ISSN 1831-9424

European Commission

JRC SCIENCE FOR POLICY REPORT

Measuring territorial innovation strengths

Hollanders, H., Tolias, Y., Radovanovic, N., Gonzalez Evangelista, M., Fabbri, E., Gerussi, E., Sasso, S., Miedzinski, M.

Edited by: Radovanovic, N., Gonzalez Evangelista, M., Fabbri, E.

2024

Joint Research Centre

EUR 31830 EN

EU Science Hub
https://joint-research-centre.ec.europa.eu

JRC136308

EUR 31830 EN

PDF ISBN 978-92-68-12035-4 ISSN 1831-9424 doi:10.2760/73871 KJ-NA-31-830-EN-N

Luxembourg: Publications Office of the European Union, 2024

How to cite this report: Hollanders, H., Tolias, Y., Radovanovic, N., Gonzalez Evangelista, M., Fabbri, E., Gerussi, E., Sasso, S. and Miedzinski, M., *Measuring territorial innovation strengths*, Radovanovic, N., Gonzalez Evangelista, M. and Fabbri, E. editor(s), Publications Office of the European Union, Luxembourg, 2024, JRC136308.

Contents

Abstract

One of the most complex steps within Smart Specialisation is to determine genuinely promising areas in an evidence-based manner, with the help of multiple data. This is also the stage where the economies from the EU Enlargement and Neighbourhood Region lacked expertise and required support. Following the progress made by these economies in the previous period, it was possible to conduct a comparison of the methodologies used for mapping the economic, innovation, scientific, and technological potential of countries and regions, as well as reflect on the challenges encountered during the data collection process in the different territories.

To achieve this goal, a technical workshop has been organized and preceded by two background documents describing the experiences in the above-mentioned countries, with a focus on collecting and interpreting economic, innovation, and scientific statistical data. Similarly, the workshop aimed to compare and evaluate methodologies used for mapping the economic and innovation potential in the countries. This was followed by a debate on how to deal with new challenges related to sustainability and non-EU territories, such as Latin America and Africa.

Acknowledgements

We would like to thank all participants at the workshop “Towards a challenge-led approach to measuring territorial innovation potential” held on February 21 and 22 2023 in Seville, Spain, for their contribution to the joint efforts on discussing and enhancing the framework for conducting the mapping exercise for the identification of economic, innovation and scientific potential in the EU Enlargement and Neighbourhood context. Their opinion helped us identify the challenges in this extent and they make an important part of this report.

Authors

Hugo Hollanders – UNU-MERIT, Maastricht, Netherlands

Yannis Tolias – Innovatia Systems, Thessaloniki, Greece

Nikola Radovanović – European Commission, Joint Research Centre, Seville, Spain

Emanuele Fabbri – European Commission, Joint Research Centre, Seville, Spain

Manuel González Evangelista – European Commission, Joint Research Centre, Seville, Spain

Elisa Gerussi – European Commission, Joint Research Centre, Seville, Spain

Simone Sasso – European Commission, Joint Research Centre, Seville, Spain

Michal Miedzinski – European Commission, Joint Research Centre, Seville, Spain

Editors

Nikola Radovanović – European Commission, Joint Research Centre, Seville, Spain

Manuel González Evangelista – European Commission, Joint Research Centre, Seville, Spain

Emanuele Fabbri – European Commission, Joint Research Centre, Seville, Spain

Executive summary

Policy Context

In recent years, economies from the EU Enlargement and Neighbourhood Region (E&N) have significantly advanced their Smart Specialisation process. The Joint Research Centre (JRC) has supported national governments in analyzing and strengthening regional ecosystems by providing the Smart Specialisation Framework for EU Enlargement and Neighbourhood Region (the S3 Framework) as a guideline for mapping the innovation potential of the territory. Furthermore, the JRC has recently incorporated the sustainability component into the Smart Specialisation approach and promoted its applicability on a global perspective, with a specific focus on Latin America and Africa. This has led to an evaluation of the work done so far in the E&N region and a reconsideration of the appropriateness of the methods proposed by the S3 Framework in non-EU contexts. Nevertheless, new global challenges and geopolitical threats may affect the actual viability of the methods provided, and new techniques and tools may need to be explored further.

Operating in the context of weak institutional capacity represents one of the main challenges for achieving an evidence-based participatory process. Nevertheless, the effort to establish more sustainable settings requires data-informed innovation policies. After applying the S3 Framework for the past five years (2017-2022) in the EU Enlargement and Neighbourhood Region and investigating its suitability in Latin America and Africa regarding sustainability solutions, an in-depth reflection on the appropriateness of the methods detected becomes necessary.

Key Conclusions

For this reason, a group of international experts who have been collaborating with JRC in recent years participated in a two-half-day workshop to discuss main issues and challenges with mapping in the E&N region and consider potential practical guidelines for the future. The workshop, named "Towards a Challenge-Led Approach to Measuring Territorial Innovation Potential," took place in Seville on 21 and 22 February 2023 and included three sessions. The first one focused on the implementation of the S3 Framework so far, the second one looked closer at the sustainability component, and the third one aimed to connect the implementation of the S3 Framework with territories beyond the European Union. Participation in the workshop was extended to other relevant professionals with significant experience on the topic worldwide, and their involvement was ensured both in-person and remotely. The workshop aimed for a wide-open discussion that brought about interesting insights for the future refinement of the S3 Framework.

Main Findings

Several issues were debated during the workshop, concerning both methods and their applicability. Not always was a common perspective found among participants, confirming the complexity of the topic as well as the difficulty of implementing evidence-based approaches in contexts with weak institutional capacity. Constraints linked to the S3 Framework, as well as the lack of data availability, affected both the methodological settings and the practical implementation of mapping exercises.

1 Introduction

In 2017, the JRC launched a project on "Smart specialisation and organisational development in enlargement and H2020 associated countries" (under the Enlargement & Integration Action, E&IA), now continued in JRC Work Programme. The overall objective of the project was to strengthen the capacity building in the EU Enlargement and Neighbourhood Region in the field of innovation policy and assist public authorities in the design of Smart Specialisation Strategies. This, among others, included a set of quantitative and qualitative analysis at national and subnational level in all Western Balkan economies, most Eastern Partnership countries and Tunisia. In 2019, the support activities were strengthened within the administrative agreement between the DG NEAR and the JRC of the European Commission, aiming at providing direct support to the Western Balkan economies in their Smart Specialisation efforts.

The initial crucial phase in each country mapping study involved providing expert support for the analysis of economic, innovation, scientific, and technological potential at the national or subnational level. Since 2017, mapping studies have been conducted for six Western Balkan economies (Albania, Bosnia and Herzegovina, Kosovo[*], Montenegro, North Macedonia, and Serbia), three Eastern Partnership countries (Georgia, Moldova, and Ukraine), and Tunisia.

This study aims to extract lessons from the implementation of the mapping methodology and proposes an improved framework based on hands-on experience, considering recent policy developments, notably the European Green Deal. Specifically, the study will conduct a comparison and evaluation of the methodologies used for mapping the economic and innovation potential of countries and regions, reflect on the challenges and limitations encountered during the data collection process in different countries, and put forward recommendations on how to customize the mapping methodology better based on needs and data availability.

The first part of this report (sections 1 and 2) served as a background paper for an expert workshop that took place in Seville in February 2023. Section 1 describes the experiences in the countries mentioned above with a focus on collecting and interpreting economic and innovation statistical data. The report includes a brief discussion on the roles and capacity of ministries, national statistical offices, and other relevant stakeholders involved in the data collection and analysis. The report also encompasses a comparison and evaluation of the methodologies used for mapping the economic and innovation potential in the mentioned countries. Additionally, the report looks forward to how to improve the mapping methodology.

In Section 2, we discuss the methodological approaches used for mapping the scientific potential in four cases; we compare and evaluate the methodologies, with a summary from the Seville workshop. Furthermore, all the evidence available is synthesized to elaborate on a forward-looking reflection on how to better customize the mapping methodology based on countries and regions' needs, data availability, and capacities, including a discussion on new data sources and new aspects relevant for Smart Specialisation.

In Section 3, we summarize the main elements discussed during the technical workshop that took place in Seville in February 2023, bringing together relevant experts in the field.

[*] This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

2 Mapping economic and innovation potential – review and potential improvements

2.1 Overview of mapping studies

The table below shows for which economies a mapping analysis of the economic, innovation and scientific potential (E&I&S) has been performed. For Albania, Kosovo, Montenegro, and North Macedonia, the analysis has been done at the level of the economy. For Bosnia and Herzegovina, Georgia, Moldova, Serbia, and Ukraine, the analysis has been done for all or a selection of regions in the country. For Tunisia the analysis has been done both at the level of the country and regions within the country. The discussion of the experiences will follow a chronological order as methodologies have been adapted for countries in later years based on the experience with countries in earlier years. Also 3 multi-country studies will be discussed, including two studies covering the Western Balkan economies and one study covering the Eastern Partnership countries.

Table 1. Overview of the mapping studies

Economy/region	Year	Type of analysis*	Unit of analysis	Benchmark unit	Study performed by
Albania	2020	E & I & S	Economy	EU28	Team of international experts
Albania	2021	E & I & S	Economy	EU28	Local expert + support of international expert
Bosnia and Herzegovina	2022	E & I & S	Regions	Bosnia and Herzegovina	Local expert + support of international expert
Georgia	2020	E & I	Imereti region	Georgia	International expert
Kosovo*	2021	E & I	Economy	Neighbouring economies	International expert
Moldova	2017 + update 2018	E & I & S	Regions	Moldova	International expert
Moldova	2021	E & I & S	Regions	Moldova	Local expert + support of international expert
Montenegro	2018	E & I & S	Economy	EU28	International expert
North Macedonia	2019	E & I & S	Economy	EU28	Team of local experts + support of international expert
Serbia	2017	E & I & S	Regions	Serbia	Team of international experts
Tunisia	2021	E & I & S	3 regions	Tunisia	International expert
Tunisia	2022	E & I & S	Economy	Mediterranean countries	International expert
Ukraine	2017	E & I & S	Regions	Ukraine	International expert

Ukraine	2019	E & I	Regions	Ukraine	International expert
Western Balkan (WB)	2018 + update 2020	E & I & S	Economies	WB aggregate	Team of international experts
Eastern Partnership (EaP)	2021	E & I	Countries	EAP aggregate	Team of international experts

* *E = Economic potential, I = Innovation potential, S = Scientific potential*

Source: Own source.

