitative mapping phase. The qualitative analysis set out four final priority areas with sub-areas for Smart Specialisation in Serbia.

1 Introduction

In an effort to develop its new innovation policy Serbia launched the Smart Specialisation Strategy development process in 2017 – under the guidance and assistance of the Joint Research Centre – based on a fully transparent, evidence-based and participatory approach. The Smart Specialisation Strategy and its development process allows priority areas for research and innovation to be identified, making the country better equipped to streamline R&I investments, increase competitiveness, encourage R&I business cooperation and strengthen R&I innovation ecosystems, as well as contribute to further integration into the regional and EU research community (Guzzo and Gianelle, 2021; Woolford et al., 2021; Marques Santos et al., 2021; Gianelle et al., 2020).

Since its launch, the Ministry of Education, Science and Technological Development has coordinated the Smart Specialisation process in Serbia with the establishment of an inter-ministerial working group tasked with the development of the Smart Specialisation Strategy. The working group was divided into two teams – analytical and operational. The Operational Team supported the organisation of activities in the Smart Specialisation development process, while the Analytical Team worked on the thorough quantitative analysis of the economic, scientific and innovation potential with the expert support of the Fraunhofer Institute.

The mapping exercise represents an evidence-based method for analysing a country's or region's economic, innovation and scientific potential. This includes quantitative and qualitative analyses of key indicators and factors related to the economic, innovation and scientific performance of a country or region (Kyriakou et al., 2016; Sorvik and Kleibrink, 2015). While the quantitative stage predominantly looks into statistical data and indicators and applies different techniques for revealing specialisation fields in the form of preliminary priority areas, the qualitative stage is focused on validating these findings through customised discussion with a number of different stakeholders and, hence, further profiling priority areas. The result of these processes is the list of main priority areas and sub-areas which are to be further discussed during the stakeholder workshops within the Entrepreneurial Discovery Process (EDP).

The quantitative mapping phase in Serbia was finalised in November 2017 and revealed several potential priority areas at both national and regional level. The analysis was carried out in accordance with the statistical division of regions in Serbia and was carried out by the Fraunhofer Institute and Serbia's S3 Analytical Team led by the Institute Mihajlo Pupin. The analysis looked into datasets of available statistical indicators at subnational level, with the aim of revealing economic sectors with strong growth and development potential. The methodology applied revealed varying areas of specialisation and included the location quotient measure for determining specialisations throughout the regions, with subsequent efforts to homogenise the findings at national level. The final identified areas provided essential input for the qualitative analysis stage.

The qualitative analysis was carried out in the second half of 2018 in order to verify the results from the quantitative analysis in the mapping exercise. It was performed by the team of experts in close collaboration with Serbia's National Smart Specialisation Team. The qualitative analysis included interviews with stakeholders from the entire quadruple helix. The representatives from the private sector comprised more than half of all interviewed parties. In addition to interviews, this stage involved additional analyses for supplementing the findings from the quantitative analysis, such as a case study, multi-criteria analysis and the results of innovation funding programmes. In addition to validating results and providing justifications for the list of selected priority areas, the qualitative analysis also provided the input for initiating the EDP process by setting a framework for stakeholder dialogue. During this phase, all identified priority areas were scoped and divided into sub-areas.

The entire mapping exercise in Serbia resulted in the final list of four vertical and two horizontal preliminary priority areas, discussed during the EDP. This report documents both quantitative and qualitative analyses of Serbia's economic, innovation and scientific potential[1].

[1] It must, however, be noted that the results of the analyses reported in this document reflect on the relevant data and indicators which were collected and analysed in 2017. In the event that the updated findings are required (e.g. for the purpose of developing the new action plan for Serbia's Smart Specialisation Strategy, or conducting a potential modification of the Strategy), the mapping exercise should be repeated taking into account the most recent data.

2 Mapping exercise within the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region

The first expressions of interest in applying Smart Specialisation beyond EU borders started to reach the European Commission's Smart Specialisation Platform in 2015 and 2016. The Joint Research Centre (JRC) decided to launch a pilot exercise with Serbia, Moldova and Ukraine in 2017. Different framework conditions in the partner countries, together with the lack of dedicated funding, tradition of regional innovation policies or evidence-informed and participative approaches resulted in the need to develop detailed guidance and increase institutional capacity before launching fully fledged strategic processes. The Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region (S3 Framework)[2] includes a set of modules and operational steps to guide the development of individual strategies. The mapping exercise in Serbia described in this report was one of the first pilots testing the recommended approach to the analytical part of the strategy development process. It has been developed jointly by JRC experts and staff: Alexander Kleibrink, Gabriela Fiori, Henning Kroll, Hugo Hollanders and Monika Matusiak in cooperation with national experts and the statistical offices of Serbia, Moldova and Ukraine. This guidance takes into account limited availability of data and analytical capabilities in the national administrations and the need to provide a robust yet simple approach applicable in countries conducting the Smart Specialisation exercise for the first time.

The idea of the mapping exercise is to collect available statistical and bibliometric data at a sufficient level of disaggregation to guide the evidence-informed choice of potential priority areas for Smart Specialisation. The hypotheses and conclusions resulting from the combination of various quantitative data sources are later verified during the qualitative phase, where in-depth interviews, focus groups and case studies are put in place. Such evidence-informed and verified proposals are only subjected to stakeholder deliberation during the Entrepreneurial Discovery Process.

There are many challenges associated with data collection, availability and analysis during the mapping exercise. They include access to the recommended indicators[3], the need to disaggregate them to achieve a sufficient level of granularity and the need to create local analytical capabilities for future exercises. In terms of the latter, Serbia created the Analytical Team, where scientists from the local research institutes worked together with the international experts and were later able to continue and update the analyses when needed. Access to recommended indicators requires a well-developed statistical system and the regular collection of indicators on Structural Business Statistics, Labour Force Survey, Community Innovation Survey, Research and Development Statistics and export-import data. These need to be disaggregated to sub-sectoral level (3 or 4-digit NACE), which requires direct cooperation with national statistical offices. This is facilitated by including them in the National Smart Specialisation Team at an early stage. The experience from 7 countries – that completed their mapping exercise by 2020 – shows that such a cooperation creates links that can support other evidence-informed policy-making exercises.

The statistical indicators are matched by the scientometric analysis based on the evaluation of specialisations in scientific publications, patents and, where available, trademarks and innovation projects. This part of the analysis requires a different set of skills that should be reflected in the local Analytical Team. Its main aim is to identify the knowledge and technological potential that, in combination with the key present and emerging economic activities, can contribute to the higher value added and development of new competitive niches. The potential combinations are explored during the qualitative stage, where the expert and market knowledge is mobilised to better understand the most promising potential priority areas and opportunities and challenges associated with them. This stage of the analysis also allows sectorally-structured data to move towards the interdisciplinary priority areas required by the Smart Specialisation approach. In such a way, the stakeholder dialogue during the Entrepreneurial Discovery Process can be based on evidence-informed preliminary priority areas verified by experts, which are now further understood, defined and developed into a knowledge-based consensus of key actors.

[2] op. cit.
[3] See S3 Framework.

3 Quantitative mapping of Serbia's economic, innovation and scientific potential

(Authors: Henning Kroll, Esther Schnabl and Djerdj Horvat, *Fraunhofer ISI*)

Quantitative mapping of Serbia's economic, innovation and scientific potential was carried out in 2017. It was conducted by the Fraunhofer Institute for Systems and Innovation Research ISI from Karlsruhe, Germany. Expert support for the preparation of the report was provided by Serbia's Smart Specialisation Analytical Team. The National Statistical Office of the Republic of Serbia provided necessary disaggregated datasets, which made the analysis possible. The Joint Research Centre of the European Commission provided financial support and methodological guidance. The opinions appearing in in this chapter are those of the authors and do not represent an official position of the European Commission.

3.1 Methodology

This chapter aims to identify potential priority areas for Smart Specialisation in Serbia based on the available quantitative indicators measuring economic, innovative and scientific potential at a low level of disaggregation. The following principal tenets of this analytical approach form the basis of this report:

a) on sectors and technologies.

It is the basic premise of the Smart Specialisation approach that growth will be triggered by the application of technologies in diverse, often traditional, sectors rather than by the support for specific 'technology sectors'. It is based on the, by now, undisputed empirical finding that the competitiveness of economies does not usually depend on the (overall still small) share of specific 'high-tech sectors', but on the extent to which they are successful in increasing productivity and competitiveness throughout the entire economy. Naturally, it does not deny the benefit of supporting 'high-tech sectors' where potential exists. However, its core ambition lies in identifying alternative economic leverage points for the majority of regions where high-tech sectors do not constitute an obvious point of departure, including strategies based on process, organisational or marketing innovations that this report cannot directly measure or cover. In sum, Smart Specialisation strategies shall be strategies of place-based economic transformation, with less of a focus on economic replacement;

b) on evidence based policy-making.

The Smart Specialisation approach underlines that, to be credible and legitimate, the development of innovation strategies for economic transformation should be grounded in a robust framework of empirical analysis rather than anecdotal impressions, situational opportunity or idiosyncratic decision-making alone. It demands that empirical realities are tabled and discussed rather than used partially and selectively. This report is a contribution to that objective. However, any quantitative analysis comes with certain limitations and can hence only constitute input to subsequent 'entrepreneurial discovery' processes in which final decisions are deliberated with important internal and external stakeholders and a deeper understanding of concrete activities that merit future support ('areas') can be gained. It is a necessary contribution to priority definition without any ambition of being exhaustive. For example, the following analysis is limited by the fact that it is conducted based on NACE categories of economic activities. Obviously, these can only serve as initial anchor points for identifying future areas of support such as the automotive or agri-food sector. Moreover, policy decisions will have to consider a number of practical insights into structures and opportunities in the 'real economy' that purely data-based analyses cannot pre-empt.

3.1.1 Data accessibility

For this exercise, the Ministry of Education, Science and Technological Development; Statistical Office of the Republic of Serbia; Intellectual Property Office; Faculty of Physics; and Mihajlo Pupin Institute provided good quality data on various analytical dimensions for all three relevant areas of analysis that need to be considered in an analysis following the Smart Specialisation approach: economic structure and dynamism, innovative activities and the related scientific basis.

In terms of substance, the received data can be subdivided in two main types:

1. data without or with limited subdivision by economic/scientific field of activity or limited subdivision at relatively coarse levels. These data will be considered in an introductory background study, which provides an initial general overview of the level of activity in the first section of this report;

2. data with detailed subdivision by economic/scientific field of activity for most indicators according to NACE 3-digit categories, for scientific activity according to Web of Science/Frascati classifications. These data will be considered in the following sections of this final report, addressing all three main areas of analysis separately (economy, innovation, science) and then, in a final step, combining them again in the last chapter. In technical terms, the latter data can be divided into two groups:

    (a) full coverage data, that is data which is available for the complete range of NACE categories from A to U, including LFS (Labour Force Survey) employment data, export data and data from the innovation surveys;

    (b) structural business statistics data for the 'business economy' (Structural Business Statistics), i.e. data that covers industry and selected services but not agriculture (NACE A), financial services (NACE K) and largely public or household-oriented services (NACE O-T).

3.1.2 Future needs in terms of data collection

The data that the Ministry of Education, Science and Technological Development; Statistical Office of the Republic of Serbia; Intellectual Property Office; Faculty of Physics; and Mihajlo Pupin Institute provided are comprehensive, topical and of a high quality. Hence, there are no specific future needs for data collection other than those to update the data provided if future analyses should be conducted. The collaboration between the different units and organisations in charge of individual data has been exemplary. Technically, an initial review would appear commendable no earlier than when all central indicators have been updated, i.e. around 2019 when the next rounds of indicators collected biannually are available.

To enable the Serbian S3 Analytical Team to continue this – or a similar – process in the future, it will be necessary to organise a methodologically and structurally permanent, obligatory and functional collection and analysis of input data.

3.1.3 Brief overview of regions

Smart Specialisation recommends a place-based and regional approach, especially in bigger countries. Serbian regions do not have the mandate or administrative capacity concerning the innovation policy, but the analysis was developed at regional level to facilitate better understanding of the spatial concentration of economic and scientific activities. The initial overview shows that Belgrade is the strongest region with a GDP per capita of around €7 500 (in 2017). Southern and Eastern Serbia has the lowest GDP per capita of €2 900. Across Serbia, gross value added primarily stems from service industries. In Belgrade, services account for 80.6% of the GVA. In the NUTS 2 region of Sumadija and Western Serbia, the share of services is 70.6% of the GVA. In all regions, the GVA share of agriculture is below 1%. However, while it is 0.3% in Belgrade, it is 0.9 in the NUTS 2 region of Vojvodina.

Unemployment is lowest in Vojvodina (17%) and highest in Southern and Eastern Serbia (20.0%). While agriculture does not constitute a high share of gross value added, it has high shares of employment. In Sumadija and Western Serbia, 30.9% of employees work in agriculture, while this is 18.0% in the NUTS 2 region of Vojvodina. However, in Belgrade, dominated by service activities, it is 2.6%.

For the following considerations, these very general findings are of great importance as they illustrate that, in rural Serbia, structures of employment and value added do not overlap at all. While agriculture remains highly important to ascertain employment and income for many, its contribution to the national GDP is not significant.

Moreover, an analysis of Serbia's regional human capital basis shows that while a significant share of the population has a medium level of education across the country, most university graduates remain located in Belgrade and Vojvodina. While these are positive findings for regional strategy building and specialisation with respect to the broadly available pool of workers with an adequate level of training – the obvious regional concentration of university graduates (e.g. engineers) – there is a risk that Serbia's southern regions will face difficulties in developing science- or technology-based growth poles in isolation.

In summary, the obvious disparities with regard to the different regions' overall level of economic development (which will later be mirrored for innovation and science) suggest that Serbian regional specialisations and priority areas, once identified, need to be developed in an integrated manner at national level. In particular in the southern regions, the sourcing of national level (or even international) capacities will be indispensable to building and developing local Smart Specialisations.

- RS11 – Belgrade/Београд

The NUTS 2 region Belgrade has 1.68 million inhabitants (2016) and extends over an area of 3 234 km^2. Between 2011 and 2016, the population grew by 1.56%.

In 2014, the total GDP amounted to €12.5 bn, meaning that the GDP per capita was €7 460. Total exports amounted to €7.77 bn in 2016. Overall, the region contributed 25.8% to Serbia's total exports. In 2016, the working-age population (aged between 15 and 64) was 1.13 million. Thereof, around 642 700 people were employed, while 121 300 were unemployed. The unemployment rate was 15.9% of the active working-age population. Monthly gross earnings amounted to RSD 79 242 per employee in 2016 (net RSD 57 717). Due to its character as a capital city region, services play an important role in general employment. The prevalence of employees with a university education is particularly high in the ICT sector, in financial services, scientific and technical activities, public administration and education, where it reaches more than 60%. Overall, on average Belgrade has the most qualified workforce in Serbia. While the share of those participating in vocational education and training is above the national average in business, administration and law (19%/15%), it is below the national average in engineering, manufacturing and construction (26%/30%).

- RS12 – Vojvodina

Vojvodina has 1.88 million inhabitants (2016). It extends over an area of 21 614 km^2. Between 2011 and 2016, the population decreased by 2.67%.

In 2014, the total GDP amounted to €8.8 bn, meaning that the GDP per capita was €4 647. Total exports amounted to €3.46 bn in 2016. The region contributed 32.1% to total national exports. In 2016, the working-age population (aged between 15 and 64) was 1.3 million. Thereof, around 690 400 people were employed, while 126 300 were unemployed. The unemployment rate was 15.5% of the active working-age population. Monthly gross earnings amounted to RSD 61 498 or approximately €506 per employee in 2016 (net RSD 44 646 or approximately €367). In simple terms, the region can be characterised as partly industrial, partly agricultural. In addition, it is the most externally oriented regional economy in Serbia. The prevalence of employees with university education is particularly high in the ICT sector, in financial services, scientific and technical activities, public administration and education, where it partially reaches around 60% and, thus, does not significantly fall short of Belgrade. Contrary to Belgrade, the share of those participating in vocational education and training is above the national average in engineering, manufacturing and construction (31%/30%), while it is below the national average in business, administration and law (13%/15%).

- RS21 – Sumadija and Western Serbia

Sumadija and Western Serbia has 1.96 million inhabitants (2016). It extends over an area of 26 493 km^2. Thus, it is the biggest region in terms of population and surface. Between 2011 and 2016, the population decreased by 3.76%. In 2014, the total GDP amounted to €6.4 bn, meaning that the GDP per capita was €3 194. Regional exports amounted to €3.52 bn in 2016, contributing 26.3% to Serbia's exports. In 2016, the working-age population was 1.3 million. Thereof, around 724 700 persons were employed, while 135 500 were unemployed. The unemployment rate was 15.7% of the active working-age population. Monthly gross earnings amounted to RSD 52 767 or approximately €434 per employee in 2016 (net RSD 38 315 or approximately €315). Sumadija and Western Serbia remains a region strongly characterised by agriculture. Compared to Northern Serbia, the regional share of employees with a high level of education is below the national average in most industries. Only in financial services, scientific and technical activities, public administration and education does it reach the typical sectoral standard. In the ICT sector, on the contrary, the share is 32% – barely half the level found in Belgrade or Vojvodina. Furthermore, more than 55% of agricultural workers have less than a high-school-level education (Vojvodina, 39%). On a positive note, the share of people involved in vocational education and training is above the national average in engineering, manufacturing and construction (32%/30%).

- RS22 – Southern and Eastern Serbia

The NUTS 2 region Southern and Eastern Serbia has 1.54 million inhabitants (2016). It extends over an area of 26 248 km^2. Between 2011 and 2016, the population decreased by 4.71%. The total GDP amounted to €4.5 bn in 2014, meaning that GDP per capita was €2 906. Total exports amounted to €2.12 bn in 2016. The region contributed 15.8% to Serbia's total exports. In 2016, the working-age population (aged between 15 to 64) was 979 300. Thereof, around 521 600 people were employed, while 105 300 were unemployed. The unemployment rate was 16.8% of the active working-age population. Monthly gross earnings amounted to RSD 55 333 or approximately €455 per employee in 2016 (net RSD 39 959 or approximately €333). The regional share of employees with high level of education was below the national average – even in financial services, scientific and technical activities, public administration and education and many other industries,

including ICT. Involvement in vocational education and training is around the national average, only slightly above average in agriculture, forestry, fisheries and veterinary and natural sciences.

3.1.4 Detailed methodological approach

The following three subsections will develop an initial overview of potential priority domains for Smart Specialisation in Serbian regions with respect to three main analytical dimensions. Each of these analytical dimensions will be substantiated by one or several indicators which are suitable for calculating specialisation and are available with a sufficient level of thematic disaggregation for making a calculation of specialisation technically possible.

- Economic potential

  - Employment, according to 2011-2016 labour force survey data,
  - Exports, according to 2012-2016 national export statistics.

- Innovation potential

  - Innovating firms, according to the 2010-2014 national Innovation Survey.
  - Patents, according to indicators developed by the Mihajlo Pupin Institute, based on data provided by the Intellectual Property Office.

- Scientific potential

  - Publications, according to indicators developed by the Faculty of Physics and Mihajlo Pupin Institute based on data collected by the Faculty of Physics.

As a primary, necessary condition, potential priority domains should display the following main characteristics in all three of the main analytical dimensions:

- *proper specialisation*, i.e. in relative terms, higher importance of the sector in the regional economy than what is standard for the economy. A typical measure for determining this specialisation is the location quotient (LQ), which compares the share of a sector in the local economy with the share of a sector in the national economy;
- *absolute size*. The mere fact that a sector is, in relative terms, more important than at national level can be irrelevant to regional economic policy if it is, in absolute terms, too small, i.e. only employs a few hundred people. Hence, absolute size is an important necessary criterion;
- *growth*. While growth is not a necessary condition for qualifying as a specialisation, it provides important additional information on the relevance of a sector. Is this an emerging field that has already gained momentum or is it rather a legacy from previous years which would require efforts directed at economic transformation?

Drawing on this approach, the following three subsections will analyse Serbia's regions with regard to the structure of local economic, innovative and scientific activity. They will predominantly use a form of illustration ('bubble charts') that permits a summary assessment of all three analytical dimensions (specialisation, size and growth) at once, while at the same time allowing for an initial filtering of those sectors or fields that do not meet the basic threshold criteria for either.

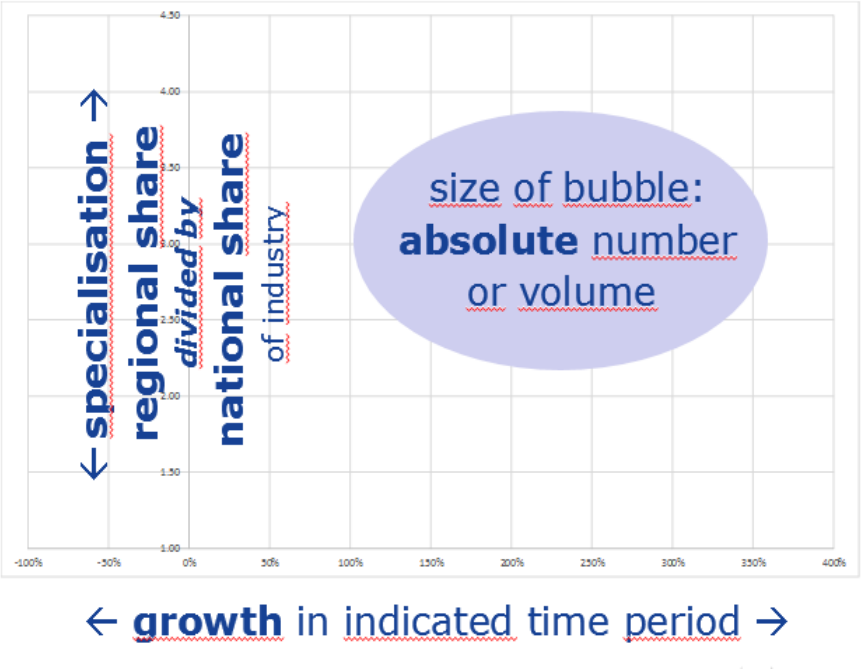
Following the notion of identifying potential priority domains for Smart Specialisation by focusing on those in which a region is specialised, the bubble charts below only include NACE sectors with a location quotient of more than 1.5, i.e. such that hold at least 1.5 times the share in a regional economy than they do in the national economy.

- In the case of employment (key indicator for baseline economic relevance), employment over 2 000 (4 000 in Belgrade). Furthermore, sectors with a location quotient between 1.0 and 1.5 are included as long as they employ more than 2 000 people individually (4 000 in Belgrade) and growth in the 2011-2016 reference period exceeded 75%. Lastly, some sectors are generally excluded from the employment diagrams: 46 (wholesale), 47 (retail), 80-84 (security, administration, public services), 85 (education), 92 (gambling), 94 (associations), 96 (personal services), 97 (activities of households) as they are either standard economic functions, very specific (gambling) or more suitably addressed elsewhere in this report (education).

- In the case of exports (key indicator for international competitiveness), export volume of over €100 000.
- In the case of innovating firms (key indicator for innovation potential), an overall number of more than 25 firms.
- In the case of patents (key indicator for latent innovation potential), an overall number of more than 5 applications.
- In the case of publications (key indicator for scientific potential), an overall number of more than 10 publications (in fractional count).

Beyond these selection criteria, the following identification of specialisations in the bubble charts will follow a visual approach. For each dimension (economy, innovation, science), NACE fields that visibly reach high values in all relevant criteria of specialisation, absolute size and growth will be identified as 'obvious specialisations' in final overview tables. In the same tables, NACE fields which stand out in some dimensions – but in a less obvious manner – will be listed as 'partial or tentative specialisations' in brackets.

Figure 1. Bubble chart illustration



Source: authors.

3.1.5 Analysis of indicators of economic, innovation and scientific potential

Following the guidelines developed by the Joint Research Centre of the European Commission, this first analytical section of the report will analyse specialisations of economic, innovation and scientific potential sequentially and, concluding, provide a synoptic review of them.

Initially, the synoptic review is conducted with a 'manual' approach, using expert judgement as the classifications of economic, innovation and scientific indicators (NACE, WoS) are not alike and, hence, do not allow for technical integration.

Later on, Section 3 will present an approach based on the technical integration of all variables that are available in the NACE classification and are therefore mutually compatible. The analysis will be presented at regional level to allow for a place-based approach to the identification of the potential priority domains.

3.2 Economic potential

1. RS11 – Belgrade

With respect to employment, several potentially relevant sectors can be identified in Belgrade's regional economy, including structural business statistics data for the business economy (SBS), i.e. data that covers industry and selected services but not agriculture (NACE A), financial services (NACE K) and largely public or household-oriented services (NACE O-T):

(a) computer programming,

(b) technical testing and analysis,

(c) R&D activities (established in natural science and growing in social science), and

(d) medical and dental practice activities,

as well as those with slightly less prominent growth:

(e) television and broadcasting,

(f) wired telecommunication, and

(g) architectural and engineering activities.

At first sight, the analysis of export data yields a less understandable picture in which only the 'manufacture of electric motors and generators' seems to relate to activities actually located in Belgrade. Apparently, many of the service sectors in which Belgrade is specialised do not demonstrate a strong export orientation. While this is typical for some of them, it is a relevant missing strength in the area of computer programming. With respect to iron and steel as well as weapons and ammunition, it seems likely that exports are accounted for by company headquarters in Belgrade, while most production is effectively located elsewhere (see below).

2. RS12 - Vojvodina

With respect to employment, several potentially relevant sectors can be identified in Vojvodina's regional economy, including:

(a) parts and accessories for motor vehicles (most prominently by far),

(b) the extraction of crude petroleum,

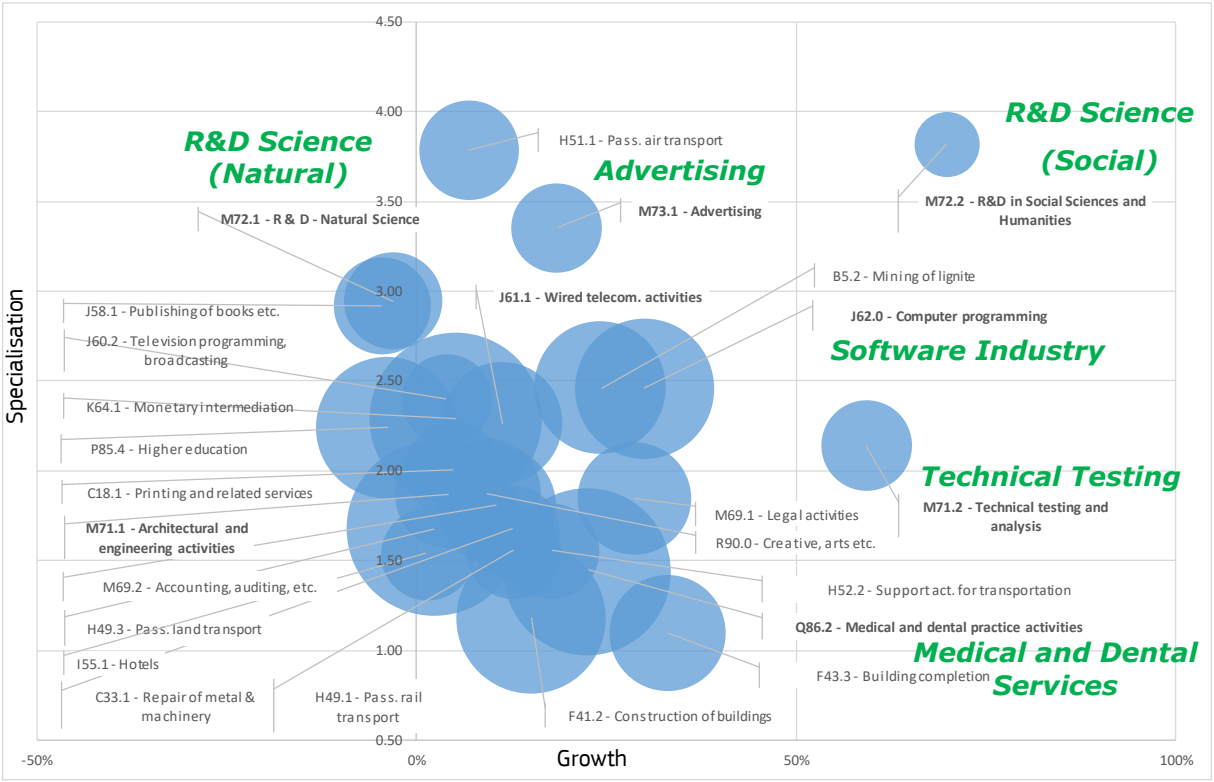
(c) technical testing and analysis, and

(d) manufacturing of apparel and textiles,

as well as – with notably less growth but a substantially larger contribution to overall employment – a large agricultural sector (non-perennial crops, i.e. cereals) and associated industries such as grain mills, meat processing, animal feeds, bakery products, etc. Furthermore, minor specialisations can also be identified in metal and plastic products.

Export data underline the role of generally less prominent but apparently internationally competitive activities in the chemical industry and reveals a general-purpose machinery sector that does not appear in the other dimensions due to its split between three NACE categories (28.1-28.3).

Figure 2. RS11 - Belgrade - Employment (LFS, 2016)

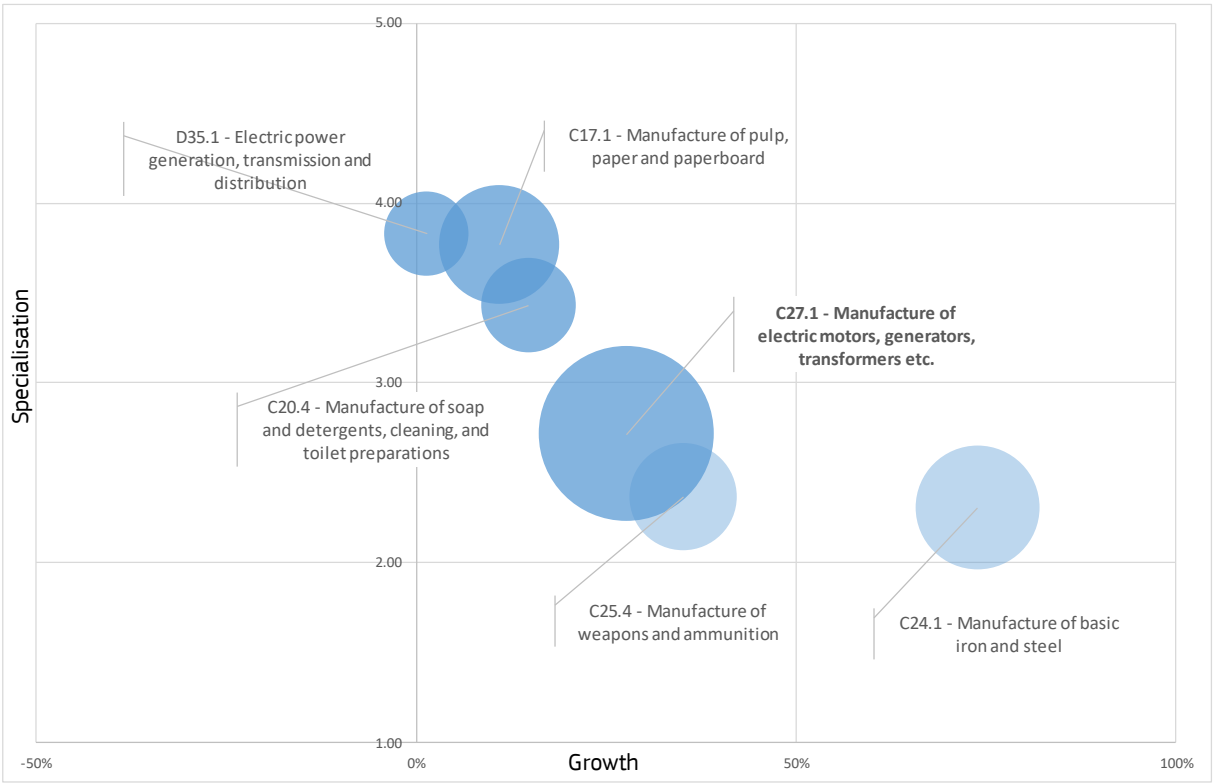


NACE codes in the graph (left to right): J58.1 - Publishing of books, etc; J60.2 - Television programming, broadcasting; K64.1 - Monetary intermediation; P85.4 - Higher education; C18.1 - Printing and related services; M71.1 - Architectural and engineering services; M69.2 - Accounting, auditing, etc; H49.3 - Passenger land transport; I55.1 - Hotels; C33.1 - Repair of metal and machinery; M72.1 - R&D - natural science; H49.1 - Passenger rail transport; J61.1 - Wired telecommunication activities; H51.1 – Passenger air transport; F41.2 - Construction of buildings; M73.1 – Advertising; M69.1 – Legal activities; R90.0 – Creative, arts, etc; Q86.2 – Medical and dental practice activities; F43.3 – Building completion; B5.2 – Mining of lignite; H52.2 – Support activities for transportation; J62.0 – Computer programming; M72.2 – R&D in social sciences and humanities; M71.2 – Technical testing and analysis.

Note: thresholds = LQ 1.5, abs. 4 000 employees, selected sectors excluded.

Source: own analysis.

Figure 3. RS11 - Belgrade - Exports (2015)

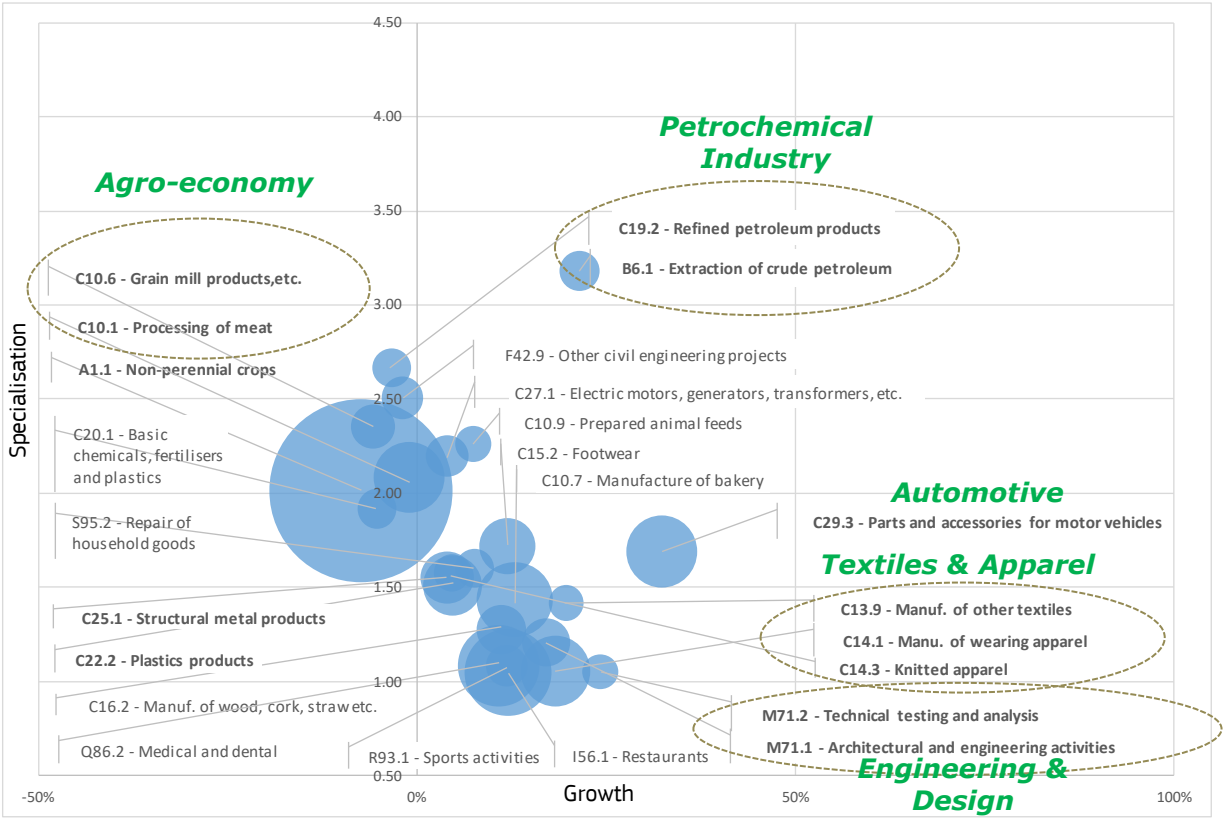


NACE codes in the graph (left to right): D35.1 – Electric power generation, transmission and distribution; C20.4 – Manufacture of soap and detergents, cleaning and toilet preparations; C17.1 – Manufacture of pulp, paper and paperboard; C25.4 – Manufacture of weapons and ammunition; C27.1 – Manufacture of electric motors, generators, transformers, etc; C24.1 – Manufacture of basic iron and steel.

Note: thresholds = LQ 1.5, abs. €100 000 export volume.

Source: own analysis.

Figure 4. RS12 - Vojvodina - Employment (LFS, 2016)

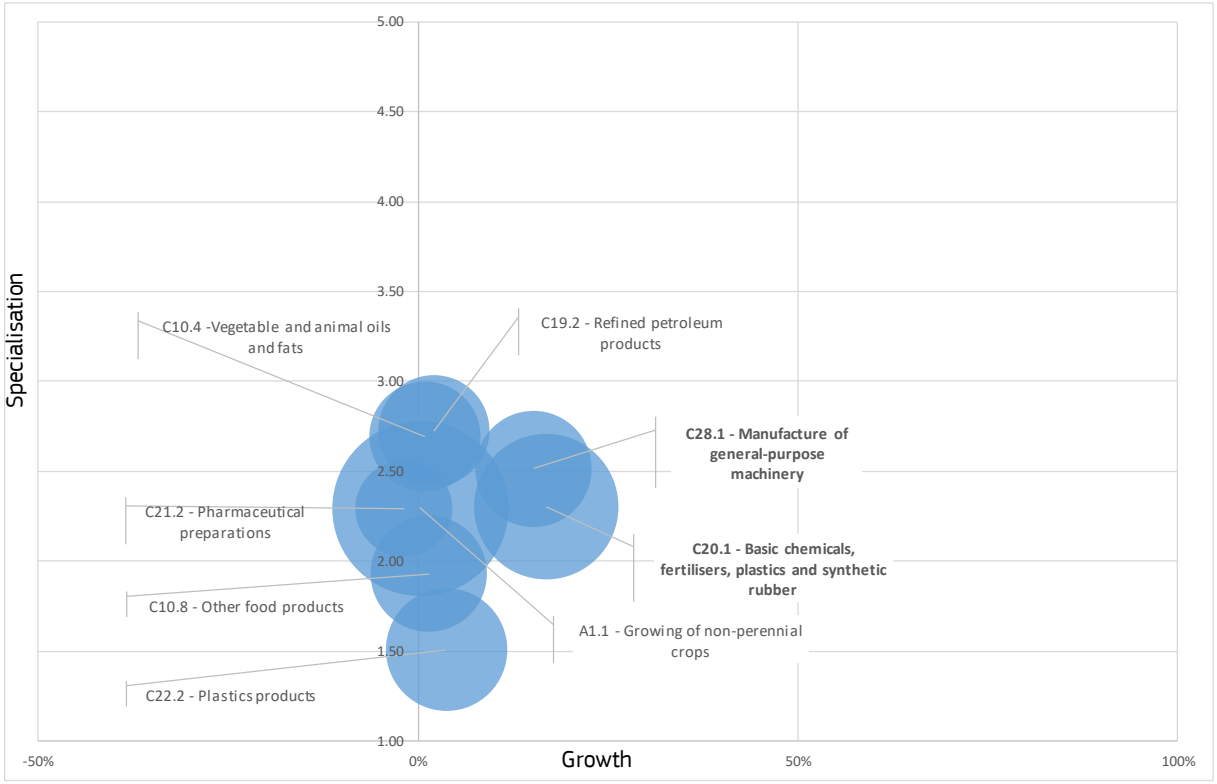


NACE codes in the graph (left to right): C10.6 – Grain mill products, etc; C10.1 – Processing of meat; A1.1 – Non-perennial crops; C20.1 – Basic chemicals, fertilisers and plastics; S95.2 – Repair of household goods; C25.1 – Structural metal products; C22.2 – Plastics products; C16.2 – Manufacture of products of wood, cork, straw and plaiting materials; Q86.2 – Medical and dental practice activities; R93.1 – Sports activities; F42.9 – Other civil engineering projects; C27.1 – Electric motors, generators, transformers, etc; C10.9 – Prepared animal feeds; C15.2 – Footwear; C10.7 – Manufacture of bakery and farinaceous products; I56.1 – Restaurants; C29.3 – Parts and accessories for motor vehicles; C13.9 – Manufacturing of other textiles; C14.1 – Manufacturing of wearing apparel; C14.3 – Knitted apparel; M71.2 – Technical testing and analysis; M71.1 – Architectural and engineering activities.

Note: Thresholds = LQ 1.5, abs. 2 000 employees, selected sectors excluded.

Source: own analysis.

Figure 5. RS12 - Vojvodina - Exports (2015)



NACE codes in the graph (left to right): C10.4 – Vegetable and animal oils and fats; C21.2 – Pharmaceutical preparations; C10.8 – Other food products; C22.2 – Plastics products; C19.2 – Refined petroleum products; C28.1 – Manufacture of general-purpose machinery; C20.1 – Basic chemicals, fertilisers, plastics and synthetic rubber; A1.1 – Growing of non-perennial crops.

Note: thresholds = LQ 1.5, abs. €100 000 export volume.

Source: own analysis.

3. RS21 - Sumadija and Western Serbia

With respect to employment, several potentially relevant sectors can be identified in Sumadija and Western Serbia's regional economy, including:

(a) the growing of perennial crops (e.g. wine, fruits),

(b) mixed farming,

(c) animal production, as well as

(d) the production of weapons and ammunition.

Different to that in Vojvodina, the agricultural sector in Sumadija and Western Serbia grows dynamically.

With respect to export data, the 'manufacture of motor vehicles' features strongly as the – more or less – only industrial sector that visibly demonstrates international competitiveness in the regional economy. Locally, however, its contribution to employment is rather small and has been shrinking in recent years.

4. RS22 - Southern and Eastern Serbia

With respect to employment, several potentially relevant sectors can be identified in Southern and Eastern Serbia's regional economy, including:

(a) the manufacture of parts for motor vehicles,

(b) the manufacture of wiring and wiring devices,

(c) subsistence agriculture, mixed farming, and

(d) the growing of perennial crops (e.g. wine, fruits).

The traditionally strong mining and associated basic iron and steel processing sector continues to stand out as a specialisation, yet one with very moderate growth rates.

With respect to exports, several specialisations can be identified:

(e) tobacco and tobacco products,

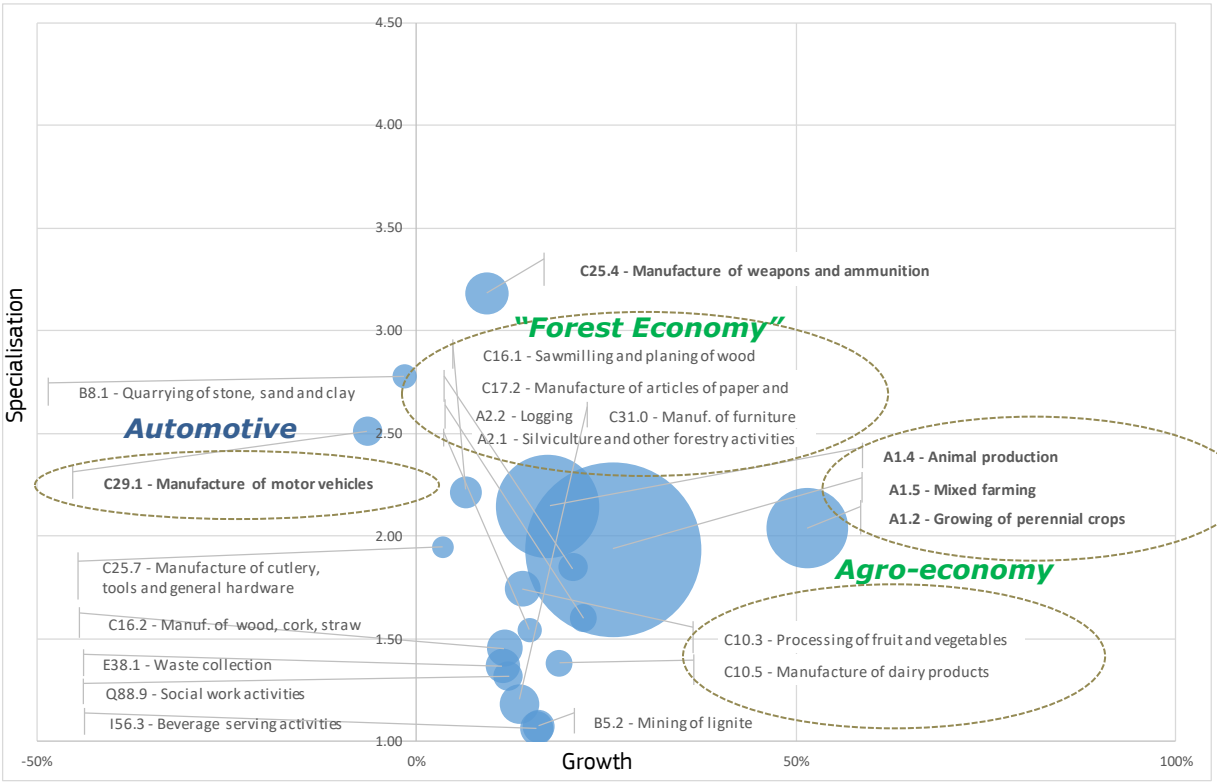
(f) rubber products,

(g) iron and steel, and

(h) furniture.

Interestingly, these are – with the exception of iron and steel processing – substantially different to those identified above, suggesting that automotive and electrical supplies are being used elsewhere in the country, rather than being exported. In comparison, local industries with international visibility are not really proven as clear regional employment specialisations.

Figure 6. RS21 - Sumadija and Western Serbia - Employment (LFS, 2016)

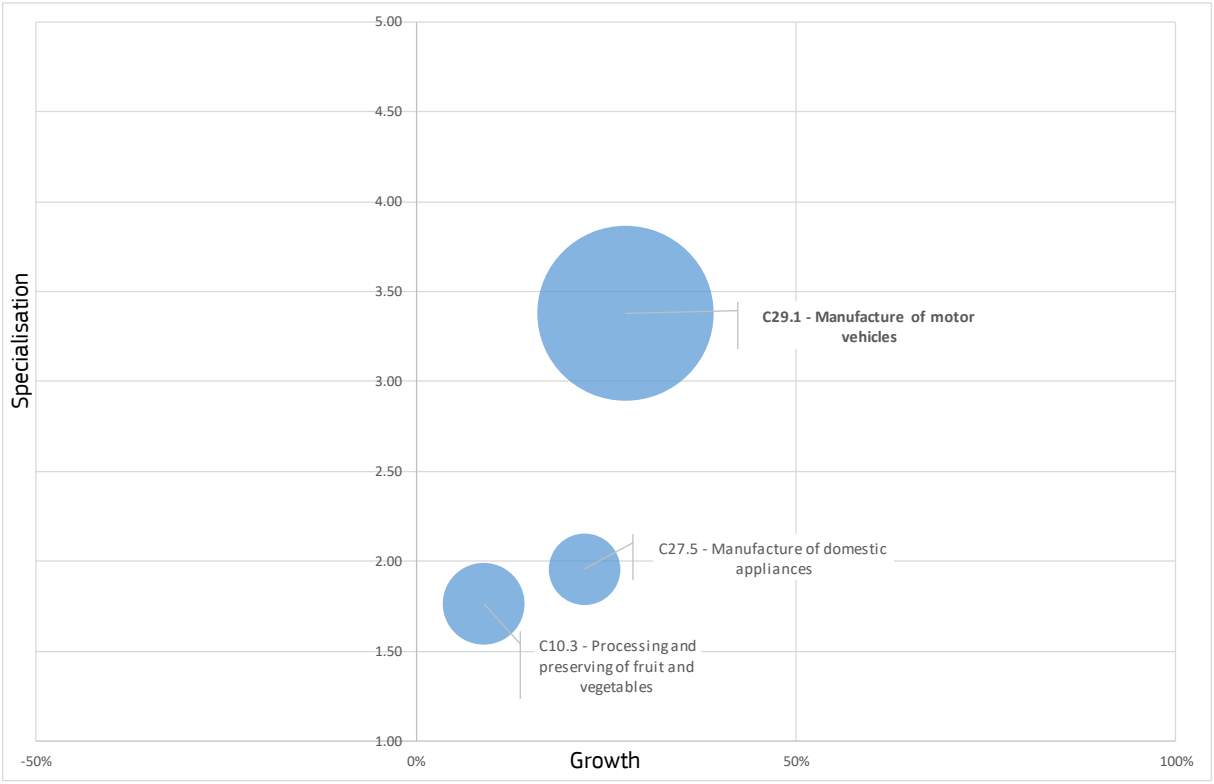


NACE codes in the graph (left to right): B8.1 – Quarrying of stone, sand and clay; C29.1 – Manufacture of motor vehicles; 25.7 – Manufacture of cutlery, tools and general hardware; C16.2 – Manufacture of wood, cork, straw; E38.1 – Waste collection; Q88.9 – Social work activities; I56.3 – Beverage serving activities; C16.1 – Sawmilling and planing of wood; C17.2 – Manufacture of articles of paper; A2.2 – Logging; A2.1 – Silviculture and other forestry activities; B5.2 – Mining of lignite; C31.0 – Manufacture of furniture; C10.3 – Processing of fruit and vegetables; C10.5 – Manufacture of dairy products; A1.4 – Animal production; A1.5 – Mixed farming; A1.2 – Growing of perennial crops.

Note: thresholds = LQ 1.5, abs. 2 000 employees, selected sectors excluded.

Source: own analysis.

Figure 7. RS21 - Sumadija and Western Serbia - Exports (2015)

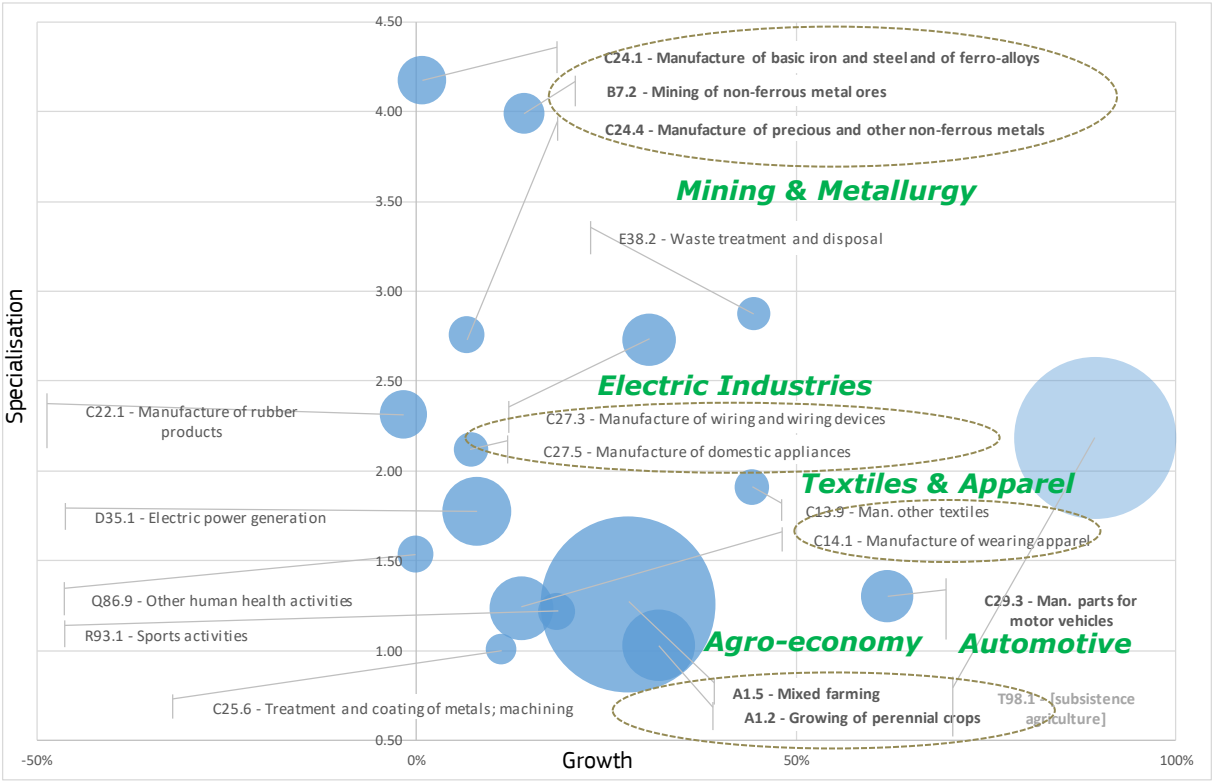


NACE codes in the graph (left to right): C10.3 – Processing and preserving of fruit and vegetables; C27.5 – Manufacture of domestic appliances; C29.1 – Manufacture of motor vehicles.

Note: thresholds = LQ 1.5, abs. €100 000 export volume.

Source: own analysis.

Figure 8. RS22 - Southern and Eastern Serbia - Employment (LFS, 2016)

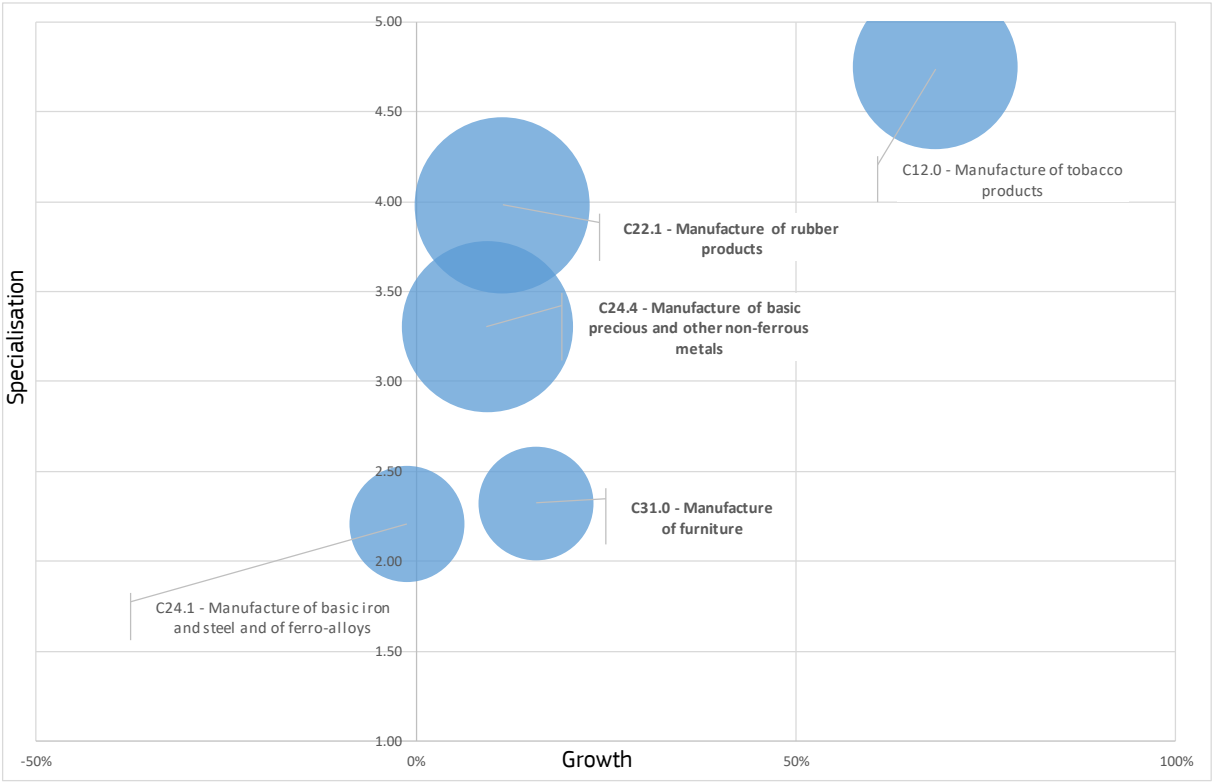


NACE codes in the graph (left to right): C22.1 – Manufacture of rubber products; D35.1 – Electric power generation; D86.9 – Other human health activities; R93.1 – Sports activities; C25.6 – Treatment and coating of metals, machining; C27.3 – Manufacture of wiring and wiring devices; C27.5 – Manufacture of domestic appliances; C24.1 – Manufacture of basic iron and steel and of ferro-alloys; B7.2 – Mining of non-ferrous metal ores; C24.4 – Manufacture of precious and other non-ferrous metals; E38.2 – Waste treatment and disposal; A1.5 – Mixed farming; A1.2 – Growing of perennial crops; C13.9 – Manufacture of other textiles; C14.1 – Manufacture of wearing apparel; C29.3 – Manufacture of parts for motor vehicles; T98.1 – [subsistence agriculture].

Note: thresholds = LQ 1.5, abs. 2 000 employees, selected sectors excluded.

Source: own analysis.

Figure 9. RS22 - Southern and Eastern Serbia - Exports (2015)



NACE codes in the graph (left to right): C24.1 – Manufacture of basic iron and steel and of ferro-alloys; C24.4 – Manufacture of bacis precious and other non-ferrous metals; C22.1 – Manufacture of rubber products; C31.0 – Manufacture of furniture; C12.0 – Manufacture of tobacco products.

Note: thresholds = LQ 1.5, abs. €100 000 export volume.

Source: own analysis.

With respect to the two indicator dimensions considered for economic potential, the potential priority areas can be identified as follows:

	Employment	Export
Belgrade	Software Industry Technical Testing R&D Natural & Social Science Advertising Medical and Dental Services	Electric Motors
Vojvodina	Agro-economy Petrochemical Industry Automotive Textiles & Apparel Engineering & Design	General Purpose Machinery Basic Chemicals Refined Petroleum Agro-economy
Šumadija and Western Serbia	Agro-economy Forest economy (Weapons & Ammunition) (Automotive)	Motor Vehicles Domestic Appliances Fruit & Vegetables
Southern and Eastern Serbia	Mining & Metallurgy Agro-economy Electric Industries Textiles & Apparel	Tobacco Products Rubber Products Non-Ferrous Metals Furniture

Note: NACE areas listed in brackets are tentative or partial specialisations (see above, p. 15).

Source: own analysis.

In Serbia, a number of clusters and associations in the different regions aim to support and organise most business activities that the above analysis identified as potential priority areas. These are:

1. RS11 - Belgrade
    (a) IT Krug, Klaster za razvoj informacionih tehnologija,
    (b) ICT Net,
    (c) Digitalna Srbija (http://www.dsi.rs),
    (d) Cluster of Serbian Aeronautical Industry - UVIS,
    (e) Automotive Cluster Serbia – AC Serbia,
    (f) 'Bipom Cluster', Balkan Black Sea Farm Machinery Cluster,
    (g) DESIGN & PRINT, cluster of designers and printers,
    (h) Cluster RE: Crafts,
    (i) FACTS – Fashion Apparel Cluster Serbia,
    (j) Plants United, cluster of ornamental plant manufacturers and retailers,
    (k) GALENIT - Cluster for the organised collection and recycling of waste batteries,
    (l) Green Chamber of Serbia,
    (m) Real-Estate Cluster KLASTER NEKRETNINE,
    (n) Klaster zdravstvenog, velnes i spa Turizma Srbije,
    (o) Medical Cluster PRO VITA Regional Association,
    (p) Medical tourism association/cluster,
    (q) Serbia Film Commission.
2. RS12 - Vojvodina
    (a) Cluster Agroindustrija,
    (b) KLASTER VOGANJ 2011 - Pig breeding,
    (c) Klaster Zeleni Sto,
    (d) Vojvodina Organic Agriculture Cluster,
    (e) Vojvodina Metal Cluster,
    (f) Vojvodina ICT Cluster,
    (g) ECOPANONIA Cluster for Ecological Energy and Ecological Culture,
    (h) Cluster ISTAR 21 – Tourism,
    (i) Fond turistički klaster mikroregije Subotica – Palić,
    (j) FUND CLUSTER FOR HEALTH TOURISM OF VOJVODINA,
    (k) CLUSTER FOR HEALTH TOURISM OF VOJVODINA,
    (l) Creative Industries Cluster of Vojvodina.
3. RS21 - Sumadija and Western Serbia
    (a) Srce Sumadije,
    (b) Sumadijski cvet Cluster of flower producers,
    (c) Agency for Wood – Wood industry cluster of Serbia,
    (d) Construction cluster Sumadija and Pomoravlja,

(e) NETWOOD - Cluster of furniture manufacturers,

(f) PeSter Agro klaster,

(g) Regional Automotive Cluster of Central Serbia,

(h) Turistički klaster Radanskog područja.

4. RS22 - Southern and Eastern Serbia

(a) Cheese Cluster SOUTH,

(b) Agro start up cluster,

(c) Association of strawberry producers and producers of other fruits 'Jagoda', Gredetin,

(d) Nisava District Agricultural Advisory Association,

(e) Association of Fruit and Vegetable Growers, Matejevac,

(f) AGRO-BLACE agricultural cooperative,

(g) the Association of Agricultural Cooperatives of Nis, Pirot and Toplica Counties,

(h) General Association of Entrepreneurs in Information Technology,

(i) MEDIANUM (Engineering & Production),

(j) ZENIT Engineering association,

(k) 'Ni CAT Cluster – Nis Cluster of Advanced Technologies,

(l) SITON Union of Engineering-Technical Organizations of Nis,

(m) Medical start up cluster,

(n) Construction Cluster OPEKA-BRICK,

(o) Serbia Green Building Council,

(p) START UP UNION – CONSTRUCTION cluster,

(q) Construction Cluster Dundjer Nis, Serbia,

(r) Nisava District Textile Cluster,

(s) Textile Start-up cluster,

(t) Serbian Furniture Cluster,

(u) KLASTER EKO TURIZMA 'BANJAC',

(v) Turistički klaster jugoistočne Srbije STARA PLANINA,

(w) NIS Region Start-up Clusters Union,

(x) Services Start up cluster.

While this list may not be exhaustive, it shows that a certain level of prior organisation exists in most relevant fields in all regions, even if relatively low – as in Sumadija and Western Serbia – and Serbian experts report that many clusters are, in practice, not particularly functional and/or fit for purpose.

3.3 Innovation potential

Overall, the share of Serbian firms that invest in innovation has been quite high in recent years, according to the Innovation Survey. The share of those earning income through innovation is lower, but still at a robust level. While the share of those engaging in innovation activities had reduced somewhat between 2010 and 2014, it recovered in 2016. While only around 50% of all innovators invest in R&D and less than 25% collaborate for innovation, these relations seems to have been improving more recently and, in any case, are not dissimilar to those reported by other countries.

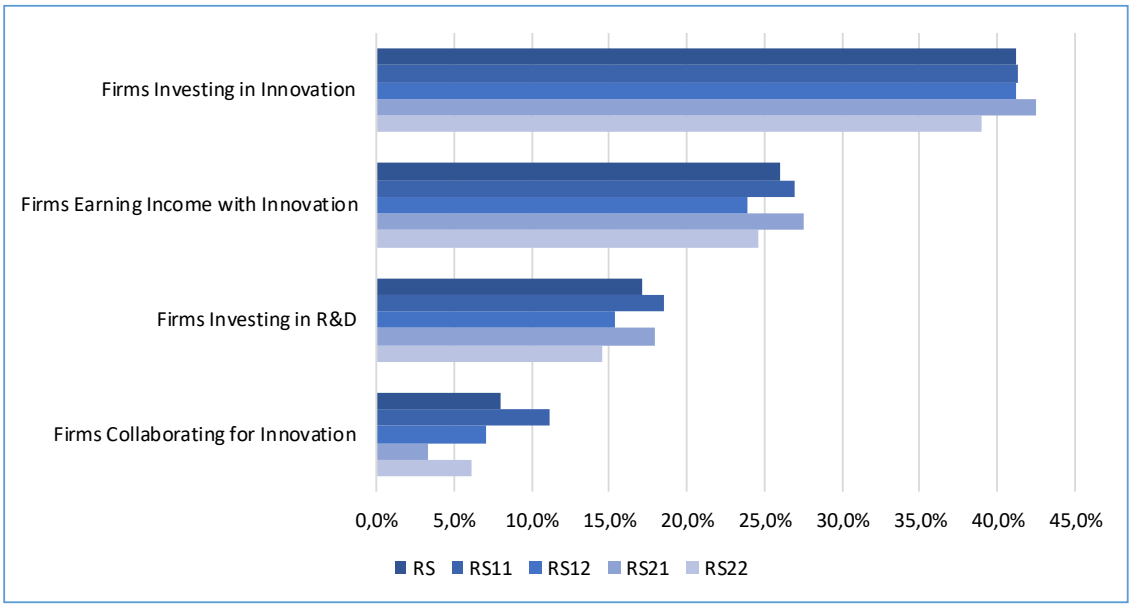
Table 1. Innovative activity in Serbia, according to surveys

	2010	2012	2014	2016
Firms investing in innovation	47.9%	44.6%	40.5%	41.2%
Firms earning income through innovation	26.9%	20.6%	19.2%	26.0%
Firms investing in R&D	20.0%	10.9%	13.3%	17.1%
Firms collaborating for innovation	8.3%	6.6%	5.0%	8.0%

Source: own analysis.