2.2 Methodology

All studies identified potential priority domains for smart specialisation by identifying areas of specialisation using economic and innovation statistics using location quotients to measure degrees of specialisation. The rationale is that comparable to trade where strength in exports of individual commodities is determined using revealed comparative advantages, to identify economic activities in which a region of country is showing above average strength, with strength being measured as the relative share of that activity being substantially higher compared to the country or a group of other countries.

A location quotient (LQ) measures the degree of concentration in a particular industry in a region compared to the same industry in the country or in a country compared to the same industry in a group of benchmark countries. It can be expressed using the following formula:

$LQ_i = (e_i / e) / (E_i / E)$

LQ_i = location quotient for industry i in the region (or country)

e_i = size of activity in industry i in the region (or country)

e = total size of activity in the region (or country)

E_i = size of activity in industry i in the country (or benchmark countries)

E = total size of activity in the country (or benchmark countries)

An LQ above 1 shows an above average concentration in a particular activity, an LQ below 1 shows a below average concentration in a particular activity. E.g., when comparing a region to the country, if employment in industry X in the region is 100 and total employment in the region is 1,000, and employment in industry X in the country is 500 and total employment in the country is 10,000, then the LQ equals (100 / 1,000) divided by (500 / 10,000) or 0.1 divided by 0.05 or 2. The region would be specialised in the activities in industry X compared to the country.

The calculation of LQs for different variables and for multiple years is the key building block of the methodologies used in all mapping studies, with industries being considered as potential priority domains if their LQ exceeds a predefined threshold.

There are no straightforward rules for determining the exact value of the threshold values to be used to identify if an industry is specialised or not. In most studies this threshold value is either 1.25 or 1.5. Lower threshold values would identify too many specialised industries, higher threshold values would identify only a very small number of specialised industries. The same also applies for the size threshold used in many studies for excluding too small industries by requiring that an industry accounts for at least x% of economic activities in the region or country. Box 1 includes an example using different thresholds using the data from the 2017 report on the regions in Moldova.

For the identification of industries with an economic strength or economic potential, the following **economic data** can be used at the 3-digit NACE industrial classification: Number of enterprises, Employment or persons employed, Turnover or Value added, or Wages.

The most used data sources for economic data are the Labour Force Survey (LFS), Structural Business Statistics (SBS) or administrative data (e.g. data from the tax office).

For the identification of industries with an innovative strength or innovation potential, the following **innovation data** can be used at the 3-digit NACE industrial classification: Innovative enterprises, Patents, Trademarks, Designs, Product exports, or Services exports.

The most common data sources are data from innovation surveys, intellectual property data from international or national IP offices, trade data from international and national statistical offices.

Box 1. Impact of size of thresholds for mapping of current economic potential

The difference in size threshold raises a question of which size threshold but also which specialisation threshold to use. There are no set rules for determining these threshold values. The most common practice is to start with threshold values which are also used in other studies and then to either use these if the number of selected industries matches policy needs, or to decrease a threshold if the number of selected industries is too small or to increase a threshold if the number of selected industries is too high.

As an example the data from the different studies on Moldova can be used. The 2017 report used a lower size threshold of 2% in a two-step analysis on, first, all industries and, secondly, on manufacturing industries only, so as also to determine small industries in Manufacturing as specialised industries. In the update in the 2021 report this two-step analysis was omitted and only all industries were analysed at once. As a size threshold of 2% as used in the 2017 report would exclude too many industries, a lower size threshold of 0.1% was used, thereby making it possible to also identify industries in Manufacturing as having a current economic potential.

In the table below the results are shown for the use of different thresholds. Increasing the specialisation threshold from 1.5 to 2, 3 or 4, will reduce the number of selected industries. For Chisinau a specialisation threshold of 2 or more will lead to no industry having a current economic potential. For the other regions increasing the specialisation threshold will lower the number of selected industries, e.g., for North from 31 to only 8 if this threshold is increased from 1.5 to 4, with the number of Manufacturing industries being reduced from 18 to 7.

Increasing the size threshold will also reduce the number of selected industries. Increasing this threshold to e.g., 1%, will reduce the number of industries with a current economic potential from 31 to only 15 in North, including a reduction of 18 to 10 Manufacturing industries.

There are a priori no ideal values for the different thresholds but setting them too low (high) leads to too many (not enough) industries having a current economic potential. In most studies the specialisation threshold is set at 1.5, and it is strongly recommended not to differ too much from this value.

Number of manufacturing industries in Moldovan regions passing at least two economic selection criteria using different criteria:

	Specialisation	Size	Chisinau	North	Centre	South	Gagauzia
2017 report a	1.5 (1.25b)	2% (1.5%b)	16 (9)	10 (7)	13 (9)	7 (3)	9 (5)
2021 report	1.5 (1.25b)	0.1%	52 (10)	31 (18)	25 (12)	16 (4)	16 (8)
2021 – option 1	2.0	0.1%	0 (0)	23 (14)	16 (9)	14 (4)	12 (8)
2021 – option 2	3.0	0.1%	0 (0)	10 (9)	12 (7)	9 (2)	6 (5)
2021 – option 3	4.0	0.1%	0 (0)	8 (7)	9 (7)	5 (2)	2 (2)
2021 – option 4	1.5 (1.25b)	0.5%	27 (1)	18 (11)	20 (9)	13 (2)	14 (7)
2021 – option 5	1.5 (1.25b)	1.0%	15 (0)	15 (10)	15 (6)	12 (2)	11 (5)
2021 – option 6	1.5 (1.25b)	2.0%	8 (0)	13 (9)	9 (3)	7 (2)	5 (1)

a: Thresholds used for both All industries and Manufacturing industries;

b: Threshold used for (All industries) for Chisinau.

Source: scenarios calculated using the data in: Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021.

a) Regions in Serbia

The study on Serbia was funded by the Joint Research Centre and carried out by a team of experts from *Fraunhofer ISI* (Kroll et al., 2017). This study can be seen as having set the benchmark for other mapping studies as the study which progressed fastest of the 3 studies in 2017. The study benefited from an intense collaboration with Serbian stakeholders and providers of statistics as will be discussed below. Data have been made available by the Serbian Statistical Office, Intellectual Property Office of the Republic of Serbia, and Mihailo Pupin Institute.

The study analysed the E&I potential of 4 regions in Serbia: Belgrade, Vojvodina, Šumadija and Western Serbia, and Southern and Eastern Serbia. All regions have a comparable population size, but there are substantial differences in GDP, GDP per capita and exports.

Table 2. Serbian regions: descriptive statistics

Region	Population (2016) - million	Area (km2)	GDP (2014) – billion Euros	GDP per capita (2014) – Euros	Exports (2016) – billion Euros
Belgrade	1.68	3,234	12.5	7,460	7.77
Vojvodina	1.88	21,614	8.8	4,650	3.46
Šumadija and Western Serbia	1.96	26,493	6.4	3,195	3.52
Southern and Eastern Serbia	1.54	26,248	4.5	2,905	2.12

Source: Kroll, H., E. Schnabl, D. Horvat, Mapping of economic, innovative and scientific potential in Serbia, Report for the EC Joint Research Centre, 2017.

Data availability

The following data were available for analysing regions' economic and innovation potential:

- Economic potential
  - Employment data for NACE 3-digit industries for 2011-2015 from the Labour Force Survey
  - Export data for NACE 3-digit industries for 2012-2016 from national export statistics
- Innovation potential
  - Data on innovative firms for NACE 3-digit industries for 2010, 2012, 2014 and 2016 from the national innovation survey
  - Patent applications for 2010-2016, from the Mihailo Pupin Institute based on data from the Intellectual Property Office of the Republic of Serbia

Methodology

Potential priority domains should display the following main characteristics in both the economic and innovation dimension:

- *Specialisation*: an in relative terms higher importance of the industry in the regional economy than is standard for the economy using Location Quotients (LQ)
- *Absolute size*: that an industry is in relative terms more important for the region than on national level can be irrelevant for regional economic policy if it is in absolute terms too small. Absolute size is an important necessary criterion

- *Growth*: While growth is not a necessary condition it provides important additional information on the relevance of an industry, e.g., if it is an emerging field that has already gained momentum

The initial methodology for identifying specialised industries was as follows:

- Economic potential
    - Employment data:
        - LQ in 2016 above 1.5 & Size of employment in 2016 above 2,000 (4,000 for Belgrade)
        - LQ in 2016 between 1.0 and 1.5 & Percentage change between 2011 and 2016 above 75%
    - Export data:
        - LQ in 2015 above 1.5 & Volume of exports in 2015 above Euro 100,000
- Innovation potential
    - Innovative firms:
        - LQ in 2016 above 1.5 & Number of innovative firms in 2016 above 25
    - Patent data:
        - LQ above 1.25 & Number of patents above 5

A more comprehensive two-step approach was used for identifying potential priority domains by combining different variables. In the first step, the following criteria were used:

- LFS employment data: Share > 1.5% & LQ > 1.5 (or 1.25) & Size of employment > 5,000
- Exports: Share > 1.5% & LQ > 1.5/1.25 & Volume > 250,000
- Innovation survey data: share > 1.5% & LQ > 1.5 (or 1.25) & Number of innovating firms > 25
- SBS Employment: Share > 1.5% & LQ > 1.5 (or 1.25) & Size of employment > 5,000
- SBS Number of Firms: Share > 1.5% & LQ > 1.5 (or 1.25) & Number of enterprises > 250
- SBS Value Added: Share > 1.5% & LQ > 1.5 (or 1.25) & Value added > 10 billion RSD
- Patents, aggregate 2010-2016 data (aggregate data were used due to low numbers by year and industry): Share > 1.25% & LQ > 1.5 (or 1.25) & Number of patents > 5

Data from the Structural Business Statistics (SBS) do not cover the whole economy but only industry and most business services, but not Agriculture (NACE A), Financial services (NACE K), and Public or household-oriented activities (NACE O to T). Results based on an analysis of SBS data should take this limitation into account.