Interestingly, the share of innovators in the respective regional economies is comparatively similar, even though the total number of innovating firms is, of course, quite different (more than 3 000 in Belgrade, close to 1 800 in Vojvodina, more than 1 300 in Sumadija and Western Serbia and less than 800 in Southern and Eastern Serbia). While this raises some need for further interpretation, it simultaneously underlines that some sort of innovation can indeed be a relevant point of reference for all regions.

Figure 10. Innovation activity in Serbia's regions, according to surveys



Note: RS = Serbia; RS11 = Belgrade; RS12 = Vojvodina; RS21 = Sumadija and Western Serbia; RS22 = Southern and Eastern Serbia.

Source: own analysis of data provided by the National Statistical Office of the Republic of Serbia.

The data on patents illustrates a clear concentration of invention activity – and thus technology-based innovation potential – in Northern Serbia, i.e. in Belgrade and Vojvodina. Even aggregated over several years, the total number of patents in the southern regions of Serbia is rather limited – in Sumadija and Western Serbia in particular. Therefore, with regard to all following analysis, it should be borne in mind that while there may be some specialisations, the question of critical mass remains a key one with regard to all of them, including those in Belgrade and Vojvodina.

Since 1990, the number of domestic patent applications at the Serbian Intellectual Property Office has dropped substantially to approximately one third of earlier activities. In Belgrade and Vojvodina, this trend has been more continuous and, in most recent years, seems to demonstrate nascent signs of recovery. In contrast, in the southern regions, earlier activities could be maintained and even expanded in the 2000s but have dropped dramatically since. After the financial crisis, there have been no signs of recovery.

1. RS11 - Belgrade

Innovation Survey data accompanies the picture developed in the section on economic potential, with particular respect to:

(a) computer programming,

(b) architectural and engineering activities, and

(c) advertising,

in which most relevant activities are concentrated, indicating a strong emphasis on the service sectors as the local carriers of innovation.

The analysis of patent applications, in contrast, suggests specialisations in chemistry and derivatives, pharmaceuticals, the manufacture of beverages and electronic components. As in all countries, however, Belgrade's capital function may entail that company headquarters apply for intellectual property in the region even though relevant production sites are located outside of the region (in Vojvodina).

2. RS12 - Vojvodina

Innovation Survey data accompanies the picture developed in the section on economic potential, with particular respect to:

(a) agricultural products (non-perennial crops),

(b) instruments and measuring appliances, and

(c) plastic products,

in which most relevant activities are concentrated, indicating an emphasis on agriculture and light industries.

The analysis of patent applications is more or less in line with these findings, indicating key specialisations in communication equipment, agricultural machinery as well as measuring instruments and appliances.

3. RS21 - Sumadija and Western Serbia

As in Vojvodina, the agricultural sector in Sumadija and Western Serbia features prominently in the results of the innovation survey, not least through a high prominence of two agri-food industries – 'processing of fruit and vegetables' and 'manufacture of other food products'. Additionally, activities can be identified in the area of 'measuring instruments and appliances', 'engineering services', 'wearing apparel' and 'furniture'. This suggests that most relevant activities in the region are concentrated in selected light industries and agriculture.

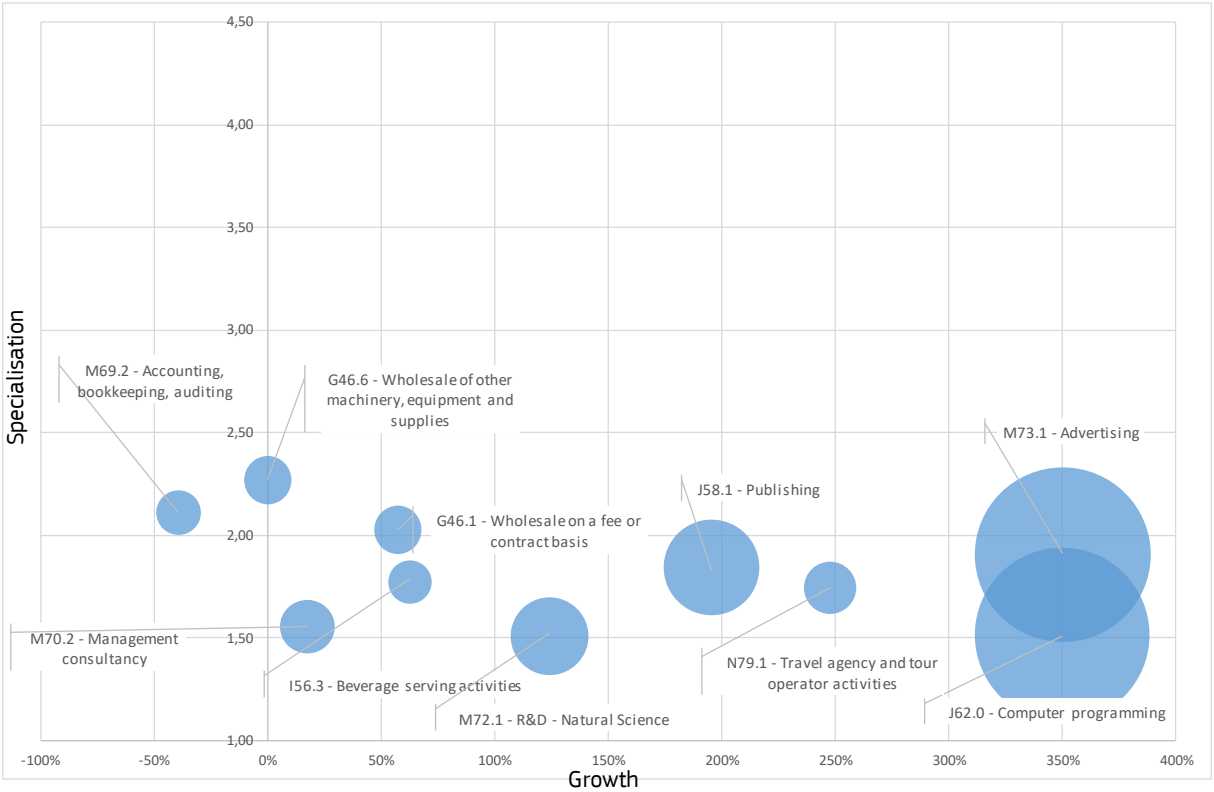
The analysis of patent applications does not reveal strong specialisations, but only two weak ones in agricultural and special-purpose machinery – which resonate with the agricultural focus of innovative activities in general.

4. RS22 - Southern and Eastern Serbia

The analysis of the innovation survey reveals findings only if the threshold is lowered to 15 firms. It then underlines the relevance of technical testing, the manufacture of computers, some food industries (bakery) and, to some extent, wearing apparel. Otherwise, it suggests that the overall level of innovative activity in Southern and Eastern Serbia is rather low and that no significant concentrations of innovation activity can be identified.

The analysis of patent applications reveals one specialisation in medical and dental instruments and one in food products.

Figure 11. RS11 - Belgrade – Innovating firms, according to 2016 Innovation Survey

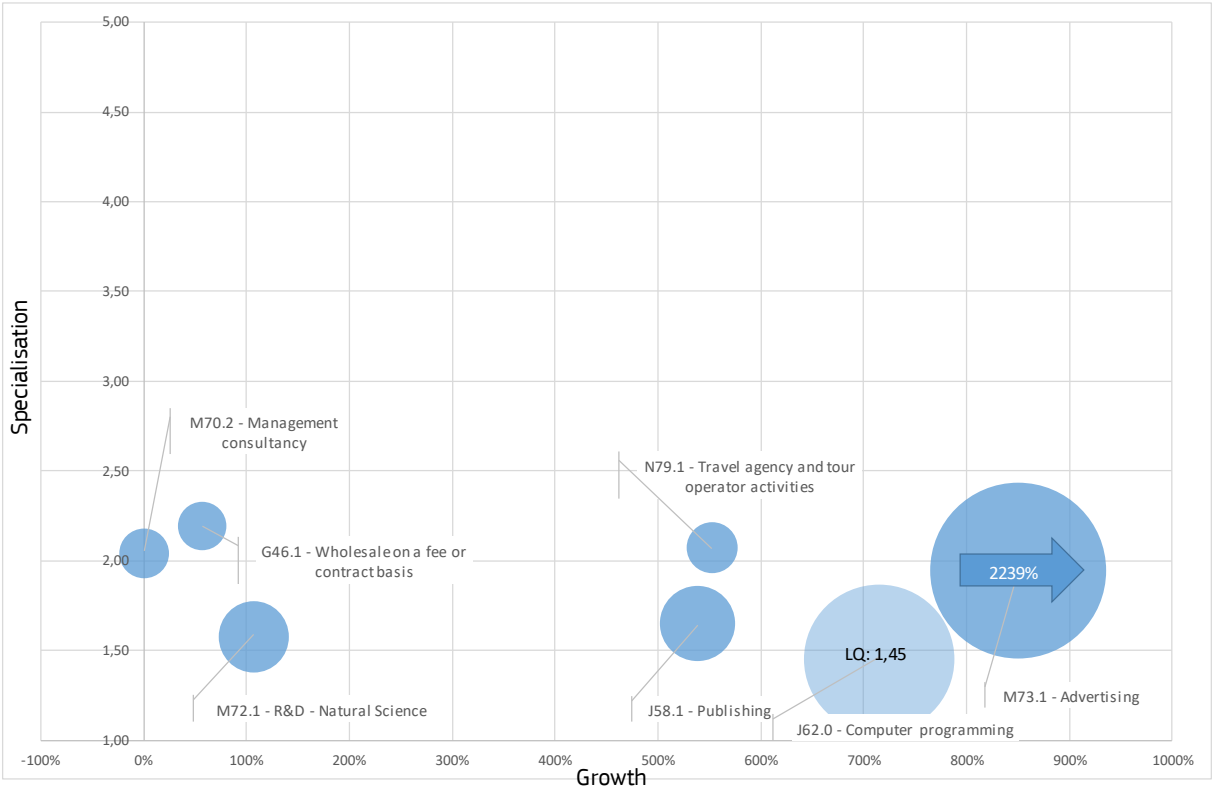


NACE codes in the graph (left to right): M70.2 – Management consultancy; M69.2 – Accounting, bookkeeping, auditing; G46.6 – Wholesale of other machinery, equipment and supplies; I56.3 – Beverage serving activities; G46.1 – Wholesale on a fee or contract basis; M72.1 – R&D – natural science; J58.1 – Publishing; N79.1 – Travel agency and tour operator activities; M73.1 – Advertising; J62.0 – Computer programming.

Note: thresholds = LQ 1.5, abs. 25 firms.

Source: own analysis.

Figure 12. RS11 - Belgrade – Firms generating income through innovation, according to 2016 Innovation Survey

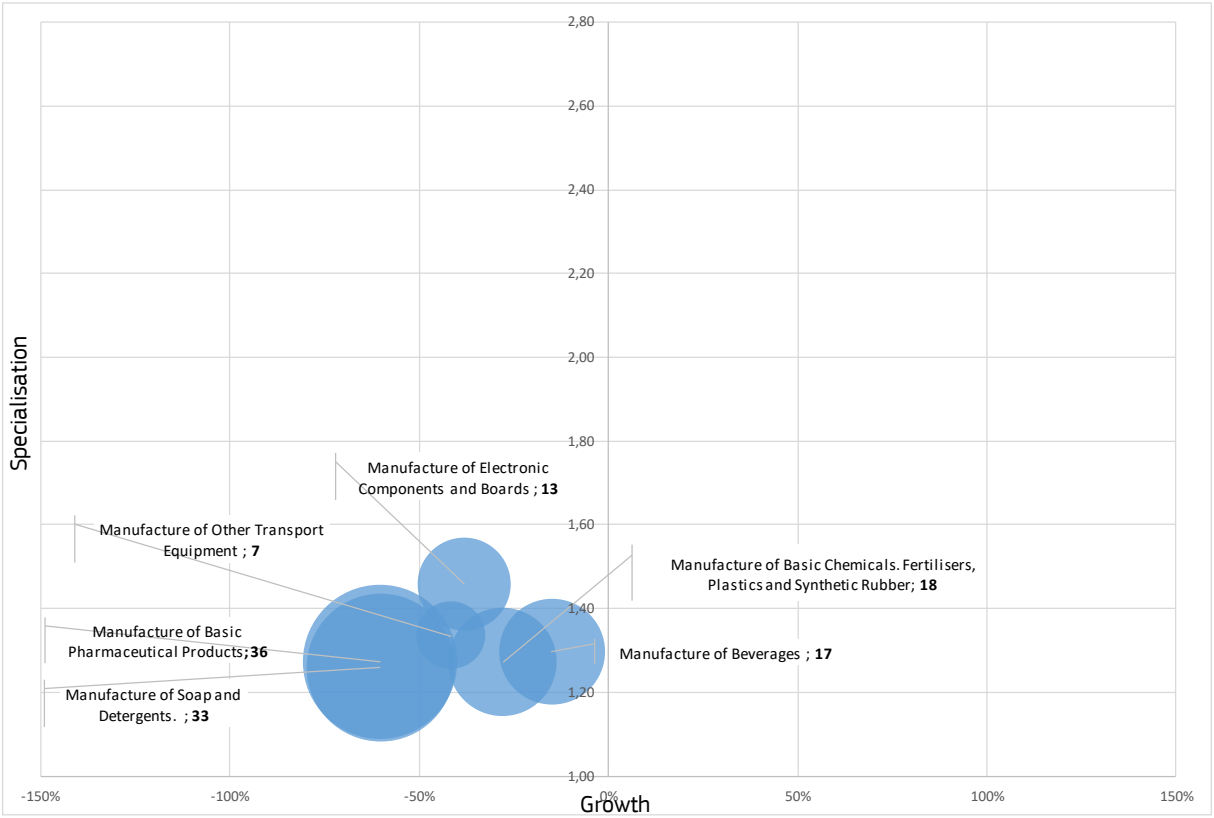


NACE codes in the graph (left to right): M70.2 – Management consultancy; G46.1 – Wholesale on fee or contract basis; M72.1 – R&D – natural science; N79.1 – Travel agency and tour operator activities; J58.1 – Publishing; J62.0 – Computer programming; M73.1 – Advertising.

Note: thresholds = LQ 1.5, abs. 25 firms.

Source: own analysis.

Figure 13. RS11 - Belgrade – Patents by NACE sections, according to IMP & IPO data

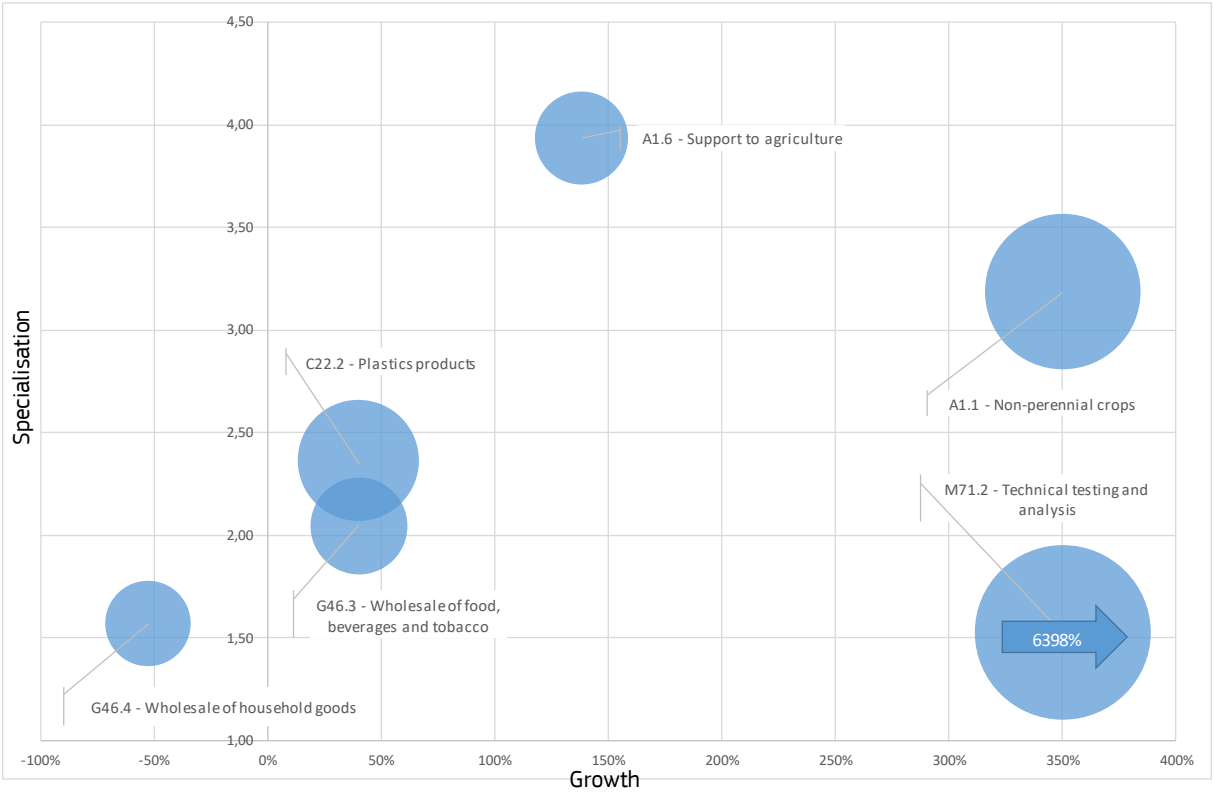


NACE codes in the graph (left to right): C21.1 - Manufacture of basic pharmaceutical products; C20.4 - Manufacture of soap and detergents; C30 - Manufacture of other transport equipment; C26.1 - Manufacture of electronic components and boards; C11.0 - Manufacture of beverages; C20.1 - Manufacture of basic chemicals, fertilisers, plastics and synthetic rubber.

Note: thresholds = LQ 1.25, abs. 5 patent applications.

Source: own analysis.

Figure 14. RS12 - Vojvodina – Innovating firms, according to 2016 Innovation Survey

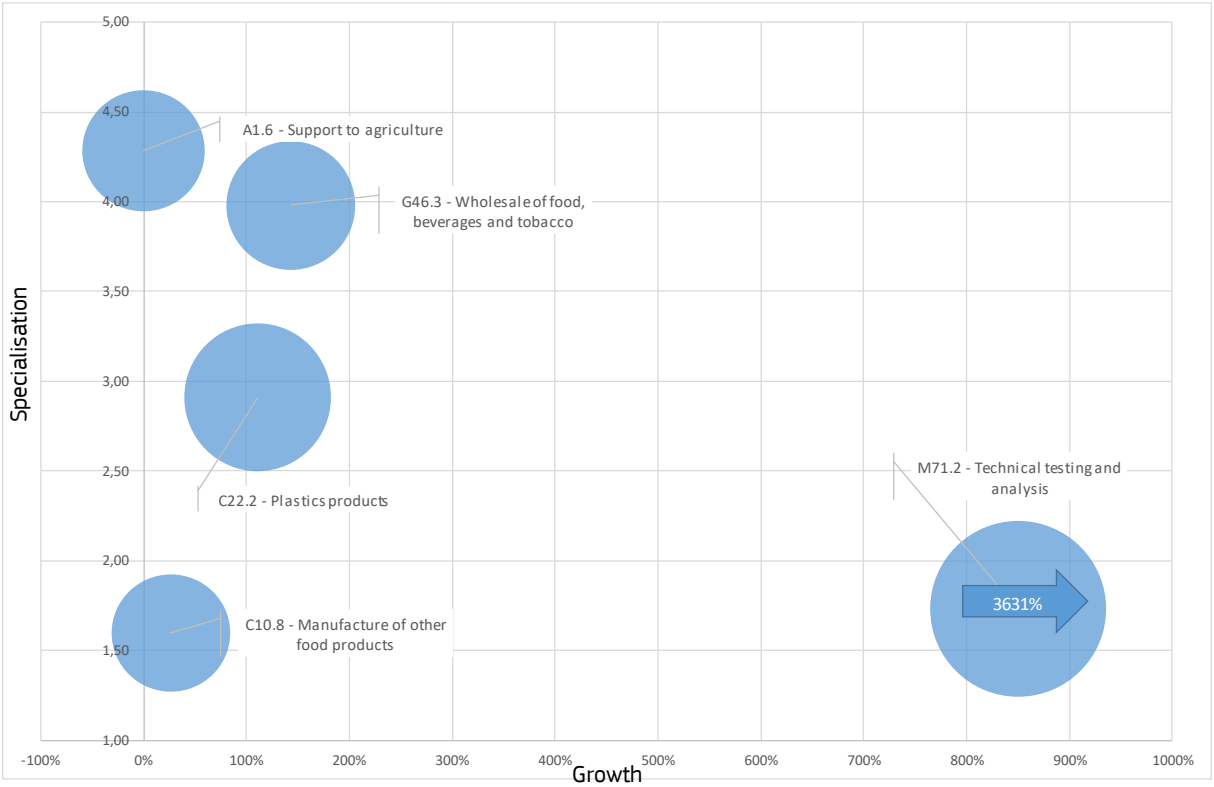


NACE codes in the graph (left to right): C46.4 – Wholesale of household goods; C22.2 – Plastics products; G46.3 – Wholesale of food, beverages and tobacco; A1.6 – Support to agriculture; A1.1 – Non-perennial crops; M71.2 – Technical testing and analysis.

Note: thresholds = LQ 1.5, abs. 25 firms.

Source: own analysis.

Figure 15. RS12 - Vojvodina – Firms generating income through innovation, according to 2016 Innovation Survey

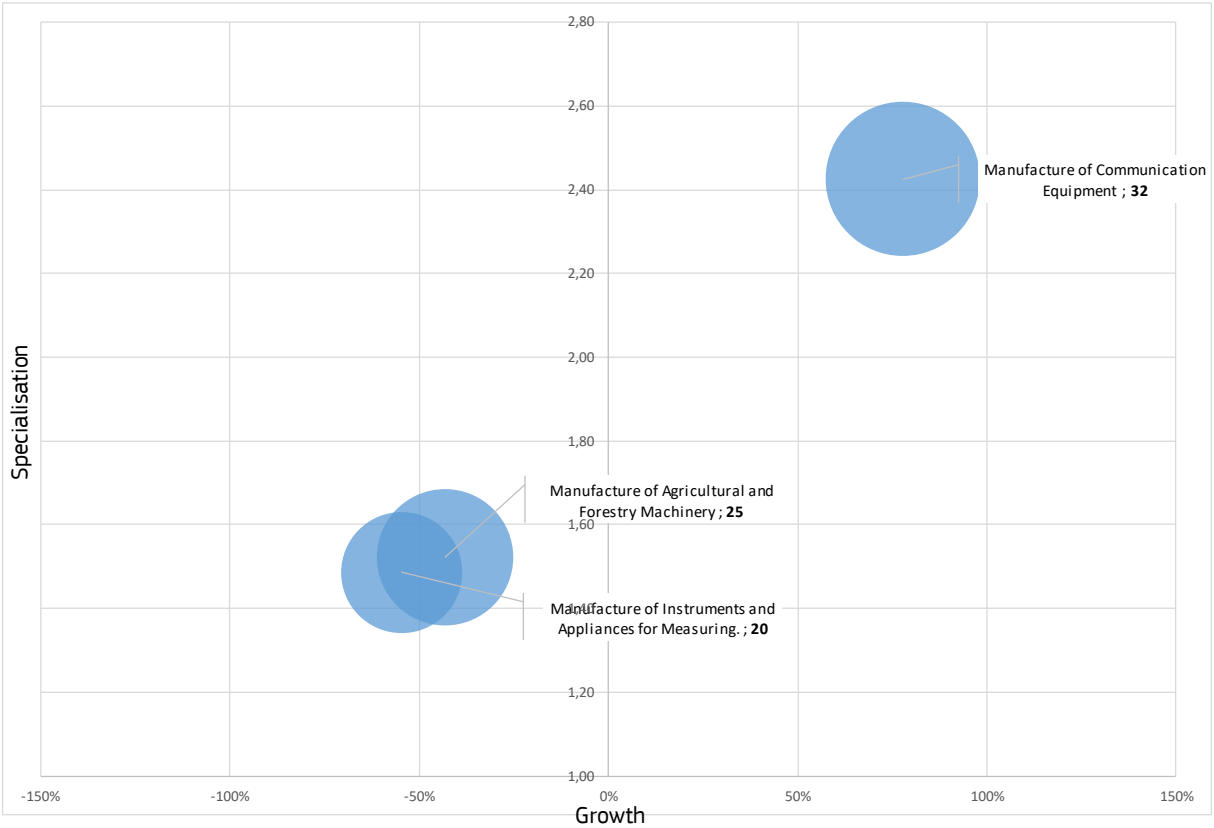


NACE codes in the graph (left to right): A1.6 – Support to agriculture; C22.2 – Plastics products; C10.8 – Manufacture of other food products; G46.3 – Wholesale of food, beverages and tobacco; M71.2 – Technical testing and analysis.

Note: thresholds = LQ 1.5, abs. 25 firms.

Source: own analysis.

Figure 16. RS12 - Vojvodina – Patents by NACE sections, according to IMP & IPO data

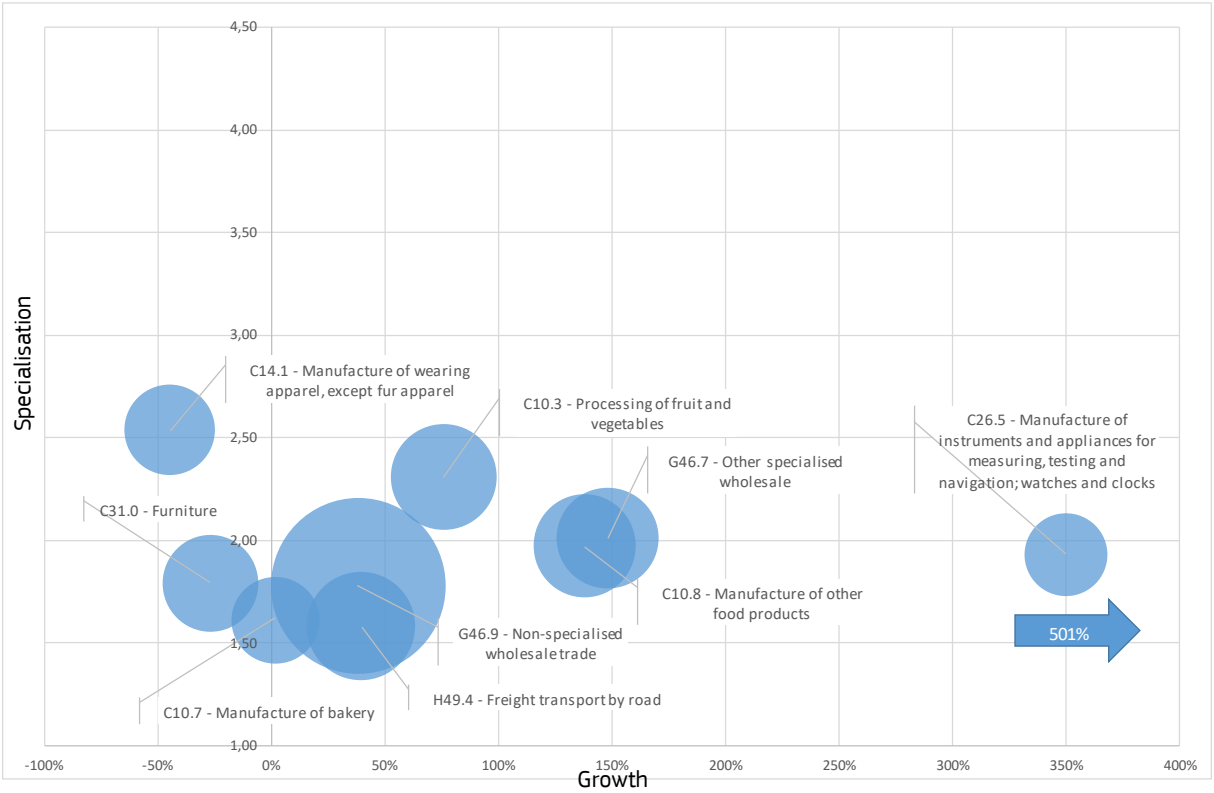


NACE codes in the graph (left to right): C28.3 - Manufacture of agricultural and forestry machinery; C26.5 – Manufacture of instruments and appliances for measuring; C26.3 – Manufacture of communication equipment.

Note: thresholds = LQ 1.25, abs. 5 patent applications.

Source: own analysis.

Figure 17. RS21 - Sumadija and Western Serbia – Innovating firms, according to 2016 Innovation Survey

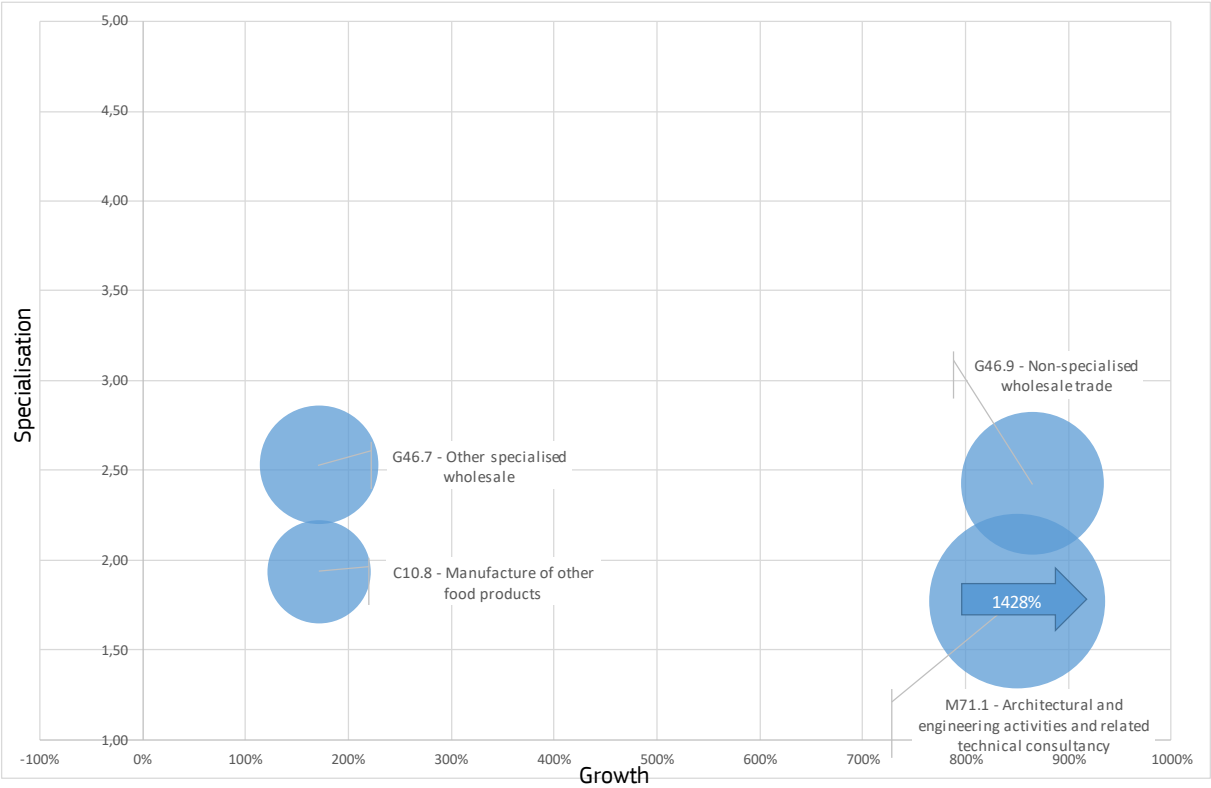


NACE codes in the graph (left to right): C31.0 – Furniture; C10.7 – Manufacture of bakery and farinaceous products; C14.1 – Manufacture of wearing apparel, except fur apparel; H49.4 – Freight transport by road; C10.3 – Processing of fruit and vegetables; G46.7 – Other specialised wholesale; C10.8 – Manufacture of other food products; C26.5 – Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks.

Note: thresholds = LQ 1.5, abs. 25 firms.

Source: own analysis.

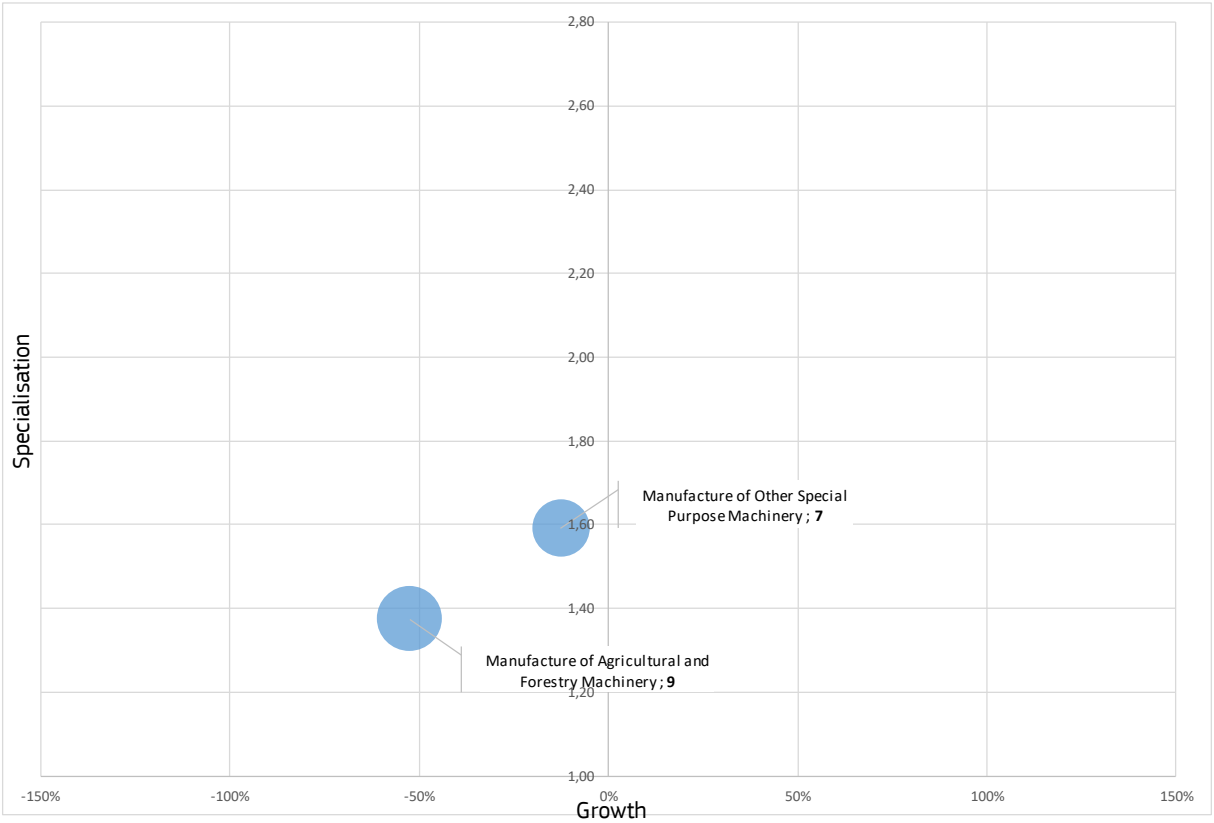
Figure 18. RS21 - Sumadija and Western Serbia – Firms generating income through innovation, according to 2016 Innovation Survey



NACE codes in the graph (left to right): G46.7 – Other specialised wholesale; C10.8 – Manufacture of other food products; G46.9 – Non-specialised wholesale trade; M71.1 – Architectural and engineering activities and related technical consultancy.

Note: thresholds = LQ 1.5, abs. 25 firms. *Source:* own analysis.

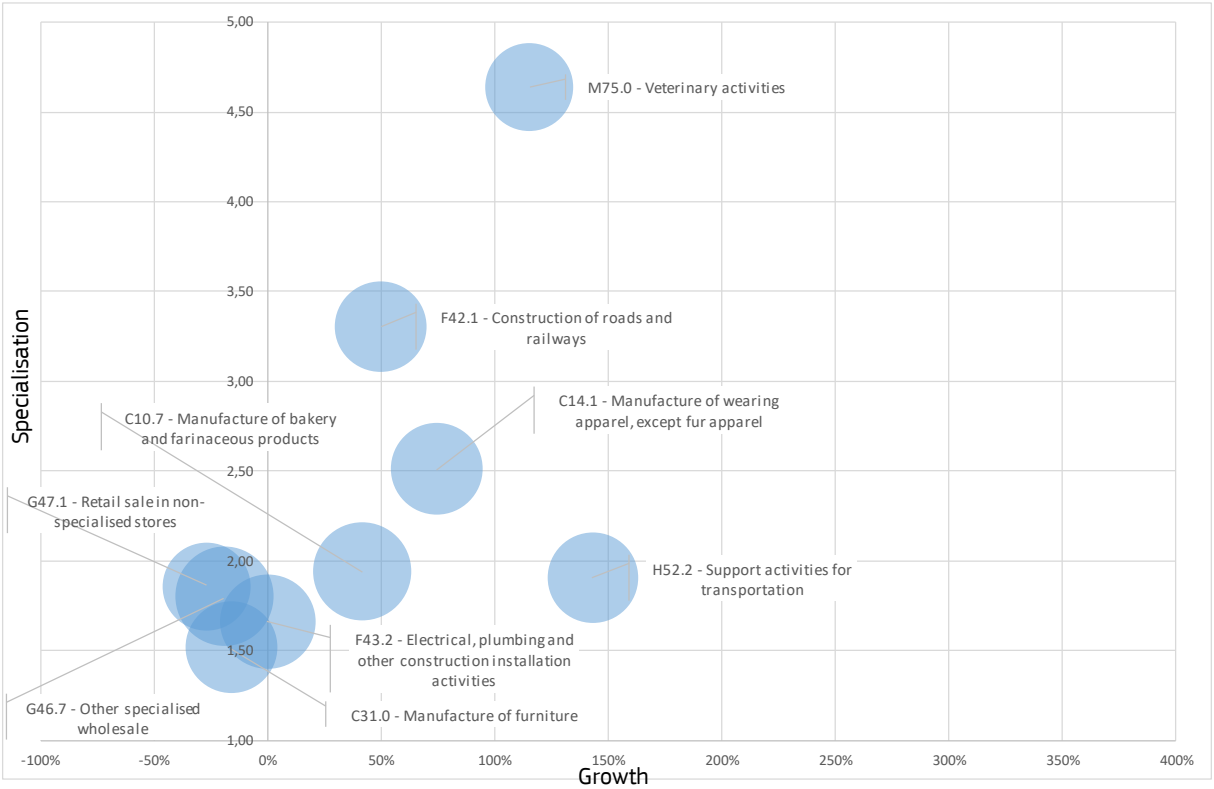
Figure 19. RS21 - Sumadija and Western Serbia – Patents by NACE sections, according to IMP & IPO data



NACE codes in the graph (left to right): C28.3 - Manufacture of agricultural and forestry machinery; C28.9 - Manufacture of other special-purpose machinery.

Note: thresholds = LQ 1.25, abs. 5 patent applications. *Source*: own analysis.

Figure 20. RS22 - Southern and Eastern Serbia – Innovating firms, according to 2016 Innovation Survey

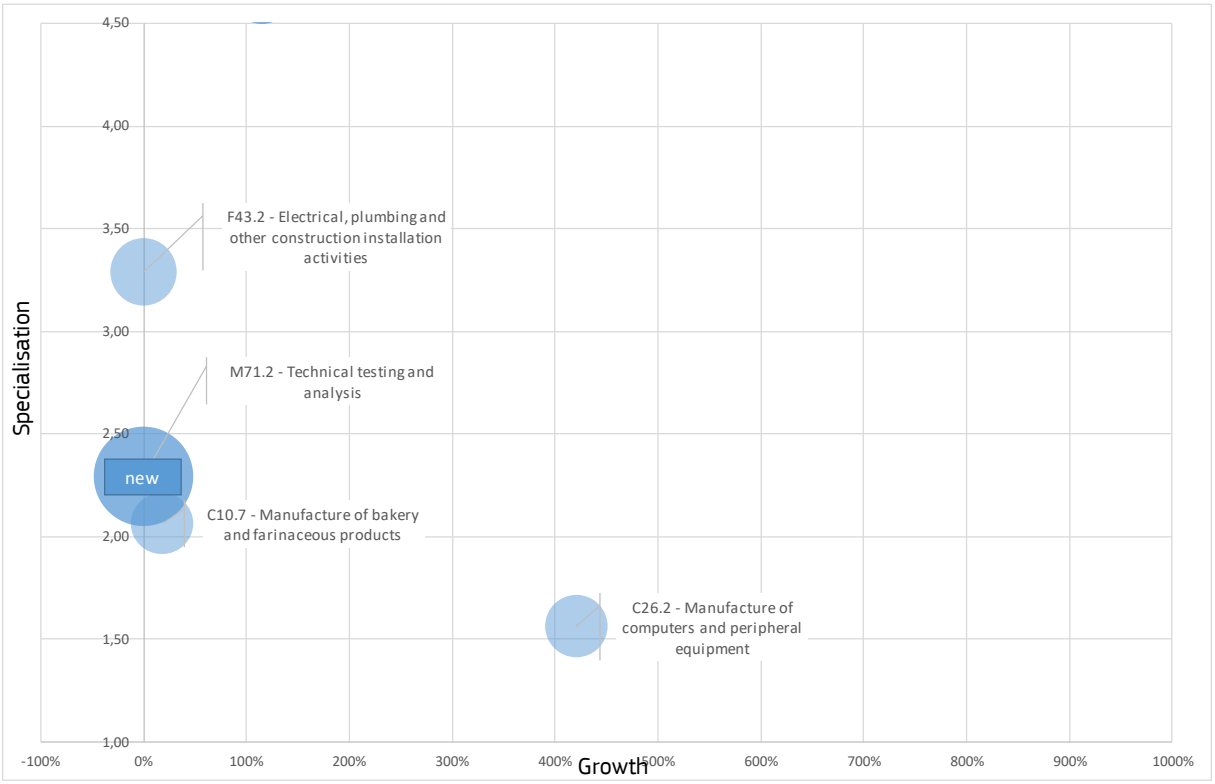


NACE codes in the graph (left to right): G47.1 – Retail sale in non-specialised stores; G46.7 – Other specialised wholesale; C10.7 – Manufacture of bakery and farinaceous products; F43.2 – Electrical, plumbing and other construction installation activities; C31.0 – Manufacture of furniture; F42.1 – Construction of roads and railways; M75.0 – Veterinary activities; C14.1 – Manufacture of wearing apparel, except fur apparel; H52.2 – Support activities for transportation.

Note: thresholds = LQ 1.5, abs. 15 firms (at 25 and 20 no findings).

Source: own analysis.

Figure 21. RS22 - Southern and Eastern Serbia – Firms generating income through innovation, according to 2016 Innovation Survey

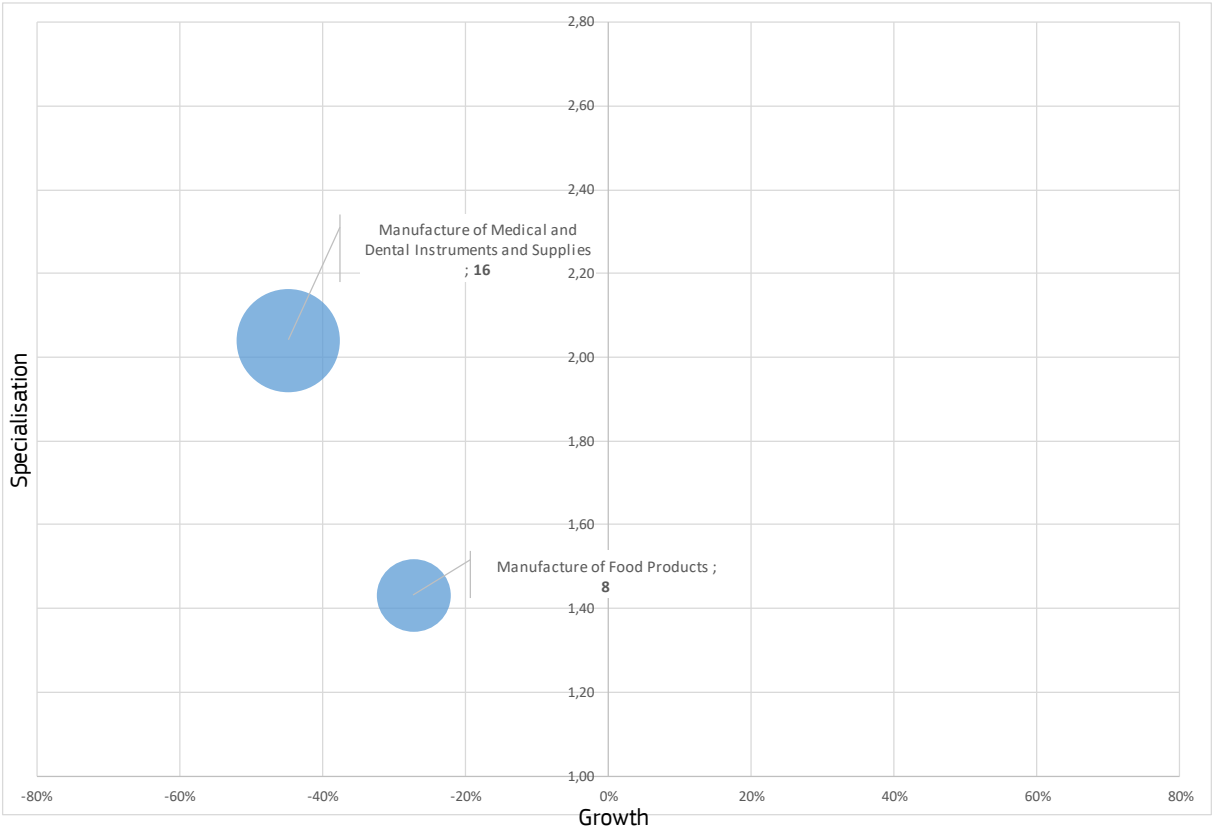


NACE codes in the graph (left to right): F43.2 – Electrical, plumbing and other construction installation activities; M71.2 – Technical testing and analysis; C10.7 – Manufacture of bakery and farinaceous products; C26.5 – Manufacture of computers and peripheral equipment.

Note: thresholds = LQ 1.5, abs. 15 firms (at 25 and 20 no findings).

Source: own analysis.

Figure 22. RS22 - Southern and Eastern Serbia – Patents by NACE sections, according to IMP & IPO data



NACE codes in the graph (left to right): C32.5 - Manufacture of medical and dental instruments and supplies; C10 - Manufacture of food products.

Note: thresholds = LQ: 1.25, abs. 5 patent applications.

Source: own analysis.

With respect to the two main indicator dimensions considered for innovation potential, the potential priority areas for future support could be identified as follows:

	Innovators	Patents
Belgrade	Computer Programming Advertising R&D Natural Science	Pharmaceuticals Chemistry & Derivatives Electronic Components (Transport Equipment)
Vojvodina	Measurement & Testing Plastic Products Support to Agriculture Food Products (Non-perennial Crops)	Communication Equipment Measurement Instruments Agricultural & Forestry Machinery
Šumadija and Western Serbia	Measurement Instruments Engineering & Architectural Services Food Products Fruits & Vegetables (Furniture, Apparel)	(Special Purpose Machinery) (Agricultural & Forestry Machinery)
Southern and Eastern Serbia	Technical Testing Services Manufacture of Computers Bakery (Wearing & Apparel)	Medical and Dental Instruments (Food Products)

Note: NACE areas listed in brackets are tentative or partial specialisations (see above, p. 15).

Source: own analysis.

3.4 Scientific potential

Serbia's scientific potentials are even more concentrated than its potentials with regard to innovation, which, as outlined above, include a strong non-technological component.

1. RS11 - Belgrade

The capital city region dominates with respect to science, technology and innovation. While its overall population share is 24%, 55% of Serbia's researchers are located in Belgrade. The capital region's strength becomes even more obvious with respect to R&D spending (64% of the national total) and publication activities (63% of the national total).

The number of researchers in Belgrade has increased since 2010. This growth mainly refers to engineering and technology as well as natural sciences. In agricultural sciences, the number has reduced. During the same period, investment in research and development increased from slightly more than RSD 15 million (approximately €123 456) in 2010 to close to RSD 25 million (approximately €205 761) in 2016. While publication activity grew more or less steadily in the long term (since 1990) it reached a peak in 2012 and has reduced slightly since.

Table 2. Scientific activities in Belgrade

	Researchers (FTE, 2016)		R&D expenditure (in RSD 1 000, 2016)		Publications (2016)	
	Number	% of nat. total	Number	% of nat. total	Number	% of nat. total
Agricultural Sciences	706	62.8	2 100 378	6.25	186	56.8
Engineering and Technology	1 842	41.5	9 599 918	22.67	850	57.9
Humanities	941	66.9	1 474 998	4.99	64	71.3
Medical and Health Sciences	929	54.8	1 674 956	4.82	576	72.2
Natural Sciences	2 572	66.0	6 564 373	21.71	1 133	63.9
Social Sciences	1 278	52.1	2 982 737	8.46	196	65.3
Total	8 269	55.1	24 397 360*	68.91	2 326**	63.1

Note: * GERD ** total without overlaps.

Source: own analysis of data provided by the Ministry of Education, Science and Technological Development, the Statistical Office of the Republic of Serbia and the Institute Mihajlo Pupin & Institute for Economics.

- *Specialisations*

Belgrade does not exhibit significant scientific specialisations, only two weak ones in polymer science and materials science. In general terms, these two areas can be seen as resonating the identified patent specialisations, but that link is not very clear. Predominantly, the overall picture underlines that that the capital region is the nation's academic centre. Belgrade is strong in many different areas and produces the bulk of the national academic output. Compared to Serbia as a whole, Belgrade therefore does not exhibit any single, specific area of excellence. Instead, Serbia's academic profile is quite often de facto constituted by Belgrade's academic profile.

2. RS12 - Vojvodina

Vojvodina's share in all researchers in Serbia amounts to 27.5%. This is slightly higher than the region's population share of 26.7%. Likewise, R&D spending constitutes 28.8% of the national total. However, the region accounts for only 18.1% of Serbia's publications.

The number of researchers in Vojvodina has increased since 2010, especially in engineering and technology. The number in this area grew from 684 in 2010 to 1 789 in 2016. In comparison, in humanities, the number dropped significantly by 470. At the same time, R&D spending increased from around RSD 4 million (approximately €33 000) to around RSD 10 million (approximately €82 500). While growth in publications was moderate until 2006, it then picked up until 2012. Since then, there has been a clear short-term decline.

Table 3. Scientific activities in Vojvodina

	Researchers (FTE, 2016)		R&D expenditure (in RSD 1 000, 2016)		Publications (2016)	
	Number	% of nat. total	Number	% of nat. total	Number	% of nat. total
Agricultural Sciences	342	30.4	1 429 287	1.53	105	31.9
Engineering and Technology	1 789	40.3	4 017 272	7.30	303	20.6
Humanities	44	3.1	136 252	0.37	21	23.2
Medical and Health Sciences	337	19.9	118 524	0.34	91	11.3
Natural Sciences	950	24.4	3 512 022	8.73	303	17.0
Social Sciences	667	27.2	1 721 481	5.19	61	20.3
Total	4 128	27.5	10 934 838*	23.47	666**	18.1

Note: * GERD ** total without overlaps.

Source: own analysis of data provided by the Ministry of Education, Science and Technological Development, the Statistical Office of the Republic of Serbia and the Institute Mihajlo Pupin & Institute of Economics.

- *Specialisations*

Contrary to Belgrade, Vojvodina exhibits clear scientific specialisations in telecommunications, various aspects of computer science and various aspects of agricultural science – well in line with its economic profile.

3. RS21 - Sumadija and Western Serbia

Compared to Northern Serbia, Sumadija and Western Serbia's overall scientific capacities are weak. While its population share is 27.7% of the national total, its share of researchers is only 6.4%. Likewise, publication activities account for a mere 6.3% of the national total and the region's contribution to R&D spending is even lower at only 3.0% of the national total.

The number of researchers was comparatively stable over the period from 2010 to 2016. The most relevant increase can be observed in agricultural sciences – with 45 researchers (note the total number). The development of R&D spending reflects the number of researchers as it was almost stable over the period 2010-2016 (around RSD 1.1 million or €9 000). Publication activities increased in the long term and otherwise show a similar development to that in Vojvodina. While development was moderate until 2006, growth increased until 2012. Since then, a slight decline has become evident.

Table 4. Scientific activities in Sumadija and Western Serbia

	Researchers (FTE, 2016)		R&D expenditure (in RSD 1 000, 2016)		Publications (2016)	
	Number	% of nat. total	Number	% of nat. total	Number	% of nat. total
Agricultural Sciences	66	5.9	64 440	0.21	22	6.8
Engineering and Technology	209	4.7	345 909	1.48	76	5.2
Humanities	146	10.4	17 749	0.05	0	0
Medical and Health Sciences	106	6.2	60 353	0.14	57	7.1
Natural Sciences	184	4.7	477 387	1.30	121	6.8
Social Sciences	243	9.9	174 274	0.45	15	4.9
Total	954	6.4	1 140 112*	3.63	231**	6.3

Note: * GERD ** total without overlaps.

Source: own analysis of data provided by the Ministry of Education, Science and Technological Development, the Statistical Office of the Republic of Serbia and the Institute Mihajlo Pupin & Institute of Economics.

- *Specialisations*

Similar to parts of Vojvodina's scientific profile, Sumadija and Western Serbia exhibits specialisations in horticulture and agriculture, which are in line with its rural economic profile and those specialisations in mechanical engineering that resonate with the traditional locations of the automotive sector in the region, for example.

4. RS22 - Southern and Eastern Serbia

Like Sumadija and Western Serbia, Southern and Eastern Serbia is weak with regard to science and technology. The share of researchers in the national total is 11.1%, while the population share is 21.8%. In line with this, the regional publication share is 12.8%. R&D spending is even lower at only 3.9% of total national R&D spending.

The number of local researchers grew between 2010 and 2016. In particular, the number of researchers in medical and health sciences increased by 307 (FTE). At the same time, the number of researchers in agricultural sciences reduced by 339. Accordingly, R&D spending increased steadily from RSD 800 000 in 2010 (approximately €6 500) to RSD 1.4 million (approximately €11 500) in 2016. As in all other regions, growth in publication was strongest from 2006, peaking in 2012 and stabilising ever since.

Table 5. Scientific activities in Southern and Eastern Serbia

	Researchers (FTE, 2016)		R&D expenditure (in RSD 1 000, 2016)		Publications (2016)	
	Number	% of nat. total	Number	% of nat. total	Number	% of nat. total
Agricultural Sciences	10	0.9	103 461	0.34	15	4.5
Engineering and Technology	595	13.4	990 492	2.58	239	16.3

Humanities	276	19.6	33 954	0.09	5	5.5
Medical and Health Sciences	324	19.1	71 704	0.28	74	9.3
Natural Sciences	193	5.0	115 692	0.32	217	12.2
Social Sciences	266	10.8	168 662	0.38	28	9.5
Total	1 664	11.1	1 483 965*	3.99	471**	12.8

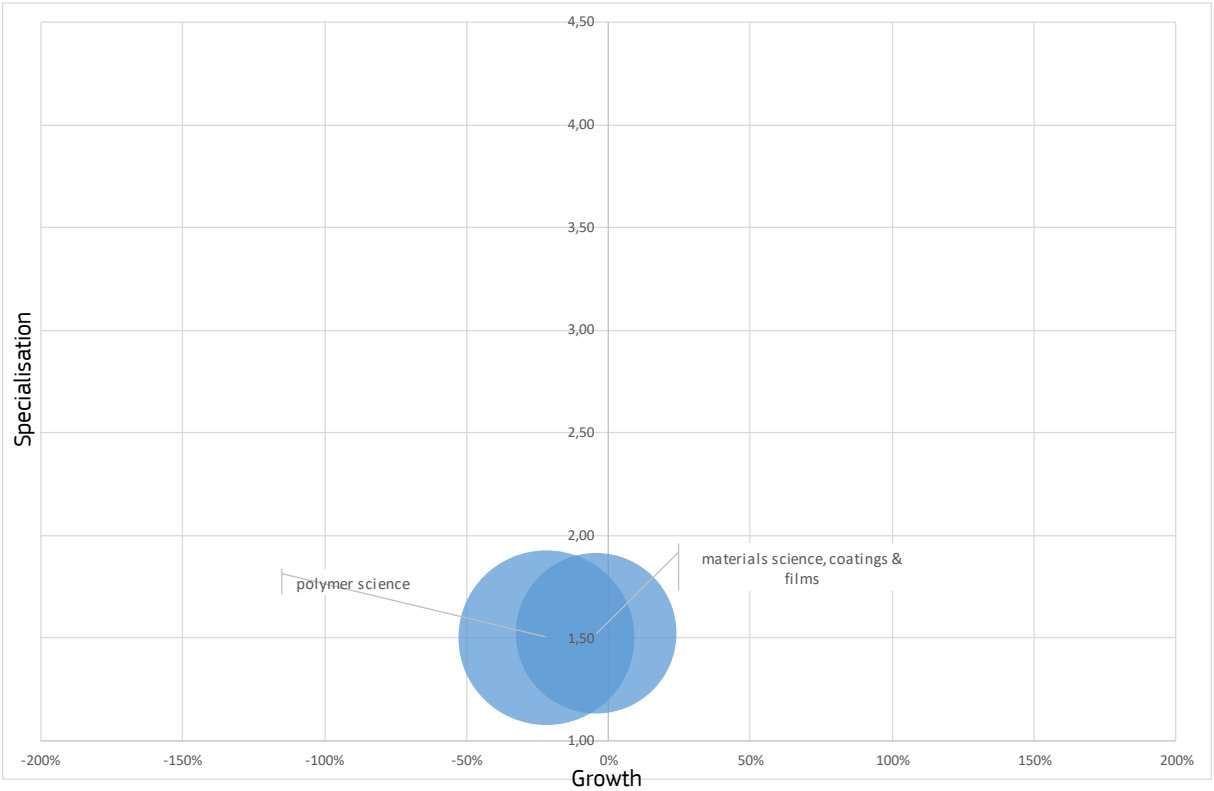
Note: * GERD ** total without overlaps.

Source: own analysis of data provided by the Ministry of Education, Science and Technological Development, the Statistical Office of the Republic of Serbia and the Institute Mihajlo Pupin & Institute of Economics.

- *Specialisations*

Southern and Eastern Serbia, in conclusion, exhibits some specialisations in electrical and electronical engineering, mathematics and pharmacology that resonate with the patent specialisations in medical and dental instruments and technical testing found above.

Figure 23. RS11 - Belgrade – Publications by SCF – WOS Groups

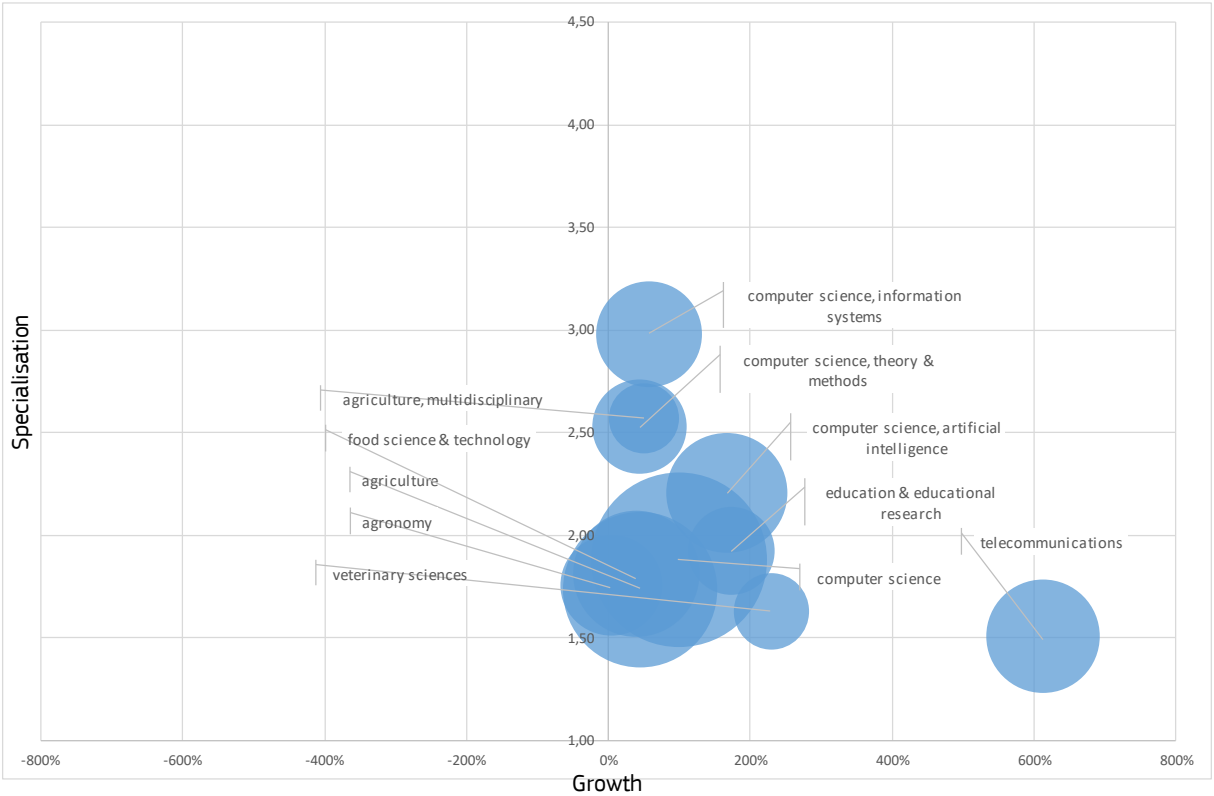


Groups in the graph (left to right): Polymer science; Material science, coatings and films.

Note: thresholds = LQ 1.5, abs. 10 publications in fractional count.

Source: own analysis.

Figure 24. RS12 - Vojvodina – Publications by SCF – WOS Groups

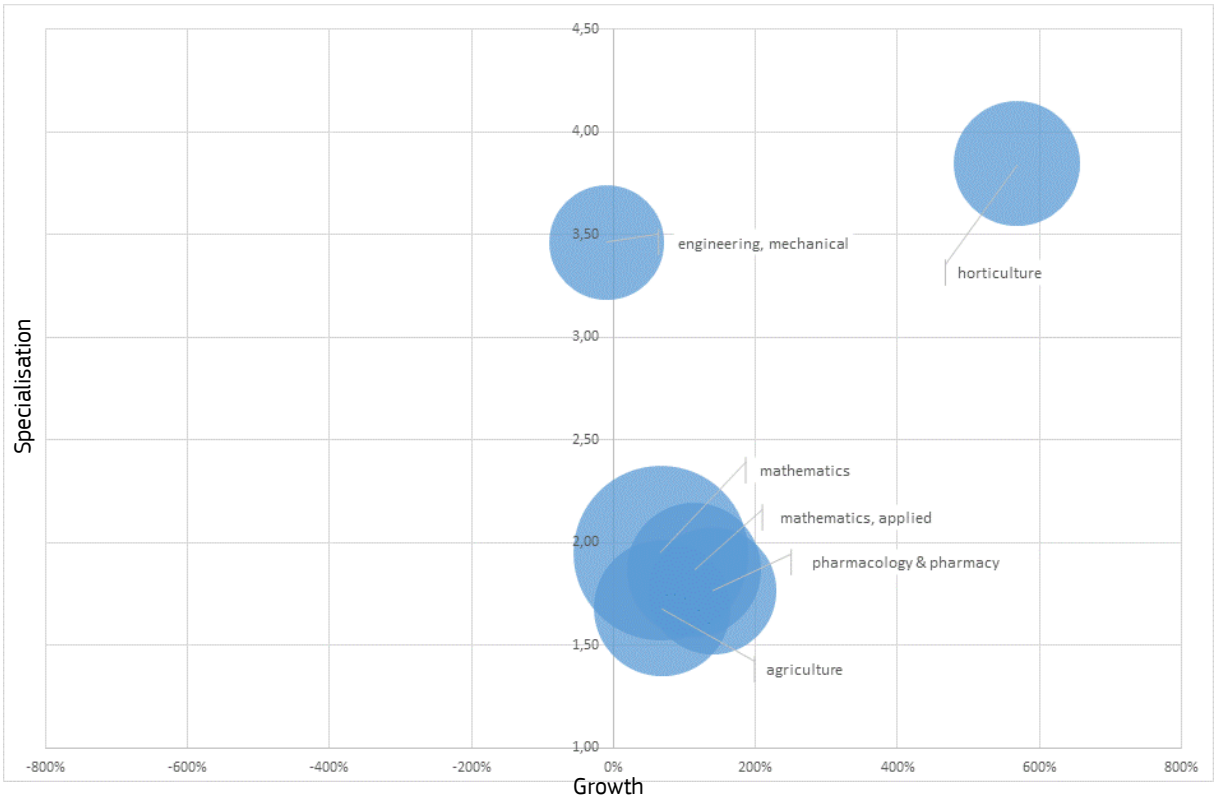


Groups in the graph (left to right): Agriculture; Food science and technology; Agriculture; Agronomy; Veterinary sciences; Computer science, information systems; Computer science, theory and methods; Computer science, artificial intelligence; Education and educational research; Computer science; Telecommunications.