In the second step, only those NACE 3-digit industries are considered as potential priority domains which either:

- Matched the criteria for LFS employment for at least 3 years
- Matched the criteria for exports for at least 3 years
- Matched the criteria for innovative firms for at least 3 years
- Matched the criteria for at least one of the SBS variable for at least 3 years
- Matched the criteria for the aggregate patent data

Results

Table 3 shows the number of identified potential priority domains for each region for the different criteria. Most industries are identified based on LFS employment data (23), followed by SBS data (16), innovation data (15), patent data (13), and exports (3).

Table 3. Serbian regions: number of industries passing the economic selection criteria

	Belgrade	Vojvodina	Šumadija and Western Serbia	Southern and Eastern Serbia
Employment LFS	9	2	9	3
Exports	0	2	1	0
Innovative firms	5	3	7	0
Patents	6	3	2	2
SBS variables	2	5	6	3
Total	**22**	**12**	**17**	**8**

Source: Kroll, H., E. Schnabl, D. Horvat, Mapping of economic, innovative and scientific potential in Serbia, Report for the EC Joint Research Centre, 2017.

Assessment

The methodology used in this study is comprehensive as it combines different variables for NACE 3-digit industries: employment, number of enterprises, value added, product exports, innovating enterprises, and patents. The study has benefited directly from the support from the Serbian Statistical Office and Mihailo Pupin Institute as data for several of the variables are not publicly available:

- Innovation survey data are drawn from a national sample and this sample is usually too small to extract representative data at the cross combination of regions and NACE 3-digit industries. As the discussion of the other mapping studies will show, usually at best NACE 1-digit industry innovation data are available at the regional level.
- Product export data are collected using the Standard International Trade Classification (SITC). These data can be recalculated to NACE using correspondence tables but detailed data by region and NACE 3-digit industries are usually not available but can be calculated using a correspondence table matching SITC codes to NACE codes. One such correspondence table is available from the World Integrated Trade Solution (WITS)[1] and matches up to 5-digit SITC Rev. 3 codes to 3-digit NACE Rev. 1 codes. Such detailed export data by region are usually not publicly available and only a national statistical office could make these calculations. Product export data will not cover exports of services and the analysis of these data will not show export specialisations in those industries where services are important, both in industry and the services sector.
- Patent data are collected using the International Patent Classification (IPC). Various correspondence tables exist matching IPC to NACE codes[2], but this too requires access to detailed patent data. Here the Mihailo Pupin Institute has done the calculations, using data from the Intellectual Property Office of the Republic of Serbia, and shared patent applications by region and NACE.

The disadvantage of the mapping methodology used in this study is perhaps the combination of individual variables without requiring that an industry should pass e.g. both the employment and innovation criteria thereby having both an economic and innovation potential.

b) Regions in Moldova

The first mapping study for Moldova in 2017 was performed by an international expert for the EC's Joint Research Centre and covered an analysis of the economic potential (Hollanders, 2017). In 2018 an

[1] http://wits.worldbank.org/data/public/concordance/Concordance_S3_to_NC.zip
[2] https://ec.europa.eu/eurostat/ramon/documents/IPC_NACE2_Version2_0_20150630.pdf

update followed also including an analysis of the innovation potential (Hollanders, 2018b). In 2021 the study was updated using more recent data for both the economic and innovation potential (Russu and Hollanders, 2021).

The first study on Moldova in 2017 was carried out by an international expert with support from the Ministry of Economy of the Republic of Moldova, National Bureau of Statistics of the Republic of Moldova, Academy of Sciences of Moldova, and the Chamber of Industry and Commerce of Moldova.

The study analysed the economic and innovation potential of 5 regions in Moldova: Chisinau, North, Centre, South, and Gagauzia. **Error! Reference source not found.**The table below summarises some k ey socio-economic differences between these regions. Centre has the largest population, Gagauzia the smallest. Chisinau, the capital region, is highly urbanised compared to the other regions. Centre, surrounding Chisinau, is the least urbanised. Employees in Chisinau earn on average more than employees in other regions; compared to South and Gagauzia at least 50% more.

Table 4. Moldovan regions (2017): descriptive statistics

Region	Population	Urban population	Rural population	Average nominal monthly earning (Lei)
Chisinau	814,100	90.9%	9.1%	5375.3
North	987,500	36.1%	63.9%	3871.0
Centre	1,057,100	19.6%	80.4%	3719.5
South	532,500	26.5%	73.5%	3527.3
Gagauzia	161,900	40.6%	59.4%	3553.2

Source: Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova, Report for the EC Joint Research Centre, 2017.

Data availability

The following data were available for the 2017 study for analysing the economic potential:

- Economic potential
    - Employment data for NACE Revision 1.1 3-digit industries for 2006-2013
    - Turnover data for NACE Revision 1.1 3-digit industries for 2006-2013
    - Wage data for NACE Revision 1.1 3-digit industries for 2006-2013
    - Employment data for NACE Revision 2 3-digit industries for 2014-2016
    - Turnover data for NACE Revision 2 3-digit industries for 2014-2016
    - Wage data for NACE Revision 2 3-digit industries for 2014-2016

Data for 2006-2013 are based on NACE Revision 1.1, data for 2014-2016 are based on NACE Revision 2. Correspondence tables between these two NACE classifications are available at the 4-digit level only. As data are only available at the more aggregated NACE 3-digit level, both time series cannot be matched[3], and the study only used the 2014-2016 NACE Revision 2 data.

Methodology

The selection of industries was done in two steps. The first step was applied to all industries and used the following criteria:

[3] NACE Rev 1.1. is different from NACE Rev 2 with industries from the old NACE broken up in multiple new NACE industries. Data can thus not be matched over time.

- Employment:
    - Specialisation: LQ > 1.5 (1.25 for Chisinau)
    - Absolute size > 2% (1.5% for Chisinau)
- Turnover:
    - Specialisation: LQ > 1.5 (1.25 for Chisinau)
    - Absolute size > 2% (1.5% for Chisinau)
- Average wages:
    - > 90% of average wages in same industry at country level (100% for Chisinau)
    - > 110% of average wages in all industries in region

A growth component was not included as the available time series of three years was too short.

An industry was selected, either at the NACE two-digit or three-digit level, if at least two of the three variables (employment, turnover, average wages) passed their thresholds. For employment and turnover this required passing both criteria for specialisation and absolute size, for average wages this required passing both thresholds for average wages relative to the region and to the same industry at county level.

The Manufacturing sector is an important sector for the economy, but it has a relatively small share in the economy and the average size of a NACE 3-digit industry is smaller than in the Services sector. The thresholds used in Step 1 could be biased against selecting industries in the Manufacturing sector. A second step was therefore used, which allowed the selection of relevant manufacturing industries. In the second step, the selection process explained above was repeated for industries in Manufacturing only, using the same thresholds for all regions, i.e., 1.5 for Specialisation and 2% for Absolute size (cf. **Table 5.** Moldovan regions (2017): threshold values used for economic mapping). An industry was selected, either at the NACE two-digit or three-digit level, if at least two of the three variables passed both thresholds.

Table 5. Moldovan regions (2017): threshold values used for economic mapping

	Employment & Turnover				**Average wages per person employed**	
	All industries		**Manufacturing**		**Relative to average wages in each industry in the Republic of Moldova**	**Relative to average wages in all industries in each region**
	Size	**LQ**	**Size**	**LQ**		
Chisinau	1.5%	1.25	2.0%	1.5	At least as high as average wages in Moldova	At least 10% higher than average wages in region
North, Centre, South, Gagauzia	2.0%	1.5	2.0%	1.5	At least as high as 90% of average wages in Moldova	At least 10% higher than average wages in region

Source: Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova, Report for the EC Joint Research Centre, 2017.

<u>Results</u>

In total 55 industries passed the selection criteria, of which 35 in the first step and an additional 20 in the second step. In total 16 industries were selected for Chisinau, 10 for North, 13 for Centre, 7 for South, and 9 for Gagauzia (**Table 6.** Moldovan regions (2017): number of industries passing the economic selection criteria). Of these 55 industries, 33 industries are in the Manufacturing sector, of which only 13 were selected in the first step and 20 in the second step. In particular, for Chisinau adding this second step is crucial as no Manufacturing industries were selected in the first step. The selected industries were finally combined in larger potential priority domains including Agriculture and Food processing for North, Centre, South, and Gagauzia, Textile, Apparel, Footwear and Leather goods (TAFL) for Centre, ICT for Chisinau, and Renewable energy for South and Gagauzia.

Table 6. Moldovan regions (2017): number of industries passing the economic selection criteria

	Chisinau	North	Centre	South	Gagauzia
First step	7	9	8	6	5
Second step	9	7	7	3	5
Total	16	10	13	7	9

Source: Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova, Report for the EC Joint Research Centre, 2017.

The innovation potential could not be analysed in the 2017 report as innovation survey data were not available. Innovation survey data for the years 2015-2016 did become available in 2018, and the second report was updated by adding the results of the analysis of the innovation potential. The update of the report for Moldova in 2018 was performed by the same international expert.

Data availability

The following data from the statistical survey on the innovation activity of enterprises in the Republic of Moldova in the years 2015-2016 were made available by the National Bureau of Statistics for NACE 3-digit industries for each of the regions:

- Total number of firms
- Number of firms which introduced at least one innovation (product or process or organisational or marketing)
- Number of firms which introduced at least one product innovation
- Number of firms which introduced at least one process innovation
- Number of firms which introduced at least one marketing innovation
- Number of firms which introduced at least one organisational innovation
- Number of firms that introduced a product innovation new to the firm's market
- Number of firms that introduced a product innovation only new to the firm
- Number of firms with own R&D activities
- Number of firms with external R&D activities

Given the small number of firms responding positively to each of these innovation activities, these data were not used for identifying the innovation potential, but only the data for the number of firms which introduced at least innovation.

Methodology

The methodology identifies industries with a substantial mass of innovation activities – using data on the share of firms that introduced at least one innovation –, for which specialisation and size are above pre-defined threshold values. The threshold values are shown in the table below, the degree of specialisation should be above 1.5 (1.25 for Chisinau) and there should be at least 4 innovative firms in an industry for Chisinau, 2 for North and Centre, and 1 for South and Gagauzia[4].

[4] The thresholds are very low due to small sample sizes for each of the regions. It might therefore be better to say that the methodology when working with small data volumes rather identified the presence of enterprises open to the introduction of innovation.