Note: thresholds = LQ 1.5, abs. 10 publications in fractional count.

Source: own analysis.

Figure 25. RS21 - Sumadija and Western Serbia – Publications by SCF – WOS Groups

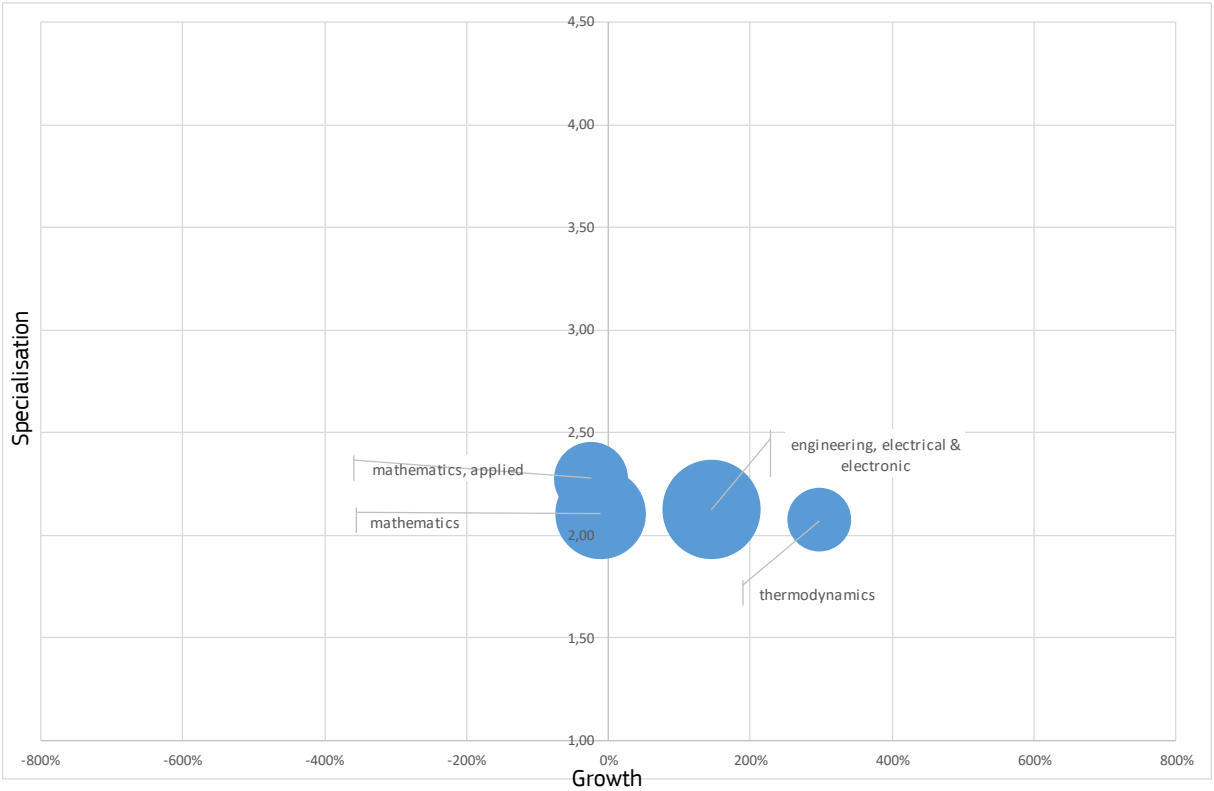


Groups in the graph (left to right): Engineering, mechanical; Mathematics; Mathematics, applied; Pharmacology and pharmacy; Agriculture; Horticulture.

Note: thresholds = LQ 1.5, abs. 10 publications in fractional count.

Source: own analysis.

Figure 26. RS22 - Southern and Eastern Serbia – Publications by SCF – WOS Groups



Groups in the graph (left to right): Mathematics, applied; Mathematics; Thermodynamics; Engineering, electrical and electronic.

Note: thresholds = LQ 1.5, abs. 10 publications in fractional count.

Source: own analysis.

With respect to scientific potential, potential priority areas for Smart Specialisation can be identified as illustrated in the following table:

Table 6: Potential priority areas from a scientific point of view

Region	Potential priority area
Belgrade	Highest volume but little specialisation Polymer science Materials science
Vojvodina	Computer science Agricultural sciences Telecommunications
Sumadija and Western Serbia	Horticulture Mechanical engineering Mathematics Pharmacy Agriculture

Southern and Eastern Serbia	Electrical engineering Mathematics Thermodynamics

Source: own analysis.

A particularly noteworthy point is the apparent decline in agricultural sciences throughout the entire country. Since research in this field is pertinent for large parts of the economy, it is not immediately obvious why they appear to be in decline.

3.5 Potential priority areas

3.5.1 Integrated two-step approach for identifying potential priority areas

In the above subsections, several areas of economic, innovation and scientific activities have been identified as typical of and relevant to specific regions. In short, an elaborated analysis of local specialisations has been conducted. What this analysis alone cannot establish, however, is whether it would really be 'smart' to support these priority areas. In line with this, the Serbian Analytical Team suggested that potential priority areas should be put into perspective with respect to several additional socio-economic dimensions before publicly proposing them in a subsequent, stakeholder-based Entrepreneurial Discovery Process (EDP). In short, it was agreed to provide further material as a basis for subsequent EDP discussions on whether the initially identified specialisations can be considered 'smart' to invest in in the future.

To that end, the following subsection will introduce a two-step approach:

1) integrate all indicators available under a NACE Level 3 classification to identify a final set of possible priority areas for smart specialisation;

2) provide further material to gauge the 'smartness' of investing in these priority areas based on additional economic data.

In the following, the technical implementation of this approach will be presented in sequence as well as the findings resulting from it under certain conditions.

The findings thus obtained are, to a strong extent, consistent with those of the 'visual', synoptic assessment performed in Section 2, thus underlining the validity of the overall assessment methodology and approach in this report.

3.5.2 Technical implementation: two-step data analysis

The two-step analysis was applied to identify final priority areas through the aggregation of the findings from the separate analyses of economic, innovation and scientific potentials. It indicates areas of specialisation based on specific threshold values and provides additional information for all NACE areas.

The data has been integrated and processed in two steps. Following these steps, data was collected and aggregated for each relevant indicator and the 'location quotient' methodology (previously described in the report) was applied to the results in order to determine the level of specialisation.

1. Step 1 – Identification of basic specialisations
    (a) Gathering of data for relevant indicators.
    (b) A specific 'location quotient' (i.e. specialisation indicator) is calculated for each NACE area, region and year.
    (c) A NACE area in a certain region and year is labelled as 'relevantly specialised' if it meets the defined criteria for specialisation, size and share of the regional economy.
2. Step 2 – Aggregation and presentation of findings
    (a) Data for relevant indicators are pasted into the sheets after conversion into a suitable format.

(b) These tables aggregate the '1'/'0' specialisation information by region – sourcing information from the raw data (through Excel references).

(c) General '1'/'0' (specialisation / no specialisation) decisions are made per NACE category, based on whether they are continuous over time.

(d) These tables directly quote and present the final specialisation information from the regional data; they also present further information that may later be relevant in assessing these specialisations as worthy of support or not.

3.5.3 Illustrative findings for a specific set of criteria

Step 1 – Identification of basic specialisations

For the analysis, the following threshold levels have been set on the above-mentioned Excel tool's criteria adjustment page:

- LFS employment (share (in region): > 1.5%, LQ > 1.5/1.25, abs. > 5 000)
- Export (share: >1.5%, LQ > 1.5/1.25, abs. > 250 000)
- Innovation Survey data (share: > 1.5%, LQ > 1.5/1.25, abs. > 25)
- SBS employment (share: > 1.5%, LQ > 1.5/1.25, abs. > 5 000)
- SBS number of firms (share: > 1.5%, LQ > 1.5/1.25, abs. > 250)
- SBS value added (share: > 1.5%, LQ > 1.5/1.25, abs. > RSD 10 bn).

Specialisations were identified in the section with raw data accordingly.

Figure 27. Setting thresholds in the two-step analysis, overall thresholds

ADJUST CRITERIA IN THE CELLS BELOW, DO NOT ADAPT THE ACTUAL SHEETS		
LFS EMPLOYMENT	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	5 000
EXPORT	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	250 000
Innovation survey Firms with R&D (currently not used)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	25
Innovation survey Innovating firms	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	25
Innovation survey Firms with income from innovative products (currently not used)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	25
Employment (SBS, NACE C only)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	5 000
Number of firms (SBS, NACE C only)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	250
Value added (SBS, NACE C only)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	10 000 000
LFS employment (NACE C only)	Decision criterion (LQ > ...)	1.5
	Minimum share of sector in region	1.5%
	Mnimum size (absolute)	5 000

	Belgrade	Vojvodina	Šumadija/W	South-East
Spec. LFS employment	3	1	6	2
Spec. exports	0	2	1	0
Spec. innovators (innovating firms)	3	1	2	0
Spec. patents	0	0	0	0
Spec. structural business statistics	2	4	6	2
Total potential specialisations	8	5	8	4

Source: own calculation.

The only element of less than full integration is that, for patent specialisations, fixed thresholds have been set (share = > 1.25%, LQ > 1.5/1.25, abs. > 5) and calculated in separate sheets. Subsequently, the results were

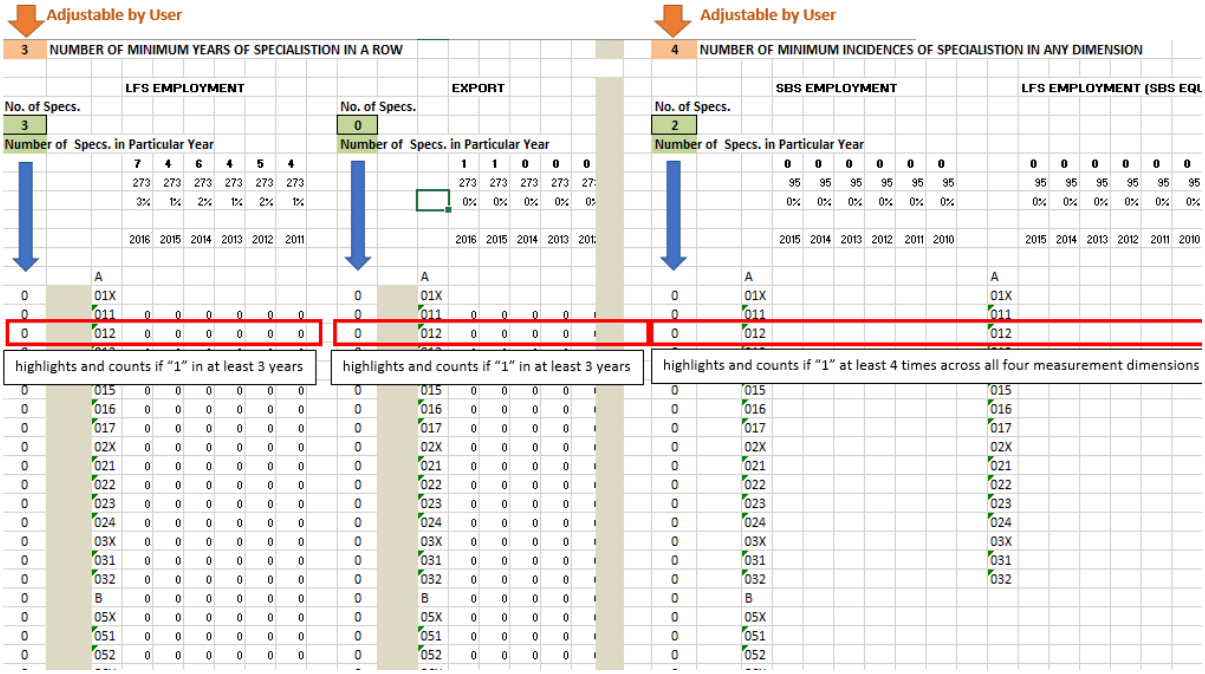
manually transferred into the table with the overview of results. The scarcity of the data and its different formats prevented its complete integration and automated processing.

As a result, only those NACE Level 3 sectors are kept as relevant specialisations in the regional data tables that appear as pertinent and stable specialisations:

- at least 3 times for single years in either of the 'complete coverage' indicator dimensions (throughout the entire economy),
- at least 3 times for single years across all indicator dimensions of structural business statistics data collectively (for the industrial sector – NACE B – only).

To emphasise the particular importance of employment and account for the different ways in which it is measured, the latter analysis covers not only SBS employment, SBS value added and SBS 'number of firms' data, but also LFS employment data for the industrial sectors covered by structural business statistics.

Figure 28. Setting thresholds in the two-step analysis, time dimension



Source: own calculation.

Specialisations had to be identified separately for the relevant patents dimension based on aggregated figures from 2010-2016 as their overall number was rather low. Hence, calculations implicitly already consider the issue of stability over time and do not need to be specifically reviewed.

Additionally, specialisations that are only present in the patent measurement dimension are listed separately. They do not typically amount to economic leverage points as is but will instead be considered with regard to their potential as emerging fields.

The specialisations identified in the four Serbian regions (for which data is available) using the two-step analysis are the following.

1. RS11 - Belgrade

- C18.1 - Printing and service activities related to printing.
- C26.2 - Manufacture of computers and peripheral equipment.
- H49.3 - Other passenger land transport.
- J58.1 - Publishing of books, periodicals and other publishing activities.
- J62.0 - Computer programming, consultancy and related activities.

- K64.1 - Monetary intermediation.
- M72.1 - R&D in natural sciences and engineering.
- P85.4 - Higher education.

This includes those with an LQ between 1.25-1.5.

- G46.7 - Other specialised wholesale.
- G47.2 - Retail sale of food, beverages and tobacco in specialised stores.
- I56.1 - Restaurants and mobile food service activities.
- M71.1 - Architectural and engineering activities and technical consultancy.
- O84.1 - Administration of the state and the economic and social policy.
- Q86.1 - Hospital activities.
- Q86.2 - Medical and dental practice activities.
- S96.0 - Other personal service activities.

Some further possible areas below could be identified with exclusive respect to patent applications.

- C11 - Manufacture of beverages.
- C20.1 - Manufacture of basic chemicals, fertilisers, plastics and synthetic rubber.
- C20.4 - Manufacture of soap and detergents.
- C21 - Manufacture of basic pharmaceutical products.
- C26.1 - Manufacture of electronic components.
- C30 - Manufacture of other transport equipment.

2. RS12 - Vojvodina

- A1.1 - Growing of non-perennial crops.
- C10.1 - Processing of meat and production of meat products.
- C19.2 - Manufacture of refined petroleum products.
- C20.1 - Manufacture of basic chemicals, fertiliser, plastics and synthetic rubber.
- C22.2 - Manufacture of plastic products.
- C29.3 - Manufacture of parts and accessories for motor vehicles.

This includes those with an LQ between 1.25-1.5.

- C10.7 - Manufacture of bakery and farinaceous products.
- C10.8 - Manufacture of other food products.
- G46.4 - Wholesale of household goods.

Three further possible areas below could be identified with exclusive respect to patent applications.

- C26.3 - Manufacture of communication equipment.
- C28.3 - Manufacture of agricultural and forestry machinery.
- C26.5 - Manufacture of instruments and appliances for measuring, testing.

3. RS21 - Sumadija and Western Serbia

- A1.2 - Growing of perennial crops.

- A1.4 - Animal production.
- A1.5 - Mixed farming.
- C10.3 - Processing and preserving of fruit and vegetables.
- C14.1 - Manufacture of wearing apparel, except fur apparel.
- C16.1 - Sawmilling and planing of wood.
- C22.2 - Manufacture of plastic products.
- C25.4 - Manufacture of weapons and ammunition.
- C29.1 - Manufacture of motor vehicles.
- C29.3 - Manufacture of parts and accessories for motor vehicles.
- C31.0 - Manufacture of furniture.
- G46.9 - Non-specialised wholesale trade.

This includes those with an LQ between 1.25-1.5.

- C10.7 - Manufacture of bakery and farinaceous products.
- C25.9 - Manufacture of other fabricated metal products.
- F43.2 - Electrical, plumbing and other construction installation activities.

Two further possible areas below could be identified with exclusive respect to patent applications.

- C28.9 - Manufacture of other special-purpose machinery.
- C28.3 - Manufacture of agricultural and forestry machinery.

4. RS22 - Southern and Eastern Serbia

- C22.1 - Manufacture of rubber products.
- C24.1 - Manufacture of basic iron and steel and ferro-alloys.
- D35.1 - Electric power generation, transmission and distribution.
- T98.1 – [Agricultural] activities of private households for own use.

This includes those with an LQ between 1.25-1.5.

- A1.1 - Growing of non-perennial crops.
- C14.1 - Manufacture of wearing apparel, except fur apparel.

Two further possible areas below could be identified with exclusive respect to patent applications.

- C10 - Manufacture of food products.
- C32.5 - Manufacture of medical and dental instruments and supplies.

Step 2 - Aggregation and presentation of findings

To assess the relevance and potential promise of the identified priority areas, a number of further, qualifying sources of information were synoptically listed:

- **total employment** - even though the selection of areas did, to a certain extent, consider a minimum threshold, concrete information on the absolute number of jobs involved can give additional information about the area's leverage with respect to growth and jobs for the regional economy in question;

- **wages** – while a sector can be relatively important for a regional economy, it will only then be relevant as a future priority area if it allows the local population to earn a sufficient living from sector-related jobs (rather than migrate). This aspect becomes even more important when national wage levels are as low as in Serbia;
- **value added** - despite being an indispensable basis, employment as such does not guarantee national well-being. At the same time, it is important that the national industry is not only concerned with assembly but with relevant activities that generate actual value added within the country;
- **labour productivity** - labour productivity differs by sector according to capital intensity. As such, it is therefore no straightforward measure to 'rank' priority areas. However, it may be a relevant aspect to consider in order to understand whether or not additional employment in a sector will be more productive;
- **growth in employment** - sectors that have displayed positive development in recent years are more likely to display such a development in years to come and are therefore more promising as future priority areas. Sectors that are visibly in decline may still be relevant, but in any case, require a different approach.

This can be relevant both with regard to existing areas that seem to be current points of economic leverage or concern as well as areas identified through patent analysis which could be considered as possible **emerging areas.**

The following tables present the overview of additional information for Serbian regions' relevant specialisations as it is provided by the two-step analysis. The tables distinguish between specialisations that are obvious (LQ > 1.5) and those that are less obvious but still detectable (LQ > 1.25).

- RS11 - Belgrade

Table 7. Additional information on potential priority areas in Belgrade

		Empl.[4]	Exports[5]	Wages[6]	Value added[7]	Labour productivity[8]	Empl. growth[9]
LQ > 1.5							
C18.1 Printing		4 936	183	41 352	3.91	1 359	24.6%
C26.2 Computers		240	41 038	136 745	4.15	2 191	19.6%
H49.3 Transport		16 463	0	47 674	13.66	1 303	21.8%
J58.1 Publishing		4 980	30 282	64 241	7.66	1 441	31.4%
J62.0 Programming		10 413	0	244 641	28.45	2 942	28.2%
M64.1 Monetary		15 931	0	104 359	x	x	26.9%
M72.1 Natural R&D		5 116	0	75 938	8.97	2 271	31.6%
P85.4 Higher educ.		10 765	0	77 967	x	X	26.5%
LQ > 1.25							

4 Number of employed persons, head count, 2016.
5 Thousand euro, 2016.
6 Net annual wages, RSD, 2016.
7 Value added at factor costs, RSD billion, 2015.
8 Factor productivity, RSD 1 000, 2015.
9 AAGR, 2011-2016.

G46.7 Wholesale		10 499	0	122 572	16.55	2 028	24.1%
G47.2 Retail (food)		20 036	0	24 859	1.37	730	18.0%
I56.1 Restaurants		16 879	0	30 319	4.37	583	19.0%
M71.1 Arch./tech. C		6 115	1 190	69 809	12.90	1 672	23.5%
O84.1 Administration		18 745	0	53 078	x	x	19.3%
Q86.1 Hospitals		20 490	0	45 152	x	x	15.6%
Q86.2 Med./dental		14 940	0	40 583	x	x	19.5%
S96.0 Pers. serv.		10 212	0	28 300	x	x	20.3%
Patents							
C11 - Beverages		2 210	51 839	109 352	7.85	3 512	83.1%
C20.1 Basic chem.		421	34 584	110 855	3.49	5 981	31.2%
C20.4 Detergents		399	134 330	n/a	4.20	2 787	57.2%
C21.2 Pharma		2 634	28 659	61 548	3.57	1 748	220%
C26.1 Electr. comp.		166	3 279	n/a	-0.22	1 215	82.1%
C30.1 Transp. eq.		465	3 594	59 985	0.06	521	152%

Source: own analysis.

With regard to the Belgrade region, the software sector contributes significantly to value added and pays high wages. The overall role of the hardware sector, in comparison, remains negligible, although apparently characterised by a large number of smaller firms.

Overall, none of the identified – predominantly service – sectors displays substantial export volumes. From those specialisations identified through patent analysis, beverages, pharmaceuticals, electrical components and transport equipment appear noteworthy candidates as emerging sectors based on their notable growth rates, basic chemistry and detergents less so. However, their overall employment potential is modest at best.

- RS12 - Vojvodina

Table 8. Additional information on potential priority areas in Vojvodina

		Empl.[10]	Exports[11]	Wages[12]	Value added[13]	Labour productivity[14]	Empl. growth.[15]
LQ > 1.5							
A1.1 N-p crops		61 889	486 872	40 624	x	x	24.7%

[10] Number of employed persons, head count, 2016.
[11] Thousand euro, 2016.
[12] Net annual wages, RSD, 2016.
[13] Value added at factor costs, RSD billion, 2015.
[14] Factor productivity, RSD 1 000 RSD, 2015.
[15] AAGR, 2011-2016.

C10.1 Meat proc.		9 088	55 458	33 347	9.00	1 415	25.3%
C19.2 Refining		2 684	191 548	133 598	42.16	14 092	29.7%
C20.1 Basic chem.		2 803	330 834	65 259	2.94	822	23.9%
C22.2 Plastics		6 396	234 372	52 938	8.42	1 738	20.2%
C29.3 Vehicle parts		9 351	274 958	39 358	6.92	938	21.9%
LQ > 1.25							
C10.7 Bakery		10 488	28 438	27 213	3.58	1 061	19.5%
C10.8 Food prod.		6 347	213 260	57 331	7.54	2 996	19.4%
G46.4 Wholesale		1 855	0	28 614	3.99	1 012	15.1%
Patents							
C26.3 Com. equip.		0	6 670	23 453	0.06	1 232	0%
C28.3 Agri. machin.		1 253	14 613	19 927	0.62	915	239%
C26.5 Instruments		475	7 398	29 387	0.58	1 454	227%

Source: own analysis.

In Vojvodina, the refinery(i.e. the petrochemical sector) stands out as extremely productive, pays high wages, has grown dynamically and contributes significantly to value added and exports accordingly. However, it only employs a very limited number of people. A second relevant industry is the vehicle parts sector that grows, pays reasonable wages, creates a relevant amount of value added and contributes to exports accordingly, even though productivity – as in the basic chemicals sector – remains low. Additionally, similar findings can be put forward for the local plastics industry where – based on sectoral specificities – labour productivity is already higher.

Most prominently, however, Vojvodina continues to depend on its agricultural sector, which employs large shares of the population, grows rather dynamically and constitutes the key source of exports from the region. By Serbian sectoral standards, wages are also relatively high. Any broad-based change introduced to that sector would have severe implications on the regional economy than that in any of the above-mentioned sectors. Among the three agro-food processing sectors highlighted relying on local farming outputs, 'food processing' stands out as paying the best wages, contributing the most to exports and reaching the highest levels of labour productivity.

Further to those specialisations identified through patent analysis, agricultural machinery and measuring instruments appear noteworthy candidates as emerging sectors based on their notable growth rates, with computer equipment being a less worthy candidate. The overall employment potential of these sectors is modest, with the possible exception of agricultural machinery.

- RS21 - Sumadija and Western Serbia

Table 9. Additional information on potential priority areas in Sumadija & Western Serbia

		Empl.[16]	Exports[17]	Wages[18]	Value added[19]	Labour productivity[20]	Empl. growth[21]
LQ > 1.5							
A1.2 P crops		29 306	49 131	25 512	x	x	24.9%
A1.4 Animal prod.		47 146	26 876	25 747	x	x	25.7%
A1.5 Mixed farm.		136 707	0	25 890	x	x	24.0%
C10.3 fruit proc.		5 584	221 273	36 595	7.51	1 824	22.3%
C14.1 Apparel		11 022	91 073	24 367	4.32	668	26.3%
C16.1 Sawmilling		4 538	22 779	30 977	1.98	915	19.6%
C22.2 Plastics		6 626	177 013	38 466	8.39	1 844	19.2%
C25.4 Weapons		8 015	88 905	55 707	9.94	1 455	33.1%
C29.1 Vehicles		3 821	1 018 810	50 058	16.81	4 057	28.5%
C29.3 Vehicle part.		4 881	248 821	36 474	10.48	1 083	12.3%
C31.0 Furniture		7 084	113 788	30 689	4.72	1 029	16.9%
G46.4 Wholesale		2 454	0	28 582	10.95	1 302	13.3%
LQ > 1.25							
C10.7 Bakery		6 938	3 121	23 646	1.68	640	17.5%
C25.9 Metal prod.		2 631	96 877	41 376	5.24	1 507	11.6%
F43.2 Installations		2 884	0	28 290	1.79	1 121	13.1%
Patents							
C28.9 Sp. purp. mach.		978	31 309	46 256	0.79	744	112%

16 Number of employed persons, head count, 2016.
17 Thousand euro, 2016.
18 Net annual wages, RSD, 2016.
19 Value added at factor costs, RSD billion, 2015.
20 Factor productivity, RSD 1 000, 2015.
21 AAGR, 2011-2016.

C28.3 Agri. machin.		262	6 397	30 172	-0.07	892	44.8%

Source: own analysis.

Sumadija is the traditional centre of automobile production in Serbia. This specialisation still appears in almost all dimensions of the analysis, in particular with regard to exports and value added. It pays the highest wages in the regions and is an obvious leverage point for future support, especially since the growth dynamics in the local supplier chain (vehicle parts) do not keep pace with the main OEM sites.

Beyond automotive, there are a number of other, smaller sectors, such as plastics, metal production, furniture and apparel. These grow and deserve attention even if their value-added contribution is lower and they export notably less than the automotive sector.

Furthermore, Sumadija and Western Serbia is characterised by a growing agricultural sector that is, however, more domestically oriented and sees less innovation than in Vojvodina. Accordingly, wages only reach about two thirds of those in Vojvodina and are among the lowest in absolute terms. Hence, the local agricultural sector should not necessarily be considered a 'potential priority domain for smart specialisation' in its common structure, but its growth dynamics indicate that it may provide a suitable leverage point for a transformation, whose benefits would quickly reach large shares of the local population. Even today, for example, the fruit processing sector pays wages higher that of other local industries like apparel or furniture.

Further to those specialisations identified through patent analysis, special-purpose machinery appears a noteworthy candidate as a potential S3 priority area, being an emerging sector based on its notable growth rates, with agricultural machinery less so. The overall employment potential of both of these sectors is still relatively modest.

- RS22: Southern and Eastern Serbia

Table 10. Additional information on potential priority areas in Southern & Eastern Serbia

		Empl.[22]	Exports[23]	Wages[24]	Value added[25]	Labour productivity[26]	Empl. growth[27]
LQ > 1.5							
C22.1 Rubber		4 711	313 158	60 348	14.88	4 708	27.0%
C24.1 Iron & steel		4 830	135 201	70 212	-6.87	-1 364	39.0%
D35.1 Electr. power		9 711	0	84 252	0.27	1 725	22.7%
T98.1 Agriculture		53 929	0	X	x	x	26.0%
LQ > 1.25							
A1.1 N-P crops		30 046	15 392	35 030	x	x	17.4%
C14.1 Apparel		8 277	45 675	23 671	3.26	592	17.5%

22 Number of employed persons, head count, 2016.
23 Thousand euro, 2016.
24 Net annual wages, RSD, 2016.
25 Value added at factor costs, RSD billion, 2015.
26 Factor productivity, RSD 1 000, 2015.
27 AAGR, 2011-2016.

Patents							
C32.5 Med. & dental		300	353	24 039	0.15	1 174	115%
C10 Food products*		~13 400	~100 000	~30 000	~10.00	~619	~50%

Source: own analysis.

In terms of industry, the local iron and steel and rubber industry stand out as paying above average wages, growing at a relevant pace and contributing substantially to exports. While the rubber industry contributes significantly to local value added, the iron and steel industry however makes losses, resulting in negative value added and negative labour productivity – insofar this can be concluded from the data. Therefore, only the rubber industry can be considered a potential priority area for Smart Specialisation.

Moreover, similar to Sumadija and Western Serbia, Southern and Eastern Serbia remains – at its core – an agricultural economy in which the respective sector displays even less dynamics. While there is growth, it is mostly in the informal sector; innovation remains absent and wages below national average. As in Sumadija and Western Serbia, business model modernisation and technology application in the agricultural sector would, in principle, be the best option to reach broader parts of the population. The current structure of the sector, however, seems to impose even further limitations than in that case, let alone in Vojvodina, where it is a real option.

Lastly, the region is home to a textiles and apparel sector that supports a relevant level of employment, even if it is at some of the lowest wages found in the overall earnings statistics. Southern and Eastern Serbia is specialised in electric power generation, a sector that pays very high wages by local standards, but that, with great likelihood, cannot be substantially expanded with respect to employment and value added, as the number of (often hydraulic) power stations is given and limited.

Further to those specialisations identified through patent analysis, both medical and dental products and the food sector appear noteworthy candidates for emerging sectors based on their notable growth rates. While the overall employment potential of the former is very modest, that of the latter is already substantial at this current moment in time.

3.6 Conclusion

It can be concluded that the following potential priority areas can be identified on the basis of the data and could serve as a basis for further consideration in a later, stakeholder-based EDP.

1. RS11 - Belgrade
    - Computer programming and ICT
    - R&D and technical consultancy
    - Creative economy
    - Monetary intermediation

    Potentially emerging innovative areas

    - Beverages, pharmaceuticals, electrical components, transport equipment

    Science

    - Various
2. RS12 - Vojvodina
    - Automotive
    - Agricultural economy (including processing industries)

- Petrochemical industry
- Plastics industry

Potentially emerging innovative areas

- Agricultural machinery, measuring instruments,

Science

- Computer science, telecommunications

3. RS21 - Sumadija and Western Serbia
    - Agri-/horti-/silvicultural economy (including processing industries)
    - Automotive
    - Textile industry
    - Plastics industry
    - Metal industry

    Potentially emerging innovative areas

    - Special-purpose machinery

    Science

    - (Mechanical engineering, pharmacy)
4. RS22 - Southern and Eastern Serbia
    - Agri-/horticultural economy (including processing industries)
    - Textile industry
    - Rubber industry
    - (Electrical engineering)

    Potentially emerging innovative areas

    - Food products, medical and dental

    Science

    - (Electrical engineering)

An overview of all potential priority areas for Smart Specialisation is provided in the following table.