Table 7. Moldovan regions (2018): threshold values used for innovation mapping

	Size (number of innovative firms)	**Specialisation (LQ)**
Chisinau	4	1.25
North, Centre	2	1.5
South, Gagauzia	1	1.5

Source: Authors.

Results

The table below shows the number of industries at both NACE 2-digit and NACE 3-digit for each region that passed both selection criteria and have an innovation potential. For Chisinau 30 industries have an innovation potential, for North 21 industries, for Centre 15 industries, for South 11 industries, and for Gagauzia 20 industries. These industries can be matched to those having an economic potential to identify industries having both an economic and innovation potential.

Table 8. Moldovan regions (2018): Number of industries passing the innovation selection criteria

Chisinau	**North**	**Centre**	**South**	**Gagauzia**
30	21	15	11	20

Source: Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova - Update, Report for the EC Joint Research Centre, 2018.

Assessment of the first two reports

The methodology used for Moldova in the 2017 and 2018 report benefits from having access to detailed industry level data for the mapping of both the economic and innovation potential. By combining the results of both analyses, those industries can be identified which have both an economic and innovation potential.

There are two disadvantages of the methodology used in these reports. The first is the lack of time series data for the economic variables, thereby prohibiting the analysis of changes over time and identifying fast-growing industries which do not yet have an economic potential, but which could have such a potential if growth would continue.

The second is that the innovation survey data are not available for all industries but only for the so-called Core industries including 2- and 3-digit industries in the following NACE Rev. 2 industries: B (Mining and quarrying), C (Manufacturing), D (Electricity, gas, steam and air conditioning supply), E (Water supply; Sewerage, waste management and remediation activities), G46 (Wholesale trade, except of motor vehicles and motorcycles), H (Transportation and storage), J (Information and communication), K (Financial and insurance activities), M71 (Architectural and engineering activities; technical testing and analysis), M72 (Scientific research and development), and M73 (Advertising and market research). The second disadvantage is a direct result of the classification of industries as Core and Non-core industries in the innovation survey. Moldova follows here EU Member States by collecting data for those industries which have been defined as the core target population in Commission Regulation 995/2012 on innovation statistics.

c) *2021 report for regions in Moldova*

The first disadvantage was overcome in an update in 2021 using longer time series for the economic variables. The report in 2021 was sponsored by the Moldovan S3 team and performed by a Moldovan expert and an international expert.

Data availability

For the mapping of the economic potential, the following statistical data have been made available for 2014-2019 by the National Bureau of Statistics of the Republic of Moldova:

- Employment, 3-digit NACE Revision 2

- Turnover (in Moldovan Leu), 3-digit NACE Revision 2
- Wages (in Moldovan Leu), 3-digit NACE Revision 2

The analysis included both a current ('proven potential') and a dynamic ('emerging potential') analysis to identify industries where regions have or are expected to have a critical mass of economic activities and specialisation.

Methodology

For the **current economic analysis**, a revised methodology was used compared to the 2017 report. By lowering the size threshold to 0.1%, the second step used in the 2017 report, including an additional analysis of Manufacturing industries only, could be omitted. The current analysis identifies those industries as having a current economic potential which pass at least two of the following three criteria. Requiring that an industry should pass all three criteria would be too restrictive and result in a relatively small number of selected industries[5].

- Size and specialisation are sufficiently high for employment, i.e., above pre-defined threshold values, for at least 5 out of 6 years.
- Size and specialisation are sufficiently high for turnover, i.e., above pre-defined threshold values, for at least 5 out of 6 years.
- Average wages are sufficiently high compared to average wages for all industries in the region and the same industry in the country, for at least 5 out of 6 years.

Table 9. Moldovan regions (2021): threshold values used for economic mapping

	Employment & Turnover		**Average wages per person employed**	
	All industries		**Relative to average wages in each industry in Moldova**	**Relative to average wages in all industries in each region**
	Size	**LQ**		
Chisinau	0.1%	1.25	At least as high as average wages in Moldova	At least 10% higher than average wages in region
North, Centre, South, Gagauzia	0.1%	1.5	At least as high as 90% of average wages in Moldova	At least 10% higher than average wages in region

Source: Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021.

For the **dynamic economic analysis**, the following methodology was used. First, the following variables were calculated:

- For every industry in a region and in Moldova *annual percentage changes in employment* were calculated for 2014-2015, 2015-2016, 2016-2017, 2017-2018 and 2018-2019.
- For every industry in a region and in Moldova the *overall percentage change in employment* was calculated for the period 2014-2019.
- For every industry in a region and in Moldova *annual percentage changes in turnover* were calculated for 2014-2015, 2015-2016, 2016-2017, 2017-2018 and 2018-2019.
- For every industry in a region and in Moldova the *overall percentage change in turnover* was calculated for the period 2014-2019.

[5] For all 5 regions combined, requiring that an industry passes all three criteria would result in 54 industries being selected, or, on average, about 10 per region. Requiring only two out of three criteria, increases the number of selected industries to 140, or, on average, 28 per region.

- For every industry in a region and in Moldova *annual percentage changes in average wages* were calculated for 2014-2015, 2015-2016, 2016-2017, 2017-2018 and 2018-2019.
- For every industry in a region and in Moldova the overall percentage change in average wages was calculated for the period 2014-2019.

An industry was identified as having an emerging economic potential if it passed at least two of the following three criteria. Requiring that an industry should pass all three criteria would be too restrictive and would result in a relatively small number of selected industries[6].

- Change in employment (all 4 criteria):
    - Annual change in employment in the industry is higher than annual change in employment for the *region* for at least 3 out of 5 years.
    - Average change in employment for the whole 2014-2019 period in the industry is higher than average change in employment for the *region* for the 2014-2019 period.
    - Annual change in employment in the industry is higher than annual change in employment for the *same industry in Moldova* for at least 3 out of 5 years.
    - Average change in employment for the whole 2014-2019 period in the industry is higher than average change in employment for the *same industry in Moldova* for the 2014-2019 period.
- Change in turnover (all 4 criteria):
    - Annual change in turnover in the industry is higher than annual change in turnover for the *region* for at least 3 out of 5 years.
    - Average change in turnover for the whole 2014-2019 period in the industry is higher than average change in turnover for the *region* for the 2014-2019 period.
    - Annual change in turnover in the industry is higher than annual change in turnover for the *same industry in Moldova* for at least 3 out of 5 years.
    - Average change in turnover for the whole 2014-2019 period in the industry is higher than average change in turnover for the *same industry in Moldova* for the 2014-2019 period.
- Change in average wages (all 4 criteria):
    - Annual change in average wages in the industry is higher than annual change in average wages for the *region* for at least 3 out of 5 years.
    - Average change in average wages for the whole 2014-2019 period in the industry is higher than average change in average wages for the *region* for the 2014-2019 period.
    - Annual change in average wages in the industry is higher than annual change in average wages for the *same industry in Moldova* for at least 3 out of 5 years.
    - Average change in average wages for the whole 2014-2019 period in the industry is higher than average change in average wages for the *same industry in Moldova* for the 2014-2019 period.

Results

In total 52 industries have a current economic potential in Chisinau, 31 in North, 25 in Centre, 16 in South, and 16 in Gagauzia. These numbers are (much) higher than those in the 2017 report because of a much lower size threshold. The 2017 report used a size threshold of 1.5% for Chisinau for both all industries and the additional analysis of Manufacturing industries, the 2021 report uses a size threshold of 0.1% for all industries and does not include, as explained above, the additional analysis of Manufacturing industries.

[6] For all 5 regions combined, requiring that an industry passed all three criteria would result in 79 industries being selected, or, on average, about 16 per region. Requiring only two out of three criteria, increased the number of selected industries to 269, or, on average, 54 industries per region.

Table 10. Moldovan regions (2021): number of industries passing the economic selection criteria

	Chisinau	**North**	**Centre**	**South**	**Gagauzia**
CURRENT					
Employment	96	31	33	19	20
Turnover	39	35	26	23	17
Average wages	55	32	26	11	8
At least two criteria	52	31	25	16	16
Industries in 2017 report	*16*	*10*	*13*	*7*	*9*
EMERGING					
Employment	49	68	83	59	62
Turnover	57	70	66	67	73
Average wages	37	49	77	69	48
At least two criteria	37	50	72	56	54
CURRENT & EMERGING	2	5	3	5	3

Source: Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021*.*

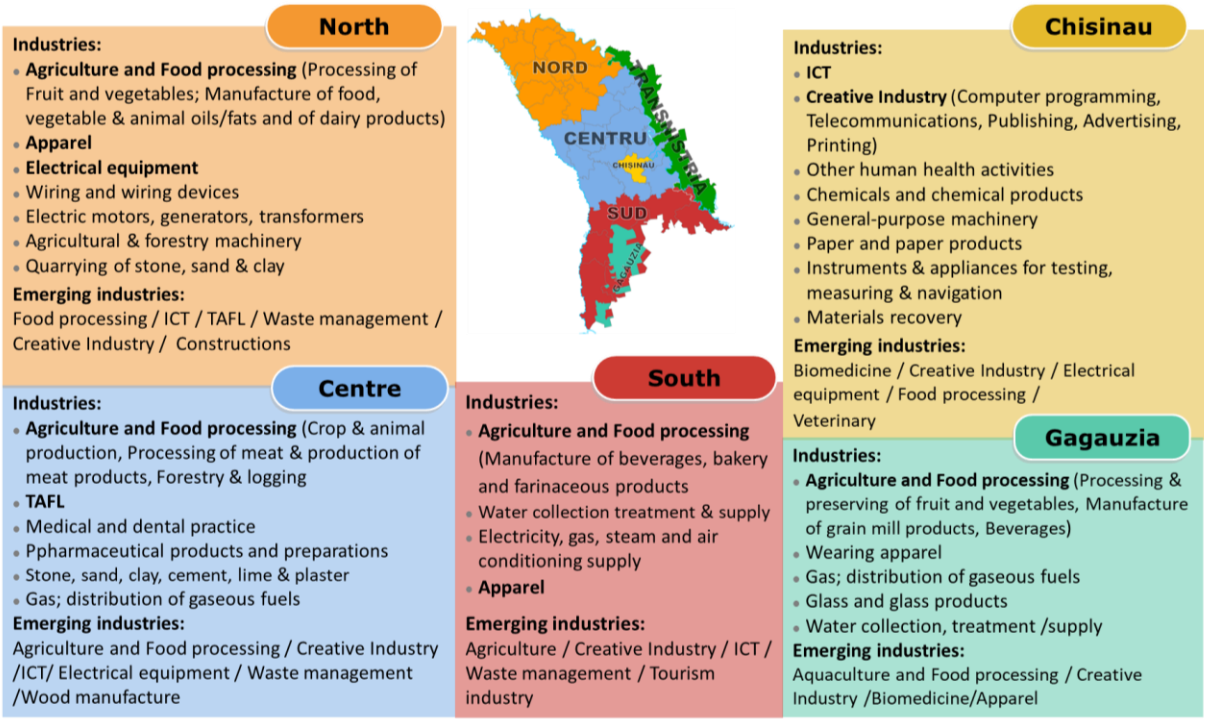
The results from both the current and dynamic analysis have been summarized in the Figure 1.

Figure 1. Moldovan regions (2021): economic priority areas

For Chisinau ICT and Creative Industries are the most important economic areas; other areas of importance include Human health activities, Chemicals and chemical products, Glass and glass products, Paper and paper products and Materials recovery. For North, Centre, South and Gagauzia comparable priority areas for smart specialisation have been identified. For all four regions Agriculture and Food processing are very important, but there are some differences as to which specific industries are included. Textiles, Apparel, Footwear and Leather (TAFL), Biomedicine, Energy and Electrical equipment are also priority areas for smart specialisation in several of these four regions.

In addition, several industries have been identified as having an emerging economic potential: ICT in North, Centre and South, Creative industries in all regions, Waste management in North, Centre and South, Biomedicine in Chisinau and Gagauzia and Electrical equipment in Centre.

Figure 1. Moldovan regions (2021): economic priority areas



Source: Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021.

For the **analysis of the innovation potential**, more recent data were made available from the statistical survey on the innovation activity of enterprises in the Republic of Moldova in the years 2017-2018. The following Innovation data have been made available by the National Bureau of Statistics of the Republic of Moldova:

- Total number of firms.
- Number of firms which introduced at least one innovation (product or process or organisational or marketing).
- Number of firms which introduced at least one product innovation.
- Number of firms which introduced at least one process innovation.
- Number of firms which introduced at least one marketing innovation.
- Number of firms which introduced at least one organisational innovation.
- Number of firms that introduced a product innovation new to the firm’s market.
- Number of firms that introduced a product innovation new to the firm.
- Number of firms with own R&D activities.
- Number of firms with external R&D activities.

Similar as for the 2018 study, given the small number of firms with product, process, organisational or marketing innovations, with new-to-market and new-to-firm innovations, and with internal and external R&D activities, these data were not used for identifying the innovation potential of industries. Only data on the number of firms which introduced at least one innovation were used for mapping the innovation potential. The methodology (specialisation and size) and thresholds were the same as those used in the 2018 report.

For Chisinau 20 industries have an innovation potential, for North 13 industries, for Centre 9 industries, for South 13 industries, and for Gagauzia 14 industries. These industries can be matched to those having an economic potential to identify industries having both an economic and innovation potential.

Also detailed data on patents granted to all national inventors were made available by the State Agency on Intellectual Property (AGEPI) at 4-digit IPC subclass level for each region for four years (2017 to 2020). Two types of patent data have been made available: Number of patents granted to national inventors for First IPC section, class and subclass, and Number of patents granted to national inventors for All IPC sections, classes and subclasses. First IPC highlights the most relevant IPC subclasses for each granted patent. Data for First IPC subclasses have been used in the analysis of patent data for innovation potential identification. Patent data have been converted to NACE industries using a correspondence table[7] between IPC subclasses and NACE 3-digit industries allowing a direct comparison with the results from the analysis of the economic potential. Results of this analysis are not included in the discussion in this report as the number of patents granted is small for almost all regions except Chisinau, which accounts for 85% or more of all patents granted.

Table 11. Moldovan regions (2021): aggregate 2017-2020 patents granted

	National inventors[8]		**First IPC section, class and subclass**					
	Volume (persons)	**%-share**	**Volume (number)**					**%-share**
	2017-2020		**2017**	**2018**	**2019**	**2020**	**Total**	
Chisinau	4,141	85%	568	335	524	439	**1,866**	88%
North	231	5%	8	15	15	11	**49**	2%
Centre	379	8%	46	40	34	44	**164**	8%
South	94	2%	6	6	6	5	**23**	1%
Gagauzia	49	1%	5	0	9	3	**17**	1%
Total	**4,894**		638	400	589	502	**2,129**	

Source: Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021. Data from Moldova's State Agency on Intellectual Property (AGEPI).

Assessment

The different reports on Moldova clearly show how, over time, improved access to data has resulted in changes in the methodology and results. With limited time series data, the economic analysis in the 2017 report did not include a dynamic analysis to identify industries with an emerging economic potential. The 2017 report also did not include an analysis of the innovation potential as regional innovation survey data were not available.

For the 2018 report regional innovation survey data did become available and this report combined the results of the current economic analysis in the 2017 report with an analysis of the innovation potential.

The 2021 report included even more improvements. With the availability of longer time series, also industries with an emerging economic potential could be identified and by lowering the size threshold also more industries could be identified with a current economic potential and the two-step methodology used in the 2017 report – which included an additional analysing of Manufacturing industries only – could be omitted. The 2021 report also benefited from more recent innovation survey data and the availability of regional data on patents granted. Given the small number of these patents for all regions

[7] https://ec.europa.eu/eurostat/ramon/documents/IPC_NACE2_Version2_0_20150630.pdf

[8] Numbers of inventors are aggregate numbers for multiple years, but which years was not specified http://www.db.agepi.md/Inventions/panorama/1#columnchart_16

except Chisinau[9], the results after recalculating patents granted from IPC technology fields to NACE industries, are not discussed in this report.

d) Montenegro

The mapping study for Montenegro in 2018 was funded by the Montenegrin Ministry of Science as part of the "Higher Education and Research for Innovation and Competitiveness" (HERIC) Project (Hollanders, 2018a). The report was performed by an international expert and identified industries with an economic potential relative to the EU28. The innovation potential could not be analysed in detail as innovation survey data were not available. Instead, the study included a descriptive discussion using data from the World Bank Enterprise Survey[10] and Balkan Barometer[11]. Results will not be discussed here as results are only available at economy level for the Balkan Barometer and for 3 highly aggregate sector – Manufacturing, Retail, and other Services – for Enterprise Survey.

Data availability

For the mapping of the economic potential, administrative data were made available by MONSTAT, the Statistical Office of Montenegro, for industries at two NACE levels:

- Number of employees, NACE 3-digit and NACE 4-digit, 2011-2016.
- Gross average wages, NACE 3-digit and NACE 4-digit, 2011-2016.
- Net average wages, NACE 3-digit and NACE 4-digit, 2011-2016.

For the mapping NACE 3-digit data have been used as many 4-digit industries are too small including only a small number of employees.

In addition, NACE 4-digit firm-level data were extracted from the Orbis database for 2008-2016 and were used to construct alternative estimates for aggregate employment and aggregate turnover for NACE 4-digit industries. Results using aggregate Orbis data will not be discussed here.

Methodology

The methodology included two steps. In the **first step**, applied to all NACE 3-digit industries, an industry has an economic potential if it passes at least one of the following criteria:

- Employment:
  - Specialisation: LQ > 1.5
  - Absolute size > 1%
- Average wages:
  - > 125% of national average wages
- Employment growth:
  - Change between 2011 and 2016 > 25%

There are however substantial differences in the average size of NACE 3-digit industries within different NACE 1-digit industries, with the average size of a 3-digit industry being above 1,000 employees for Wholesale and retail trade, repair of motor vehicles and motorcycles (NACE G), Accommodation and food service activities (NACE H), Public administration and defence, compulsory social security (NACE O), Education (NACE P), and Human health and social work activities (NACE Q). For Manufacturing (NACE C), the average size of a 3-digit industry is only 156 employees and is thus much more difficult for an industry in Manufacturing to pass the size threshold.

---

[9] Patent data were available for 4-digit IPC codes which were recalculated to 2/3-digit NACE industries, but absolute patent numbers were close to or even 0 for most industries, except for NACE 20.1, 21, 28.3 and 32.5. LQs were calculated for these industries, but results are only available for between 10 (South) and 34 (Chisinau) industries, which gives a too limited picture to include them in this report. Results are available in the 2021 report on Moldova.

[10] http://www.enterprisesurveys.org

[11] https://www.rcc.int/seeds/results/3/balkan-business-barometer

In a **second step** of the analysis, NACE 1-digit specific size thresholds were used to identify specialized industries. These industries are then added to the industries already identified in the first step of the analysis.

Table 12. Montenegro: differences in average NACE 3-digit industry size across NACE 1-digit industries and specific size thresholds

NACE 1-digit	Industry	Number of 3-digit industries	Average number of employees in 3-digit industry	Share in total number of employees in all industries	NACE 1-digit specific size threshold
A	Agriculture, forestry and fishing	13	194	1.5%	-- *
B	Mining and quarrying	6	304	1.1%	> 0.5%
C	Manufacturing	80	156	7.3%	> 0.3%
D	Electricity, gas, steam and air conditioning supply	3	962	1.7%	> 1.7%
E	Water supply, sewerage, waste management and remediation activities	6	807	2.8%	> 1.4%
F	Construction	9	987	5.2%	> 1.8%
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	21	1,762	21.6%	> 3.2%
H	Transportation and storage	15	652	5.7%	> 1.2%
I	Accommodation and food service activities	7	1,982	8.1%	> 3.5%
J	Information and communication	13	375	2.8%	> 0.7%
K	Financial and insurance activities	10	433	2.5%	-- *
L	Real estate activities	3	499	0.9%	> 0.9%
M	Professional, scientific and technical activities	15	484	4.2%	> 0.9%
N	Administrative and support service activities	19	320	3.5%	> 0.6%
O	Public administration and defence, compulsory social security	3	6,821	11.9%	-- *
P	Education	6	2,202	7.7%	-- *

Q	Human health and social work activities	9	1,239	6.5%	-- *
R	Arts, entertainment and recreation	5	930	2.7%	-- *
S	Other service activities	4	840	2.0%	> 0.4%

** No threshold as there are no EU28 aggregate data for this industry and no degrees of specialisation can be calculated.*

Source: Hollanders, H., Mapping economic, innovation and scientific potential in Montenegro. Report for the Ministry of Science, Montenegro, 2018.