Table 11. Overview of potential priority areas in Serbia

Region	Existing core	Potentially emerging	Science base
Belgrade	Computer programming and ICT, R&D and technical consultancy, creative economy, monetary intermediation	Beverages, pharmaceuticals, electrical components, transport equipment	Various
Vojvodina	Automotive suppliers, agricultural economy (including processing industries), petrochemical industry, plastics industry	Agricultural machinery, measuring instruments	Computer science, telecommunications

Sumadija and Western Serbia	Agri-/horti-/silvicultural economy (including processing industries), automotive, textile industry, plastics industry, metal industry	Special-purpose machinery	Mechanical engineering, pharmacy
Southern and Eastern Serbia	Agri-/horticultural economy (including processing industries), textile industry, rubber industry, (electrical engineering)	Food products, medical and dental	Electrical engineering

Source: own illustration.

3.7 National and regional specialisations

Irrespective of their absolute economic or dynamic relevance, specialisations can be analysed in a further dimension with respect to whether they are genuinely regional (i.e. affect one Serbian region alone or almost one) or whether they are relevant for at least two regions, or even more.

At a later stage, this will inform decisions on whether a strategy needs to foresee a national-level effort for certain activities, or if these can – and should – be delegated to regional stakeholders and policy-makers. As such a consideration will mainly be relevant from an impact perspective, the following analysis will focus on the distribution of employment in the preliminary priority areas that the prior analysis has identified.

In consequence, two different types of preliminary priority areas can be identified:

- those in which more than 50% of all employment is concentrated in one region,
- those in which there is an emphasis in one region, but further activities in others,
- those in which there is no particular regional emphasis.

The preliminary priority areas, with one region displaying a share above 50% of the national total and thus a dominant concentration, are:

- for Belgrade - R&D in natural sciences, publishing of books, computer programming, monetary intermediation, higher education, (manufacture of communication equipment);
- for Vojvodina - manufacture of refined petroleum products, manufacture of agricultural and horticultural equipment, processing of meat, growing of non-perennial crops, (manufacture of computers, manufacture of measuring and testing equipment);
- for Sumadija and Western Serbia - manufacture of weapons and ammunition, manufacture of motor vehicles, sawmilling and planing of wood, animal production, growing of non-perennial crops, mixed farming, processing of fruit;
- for Southern and Eastern Serbia - manufacture of basic iron or steel.

While this is relevant in terms of underlining that each region has its own, very particular potentials or at least characteristics, it is equally relevant to underline that all other preliminary priority areas concern at least two – but not uncommonly three – regions as illustrated in the figures below. In some cases, capacities are clearly predominantly shared with one region. In the majority, however, they exist across the country, at different levels. What is rare, however, is that preliminary priority areas are more or less equally relevant to all regions. Currently, the only exception is the hospital and medical sector.

In line with earlier in-depth analyses for the individual regions, preliminary priority areas with relevance to more than one region and to be addressed at national level include:

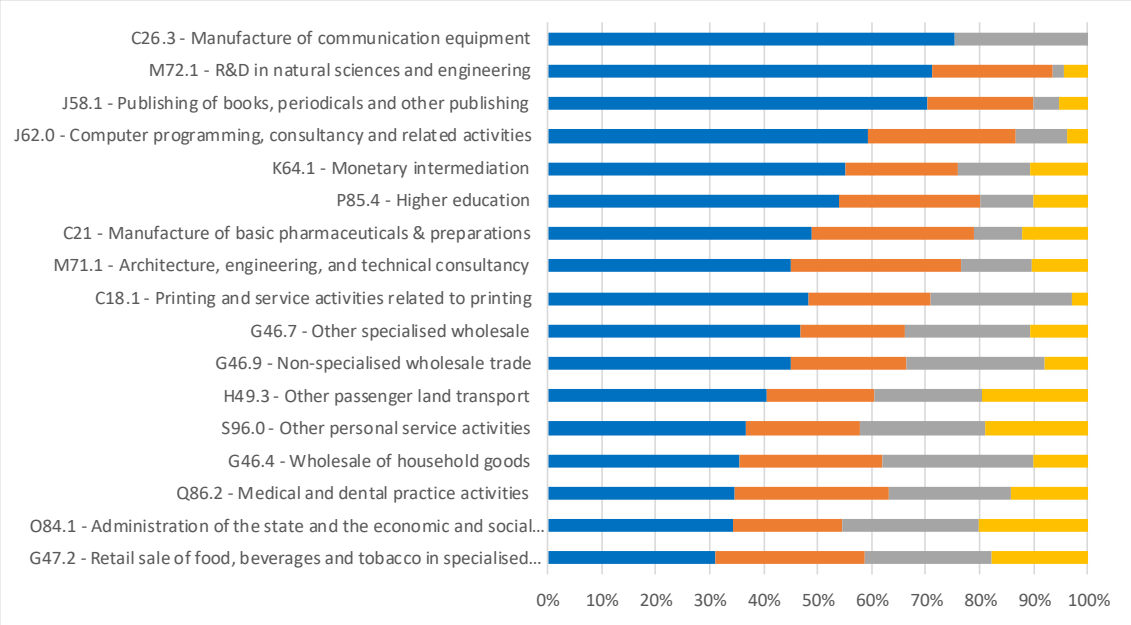
- pharmaceuticals (Belgrade & Vojvodina),
- engineering and technical consultancy (Belgrade & Vojvodina),

- parts and accessories for motor vehicles (Vojvodina & Southern/Eastern Serbia),
- the manufacture of food products (Vojvodina & Sumadija/Western Serbia),
- the manufacture of plastic products (Sumadija/Western & Southern/Eastern Serbia),
- the manufacture of special-purpose machinery (Sumadija/Western Serbia & Belgrade),
- the manufacture of fabricated metal products (Sumadija/Western Serbia & Vojvodina),
- the manufacture of furniture (Sumadija/Western & Southern/Eastern Serbia),
- the manufacture of apparel (Sumadija/Western & Southern/Eastern Serbia),
- the manufacture of rubber (Southern/Eastern, Vojvodina & Sumadija/Western Serbia).

As the figures below illustrate, however, a national level approach may even be relevant to priority areas in which one region holds more than 50% of all Serbian employment, taking into account the other 50%.

Since Serbia exhibits a clear-cut, region-by-region specialisation in hardly any field, these decisions will ultimately have to be taken at policy level when the selection of priority areas has been finalised and a more in-depth investigation of the relevant ones can be launched.

Figure 29. Preliminary priority areas with most employment in Belgrade

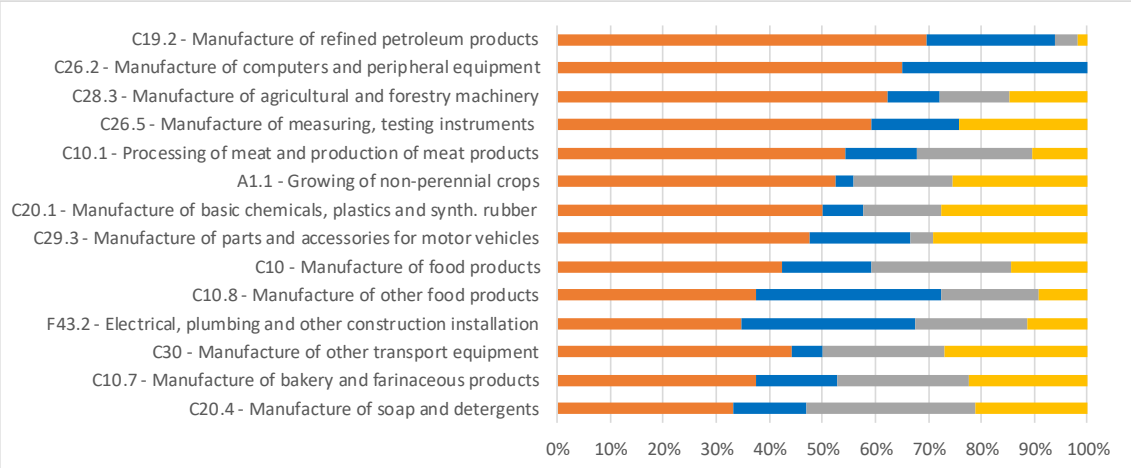


Legend: blue – Belgrade; orange – Vojvodina; gray – Sumadija and Western Serbia; yellow – Southern and Eastern Serbia.

Note: These will be predominantly but not necessarily fully identical to the priority areas suggested for this region – it could be that this region has more employees than the specialised region.

Source: own calculation.

Figure 30. Preliminary priority areas with most employment in Vojvodina

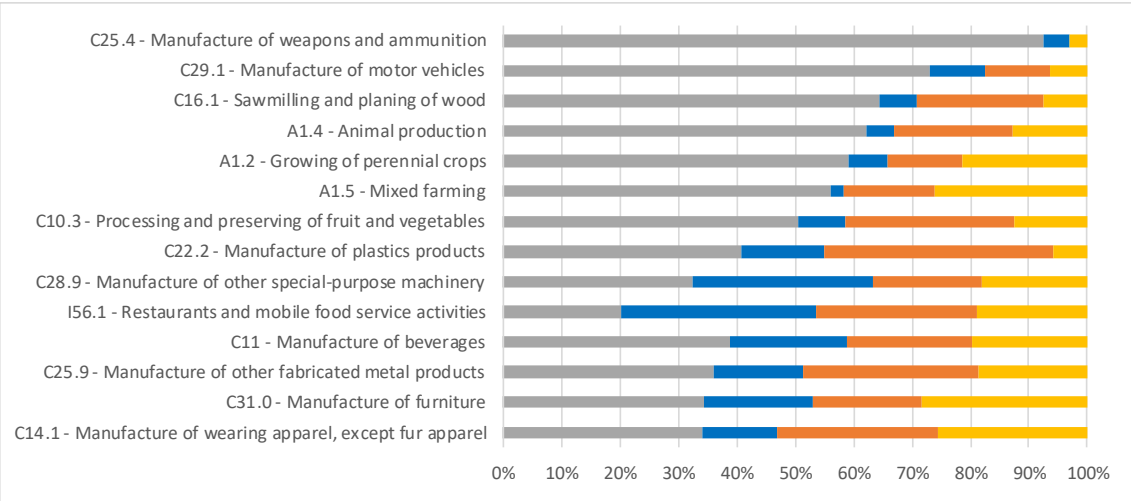


Legend: blue – Belgrade; orange – Vojvodina; gray – Sumadija and Western Serbia; yellow – Southern and Eastern Serbia.

Note: These will be predominantly but not necessarily fully identical to the priority areas suggested for this region – it could be that this region has more employees than the specialised region.

Source: own calculation.

Figure 31. Preliminary priority areas with most employment in Sumadija and Western Serbia

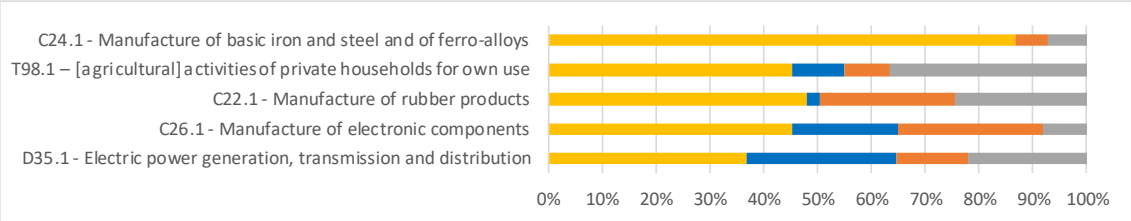


Legend: blue – Belgrade; orange – Vojvodina; gray – Sumadija and Western Serbia; yellow – Southern and Eastern Serbia.

Note: These will be predominantly but not necessarily fully identical to the priority areas suggested for this region – it could be that this region has more employees than the specialised region.

Source: own calculation.

Figure 32. Preliminary priority areas with most employment in Southern and Eastern Serbia

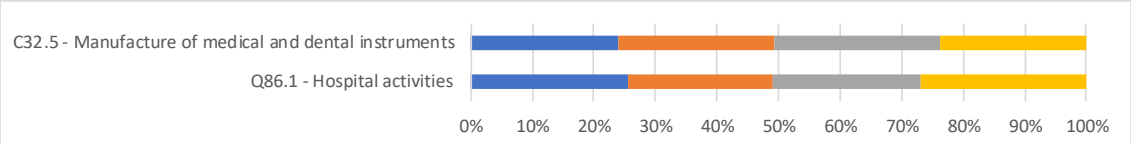


Legend: blue – Belgrade; orange – Vojvodina; gray – Sumadija and Western Serbia; yellow – Southern and Eastern Serbia.

Note: These will be predominantly but not necessarily fully identical to the priority areas suggested for this region – it could be that this region has more employees than the specialised region.

Source: own calculation.

Figure 33. Preliminary priority areas without clear regional focus

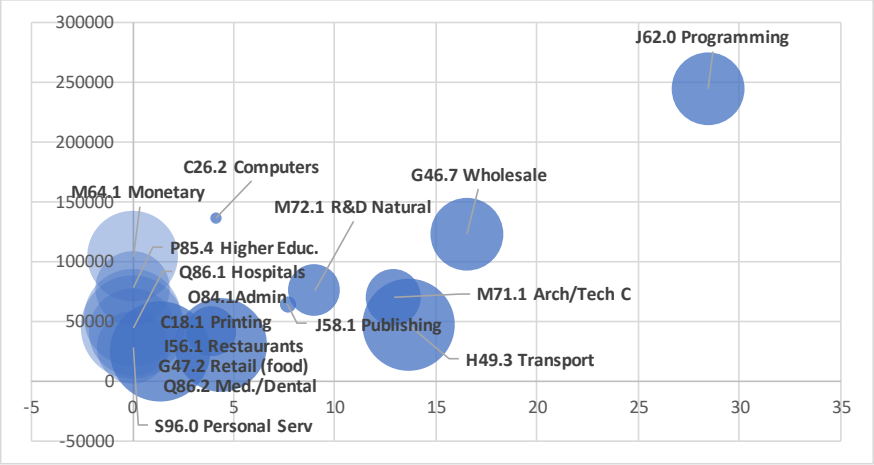


Legend: blue – Belgrade; orange – Vojvodina; gray – Sumadija and Western Serbia; yellow – Southern and Eastern Serbia.

Source: own calculation.

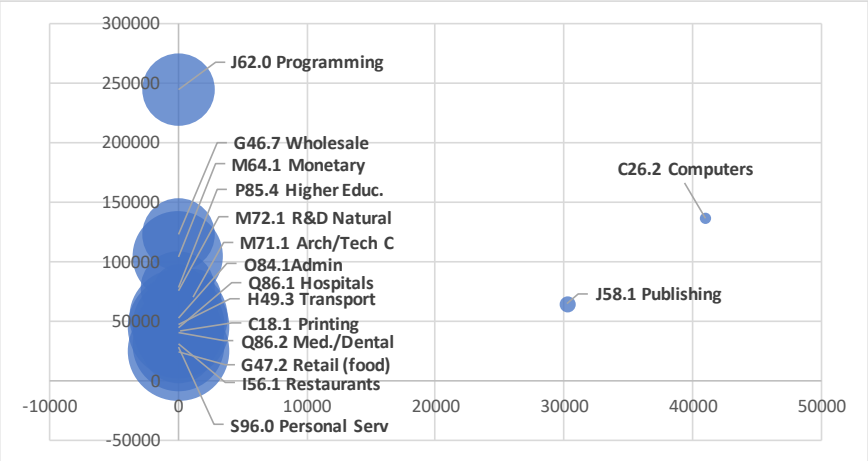
Further illustrative information on potential priority areas is presented in the figures below.

Figure 34. Wages (left axis) vs value added (right axis) for Belgrade



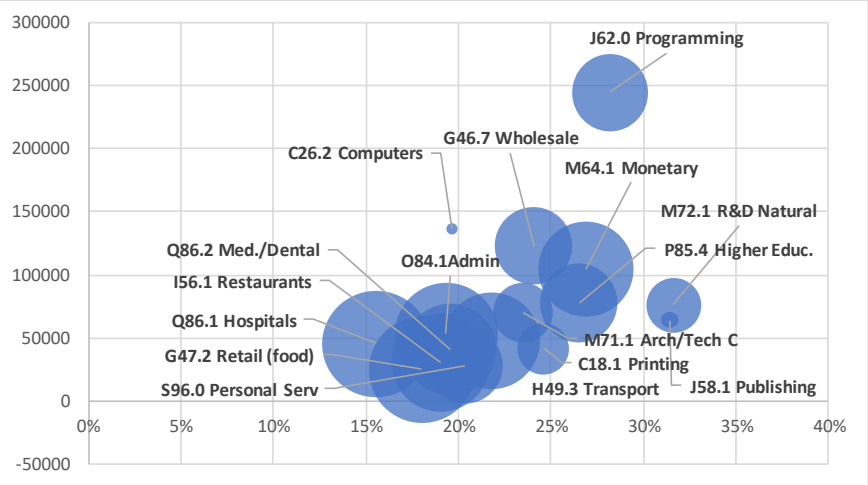
Source: own calculation.

Figure 35. Wages (left axis) vs export (right axis) for Belgrade



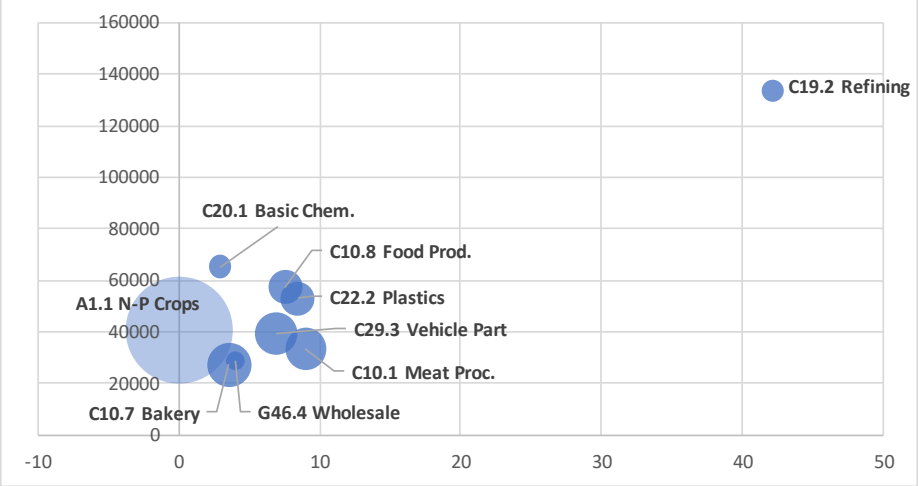
Source: own calculation.

Figure 36. Wages (left axis) vs employment growth AAGR (right axis) for Belgrade



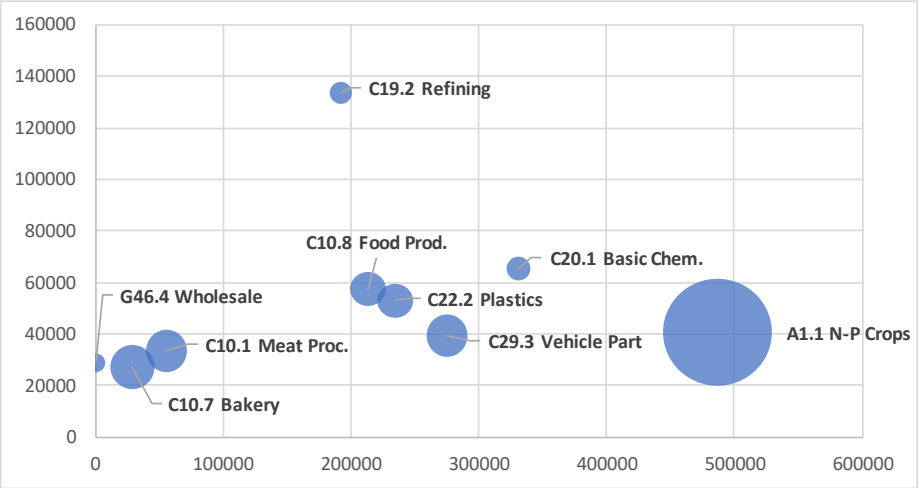
Source: own calculation.

Figure 37. Wages (left axis) vs value added (right axis) for Vojvodina



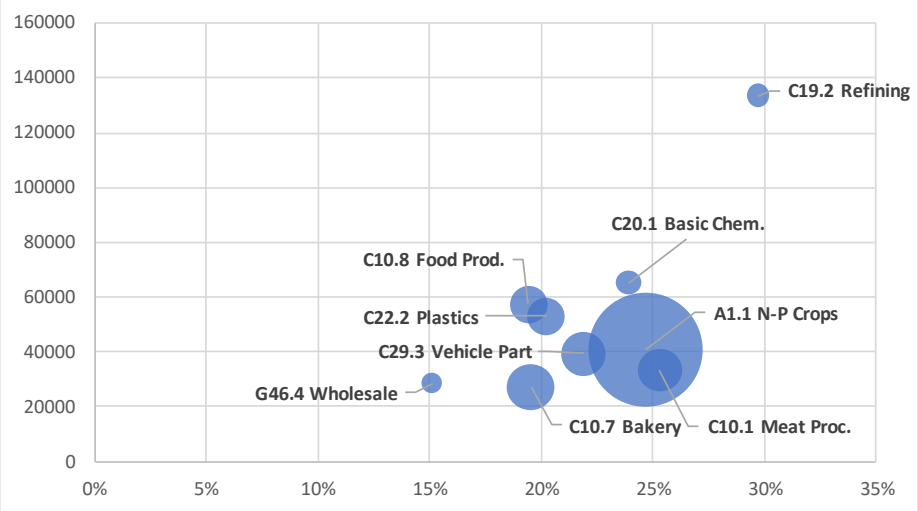
Source: own calculation.

Figure 38. Wages (left axis) vs exports (right axis) for Vojvodina



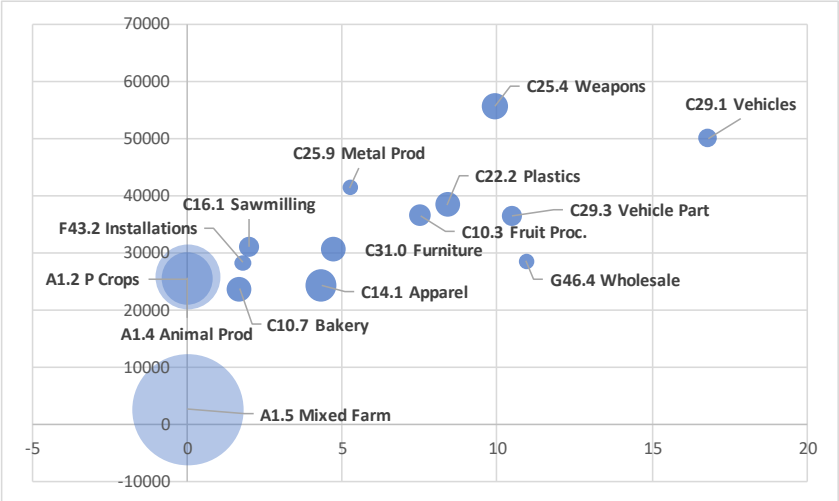
Source: own calculation.

Figure 39. Wages (left axis) vs employment growth AAGR (right axis) for Vojvodina



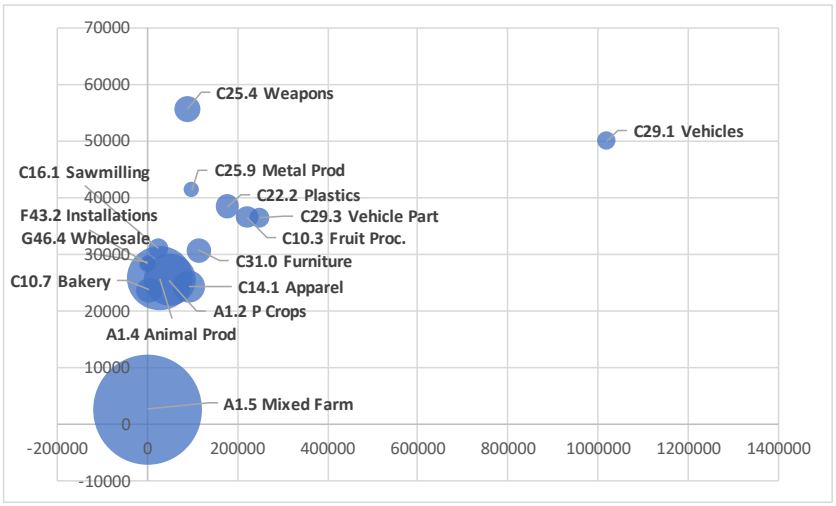
Source: own calculation.

Figure 40: Wages (left axis) vs value added (right axis) for Sumadija and Western Serbia



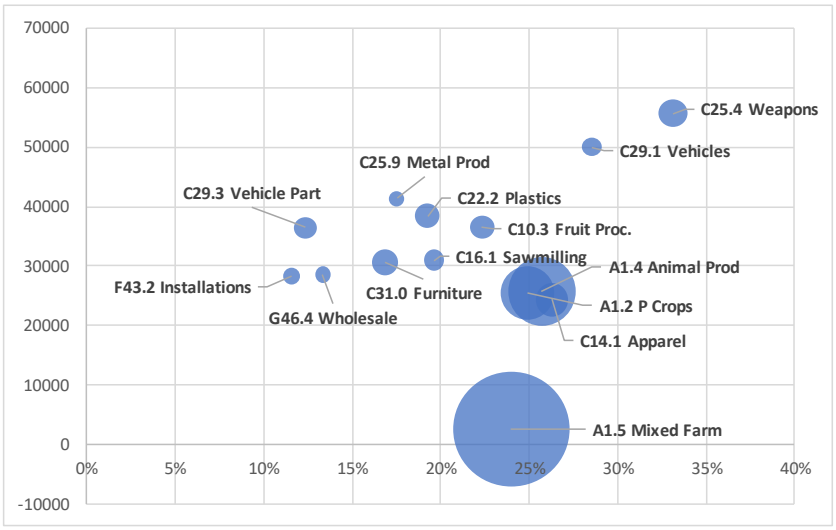
Source: own calculation.

Figure 41. Wages (left axis) vs exports (right axis) for Sumadija and Western Serbia



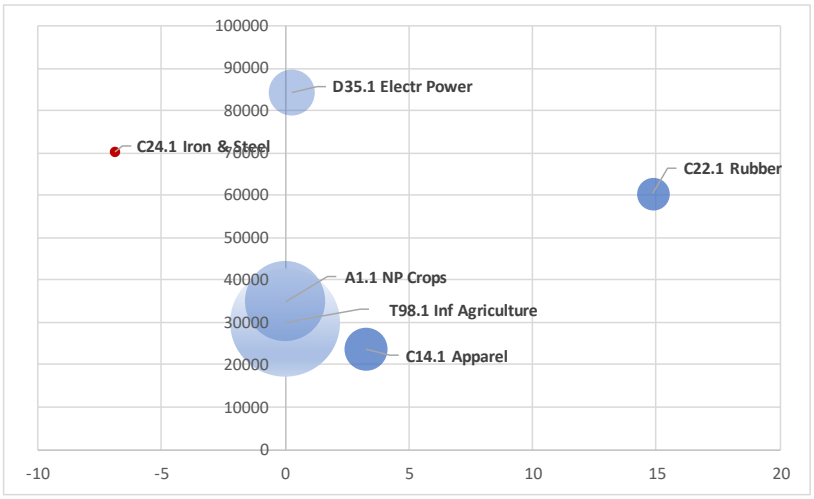
Source: own calculation.

Figure 42. Wages (left axis) vs employment growth AAGR (right axis) for Sumadija and Western Serbia



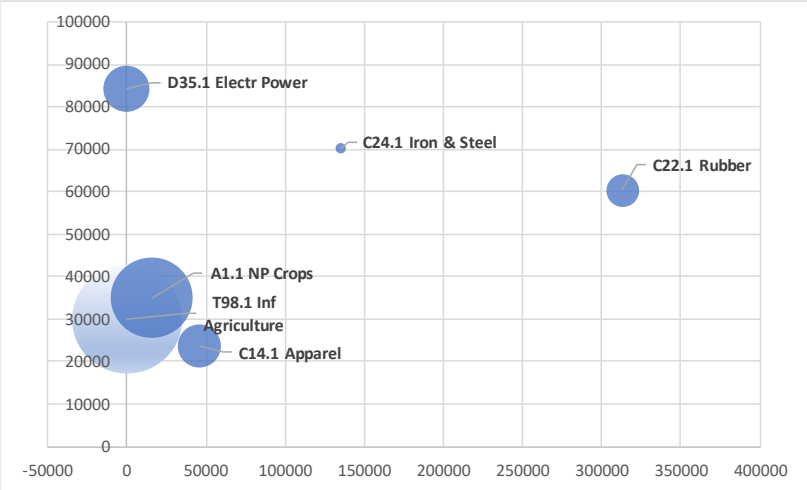
Source: own calculation.

Figure 43. Wages (left axis) vs value added (right axis) for Southern and Eastern Serbia



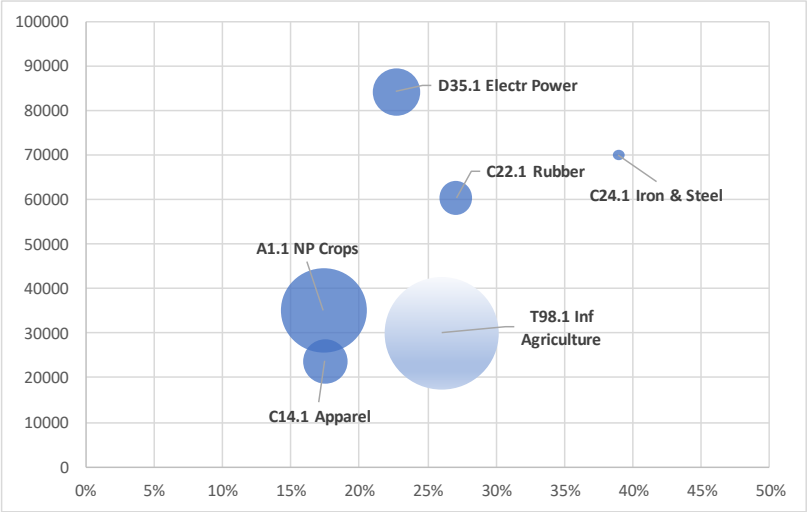
Source: own calculation.

Figure 44. Wages (left axis) vs exports (right axis) for Southern and Eastern Serbia



Source: own calculation.

Figure 45. Wages (left axis) vs. employment growth AAGR (right axis) for Southern and Eastern Serbia



Source: own calculation.

3.8 Recommendations and next steps

This report has compiled different sources of data concerning the economies of Serbian regions from two analytical perspectives. It has analysed the available datasets and most up-to-date information provided by the National Statistical Office of the Republic of Serbia.

After analysing the economic, innovation and scientific activities from various angles, the authors have made some progress in integrating the different perspectives and developing an actual tool with which potential areas of specialisation can be identified based on adaptable hypotheses and judged based on additional criteria.

Together with the Serbian Analytical Team, the authors now feel safe to say that they have covered and interpreted all pertinent quantitative information to a degree that further analysis or the integration of additional data would not substantially affect the outcome of the analysis.

An overall picture of regional strengths, weaknesses and possible leverage points has emerged in the form of potential priority areas. The report provides information for further assessment and analysis and suggests threshold values to identify areas of specialisation.

This, however, can only be the basis for a further discussion of actual political prioritisations in the upcoming Entrepreneurial Discovery Process. Quantitative data alone cannot sufficiently indicate what is desirable and feasible within both the political and the economic domain.

However, it gives clear indications upon which economic sectors the Serbian population relies for growth and jobs and where dynamic development is more likely. Without pre-determining its outcome, it thus clearly indicates which areas may not be overlooked in future stakeholder consultations.

As one bottom line message, it would seem essential that an economy such as Serbia's – that is still highly dependent on agriculture and various light industries – also leverages on these potentials, rather than focusing on classic high-tech sectors alone.

4 Qualitative mapping of the economic, innovation and scientific potential of Serbia

(Authors - Domen Bole, co-creation, Lazar Zivkovic, Institute Mihajlo Pupin, Viktor Nedovic, Ministry of Education, Science and Technological Development of Serbia)

As the transitional step between quantitative and qualitative mapping, additional analyses took place with the aim of further profiling the preliminary priority areas proposed based on the quantitative analysis.

After the regional-level analysis and following the indications of insufficient institutional capacity and mandate for management of innovation policies at regional level, a decision was made to develop the national-level Smart Specialisation Strategy built up from the regional priorities. Multi-criteria analysis was used for this purpose based on the ideal point method (Kutlaca et al., 2018b; Zeleny, 1976).