Results

In total 46 industries were identified as specialized industries having an economic potential[12], of which:

- 1 industry in Agriculture, forestry and fishing (NACE A)
- 1 industry in Mining and quarrying (NACE B)
- 7 industries in Manufacturing (NACE C)
- 1 industry in Electricity, gas steam and air conditioning (NACE D)
- 2 industries in Water supply, sewerage, waste management and remediation activities (NACE E)
- 4 industries in Construction (NACE F)
- 2 industries in Wholesale and retail trade, repair of motor vehicles and motorcycles (NACE G)
- 3 industries in Transport and storage (NACE H)
- 3 industries in Accommodation and food service activities (NACE I)
- 4 industries in Information and communication (NACE J)
- 3 industries in Financial and insurance activities (NACE K)
- 1 industry in Real estate activities (NACE L)
- 3 industries in Professional, scientific and technical activities (NACE M)
- 4 industries in Administrative and support service activities (NACE N)
- 2 industries in Education (NACE P)
- 1 industry in Human health and social work activities (NACE Q)
- 2 industries in Arts, entertainment and recreation (NACE R
- 2 industries in Other service activities (NACE S)

The identification of these industries with an economic potential confirmed several of the government's priority sectors[13]: Agriculture, Energy, ICT, Manufacturing, Medicine and health, and Tourism. The results also identified a possible new priority sector: Construction.

---

[12] For a country the size of Montenegro 46 industries is a relatively large numbers, but this long(er) list of industries was decided upon in collaboration with the Montenegrin Ministry of Science.

[13] See the following government reports:

- Miljić, V. and B. Kilibarda (2016), Montenegro's Economy SWOT Analysis, Central Bank of Montenegro Working paper 24
- Ministry of Agriculture and Rural Development (2015), Strategy for the Development of Agriculture and Rural Areas 2015-2020
- Ministry of Economy (2017), Strategic Guidelines for Development of MSME - 2017-2021
- Ministry of Finance (2015), Montenegro Development Directions 2015-2018
- Ministry of Tourism and Environment (2008), Montenegro Tourism Development Strategy to 2020

Assessment

The methodology for mapping the economic potential uses a two-step approach, acknowledging that there is an unequal distribution of the size of NACE 3-digit industries making it less likely for some of these industries to pass the size criterion. In an additional second step customized NACE 1-digit size thresholds are used to allow the identification of a sufficient and representative number of industries across the whole spectrum of NACE 1-digit industries. A similar but slightly different two-step approach was also adopted in the 2017 report on Moldova, making these two reports stand out as having used customized size criteria.

Due a lack of detailed innovation survey data, an analysis of the innovation potential for individual industries was not possible. This would be possible for a possible update of the report as MONSTAT initiated it first pilot innovation survey in 2018. Similar size and specialisation thresholds could be used as those used the mapping of the economic potential.

e) North Macedonia

The study on mapping the economic and innovative potential of North Macedonia was funded by *GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH* and performed by experts from the *National Center for Development of Innovation and Entrepreneurial Learning (NCDIEL)* with the support of an international expert (NCDIEL, 2019).

Data availability

For the economic potential, the following data were made available by the State Statistical Office of the Republic of Macedonia:

- Number of enterprises, NACE Rev.2, 2012-2016
- Employment, NACE Rev.2, 2012-2016
- Wages, NACE Rev.2, 2012-2016
- Turnover, NACE Rev.2, 2012-2016

For the innovation potential, data were made available by the State Statistical Office of the Republic of Macedonia from the 2012-2014 and 2014-2016 innovation survey for 3-digit NACE Revision 2 industries for the following variables:

- Number of firms in the population
- Innovative firms
- Product and/or process, innovative firms only
- Organization and/or marketing innovative firms only
- Number of innovative firms that cooperate with others
- Share of innovative firms that invest in R&D (either in-house or contracted out)

Methodology

For identifying industries with an **economic potential**, a comparison was made between the industries in North Macedonia and those in the EU28. The methodology was similar as that in other studies. An industry is identified as having an economic potential if it passes the following criteria:

- Specialisation > 1.25 for at least 4 years & Size > 0.25% for at least 4 years
- Average wages > 125% of average wages for all industries in North Macedonia for at least 4 years
- Employment growth > 1.5 * employment growth for all industries in North Macedonia
- Average wages growth > 1.25 * average wages growth for all industries in North Macedonia

For identifying industries with an **innovation potential**, for each NACE 3-digit industry first the share of innovative firms was calculated using data from both the 2012-2014 and 2014-2016 innovation survey. For each industry the degree of specialisation was then calculated by dividing this percentage share by that for all industries. An industry is identified as having an innovation potential if:

- Specialisation in 2012-2014 > 1.25 & Specialisation in 2014-2016 > 1.25

Results

Only very few industries passed all selection criteria for mapping the economic potential. The study emphasized the importance of the growth performance for employment and average wages. Industries passing both growth criteria were identified as industries with a (high) economic potential. The analysis identified 10 industries having an economic potential and 16 industries having an innovation potential. Only one industry was identified having both an economic and innovation potential: J62.0 Information technology service activities.

Assessment

The methodology used for mapping the innovation potential is comparable to that used in other studies. But the methodology used for mapping the economic potential is quite different by overemphasising the importance of the growth performance for employment and average wages. This approach did not make sufficient use of the degree of specialisation of industries compared to the EU28 and is the only mapping study not explicitly using specialisation thresholds for the identification of industries with an economic potential. Also, by not using the relative to EU28 specialisation data, the analysis in this study is in fact only using national data and comparisons of industries' performance to that of the economy itself. It therefore 'violates' the recommendations for studies at the economy level to compare the performance of industries to those in the EU or a group of benchmark countries.

f) Albania

The first mapping study for Albania was performed by a team of experts from *Fraunhofer ISI* (Kroll et al., 2020). This study was funded by the European Union, GIZ Germany, and the Swedish International Development Cooperation Agency (SIDA). A new study in 2020 was funded by the Joint Research Centre and performed by an Albanian expert with the support of an international expert (Sinjari and Hollanders, 2021). Both studies suffered from a lack of data severely limiting the level of detail of the analyses.

The approach in the 2020 report tried to follow the common methodology using degrees of specialisation to identify industries with an economic potential.

Data availability

For this study only a limited amount of data was available. Employment data, which are usually used to identify specialised industries, were not available. Instead, data for 2011-2016 on gross value added were used which were made available for NACE 2-digit industries, or combination of NACE 2-digit industries, by the Albanian Institute of Statistics (INSTAT).

No innovation survey or other data were available to map the innovation potential of Albanian industries.

Methodology

An industry is specialised and having an economic potential if the degree of specialisation is above 2. This degree of specialisation has been calculated relative to the EU28.

Results

Data and results are available for a limited number of industries only. Specialised industries include Mining and quarrying (NACE B), Manufacture of textiles, wearing apparel and leather products (NACE 13-15), Construction (NACE F), and Real estate activities.

Assessment

With only a limited amount of economic data, the methodology for mapping the economic potential provides insufficiently detailed results compared to the studies for all other countries. With no innovation survey data, the mapping of the innovation potential was not possible.

The first report on Albania was quickly followed by a second report published in 2021, this time funded by the Joint Research Centre.

Data availability

For mapping the economic potential, detailed industry level data were not available from published data sources. INSTAT made an additional effort by sharing firm-level data from their Structural Business

Statistics by remote access allowing both experts to calculate aggregate firm-level data for NACE 3-digit industries. The following data were calculated for 2010-2018 for NACE Rev. 2 3-digit industries:

- Number of enterprises
- Number of employees
- Wages
- Turnover

For mapping the Innovation potential, the same procedure was followed, with INSTAT sharing firm-level data by remove access from their Innovation activity survey in enterprises for 2017-2019. The following data could be calculated for NACE Rev.2, 1-digit industries:

- Number of enterprises in the population
- Innovative enterprises
- Product and/or process innovative enterprises only
- Share of innovative enterprises that invest in R&D
- Share of enterprises that purchased new technologies not used in the enterprise before

Methodology

For identifying industries with a **current economic potential**, first the following indicators were calculated for every NACE 3-digit industry:

- Average results for Number of employees and Wages for 2011-2018.
- Average wages per employee for 2011-2018.
- A Relative wage index by expressing Average wages per employee relative to average wages per employee for all industries combined.
- Size as the percentage share in total number of employees.
- Degree of specialisation (location quotient) by dividing Size for the industry for Albania by Size for the same industry for the EU27.

An industry has a current economic potential if it passes all criteria:

- Specialisation > 1.25
- Size > 0.1%
- Relative wages > 1.25, average wages in the industry should be more than 25% higher than average wages in Albania.

For identifying industries with an **emerging economic potential**, first the following indicators were calculated for every NACE 3-digit industry:

- Growth or trend performance for Number of employees as the average annual growth rate for the Number of employees between 2011 and 2018.
- Growth or trend performance for Average wages per employee as the average annual growth rate for Average wages per employee between 2011 and 2018.

An industry has an emerging economic potential if it passes all criteria:

- Trend performance for Number of employees > 1.5 * average annual growth rate for all industries combined.
- Trend performance for Average wages per employee > 1.5 * average annual growth rate for all industries combined.
- Size > 0.1%

For identifying industries with an **innovation potential**, detailed industry level data were not available, and the analysis was limited to a descriptive analysis highlighting differences in innovativeness at the NACE 1-digit level.

Results

For the current economic potential, 13 industries passed all criteria, while for the emerging economic potential, 16 industries passed all criteria. In total, 27 industries have a current or an emerging economic potential.

The descriptive analysis of the innovation data for NACE 1-digit industries showed that the highest rates of innovative activities were in Information and communication (NACE J), followed by Financial and insurance activities (NACE K) and Professional, scientific and technical activities (NACE M). Combining the results, suggest that the following industries have both an economic and innovation potential:

- Current economic potential and innovation potential:
  - J60.1 Radio broadcasting.
  - J60.1 Television programming and broadcasting activities.
  - J61.1 Wired telecommunications activities.
- Current and emerging economic potential and innovation potential:
  - J61.3 Satellite telecommunications activities.