4.1 Multi-criteria analysis

The multi-criteria analysis was performed by the team from the Institute Mihajlo Pupin with the objective of ranking preliminary priority sectors at national level. The specific method used in this analysis was the 'ideal point method', which ranks alternatives according to their closeness to certain 'ideal' criteria values. This method defines the alternative with the least distance from the ideal solution in the set of possible solutions as the best alternative. For a more detailed methodology, please see Kutlaca et al. (2018b).

Table 12. The ranking list for the first 30 activities in Serbia formed using the multi-criteria ranking method

Rank	Activity name
1	Computer programming, consultancy and related activities
2	Advertising
3	Architectural and engineering activities and related technical consultancy
4	Non-specialised wholesale trade
5	Technical testing and analysis
6	Manufacture of other food products
7	Other retail sale in specialised stores
8	Growing of annual and biennial plants
9	Manufacture of plastics products
10	Manufacture of other general-purpose machinery
11	Manufacture of furniture
12	Research and experimental development in natural sciences and engineering
13	Processing and preserving of fruit and vegetables
14	Manufacture of parts and accessories for motor vehicles and their engines
15	Publishing of books, periodicals and other publishing activities
16	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks

17	Manufacture of wearing apparel, except fur apparel
18	Retail trade in non-specialised shops
19	Manufacture of beverages
20	Construction of residential and non-residential buildings
21	Manufacture of bakery and farinaceous products
22	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
23	Processing and preserving meat and meat products
24	Other specialised wholesale
25	Manufacture of computers and peripheral equipment
26	Manufacture of medical and dental instruments and supplies
27	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
28	Manufacture of other special-purpose machinery
29	Manufacture of rubber products
30	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations

Source: own analysis.

With the aim of considering broader areas, Table 12 provides the first 11 groups to which the activity areas belong according to the official classification of activities.

Table 13. Ranking list for the first 11 NACE sector-groups in Serbia formed using the multi-criteria ranking method

Ranking	NACE sector-group
1	Computer programming, consultancy and related activities
2	Architectural and engineering activities, technical testing and analyses
3	Advertising and market research
4	Manufacture of furniture
5	Manufacture of beverages
6	Manufacture of rubber and plastic products
7	Manufacture of other machinery and equipment
8	Scientific research and development

9	Manufacture of motor vehicles, trailers and semi-trailers
10	Manufacture of tobacco products
11	Manufacture of food products

Source: own analysis.

4.2 Additional analyses

In order to further validate the findings on innovation potential from the previous part of the report, the Serbian Smart Specialisation Team analysed additional studies and data from the programmes of the Serbian Innovation Fund, which provided additional sources for the analysis of the innovation potential. The results in that aspect are provided in the tables below.

Table 14. Number of projects financed within the cooperation programme for science and industry, early development and co-financing innovations in 2017

Scientific area	Science and industry cooperation programme	Co-financing innovation programme	Early development programme
Food and agriculture	4		
Electrical engineering	2		
Natural sciences	2		1
Software and app. development	1	2	7
Information and communication technologies	1	1	4
Mechanical engineering	1		2
Environmental protection	1		1
Medical and therapeutic devices	1		1
Energy and energy efficiency	1		
Electronics		1	1
New materials and nanotechnologies		1	1
Construction			1
Total	14	5	19

Source: Innovation Fund of the Republic of Serbia.

Table 15. Approved innovation vouchers by scientific area in 2017

Scientific area	Number of approved innovation vouchers
Mechanical engineering	18
Food industry and agriculture	13
Energy and energy efficiency	4
New materials and nanotechnologies	3
Construction	2
Software and application development	2
Medical and therapeutic devices	2
Other industries	2
Information and communication technologies	1
Total	47

Source: Innovation Fund of the Republic of Serbia.

Table 16. Projects registered for green innovation vouchers in 2018

Scientific area	Percentage of projects registered for innovation vouchers
Machinery and equipment	27%
IT/IoT	21%
Energy/resource efficiency	18%
Waste management	18%
Renewable sources	8%
Sustainable products	8%

Source: EBRD, 2018.

4.3 Conclusion from the additional analyses

Based on the results of the quantitative mapping, multi-criteria analysis and additional analysis, Serbia's Smart Specialisation Working Group carried out a generalisation of potential priority areas and decided to continue the analysis with the following priority areas:

1. information and communication technologies - Digitisation of economy and society,
2. production and processing of food and beverages - Food and health,
3. cultural and creative industries,

4. production of machines and electronic devices - Industry 4.0,

5. environmental protection and energy efficiency,

6. Key Enabling Technologies (KET) and emerging technologies.

New potential priority areas from the list were: energy and energy efficiency, Key Enabling Technologies and environmental protection.

1) Energy and energy efficiency

The inclusion of this area is based on the traditional importance of the energy sector in Serbia, its strategic orientation to further develop this sector and a strong human capital base. Innovative solutions in this area are required for Serbia to apply EU directives in the area of renewable energy sources (RES), such as the measure to improve energy efficiency. The Republic of Serbia's capacity for development and innovation in the area of energy and energy efficiency is reflected in the existence of significant industrial capacities for electrical equipment for electrical power systems; long-standing tradition and experience in designing and building power plants, transmission lines, transformer stations and control systems; the existence of natural resources suitable for the production of energy from renewable sources; numerous educational institutions and study programmes in this area; scientific research organisations that may support and enhance competitiveness in the industry through research and development; and the existing market, which requires an upgrade and expansion of production capacity.

2) Key Enabling Technologies (KET)

As a result of the findings from the additional analyses (e.g. Abramytchev, 2013) as well as their horizontal nature and importance to the Republic of Serbia's entire innovation system, KETs (micro- and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics and advanced manufacturing technologies) represent important technologies and research topics. Due to their spillover effects on the economy in various parts of the innovation value chain, KETs have the ability to support innovation, increase productivity, lead to new applications in economy and, ultimately, help to respond to current societal challenges.

3) Environmental protection

The area of environmental protection has been actively researched in Serbia for decades. It is estimated that Serbia should invest 15 billion euro in environmental protection over the next three decades in order to reach the EU environmental standards. Environmental projects in the area of water protection and purification are particularly important in the countries in the Danube region. The orientation towards enhancing this area is also visible in a series of programmes which are already available to researchers and companies that would direct cooperation towards sustainable development and ecological innovations – such as the IPA Cross-border Co-operation Programmes or green innovation vouchers. Despite the fact that economic results in the areas of renewable energy sources, recycling and reduction in the amount of exhaust gasses or preservation of the quality of the environment are not significant, the area of eco-innovations is a top priority for sustainable development in the long term.

4.4 Qualitative analysis and collection of qualitative data

The fourth phase in the Smart Specialisation Framework for the EU Enlargement and Neighbourhood Region represents the qualitative analysis of priority areas. Qualitative interpretation of quantitative mapping results were necessary for overcoming limitations of the existing classifications of industry and science and identifying the actual priority areas and value chains they represent.

The result of this analysis is a better definition of preliminary priority areas for entering the next phase of the general framework relating to the Smart Specialisation Framework, namely the Entrepreneurial Discovery Process - EDP.

The purpose of the qualitative analysis in Serbia was to collect information on the following matters related to the preliminary priority areas.

1. Who are key players in the preliminary priority areas?

2. What are the subspecialisations within the area?

3. Where in the value chain was the largest value created globally and what is the position of Serbian players in global value chains?

The purpose of the process in the Republic of Serbia, in particular, was to collect key information to develop adequate EDP guidelines, namely the choice of working groups.

The purpose was also to identify 'ambassadors' of processes in every priority area. These are the representatives of economic, scientific and civic sectors, who quickly recognised the usefulness of EDP and who were influential enough to be able to ensure participation of other key stakeholders, as well as being prepared to contribute to the quality of the process by frequently providing opinions and recommendations.

Qualitative data was collected on the basis of detailed interviews and the additional case study on the ICT sector in Serbia.

4.4.1 Data collection by preliminary area – qualitative interviews

In September 2018, workshops were held by the EDP team and the EDP coordination body in preparation for collecting qualitative data through interviews. The objective was to conduct at least 10 interviews with stakeholders per preliminary priority area.

In order to ensure the participation of key stakeholders and obtain quality and comparable information through qualitative interviews by area, the following tools were used at the workshops by the EDP team and the EDP coordination body:

- texts (pitches) used for presenting the process in public for various target groups and purposes,
- standardised questions related to areas, which are listed below:
    1. Is the area considered strong in economic terms?
    2. What makes it strong (export, human resources, innovation, etc.)?
    3. Who are the key players in your industry?
    4. Do you collaborate with them and how much?
    5. Who are the key players in science in your area?
    6. Do you collaborate with them and how much?
    7. Is the area that you/your organisation operates in innovative (do you have R&D, manage innovations, have intellectual property)?
    8. Which are the highest earning segments of the value chain you operate in? How far are you from the final customer?
    9. What is the potential of your area (grade 1-5)? Why?
    10. What are the emerging sub-areas within the area?
    11. In which field (sub-area) within your area do you recognise strong economic potential and opportunities now and in the future?
- standardised questions related to a further EDP,
- standardised questions for identifying 'ambassadors'.

With regard to the workshops, data documentation and team communication protocols were developed. The schedule was also drawn up with the aim of completing the qualitative phase with the panel to confirm the chosen priority areas prior to the Smart Specialisation in Serbia event.

In order to implement this ambitious plan with high quality and within the deadlines, a large EDP team was created consisting of experts from academia and economy in certain areas and experts for process analytics, with the support of the Serbian Chamber of Commerce, whose experts served as co-coordinators. The EDP team consisted of:

- Viktor Nedović, coordinator of the inter-ministerial working group and coordination body for the EDP team,
- Milan Solaja, coordinator for the information and communication technology area,

- Jelena Jovanović, co-coordinator for the information and communication technology area,
- Jelena Begović, coordinator for the food and beverage production and processing area,
- Jasna Mastilović, co-coordinator for the food and beverage production and processing area,
- SaSka Biorčević, co-coordinator for the food and beverage production and processing area,
- Aleksandar Bogunović, co-coordinator for the food and beverage production and processing area,
- Milica Božanić, coordinator for the creative industries area,
- Srđan Markotić, co-coordinator for the creative industries area,
- Mirjana Opačić, coordinator for the production of machines and electronic devices area,
- Ana Raičević, coordinator for the production of machines and electronic devices area,
- Mirjana Opačić, coordinator for the environmental protection and energy efficiency area,
- DuSan Stokić, co-coordinator for the environmental protection and energy efficiency area,
- SiniSa Mitrović, coordinator for the environmental protection and energy efficiency area,
- Petko SiSović, coordinator for the environmental protection and energy efficiency area,
- Srđan Verbić, coordinator for the KET and emerging technologies area,
- Dražen Miletić, co-coordinator for the KET and emerging technologies area,
- Domen Bole, head advisor for the EDP,
- Jasna Atanasijević, coordinator of expert support for competitiveness policies,
- Lazar Živković, analytics consultant,
- Tijana Knežević, operational and expert support,
- Jelena Todorović, operational and expert support,
- Ankica Momčilović, operational and expert support.

A total of 143 interviews were conducted with relevant representatives from the business and academic sector and civic society. The selection of the stakeholders to be interviewed was made by the consensus of the S3 Working Group members and in accordance with their area of operation. The number of interviews conducted is presented within the defined preliminary areas in the following table:

Table 17. Interviews conducted per preliminary area

Preliminary area	Number of interviews conducted
Information and communication technologies	22
Production and processing of food and beverages - Food and health	25
Creative industries	20
Production of machines and electronic devices - Industry 4.0	31
Environmental protection and energy efficiency	20
Key Enabling Technologies (KET) and emerging technologies	25

4.4.2 Case study of the ICT sector

Following the discussion on the quantitative analysis results, operational and analytics teams for the preparation of RIS3 in the Republic of Serbia together with JRC experts concluded that an additional evaluation of the ICT sectors in Serbia needed to be carried out. The key reason for selecting ICT sectors for additional evaluation through a case study is that the value of the Serbian ICT market was estimated at EUR 1.73 billion in 2016, equal to 6% of Serbia's GDP. ICT has been the fastest growing sector over the last 10 years. The software sector in Belgrade significantly contributes to added value, growth and wages – which are the highest in the country. The general role of hardware production, on the other hand, remains relatively small, although there is a large number of smaller companies in this industry.

Activities for the ICT case study were started in October 2017 with a special focus on the software industry (Kutlaca et al., 2018a). The Institute Mihajlo Pupin was in charge of implementing the entire study. The main objective of the ICT case study was to identify strengths and challenges of ICT sectors in Serbia, its sub-specialisations, the position of sectors in the global value chain, future development trends, the internationalisation level and future directions for development. The study showed that the ICT industry in Serbia is experiencing high growth in terms of profit, employment and exports and is becoming one of the crucial drivers of the national economy. Alternatively, it also identified main areas for improvement, such as enhancing entrepreneurial skills, increasing quotas for software engineering at universities and modernising curricula and strengthening the financial instruments available (Kleibrink et al., 2018). The results of the case study serve as an input for decision-makers in Serbia to assess the current state of Serbia's software industry in order to plan future activities and the EDP.

In addition to evaluating the current state of the ICT sector in Serbia, an additional objective of the ICT case study was to raise stakeholder awareness of the Smart Specialisation Strategy. During interviews, respondents were informed about the process and objectives of RIS3 and further steps in the process of designing a Smart Specialisation Strategy in Serbia.

The total duration for data collection within the ICT case study was 3 months (October-December 2017). Two methodological approaches were used in the preparation of the ICT case study:

- surveying respondents by filling out an electronic survey. The target population for the survey were companies operating in the sector of information technologies (software) in Serbia. The database on software companies was provided by the Serbian Chamber of Commerce. The call for filling out questionnaires was sent to 1 089 companies, of which 195 responded, providing an approximate 18% response rate;
- interviewing key stakeholders. The purpose of conducting an interview was to collect qualitative answers from the stakeholders on the identification of key characteristics of the sector, innovations and growth limitations; key drivers of innovation; and business and technological trends in the software industry. Interviews were conducted with key stakeholders from the following groups: managers of large companies; leading researchers; government officials; small and medium enterprises; and other organisations supporting business operations.

From November to December 2017, a total of 35 interviews were conducted, 23 of which were with leading companies in the area of software industry in Serbia; 6 interviews with stakeholders from academia; 2 interviews with government sector representatives; and 4 interviews with stakeholders from organizations supporting business operations (incubators and science and technology parks). Interviews were conducted with stakeholders from all over Serbia with the aim of obtaining a clearer picture of the sector's strength in all regions.

4.5 Data analysis by current and potential preliminary (sub-)area

Based on data collected through interviews and certain focus groups with the key representatives from the economic, academic and civil sector, members of the EDP team and the coordination body presented conclusions pertaining to:

- identify current and potential (sub-)areas;
- identify key stakeholders by area; and
- key inputs for planning the next phase in S3 design.

1. Information and communication technologies

In the area of information and communication technologies, a total of 22 interviews were conducted with the relevant stakeholders from academia and economy. In addition to these interviews, the source of data for the qualitative analysis of the ICT sector included the results of the ICT case study, in the scope of which 35 interviews were conducted with the relevant stakeholders from academia, the civil sector, economy and the government sector, as well as the main conclusions of the study *ICT in Serbia – At a Glance* published by the Vojvodina ICT Cluster. This section presents the conclusions of interviews and other studies conducted by the coordinator for this area, Milan Solaja.

Within the broader area, the following sub-areas have been proposed on the basis of systematised data obtained from a number of sources:

- Big Data & analytics
- Cloud technologies
- Internet of Things (IoT)
- Custom software development
- Embedded systems

According to data from 2016, more than 2 000 companies were registered in the area of ICT, employing more than 21 000 people and accounting for 1.4% of the workforce on Serbia's market. Profit per employee index in the ICT sector is six times the average profitability of the economy as a whole. This sector has been the fastest growing sector in Serbia in the last 10 years. Around 200 new ICT companies are registered in Serbia every year. Most start-ups hire programmers and are targeting more developed international IT markets. The total net assets of the Serbian IT industry are recording a significant increase. In 2006, the total net assets stood at around EUR 150 million, while 10 years later, in 2016, they equalled EUR 504 million – generating annual growth in excess of 15%. This trend represents a driving force for the private sector, which is dominant in the ICT industry. Software exporters account for the highest net assets – around EUR 212 million. Approximately 70 organisations in the ICT sector in Serbia have been identified as potential centres of excellence. The table below presents ICT organisations which implemented projects financed by the Horizon 2020 Programme.

Table 18. Organisations from the ICT sector in Serbia with H2020 Programme projects implemented

Organisation	No. of projects in the HORIZON 2020 Programme
BIOSENSE INSTITUTE, NOVI SAD	12
INOSENS, NOVI SAD	7
NISSATECH INNOVATION CENTRE, NIS	6
DUNAVNET, NOVI SAD	5
INSTITUT MIHAJLO PUPIN, BEOGRAD	5
BELIT, BEOGRAD	3
RT-RK, NOVI SAD	2
BITGEAR WIRELESS, BEOGRAD	2
NOVELIC, BEOGRAD	1
BIOIRC, KRAGUJEVAC	1

Source: own calculation.

The largest and most significant companies are located in three major centres: Belgrade, Novi Sad and NiS. The general conclusion for all sub-areas is that two dominant business models have been identified – the development of own solutions and outsourcing. Competitive advantage in the global market is based on the quality of the labour force and competitive prices. Domestic IT companies mostly provide an advanced level of service whose quality is recognised in the global market. If they sell their own solutions, they directly supply their end customers. Serbian IT companies generally do not create full value chains and they do not see each other as true competitors due to the huge demand in the global market. Overlapping with other areas and technologies is very common due to the horizontal nature that enables the development of other areas.

Sub-area 1 - Big Data and analytics

The Big Data area refers to large and growing sets of unstructured data, which cannot be processed using typical databases, tools and techniques, while the business analytics area refers to technologies, techniques, processes and methods for data analysis and involves human resources who turn data into information to help companies to better understand business processes and support decision-making.

The majority of respondents in this area indicated that they dealt with the development of ERP solutions and subsequently, following international trends, upgraded business solutions towards business development and analytics. The leading companies are M&I Sistems Co. and ComData from Novi Sad, and IIB from Belgrade. There are also other companies in this area whose target market is different, such as Seven Bridges Genomics from Belgrade, which does not use the principles of Big Data and analytics in business, but rather in the field of medical research. Most companies in this subsector work for end clients and compete with domestic and foreign companies in target markets.

Overlap with other areas

Big Data and Analytics is becoming increasingly present in other areas. The best example is the Internet of Things, where a variety of physical devices generate huge amounts of new data that needs to be managed and analysed. Other overlapping areas include medicines, the financial sector, demographics and agriculture. Bearing in mind the trend in data collection in almost all sectors, this list is not exhaustive.

Overlap with other technologies

Cloud, IoT, AI, Blockchain.

Critical mass

There is currently not a large number of companies in this sub-area, but there is significant growth.

Potential

Strong potential in the Western Balkans region; there are companies that started expanding to other European markets.

Sub-area 2 - Cloud technologies

Cloud computing is an on-demand service, which gained mass consumption in corporate data centres. The cloud enables central data to function as the internet and computer resources accessed in a secure and scalable manner. Most companies in this subsector in Serbia work for end clients and compete with domestic and foreign companies in target markets.

Overlap with other areas

Practically, any sector that requires data storage and management represents a potential market for cloud technologies.

Overlap with other technologies

Big Data and business analytics, IoT, content technologies and IM.

Critical mass

Cloud technologies require a strong and stable internet infrastructure. Considering the progress in the development of IT infrastructure in Serbia over the past several years, a stronger presence of Serbian companies is expected in this subsector.

Potential

Strong, given the penetration of IT in other sectors.

Sub-area 3 - Internet of Things (IoT)

The Internet of Things represents an internetworking of physical objects, vehicles (including connected devices and smart devices), buildings and other things with built-in electronics, software, sensors and connectivity, which allow objects to exchange data with the manufacturer, operator and/or connected devices, creating a possibility for direct integration of the physical world into systems based on computers. This leads to improvements in efficiency, economic benefits and a reduction in human effort.

Number and position of Serbian players

Further research is necessary, but most Serbian IoT companies are associated with research and development projects funded by the EU.

Overlap with other areas

Agriculture, medicine, process automation, asset and infrastructure management, transport, etc.

Overlap with other technologies

Cloud, Big Data & BA, AI.

Critical mass

Requires further research.

Potential

Strong; global demand is on the rise.

Sub-area 4 - Custom software development

Custom software development is the designing of software applications for a specific user or a group of users within an organisation. Such software is designed to meet the clients' needs as an alternative to the traditional and widespread software which is not available.

Serbian companies in this sub-area predominantly come from the outsourcing industry and from there developed sub-areas in custom software development by specialising in a market niche and/or on one client. This sub-area has dozens of companies and generates a large share of software exports in Serbia. Some of them are Ekecom, Levi9, Endava, GTech and ComData. The basic concept of custom software development determines the market position of Serbian IT companies in custom software development – sale of own solutions to end customers which provides greater value for these companies.

Overlap with other areas

Applicable solutions within all areas.

Overlap with other technologies

Cloud, Big Data & BA, embedded systems, content technologies and IM.

Critical mass

There is a large number of companies in Serbia in this sub-area.

Potential Strong, global demand on the rise.

Sub-area 5 - Embedded systems

Embedded software is computer software written to control machines that are not typically thought of as computers. It is typically specialised for the particular hardware it runs on and has time and memory constraints.

Number and position of Serbian players

Not numerous, but with strong position on the market. Examples include RT-RK from Novi Sad, Mikroelektronika from Belgrade.

Overlap with other areas

Automotive industry, telecommunications, signal processing, electricity distribution and management, medicine, transportation, machinery, production automation.

Overlap with other technologies

Cloud, Big Data & BA, Smart Anything Everywhere.

Critical mass

There is not a large number of players on the market. Requires further research.

Potential

Strong, influenced by development and automation in other sectors.

Rapid sector growth (average growth above 25% in the past 10 years) is a strong indicator of current and future potentials. Investment in and support to the SME sector is considered as the decisive factor for further development of the ICT industry in Serbia. The general conclusion in the area of information and communication technology is that it is difficult to say whether a critical mass exists for certain sub-areas, and for further analysis of this matter the upcoming EDP workshops will provide a clearer picture of potentials within each sub-area and definition of the final names of priorities within the ICT sector.

In addition to the 5 sub-areas mentioned, the coordinator proposed two additional sub-areas that do not have the critical mass but have strong horizontal influence on the development of other areas, namely:

- Artificial intelligence (AI)
- Blockchain technologies.

Cross-sectoral innovation

A unique characteristic of information and communication technologies is their horizontal nature and applicability in almost any other sector. Accordingly, particular attention during the upcoming EDP workshops will be devoted to the horizontal aspect of ICT and the networking of key stakeholders in this area with other sectors. The number and position of Serbian players differs depending on the sector and type of business (e.g. digital companies specialised for a sector and sector companies with widespread use of digital technologies).

2. Food and beverage production and processing

In the area of food and beverage production and processing, a total of 25 interviews were conducted with the relevant stakeholders from academia, the civic sector and the economy. This section provides conclusions of the interviews conducted by the area coordinator (Jelena Begović) and co-coordinators (Jasna Mastilović and Aleksandar Bogunović).

The interviews indicated the high potential and numerous innovative trends in the area of food and beverage production through which Serbia's existing natural resources for agricultural production are used in an optimised manner, and through which Serbia's long-standing tradition as a farmland is turned into a modern development resource. Because of its high potential, the area of food and beverage production and processing should be set as one of Serbia's strategic directions in the process of designing the Smart Specialisation Strategy. The name suggested for the broader area is Food for future (F3).

Three sub-areas are proposed within the broader field, based on systematised data obtained in interviews:

- high-tech agriculture
- value-added food products
- sustainable agri-food production.

Sub-area 1 – High-tech agriculture

For decades, agricultural production in Serbia was based on conventional production methods that marked the agriculture of the 20th century. At present, achieving a competitive position in agriculture involves the use of high-tech technologies that enable:

- the attainment of yields per unit of arable land that are a few times larger than those obtained using the traditional approach to production;

- the crop to be minimally dependent on agro-climatic conditions and climate changes;

- the achievement of a product quality which meets increasingly stringent requirements of modern consumers and distribution chains.

There is an increasing number of manufacturers in Serbia who are successfully transitioning to high-tech agricultural production that is continuously growing. Agricultural manufacturers, investors who gained capital in other business areas and foreign investors invest in high-tech and labour-intensive production. Some examples include fruit plantations (apple, apricot, peach, cherry, sour cherry, raspberry, aronia, walnuts, hazelnuts, etc.), greenhouses for vegetable production (tomato, pepper, cucumber, etc.), new production domains such as horticultural products and vineyards. In the largest number of cases, the development of modern plantations is also accompanied by the construction of storage capacities (cold storage, ULO (ultra-low oxygen) cold storages) or processing capacities (wineries) that belong to the manufacturers themselves, thus enabling direct market access.

Products in the areas described are mainly marketed on foreign markets at prices that are considerably higher than products of lower quality obtained through conventional production methods. Unfortunately, conventional production is still dominant in the agricultural production structure, but broad possibilities for strengthening Serbian agriculture are identified in the shift to high-tech agriculture that would also include other types of fruit, vegetables and horticultural plants. While field crops are dominant in terms of produced and exported quantities, a strong development potential is observed in the area of high-tech agriculture; however, the application of modern agricultural techniques and adoption of measures of agrarian policy are necessary for enhancing this area, considering that available arable surfaces currently favour the production of field crops.

High-tech agricultural production requires new resources, thus generating innovations in a range of ancillary activities – production of seeds and crops; production of mineral and microbiological fertilisers; production of infrastructural crop elements (pillars, nets, irrigation systems); production of measuring and control equipment (sensors, data lagers, information systems for data collection, processing and management); growth regulators; biological and chemical agents for combating pests and diseases; production of packaging; logistics systems; etc. Some of the activities have already been developed by entrepreneurs in Serbia, and there is development potential in many of them.

Products obtained from high-tech agriculture have already been recognised as highly competitive on the market. This area is on the rise. There is a developed pool of knowledge of domestic experts connected with manufacturers; funding of the expansion of this type of production is planned in pre-accession funds (IPARD), and with numerous other advantages this area has been identified as one of Serbia's development potentials.

Critical mass

This area is on constantly growing. An increasing number of manufacturers are operating in this area.

Potential

Strong, influenced by global trends and increasing demand.

Sub-area 2 - Value-added food products

Almost without exception, all respondents who were interviewed stressed the need to encourage and take steps in the food production chain towards products with a higher degree of finalisation and to transform Serbia from an exporter of agricultural products into a food exporter. In the area of food production, there are already numerous companies that successfully produce, place on the domestic market and export food products. In this respect, the confectionery industry, fruit and vegetable processing industry, oil production industry and others stand out in particular.

A special role in the further development of the food industry is played by value-added products that encompass several different groups of food products with increasing demand in both the domestic and – specifically – in foreign markets. These include:

- functional food marked by one or more nutritional or health statements (rich in fibre, protein, minerals, antioxidants, etc.);
- enriched food with added nutrient(s) from natural sources that are essential to the diet of a modern consumer;
- fortified food with added nutrients that are deficient in the consumer's diet;

- organic products with an emphasis on a shift from certified primary agricultural products to processed organic products (frozen organic products, organic dairy products, etc.);
- foods for special dietary use such as gluten-free products, products intended for diabetics, products intended for different groups of consumers such as athletes, children, etc.;
- products for the food production industry (modified starches, mixtures for bakery products, etc.);
- products obtained from raw materials of special characteristics protected by geographical origin labels (GI food);
- products obtained using traditional methods (traditional food);
- products adapted for easier use by consumers/high convenience food (tea in the form of a teabag);
- products of extended durability with preserved, nutritionally valuable components of raw material (lyophilised fruit).

Numerous products from the above-mentioned product groups already represent some of the range of products from successful food producers. A share of the products is exported, predominantly to neighbouring countries, but there are also examples of successful exports to farther markets.

A substantial number of researchers in Serbia are focused on research in the area of the development of different value-added products, which additionally strengthens this area, but it is necessary to establish mechanisms so that numerous existing results and developed products go to production.

Critical mass

Still under development.

Potential

Strong with demonstrated research focus on further development.

Sub-area 3 - Sustainable food chain

The sustainability of food production chains involves the application of manufacturing practices, procedures and technologies along the entire production and processing chain that will ensure products that are competitive on the market, without degrading the natural resources on which agricultural production is based. When it comes to agriculture, sustainable production represents an integrated system of plant and livestock production that enables optimal utilisation of resources in a manner that provides maximum energy efficiency, top quality products and care for preserving resources for agricultural production. In food production, sustainable production implies full utilisation of agricultural products so as to optimally use all nutrients, while reducing waste to a minimum. Sustainable production also includes taking measures to reduce losses and waste from agricultural and food products in the chain of production, storage, processing, distribution and consumption.

In agriculture and food production in Serbia, there are growing cases of companies that operate on the principles of sustainable production, invest in innovations in this domain and support research projects aimed at enhancing production sustainability.

Some examples include the:

- increasing number of agricultural companies with integrated production;
- significant number of plants for the production of biogas and biodiesel;
- significant number of examples of restoring waste from food production and nutrients from by-products into secondary food and feed products;
- significant number of examples of using by-products from food production for alternative food and non-food products;
- significant number of research projects in this area.

Companies applying principles of sustainable production additionally contribute to the reduction of expenses, thus increasing their competitiveness in the market. The application of sustainable production principles involves investments into power plants and other plants, which represent potential for launching machine-building.

Cross-sectoral innovation

The development of high-tech agricultural production initiates the development of innovations in other related areas, notably in KET and ICT, as inseparable support technologies for future agriculture growth and development. The production of plant material for the generation of green energy (biomass energy) is a key focus for research and industry.

Research and cross-sectoral innovations in horizontal priority areas, including KETs (nanotechnology, industrial biotechnology, sophisticated machines, sensor technologies) in particular, represent a significant part of the development in value-added food products. ICT solutions (blockchain, IoT, Big Data) play an important role in transforming the food industry by increasing transparency, efficiency, safety and cooperation along the entire food product production chain.

The development of key aspects of the sustainable food chain, which implies the reduction of losses and waste of agriculture products and food, is closely related to new solutions being developed in ICT and KET areas.

The general conclusion is that the identified sub-areas have the critical mass of stakeholders' potential necessary for successful implementation of the EDP process and that there are development opportunities that need to be further explored and utilised in the Smart Specialisation Strategy process. Traditional food production, largely dominated by smaller entities such as small farms and handicraft shops, represent a special sub-area with potential that should not be neglected. This area has great but economically untapped potential. Traditional foods, especially, acquire value when marketed within a tourist offer, through rural and other forms of tourism. Taking into account the insufficiently visible sector of the hospitality industry - which is developed in Serbia in different areas (medical tourism (dentists, cosmetic surgery), the organisation of high-attendance events (Exit, Guča), spa tourism, visits with the purpose of performing certain activities (filmmaking), etc. – perhaps it would be advisable to review whether to identify the area of hospitality as one of the vertical strategic priorities.

Critical mass

Exists, as described above.

Potential

Evident, as described above.

3. Creative industries

In the area of creative industry, a total of 20 interviews were conducted with the relevant stakeholders from academia, the civil sector and the economy. This section provides conclusions of the interviews conducted by area. The coordinator was Milica Božanić and the co-coordinator was Srđan Markotić.

Interviews stressed the high potential in certain sub-areas, particularly in high-quality personnel, but also pointed to infrastructural constraints.

Based on systematised data obtained in interviews, three sub-areas were proposed within this area:

- creative digital media production and services
- gaming industry
- smart and active packaging.

Sub-area 1 - Creative digital media production and services

This sub-area may broadly be called the 'creative digital production of audio-visual content' as it included: the production of 3D animation, visual effects and a variety of sub-processes and disciplines to create a partially or fully digitally created image for film, TV, advertising industries, animated film, gaming and active expansion towards VR and various AI applications and upgrades through the use of 'deep learning', artificial intelligence and machine learning. While high-tech development within this discipline takes place abroad in scientific and corporate centres, there are around a dozen studios in Serbia which actively produce high-quality content for foreign markets. The number of companies and teams is substantially higher taking into account the great possibilities of working 'online' and finding jobs abroad 'under the radar'. This market emerged in Serbia in the late 1990s, simultaneous to the global rising trends, self-taught under the conditions of complete isolation. Most players in the field have secondary technical education, and the narrow domestic market made them turn towards foreign clients. It is latter from whom they learned the methods for organisation and work, so that, at present, they are almost exclusively export-oriented, with foreign clients accounting for between 50% and 70%

of work performed. It should be noted that 'brain drain' in this area has been extremely pronounced for a decade, due to which Serbia now has a very strong and successful expatriate community of professionals in computer graphics.

The global industry for visual effects is estimated to reach $20.7 billion by 2022, with estimated growth of 9.9% and 11.2% respectively for the USA and Europe, where the majority of current clients are based. All respondents have assessed the current strength of the sector with a certain level of reservation attributable to various distortions and an unregulated market, domestic legal framework, etc. However, they highly rated the prospects of the industry since the current production volume is only a small part of the total potential.

The Ministry of Economy, through the programme of incentives for investors in audio-visual productions, grants a 25% refund for private investments in a film (foreign or domestic), including all phases of production. This is one of the successful mechanisms underlying many industries worldwide. Owing to this mechanism, the volume of foreign assignments carried out in Serbia in film, TV and advertising production tripled in the period 2016-2018. With its strong growing tendency, it could easily reach EUR 50-60 million per year by 2020. At the same time, through the system of financing from the Ministry of Culture and Information, the investment of TV corporations in the production of series has resulted in the expansion of the domestic market, while the market for advertising in the media is declining, providing an increasing space for export.

The main competitive advantage on the foreign market is low price, i.e. good price-quality ratio. The challenges in the industry include the provision of a continuous business flow since it is related to project cycles and possibilities to create and distribute own content – shifting from the subcontractor towards the author.

The academic sector has recognised the need to introduce new study programmes and to modernise the existing educational programmes, with greater emphasis on the use of digital tools and a focus on creating content that is relevant to the present point in time. The challenges faced by the academic sector include an insufficient number of academic staff and the absence of incentives for scientific and research work in the arts field on the practical value of theoretical works. Interdisciplinary character and the establishment of links between art universities and universities of humanities and sciences are among the key barriers to completing competences that could produce better results in the R&D process. Striking a balance between academic research and responding to the needs of the commercial sector seems to be the main challenge in the present environment, which has a discouraging effect on resources (in the form of equipment at the disposal of faculties); inertia of a significant proportion of teaching staff towards contemporary technologies and trends; the inability to hire new teaching staff; lack of interdisciplinary cooperation; lack of resources for participation in international competitions; research projects; conferences; etc.

The number and position of Serbian players in the global (regional) value chain

Depending on their specialisation and niches, they mostly perform in advanced or segmented parts of the value chain, thereby competing in the domestic market; however, on the foreign market they complement one another so as to obtain larger jobs. The degree of cooperation remains low. They have a big competition problem among staff as all members of staff are employed on projects. They are not too distanced from customers, usually with one or two mediators, and sometimes they are hired directly. Margins are low (10% and lower) due to poor negotiating power and the high expenses of investment in hardware and foreign software licences (the degree of illegal software use is still a significant factor in the low price).

Teams are good, achieving high-quality content with a small number of people, but most respondents suffer from the growth crisis – they prefer to run a 'boutique studio', with a small number of employees and without excessive hierarchy, than build up a structure and introduce procedures in their work that would make it possible for the company to grow. They can establish shorter chains; larger studios are already using smaller studios for subcontracting in the periods of heavier workloads. They are lacking managerial skills and a common infrastructure (the creation of a unique production capacity that would provide sufficient capacity for the working space, cyber security, optical network, space for testing and development, space for expansion toward new disciplines).

Current and future overlap

With other areas (film, advertising, gaming, education); with technologies (VR, AI, drone, cloud).

Critical mass: under development.

Potential

There is room for improvement, mostly affected by the global trends.

Sub-area 2 – Gaming industry

The gaming industry in Serbia involves some five medium-sized companies, each employing over 100 persons, as well as a large number of smaller studios and teams involved in different segments of the video game production and distribution chain. The Serbian Games Association was founded in mid-2018, gathering 28 members and with the perspective of expanding, with the ultimate goal of separating the gaming industry from the IT sector – strengthening the development of small companies and talents in gaming through the development of capacities for attracting investments in game development. It is estimated that the wider community engages around 2 000 people in Serbia with a potential annual turnover of around EUR 50 million. The existing development is the result of good engineering staff, while further investment in art disciplines is necessary. The subsector is only beginning to organise itself into an alliance. Cooperation with the academic sector is stronger in Novi Sad, but this only applies to education, not to research and development potential. According to interviewees, present investments in education may only be expected to yield notable results after 5 years.

Number and position of Serbia's players in the global (regional) value chain

The services involved are advanced, provided in full to end customers at prices entirely competitive on the global market; sometimes they perform some outsourcing for other companies or have perfected a part of the service production. They work fully independently from each other; they are not direct competitors as their markets are global and they sell their services to customers abroad. They do not complete a chain, with the exception of talent resourcing.

Current and future overlap

- With other areas – e-sports – organisation of large-scale gaming competitions, destination branding through major events (MICE (meetings, incentives, conferences, exhibitions) tourism subsection, small potential impact).
- With technologies – mobile technologies, blockchain technologies (GameCredits).

Critical mass

On an upward path owing to the attraction of high earnings.

Potential

High, as a result of global growth.

Sub-area 3 – Smart and active packaging

The key strength of the smart and active packaging sub-area is in the technology – modern trends and production machines, human resources and innovation are tracked. A strong willingness to move towards smart and active packaging was demonstrated in the interviews with companies. Future trends and directions of development were identified within this sub-area.

- The development of green materials (degradable, from renewable resources) – packaging which is not oil but nanocellulose- and starch-based.
- New colours and pigments that will allow a switch to smart packaging.
- The development of information technologies which is applied in all areas of the production process.

A strong willingness for cooperation with food producers and merchants (retail chains) was emphasised. Due to the proximity to the market, Serbia may offer good-quality packaging at prices lower than those on the markets of western and central Europe. The main advantage of protective packaging and so-called smart packaging is the prevention of fraud, the packaging of wrong products or the possibility of monitoring the freshness of packed products.

The number and position of Serbian players in the global (regional) value chain

- For products. Raw material producers, suppliers of simple/advanced/intermediate or final products compete in the local/mass market, compete with price or quality, sell to end customers by themselves;
- For services. They perform simple or advanced services, compete with price or quality, perform partial or full services for the end customer, sell to end customers by themselves.

Current and future overlaps

With other areas (food industry, transport).

Critical mass

Exists, as described above.

Potential

Identified, with competitive prices on the global scale.

The general conclusion is that, in identified sub-areas within broader areas of the creative industry there is a critical stakeholder mass necessary for the successful implementation of the EDP process. Respondents in interviews confirmed the sub-area potential as well as the current and future overlap with other areas.

4. Production of machines and electronic devices

In the area of the production of machines and electronic devices, a total of 31 interviews were conducted with the relevant stakeholders from academia, the civil sector and the economy. This section provides conclusions of the interviews conducted by the area coordinator, Mirjana Opačić.

Proposed broader field name

Future machines and manufacturing systems

Based on systematised data obtained in interviews, five key sub-areas are proposed within this area:

- specific-purpose machines (application machines)
- information systems for smart management – Industry 4.0 (Data to Decision – Industry 4.0)
- premium tools and components for the automotive, railway and aviation industry (premium tools and smart mobility solutions)
- Energy efficient devices (sustainable heat appliances and devices).

Sub-area 1 - Application machines

This sub-area encompasses all application machine producers, including those who manufacture individual assemblies and parts. While manufacturers are not solely linked by the same field of application, the production of machines and individual components follows the same or similar parts of the process. Problems encountered in this type of production are common for all manufacturers. Within this sub-area, participants in EDP workshops – in addition to producers of machines and electro-mechanical components – should also include other participants in the production chain (key players in the metals industry, service activities within the metals industry, companies engaging in engineering and development in the mechanisation field, quality assurance (testing and certification of new products), penetrating new markets and preserving the existing ones). There are several manufacturers in Serbia operating in the global market – such as Stax from Čačak, which produces packaging lines – then companies which produce machines for paper production, driers, medical machines, etc.

The application machines sub-area includes all participants in the chain, from the production of specific-purpose materials, to mastered engineering technological processes (alloying metals, thermal treatment, welding technology and production technology), components assembling to the final version of product. Most processes within these activities are carried out with the support of domestic infrastructure and inherited knowledge combined with the adoption of new trends present in international manufacturing and development. In most cases, Serbian manufacturers made their way to the European markets with isolated cases of penetration into the global market. There is huge potential to strengthen certain processes in the production chain within domestic manufacturer and service activities (driving technology). This would greatly contribute to upgrading the infrastructure of activities ancillary to the manufacturing of machines and components, and to strengthening further development and increasing competitiveness on the global market. There is coupling with a measurable number of service activities, such as engineering, production technology. There is also potential for cooperation with scientific institutions, product development and testing, quality assurance and certification according to applicable standards, with the aim of providing access to European and global markets.

Position in the value chain

Manufacturers who deliver final products are at the very top of the value chain, while, for the rest of participants, it would be necessary to further assess the situation and potential for upgrading the value of their final products and services.

Current and future overlapping

Energy efficiency, environmental protection, ICT.

Critical mass

Developing.

Potential

Identified, as described above.

Sub-area 2 - Data to Decision – Industry 4.0

This sub-area encompasses automatic system management, the collection of process data and parameters and their further processing, conversion into information and their further application, as well as automation in industry with a step towards Industry 4.0: system integrators, automation, measuring and regulation equipment, industrial engineering, industrial pneumatics. This sub-area is based on a developed infrastructure and winning domestic and foreign markets. There is great potential in the further development of process automation and digitisation (system integrators with software solutions for system integration; management; improvement of process management based on 'data to decision' feedback; automation in the food industry, water treatment, water supply, oil, gas, rubber industry, electric power industry; as well as in energy and efficiency systems). Key companies in this area export over 60% of their output. Based on the present situation, there is great potential in the development towards Industry 4.0. One of the main challenges for this sub-area is positioning on the global market as a 'lead project/job partner'.

The number and position of Serbian players in the global (regional) value chain

- For products. Manufacturers of final products required for marketing engineering – which is the basis of their business – compete on the mass market, compete with price or quality, sell to end customers by themselves and operate with other companies as subcontractors.
- For services. They have their software solutions and accompanying installations (microcontrollers, PLCs, connectors, sensors. Etc.), which make these solutions 'smart'. They provide advanced services, compete with price or quality, perform partial or full services for the end customer depending on the project's nature, sell to end customers by themselves and as sub-suppliers.

Current and future overlap

- With other areas – energy efficiency, environmental protection, IT, food and beverage production.
- With technologies – this area fundamentally goes in the direction of Industry 4.0.

Critical mass

Developing.

Current or future potential

Identified, as described above.

Potential for further division or association with other areas is applicable to the food industry, water management, power industry, environmental protection, utilities, oil industry and mining.

Sub-area 3 - Premium tools and components for automotive, railway and aviation industry (premium tools and smart mobility solutions)

Evident production growth and industry development at national level made it necessary to recycle former tools and modernise them, as well as to develop new production systems that would accompany and support industrial development. Tools are directly connected to the manufacturing of individual components intended for broad industrial applications. Individual components and new quality requirements dictate a direction for developing the tools.

The main challenge in this area is to fabricate a tool with desired characteristics, a satisfactory level of quality, the required geometry and other mechanical properties, make it quickly and make it in such a way that it is

compatible with automated lines. The need for this service is on the rise, which was recognised by some domestic companies, as well as by some globally renowned companies (e.g. in the automotive industry) which came to Serbia with their production facilities with the aim of further development. In addition, design is the area which is inexhaustible and ever-changing. Changes in design imply a change of tools in production. However, what most companies stressed during interviews is that Serbia, as a country, does not enjoy a good reputation on the global market. The winning strategy is to deliver good-quality products and services in challenging timeframes, and such production has to be supported by specialised tool-rooms ready to provide an instant response.

The main directions for development and the identified needs of this sub-area are:

- the modernisation of the development strategy process for the medium term (3/5 years);
- the modernization of the production stock in cooperation with the R&D sector and in accordance with the chosen strategy, with the aim of improving competitiveness in global commercialisation;
- the cooperation with the educational institutions (secondary and higher education) with the aim of forming a young generation of specialised workers and engineers, which also has the positive result of an increase in employment of personnel with secondary and higher qualifications;
- bringing together present tool manufacturers with representatives of component producers to assess actual needs and directions for further development.

Number and position of Serbian players in the global (regional) value chain

Tools can be both a final product and an intermediary product. Components are custom-made for clients.

Current and future overlap

- With other areas – applicable in all manufacturing industries, IT.
- With technologies – Industry 4.0, production technology, quality assurance and metrology.

Critical mass

There is a large number of manufacturers in the automotive, railway and aviation industry in Serbia.

Current or future potential

Exists, mostly driven by global trends.

Sub-area 4 - Appliances running on eco-friendly and sustainable fuels (sustainable heating appliances and devices)

This sub-area includes the production of furnaces, stoves, cooking ranges, fireplaces and low- and high-power boilers. The efficiency of these appliances is over 90%. The innovation potential lies in the creation of value added through greater process automation and movement towards Industry 4.0. The potential also lies in the development of individual components (automatics, burners) that are currently predominantly imported.

Position in the value chain

Companies in Serbia manufacture the entire product, but some components are imported. They compete in the domestic, European and world markets. They compete in terms of price and quality. With regards to sales, in certain markets they sell under their own brand and in others under someone else's. The first reason for this is that they cooperate with another company which uses them as producers, ordering a certain number of units (usually in thousands of units) which the domestic company manufactures according to the specified documentation. The second reason is that while Serbian companies are strong and competitive in terms of price and quality, the foreign market is not familiar with their brand, which is their main handicap (there is room to address this).

Current and future overlap

Energy efficiency, environmental protection, creative industries, ICT.

Critical mass

There is a large number of manufacturers in this area.

Current or future potential

Exists, as described above.

Sub-area 5 – Solutions for a smart lighting ecosystem

Within this sub-area, the largest potential lies in the production of lamps and solutions for smart lighting systems, detection sensors (e.g. degree of air pollution, wastewater, land degradation, resistance to climate change, degree of occupancy of containers at city, village, production plant level, etc.).

The production of lamps and equipment for lighting is of high quality, as well as smart solutions for lighting systems for special purposes in the field of industrial, sports, medical, office and public lighting (smart management, high degree of energy efficiency, top quality and compliance with the environmental protection requirements).

Position of Serbian players in the global (regional) value chain

Manufacturers of raw materials and end products compete in the mass market, compete with quality and sell to end customers with the assistance of distributors and consultants.

Current and future overlap

- With other areas – production of electrical devices, ICT.
- With technologies – LED technology, smart management and digitisation.

Critical mass

Very likely, taking into consideration many foreign firms that established their manufacturing operations in Serbia.

Current or future potential

Exists, as described above.

The general conclusion by the coordinator for the production of machines and electronic devices area is that there is a critical mass of stakeholders required for the implementation of the EDP process. The potential of the sub-area, as well as any current and future overlap with other areas, have been confirmed by respondents in interviews. It is necessary to continue communication with the identified stakeholders. In the further course of the EDP workshops, it would be advisable to provide the possibility for involvement of new players that could contribute to the entire process, particularly in terms of defining specific sub-groups within sub-areas. The final version of priorities should only be defined after workshops are held and inputs by stakeholders processed.

5. Environmental protection and energy efficiency

In the area of environmental protection and energy efficiency, a total of 20 interviews were conducted with the relevant stakeholders from academia and the economy. This section provides the conclusions of the interviews conducted by the area coordinator, Mirjana Opačić.

Proposal for the broader area name

Energy-efficient and eco-smart solutions.

The sub-area 'Eco-smart energy sources' has been identified based on systematised data obtained in interviews. Within this sub-area, the following potentials which require additional research have been identified:

- biomass (pellet, biodegradable waste),
- efficient batteries,
- residues from other waste-treatment processes: dry farm waste (dairy, cattle, pig, chicken farms), meat industry residues – their reclamation and further exploitation,
- municipal waste treatment,
- geothermal energy,
- solar power.

Based on the input from stakeholders from this area, there is potential for a large centre for car recycling, design and the production of special-purpose machines within unique project solutions for municipal waste

treatment, the construction of regional waste treatment systems, solving waste collection problems, recycling waste after separation, the utilisation of waste in energy and further production, closure and rehabilitation of all dumps and unregistered landfills and the safe removal and disposal of hazardous waste. In the area of water treatment, there are a certain number of domestic companies designing electro-hydraulic plants for water intake in small hydropower plants.

Current and future overlap

With automation, Industry 4.0, power generation from renewable sources, ICT.

The production of machines, assemblies, definition of production technology and welding are fully compliant with the definition of measures and procedures relating to current energy efficiency requirements, as well as with environmental protection measures. Energy efficiency is a requirement addressed in the course of production processes and it provides an opportunity for association and overlapping, i.e. for involvement of manufacturers and service providers whose sole business is energy efficiency in plant and production optimisation processes. On the other hand, finished products must be designed in such a way that they follow and comply with the applicable requirements concerning energy aspects of use (efficient energy consumption, harmful gas emissions within permitted limits, optional operational optimisation depending on input parameters, etc.). Production processes, further use and the exploitation of products, as well as components and materials used, must meet the applicable requirements according to European standards with respect to preserving and protecting the environment.

The general conclusion for the environmental protection and energy efficiency area is that it has both innovation and scientific potential. Due to the horizontal nature and importance of the innovation system, the environmental protection and energy efficiency area will be horizontally supported within EDP workshops. Horizontal linking of identified companies in this area with the key stakeholders in machine-building and electrical industries, as well as with those in agriculture and the food industry, will contribute to the successful implementation of the Smart Specialisation concept in Serbia. All identified priority areas, to a lesser or greater extent, have to address energy efficiency and environmental protection requirements, which constitutes the key difference in building competitiveness on the world market.

6. Key Enabling Technologies (KET) and emerging technologies

In the field of Key Enabling Technologies (KET) and emerging technologies, a total of 25 interviews were conducted with the relevant stakeholders from the economy and academia. This section provides the conclusions of the interviews conducted by the area coordinator, Srđan Verbić, and co-coordinator, Dražen Miletić.

Sub-areas identified in the current discussions regarding KET and emerging technologies are as follows:

- photonics
- advanced materials
- advanced manufacturing technologies and electronics
- industrial biotechnology
- blockchain technologies
- autonomous driving, aerospace systems and engineering.

The general conclusion for the area Key Enabling Technologies (KET) and emerging technologies is that there is no critical mass of companies required to create competitiveness in the global market. Cooperation with academia is on a very low level. Domestic companies do not sell in the domestic market and do not manage to sales abroad; they mainly hire foreign companies to run sales abroad. When it comes to patents, intellectual property protection is at a very low level.

On the other hand, there is a trend of large companies arriving from the EU and other countries, such as China, which increasingly invest in the areas applying advanced technologies in Serbia (the latest examples include ZF from Germany, one of the largest companies in the world in the field of electric drives and accompanying systems for the automotive industry, Siemens in the production of railway vehicles and wind turbines, IT development centres from large companies such as Microsoft, but also serious IT investments from China and the announced opening of the jadarite mine, which is the basis for the production of electric batteries, etc.).

Sub-area 1 - Photonics

Interview results have demonstrated that certain technologies, particularly optoelectronics, possess certain scientific and innovation potential. Optoelectronics is currently a small group of innovative and high-tech companies in the area of image digitalisation, sensors, etc. They produce products for both domestic and the primarily foreign market, including cameras and lenses for night surveillance, thermal vision, accompanying camera systems, special-purpose cameras and custom-made optical systems lenses, fibre optic sensors and a relatively broad range of optoelectronic components. In the area of photonics, there are more than 10 spin-off companies that participate in the development of new advanced systems, e.g. the EU's Horizon Europe programme resulted in the first prototype for obstacle detection (at far distances) in railway traffic. The Innovation Fund of the Republic of Serbia supports the development of detection systems with application in the area of firefighting. In the area of optoelectronics and accompanying areas such as display, traffic lights and image digitisation (image processing), the following are also present in addition to the above: Teleoptik, Damiba, Zodax, Vlatacom and, in the broadest sense of the optoelectronics area, DMV, Fazi, Institute Mihajlo Pupin, DSP Motion, Frame, Biosense, Niri, Visaris and others.

Overlap with other areas and technologies

Advanced manufacturing technologies and electronics, autonomous driving aerospace systems and engineering, signal processing, image digitisation, software development, telecommunications, production automation, electronics and various industry sectors.

Sub-area 2 - Advanced materials

There are smaller companies in the production of advanced materials that are already dealing with the development and use of composite materials. According to the opinions of respondents, there is a good chance that advanced materials will be used in the automotive and other transportation industries, textile industry and in the furniture industry. In cooperation with agriculture in the production of basic material of natural fibres (e.g. hemp), the biodegradability of advanced materials and expansion of capacities in agriculture is achieved, while also creating additional competitiveness on global markets. Serbia has a very well developed agro-business and related service (seed, research, science) for new product development. Natural fibres (e.g. hemp) would be, through the process of mixing with polypropylene – a composite material based on biodegradable material, which has a high functional value in the automotive industry. Serbia has several successful manufacturers of plastic components for the automotive industry (primarily export-oriented, e.g. to the German market), which could close the entire value chain – from natural fibre to processing into composite material and the export of specific products for the automotive industry.

The additional potential lies in the application of biopolymers in the packaging of food products and the application of nanotechnology in the packaging of food products. The above-mentioned examples of packaging can be used in all areas of the food industry. For example, cooperation on the development and quality control of polymer barrier and high-barrier films with the manufacturer 'Spektar' Gornji Milanovac from the food industry has already been negotiated, and these material areas are used by the industries for processing meat, milk and other products (e.g. packaging of cured meat products in a vacuum or modified atmosphere, packaging of cheese or snack products, etc.). There is also a multi-decade contractual cooperation with 'Tipolastika' Gornji Milanovac, which operates in the same area.

Overlap with other areas and technologies

Biotechnology, autonomous driving, aerospace systems and engineering, advanced manufacturing technologies and electronics, creative industries, various industry sectors – from food and textile to the automotive industry.

Sub-area 3 - Advanced manufacturing technologies and electronics

In the area of advanced manufacturing technologies and electronics, companies were identified that are related to industrial automation, the introduction of 'custom' systems, robotisation, connecting hardware and software, etc. This area is very promising since the government institutions of Serbia have also recognised digitisation and Industry 4.0 as strategic goals. Electronics was added to the name of the area due to the need to connect hardware and software and electrical components. The current cooperation between the economy and science is not optimal. From an institutional perspective, additional investment is required in equipment and human resources for mechanical engineering, electrical engineering and IT faculties, of which some are already 'producing' an extremely professional and essential labour force on the market.

Overlap with other areas and technologies

Advanced materials, photonics, autonomous driving, aerospace systems and engineering and almost all industry sectors and topics associated with future machines, the IT sector in general, software development, etc.

Sub-area 4 - Industrial biotechnology

Serbia has experts in this area in the scientific and research community. Due to the importance of agriculture and the food industry, new biotechnologies for enhancing the food and agricultural industry can contribute to the maintenance and creation of new competitive advantages in the global market. Serbia is a major exporter of agricultural products, but the great importance of the food industry has also been recognised. Topics that can potentially be considered are as follows.

1. The application of PGPB (plant growth promotion bacteria) for the improvement of yields and functional properties of plant cultures. The Institute for Medicinal Plant Research 'Dr Josif Pančić' and the Institute for Soil Science, Belgrade, cooperated on this topic. One possible cooperation is in the preparation phase with Iceberg Salad Centre, Beograd, and mushroom growers Ekofungi, Beograd. The application of bacteria in agriculture generally increases the possibility of organic food production.

2. The application of microbial fermentation for the enhancement of yields of extractions and functional properties of plant extracts (polyphenols, antioxidants). Possible companies are manufacturers of dietary supplements, e.g. Probotanic, Beograd, and Institute Dr Josif Pančić.

3. The application of new-generation probiotics for the improvement of functional properties and the safety of fermented food. Generally, companies may be included that deal with milk and dairy product fermentation, such as Pirot Milk School, but also other smaller and larger dairies.

4. The application of microbial preparations for the improvement of health and yield of bees. Honey manufacturers (beekeepers) demonstrate interest in this area.

5. Biotechnology in environmental protection. The companies generate organic waste and treat waste themselves; composting or another microbial process would be included in the process.

Overlap with other areas and technologies

Advanced materials, environmental protection, creative industry and mainly agriculture and food industry, also application machines, medicine, etc.

The general conclusion regarding biotechnology is that more time and additional interviews are needed to evaluate the current and future development levels in this area.

Sub-area 5 - Blockchain technologies

Around 150 blockchain programmers have been identified in Serbia, who predominantly work for foreign markets but are also increasingly developing their own solutions. Blockchain technology may be applied in various sectors – ranging from data storage to financial transactions.

Overlap with other areas and technologies

IT area in general, software solutions, in addition to the possibility of use in various sectors such as the financial sector.

Sub-area 6 - Autonomous driving, aerospace systems and engineering

This industry is in its infancy and has good potential, both from a scientific perspective but also from the perspective of business entities which have started to develop and manufacture advanced systems, such as unmanned aircraft with different purposes (from border surveillance to application in agriculture, such as the company Konalek Aerospace Entered, which has its first prototype for an unmanned quadcopter with a large capacity up to 80 kg intended for spraying plants in agriculture, and at the same time is a certified supplier for the Airbus company). In addition, this industry is focused on new advanced composite materials and the use of various advanced technologies. In the area of autonomous driving, RT-RK has developed a cooperation with AUDI from Germany, thus demonstrating a good basis as well in terms of adequate developers and development centres.

Overlaps with other areas and technologies

Photonics, advanced materials, advanced manufacturing technologies, telecommunications, signal processing and image digitisation, control systems, software, transport, specialised machines and production automation.

The general conclusion is that, in the area of KET and emerging technology, there is no critical mass of companies, strong research infrastructure or any large research centres engaged in the production of new technologies and materials. Due to the horizontal nature and importance of the innovation system, identified technologies in the area of KET and emerging technologies should be horizontally supported. Horizontal linking of identified companies in this area with vertical priorities would contribute to successful implementation of Smart Specialisation concepts in Serbia.

4.6 Input for the future Entrepreneurial Discovery Process

In accordance with the S3 design guidance, the next phase of the strategic process in Serbia is the Entrepreneurial Discovery Process – EDP. The EDP is the key element for the successful design and implementation of the Strategy, and it represents a continuous public and private dialogue among stakeholders from the quadruple helix, namely the private sector, academia, government and civic society. The EDP is carried out through a series of joint workshops for each specialisation area and through consultations before and after them. Workshops during the EDP cover the following four topics:

- the EDP conference which presents all priority areas,
- SWOT analysis,
- vision of future development and final name of the priority area,
- policy mix (objectives and actions with indicators).

The EDP should lead to the development of a shared vision among key stakeholders, since the S3 design cannot be properly undertaken without their participation. For that reason, a number of questions in qualitative interviews were intended to detect stakeholder preferences in order to ensure their participation.

4.6.1 General conclusion of qualitative interviews

The general conclusions after the analysis of qualitative interviews by the EDP team and the coordination body for EDP are the following:

- EDP workshops should last no more than 2-3 hours, i.e. half a day;
- The period between workshops should be one month. It is generally extremely preferable to determine the workshop dates as soon as possible;
- preferences regarding official invitations are very different – from personal calls for smaller companies, to formal summons for academia, large companies and the government sector. Official invitations should be sent at least 2 weeks in advance;
- in the areas represented throughout the territory of the Republic of Serbia, stakeholders are prepared to come to workshops in other areas of Serbia. On the other hand, in areas that are geographically concentrated, it is not desirable to organise them in parts of Serbia where there are no stakeholders;
- the content and details regarding the method of working should be prepared accurately prior to the workshop, in dialogue with the stakeholders. Conclusions from every workshop should be checked in dialogue with stakeholders after each workshop.

4.6.2 The proposed EDP plan in Serbia

General conclusions from qualitative interviews indicate that the EDP will be implemented differently for each area – even for certain (sub-)areas – to ensure the performance of dialogue needed for high-quality design of RIS3. However, a 'rough' schedule of activities following each of the four workshops is presented below.

Table 19. Schedule of activities for each series of workshops

Activity	Week
Stakeholder consultations on the next workshop agenda	1

Official invitation to the next workshop	2
Stakeholder consultations on the next workshop execution details	3-4
1. Workshop execution	4
Stakeholder consultations on minutes from the last workshop & on the next workshop agenda	5
Stakeholder consultations on confirmation of conclusions from the last workshop & the next workshop execution details	7-8
2. Workshop execution	8

4.7 Main findings and recommendations for the Entrepreneurial Discovery Process

On the basis of systematised data obtained in interviews and according to the work of coordinators and co-coordinators for individual areas, the proposal for the names of broader areas and sub-areas for the Entrepreneurial Discovery Process is as follows.

Vertical priority areas

1) Information and communication technologies

- Big Data
- Cloud technologies
- Internet of Things
- Custom software development
- Embedded systems

2) Food for future

- High-tech agriculture
- Value-added food
- Sustainable food chain

3) Creative industries

- Creative digital media production and services
- Gaming industry
- Smart and active packaging

4) Future machines and manufacturing systems

- Application machines
- Data to Decision – Industry 4.0
- Premium tools and smart mobility solutions
- Sustainable heat appliances and devices
- Solutions for smart ecosystems

Horizontal (supporting) areas

1) Energy-efficient and eco-smart solutions

- Eco-smart energy sources

2) Key Enabling Technologies (KET) and emerging technologies

- Photonics
- Advanced materials
- Advanced manufacturing technologies and electronics
- Industrial biotechnology
- Blockchain technologies
- Autonomous driving, aerospace systems and engineering

5 Conclusions

Mapping exercises represent a crucial evidence-based step in the development of Smart Specialisation strategies. Hence, both the quantitative and qualitative analysis of economic, innovation and scientific potential require detailed data, a targeted mapping methodology and the engagement of relevant quadruple helix stakeholders in defining preliminary priority areas prior to entering into the Entrepreneurial Discovery Process. The Serbian Smart Specialisation Team has prepared the data needed for the exercise and engaged its Analytical and Operational teams in supporting the process.

The initial step included the identification of preliminary priority areas by applying a quantitative mapping methodology for the first time in Serbia. An extensive range of data has been used for this purpose. As a result, several promising economic areas have been identified, which helped Serbia's Smart Specialisation Team to streamline their further efforts into targeting and elaborating each potential priority area in order to understand its strengths, innovation and cross-innovation capabilities, promising sub-areas and interlinkages. For this purpose, they used a qualitative mapping methodology based on in-depth interviews and expert analyses of each identified priority area. Conducting a multi-criteria analysis helped the team to take a national, rather than regional, perspective in defining priority areas before entering into the in-depth interview stage.

The level of engagement of relevant stakeholders during the qualitative analysis was satisfactory, which was very important for their introduction to the Smart Specialisation concept and preparing them for their upcoming role in the Entrepreneurial Discovery Process. After conducting interviews with the relevant stakeholders, the subsequent analysis of the results discussed the actual specialisation profiles of the potential priority areas and the existence of critical mass and economic potential. Its findings on specialisations and potential served as a basis for the validation of the proposed areas.

The application of both quantitative and qualitative mapping analyses provided a strong foundation for further profiling of the priority areas at the stakeholder workshops that followed. Most importantly, perhaps, the qualitative analysis identified key stakeholders for the EDP and its conclusions established the basis and initial topics to be discussed in the upcoming dialogue, which will further fine-tune the priorities based on thorough discussions between all of the relevant actors involved in Smart Specialisation in Serbia.

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List of abbreviations and definitions

AAGR	Average annual growth rate
AI	Artificial intelligence
BA	Business analytics
EDP	Entrepreneurial Discovery Process
FTE	Full-time equivalent
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
GI	Geographic indication
GVA	Gross value added
ICT	Information and communication technology
IM	Information management
IMP	Institute Mihajlo Pupin
IoT	Internet of Things
IPO	Intellectual Property Office
KET	Key Enabling Technologies
LED	Light-emitting diode
LFS	Labour Force Survey
LQ	Location quotient
MICE	Meetings, incentives, conferences, exhibitions
NACE	French Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical classification of economic activities in the European Community)
NUTS	Nomenclature of territorial units for statistics
OEM	Original equipment manufacturer
PGPB	Plant growth promotion bacteria
R&D	Research and development
R&I	Research and innovation
SBS	Structural business statistics
VR	Virtual reality
WoS	Web of Science

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KJ-NA-30811-EN-N

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doi:10.2760/003800

ISBN 978-92-76-41079-9