Assessment

In its initial stages this study faced the same lack of data as the first report on Albania. But data availability issues were solved by INSTAT by allowing access to firm-level data from the SBS and innovation survey to both experts. This allowed the construction of NACE 3-digit aggregates for the SBS data and NACE 1-digit aggregates for the innovation survey data. Without this support of INSTAT, the study would not have been able to identify industries with an economic and innovation potential. Opening up a remote access facility not only required INSTAT to invest resources, but it also required a confidentiality agreement between INSTAT and both experts preventing any firm-level data to be released by the experts.

The methodology used for mapping the economic potential is comparable to that used in other studies and shows no deficiencies. The methodology used for mapping the innovation potential still suffered from a lack of more detailed industry-level data, but the available data for NACE 1-digit industries did allow a descriptive analysis identifying those industries with above average innovation activities.

g) Georgian region of Imereti

In 2020, funded by the Joint Research Centre and conducted by an international expert, a mapping study developed a coherent methodology for analysing the economic and innovation potential for regions in Georgia (Hollanders, 2020). The study applied this methodology to the region of Imereti.

Data availability[14]

For the mapping of the **economic potential** of Imereti and other Georgian regions, at first, published regional data from the *Statistical Survey of Enterprises*[15] were made available by *Geostat*, the National Statistics Office of Georgia. For all regions, published regional data include NACE Rev. 1.1 one-digit level data for the period 2006 to 2018 for the following variables: Turnover, Production value, Value added, Intermediate consumption, Number of employed persons, Number of employees, Personnel costs, Salary, Purchases of goods and services, Purchases of goods and services for re-sale, and Investments. For the initial mapping, data at more detailed NACE levels were not available.

At a later stage *Geostat* shared firm-level data for 2018 from the *Statistical Survey of Enterprises*, including regional identifiers, to explore if such data could be used to estimate more detailed industry level data. All records in the database include four-digit NACE Rev. 1.1 codes for among others the following variables: Total turnover, Total remuneration paid to employees, Average annual number of persons employed, Average annual number of employees, and Number of hours worked by employees. The more detailed NACE Rev. 1.1 data from this database were not used in the initial mapping analysis for Imereti as data were available for only one year and an email communication with *Geostat* had

[14] The following is a revised and shortened version of the text in Hollanders (2020).

[15] Aggregate results are available at https://www.geostat.ge/en/modules/categories/326/statistical-survey-of-enterprises. The questionnaires for the survey are available at ('Annual Business Survey (legal persons)' and 'Annual Business Survey (individual)'): https://www.geostat.ge/en/modules/categories/558/questionnaires-business-statistics

confirmed that for regions the sample size of the *Statistical Survey of Enterprises* only allowed the use of NACE Rev. 1.1 one-digit data for all regions in Georgia. For Georgia as a country however, data at more detailed NACE Rev. 1.1 levels could be used, including data for 76 industries at NACE Rev. 1.1 two-digit level, 109 industries at NACE Rev. 1.1 three-digit level, and 91 industries at NACE Rev. 1.1 four-digit level.

Further communications with *Geostat* and the Georgian S3 team, revealed that more detailed NACE Rev. 1.1 industry level data from the *Statistical Survey of Enterprises* could also be used for Imereti if for a particular industry data were available for at least 3 enterprises. In addition to the detailed 2018 firm-level data shared earlier, *Geostat* also shared detailed firm-level data for 2013-2017. These detailed data for 6 years (2013-2018) at the NACE Rev. 1.1 three-digit level were used for the final version of the report, replacing the results from the initial mapping.

For mapping the **innovation potential**, *Geostat* made available NACE Rev. 2 data for 2016, 2017 and 2018 from the survey on the *Innovative activity of enterprises*. The survey covers the entire business sector, including non-financial corporations. Anonymous firm-level data for 2016, 2017 and 2018 were available for the following variables (with firms answering either yes or no to each of them):

- Enterprise introduced a product innovation
- Enterprise introduced a process innovation
- Enterprise introduced an organisational innovation
- Enterprise introduced a marketing innovation

Regional identifiers were included in the anonymised datafile, and results could be used if data are available for at least three enterprises. Data from the survey on the *Innovative activity of enterprises* were thus used to analyse the innovation potential of up to NACE Rev. 2 three-digit industries in Imereti if data were available for three or more enterprises.

Methodology

Industries in Imereti have a **current economic potential** if they pass the following criteria:

- Number of firms in industry >= 3
- And for both at least 5 (out of 6) individual years and the average for 2013-2018:
    - Specialisation > 1.25
    - Size > 0.1%
    - Average wages > 0.8 * average wages in the region
    - Average wages > 0.6 * average wages in the same industry in Georgia

Industries in Imereti have an **emerging economic potential** if they pass the following criteria:

- Employees:
    - Slope of the linear regression of 2-year averages between 2014 and 2018 > 0
    - Slope should be statistically significant at 5%
- Average wages:
    - Slope of the linear regression of 2-year averages between 2014 and 2018 > 0
    - Slope should be statistically significant at 5%

For identifying the **innovation potential**, first three indicators have been calculated:

- Size or the percentage share of the number of enterprises in the industry.
- Share of PPMO innovators or the share of enterprises with at least one product, process, marketing, or organisational innovation.
- Share of high-innovation intensive innovators, i.e., those PPMO innovators that introduced at least two different types of innovations (this indicator serves as a proxy for differences in innovation intensities).

Industries have an innovation potential if they qualify the following criteria:

- Confidentiality: data for at least three enterprises.
- Size: the industry should represent at least 0.5% of all enterprises covered in the innovation survey.
- PPMO innovators: the share of PPMO innovators should be above the average for the region.
- High-innovation intensive innovators: the share of high-innovation intensive innovators should be above the average for the region.

Any industry passing all criteria will be identified as having an innovation potential. As the sample sizes of the innovation survey are relatively small[16], in particular at the regional level, the analysis has been using aggregate data for the 2016-2018 period, and not for the individual years in this time period.

Results

The table below shows the number of industries that passed each criterion for having a **current economic potential**. The size criterion was kept low to allow the inclusion of a large number of industries.[17] The threshold of 1.25 for the specialisation criterion has also been used in mapping studies for other countries.[18] Average wages relative to those of the region should be at least 80% of average wages for the whole region and is relatively low but increasing it would significantly reduce the number of industries passing all criteria.[19] Average wages relative to those of the same industry in the country should be at least 60% of average wages for the whole region and is relatively low but increasing it would significantly reduce the number of industries passing all criteria.[20] In total, 15 industries pass all criteria including 7 industries at NACE Rev 1.1 two-digit and 8 industries at NACE Rev 1.1 three-digit, of which 6 NACE Rev 1.1 three-digit industries are included in a higher aggregate NACE Rev 1.1 two-digit industry. The selected industries account for 30% of the average number of employees for 2013-2018.

Table 13. Imereti (Georgia): number of industries passing criteria for current economic potential

Criteria	Threshold	Number of industries
Number of firms	>= 3	86
Specialisation	> 1.25	24
Size	> 0.1%	82
Average wages relative to region	> 80%	37
Average wages relative to industry	> 60%	25
All criteria		15

Source: Hollanders, H., Mapping of smart specialisation in Georgia: economic and innovation potential for Imereti region, Report for the EC Joint Research Centre, 2020.

The table below shows the number of industries that passed each criterion for having an **emerging economic potential**. For 27 industries the number of employees has been increasing and for 39 industries average wages have been increasing. In total, 11 industries passed both criteria, including 5 industries at NACE Rev. 1.1 two-digit and 6 industries at NACE Rev. 1.1 three-digit, of which 2 NACE

[16] For Imereti the database includes results for 277 firms in 2016, 252 firms in 2017, and 337 firms in 2018 (unweighted results). Combining the years, the database includes results for 866 firms for 2016-2018.
[17] Increasing the threshold from 0.1% to 0.25% (0.5%) reduces the number of industries passing the threshold from 82 to 64 (46).
[18] Increasing the specialisation threshold from 1.25 to 1.5 reduces the number of industries passing the threshold from 24 to 21. Decreasing the threshold from 1.25 to 1.0 increases the number of industries passing the threshold from 24 to 31.
[19] Increasing the threshold from 0.8 to 1.0 reduces the number of industries passing it from 37 to 24.
[20] Increasing the threshold from 0.6 to 0.8 reduces the number of industries passing it from 25 to 15.

Rev. 1.1 three-digit industries are included in a higher aggregate NACE Rev. 1.1 industry. The selected industries account for 28% of the average number of employees for 2013-2018. By far the largest share, about 12%, of these employees are working in NACE Rev. 1.1 45 Construction.

Table 14. Imereti (Georgia): number of industries passing criteria for emerging economic potential

Criteria	Threshold	Number of industries
Employees	Significantly increasing	27
Average wages	Significantly increasing	39
Both criteria	--	11

Source: Hollanders, H., Mapping of smart specialisation in Georgia: economic and innovation potential for Imereti region, Report for the EC Joint Research Centre, 2020.

For having an **innovation potential**, in total 94 industries passed the confidentiality threshold, 68 industries passed the size criterion, 62 industries passed the criterion of having an above average share of PPMO innovators, and 45 industries pass the criterion of having an above average share of high innovation-intensive innovators. For Imereti, 19 NACE Rev. 2 two- or three-digit industries passed all criteria including 10 industries in Manufacturing and 9 industries in Services.

Combining the results to identify industries with both an economic and innovation potential is not directly possible as the analyses use data from different NACE classifications with NACE Rev. 2 including industries at a higher level of detail compared to NACE Rev 1.1. A direct comparison of categories between the two NACE classification systems is therefore complex and difficult to realise at the four-digit level, and impossible at the NACE two-digit and three-digit level.[21]

Instead, the study has used a more basic approach by visually matching the names of the industries[22] selected in the economic mapping with the names of the industries selected in the innovation mapping. Only 3 industries would have both an economic and innovation potential:

- NACE Rev. 1.1 20 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials.
- NACE Rev. 1.1 20.1 Sawmilling and planing of wood; impregnation of wood.
- NACE Rev. 1.1 55.1 Hotels.

Assessment

The mapping study on Imereti uses a methodology that is comparable to that used in other studies. The study has benefited from access to detailed firm-level data for both Georgia and Imereti. Support from the national statistical office, *Geostat*, has been crucial. For the economic mapping, firm-level data were shared for six years (2013-2018) of which aggregate NACE three-digit industry data were used for the mapping of the current and emerging economic potential. For the innovation mapping, *Geostat* made available firm-level data for several variables for three years (2016-2018). Given smaller sample sizes, aggregate data were used in the analysis instead of data for the individual years. The main limitation to the use of innovation survey data is that data are not available for all industries as several industries, in particular in agriculture and services, are not included in the sample of the survey.

With both economic and innovation data being available at the NACE three-digit level, in theory the results of the two mapping exercises could be combined. However, the data shared for the economic mapping followed the NACE Rev. 1.1 classification and the data shared for innovation mapping followed the NACE Rev.2 classification. These two industrial classifications are not directly comparable at the three-digit industry level as correspondence tables are available at the four-digit industry level, and

[21] See for more details: Schnabl. Esther and Andrea Zenker, Statistical Classification of Knowledge-Intensive Business Services (KIBS) with NACE Rev. 2, Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, June 2013, evoREG Research Note #25 (http://www.evoreg.eu/docs/files/shno/ResearchNote_25_classificationKIBS_SCE_AZ_9_jb.pdf).

[22] This visual inspection was based on comparing names of industries in the two NACE classifications.

results for the economic and innovation potential could not be linked directly. It is strongly recommended for this and other mapping studies to provide data using the same NACE classification.

h) Regions in Ukraine

The first mapping study for Ukraine started in 2017 and was finalized in 2018. This study focused on mapping the economic and innovation potential of 3 Ukrainian regions (Fiori, 2018). An update of the study followed in 2019 providing results for all Ukrainian regions (Hollanders, 2019). Both studies were performed by different international experts for the EC's Joint Research Centre.

Figure 2. Ukrainian regions with three selected for the analysis (in blue)

Source: Authors.

- *First report for regions in Ukraine*

The first study in 2017 analysed the economic and innovation potential of 3 regions: Kharkiv, Odessa, and Zaporizhia (Fiori, 2018).

Data availability

Data were made available by the State Statistics Service of Ukraine for the following variables for NACE 4-digit industries for mapping the economic potential:

- Number of firms for 2012-2016
- Number of employees for 2012-2016
- Turnover for 2012-2016

Data were made available by the State Statistics Service of Ukraine for the following variables for NACE 4-digit industries for mapping the innovation potential:

- Internal R&D for 2012-2015
- External R&D for 2012-2015
- Equipment innovation for 2012-2015
- External Know how for 2012-2015
- Education for 2012-2015
- Product new for the market for 2012-2015
- Other type of innovation for 2012-2015

Neither the report nor the accompanying data file explains if these variables capture activities (i.e., whether a firm was involved in a certain innovation activity or not) or expenditures.

Methodology

An industry has an economic potential if the degree of specialisation for employment and the degree of specialisation for turnover are equal to or above 3. The report does not explain if these criteria should be met for only the most recent year, the average of all years, or for a minimum number of years.

An industry has an innovation potential if the degree of specialisation is equal to or above 4, but the report does not explain which variables have been used nor for which year(s).

Results

Results are not clearly presented in the report and the accompanying PowerPoint presentations for each of the regions does include more detailed results but not a structured overview. No results will therefore be shown here.

Assessment

The methodology used in this study is incompletely explained, there are different specialisation thresholds mentioned in the report and the accompanying PowerPoint presentations. It is not clear for which years the selection criteria have been applied.

The lack of detail in both the methodology and results in this first study triggered the request for an update of the report in 2019.

- *Second report for regions in Ukraine*

The report on Ukraine was updated in 2019, using data for more years, a coherent methodology, and including additional reports for Kharkiv, Odessa, and Zaporizhia, and statistical analyses for all regions (Hollanders, 2019).

Data availability

For the mapping of the economic potential, the following statistical data were made available by the State Statistical Office of Ukraine for all NACE industries excluding Public administration (NACE O):

- Number of enterprises (units), NACE 3-digit for 2012-2017
- Number of engaged persons (persons), NACE 3-digit for 2012-2017
- Number of employees (persons), NACE 3-digit for 2012-2017
- Volume of sold products, good, services (thousand UAH), NACE 3-digit for 2012-2017
- Salary expenses (thousand UAH), NACE 3-digit for 2012-2017

The available data on engaged persons was not used in the analysis as the data on salary expenses are more closely linked to the number of employees. The difference between engaged persons and employees is the number of self-employed persons. The number of employees is also a more common measure used in other mapping studies.

The preferred level of analysis is at the NACE 3-digit level. For most regions not for all NACE 3-digit industries economic data are available. For several industries data are not disclosed by the State Statistics Service for reasons of confidentiality, e.g., when the number of firms in an industry is too small. For several NACE 2-digit industries data are available for the aggregate industry but not for all NACE 3-digit industries belonging to that NACE 2-digit industry. After a visual inspection of the economic data, several NACE 3-digit industries were excluded from the analysis and instead the higher-level NACE 2-digit industry was used.

For the mapping of the innovation potential, data were made available from the “Survey of innovation activity of enterprises for the period 2012-2014” and the “Survey of innovation activity of enterprises for the period 2014-2016” for the following variables:

- Share of companies that introduced innovative products, NACE B-E 4-digit
- Share of companies that introduced innovation processes, NACE B-E 4-digit
- Share of companies that introduced organisational innovations, NACE B-E 4-digit
- Share of companies that introduced marketing innovation, NACE B-E 4-digit

The mapping of the innovation potential did not include Agriculture (NACE A), Construction (NACE F) and Services (NACE G-S) as innovation survey data were not available.

Methodology

For identifying industries with an **economic potential**, a comparison was made between the industries in each of the regions and the same industry at country level. An industry was identified as having a **current economic potential** if it passed the following criteria:

- Employment:
    - Average degree of specialisation for 2012-2017 > 1.25
    - Average size for 2012-2017 > 0.25%
- Average wages:
    - Average for 2012-2017 > 90% of average wages for all industries in the region
    - Average for 2012-2017 > 90% of average wages in the same industry in Ukraine

An industry was identified as having an **emerging economic potential** if it passes the following criteria:

- Change in employment:
    - Change between 2012 and 2017 > change for all industries in the region
    - Annual changes for the years 2012 to 2017 > annual changes for all industries in the region for at least 3 years
    - Change between 2012 and 2017 > change for same industry in Ukraine
    - Annual changes for the years 2012 to 2017 > annual changes for the same industry in Ukraine for at least 3 years
- Change in average wages:
    - Change between 2012 and 2017 > change for all industries in the region
    - Annual changes for the years 2012 to 2017 > annual changes for all industries in the region for at least 3 years
    - Change between 2012 and 2017 > change for same industry in Ukraine
    - Annual changes for the years 2012 to 2017 > annual changes for the same industry in Ukraine for at least 3 years.

For identifying industries with an **innovation potential**, it would be easiest to use data for the share of firms that introduced at least one type of innovation (product, process, organisational or marketing innovation), but this variable could not be constructed using the available data. Instead, for each of the 4 types of innovation, two degrees of specialisation were calculated:

- Specialisation relative to the region
- Specialisation relative to the industry in Ukraine

An industry has an innovation potential it passes at least 3 of the following criteria:

- in 2014 for at least 2 of the 4 types of innovation the degree of specialisation > 1.25 relative to the region
- in 2014 for at least 2 of the 4 types of innovation the degree of specialisation > 1.25 relative to the aggregate industry in the country
- in 2016 for at least 2 of the 4 types of innovation the degree of specialisation > 1.25 relative to the region
- in 2016 for at least 2 of the 4 types of innovation the degree of specialisation > 1.25 relative to the aggregate industry in the country

A pre-selection of industries was done by only including those industries which were also included in the mapping of the economic analysis.

An industry if selected to have **both an economic and innovation potential** if it passes the selection criteria as follows:

- Employment current OR Employment emerging

AND

- Innovation – at least 3 out of 4 criteria

Results

For each of the regions, the table shows the number industries passing the different selection criteria. For example, for the 3 pilot regions, for Kharkiv 15 industries passed the criteria for having a current economic potential, for Odesa 9 regions passed the criteria for having an emerging innovation potential, and for Zaporizhia 19 industries passed the criteria for having an innovation potential.

For some regions the number of industries is quite small, e.g., for Chernivtsi only one industry passed the criteria for an emerging economic potential and for Lugansk no industry passed the criteria for the innovation potential.

In total, 9 industries have both an economic and innovation potential for Kharkiv. These industries account for almost 10% of total employment. For Odesa, only 5 industries have both an economic and innovation potential. These industries account for less than 3% of total employment. For Zaporizhia, 9 industries have both an economic and innovation potential. These industries account for a substantial share (23.5%) of total employment, mainly due to high employment shares in two industries (Manufacture of basic iron and steel and of ferro-alloys and Manufacture of air and spacecraft and related machinery).

Table 15. Ukrainian regions: number of industries passing different selection criteria

	Economic – current			**Economic – emerging**			**Innovation**				
	Employ-ment	**Wages**	**Both**	**Employ-ment**	**Wages**	**Both**	**2014 region**	**2016 industry**	**2014 region**	**2016 industry**	**At least 3**
3 Pilot regions											
Kharkiv	39	43	15	59	34	21	35	37	37	37	22
Odesa	29	32	13	49	37	9	28	26	25	22	16
Zaporizhia	29	19	15	25	21	7	30	24	29	26	19
Other regions											
Cherkasy	32	29	16	31	16	8	18	10	21	11	6
Chernikiv	34	22	9	24	13	4	14	14	20	14	10
Chernivtsi	40	14	7	15	11	1	10	10	15	10	8
Dnipropetrovsk	26	33	14	41	29	11	36	25	34	34	19
Donetsk	25	23	11	15	19	2	10	11	15	8	5
Ivano-Frankivsk	36	25	13	27	22	5	24	27	29	26	16
Kherson	32	13	9	23	19	4	16	16	14	21	10

	Economic – current			Economic – emerging			Innovation				
	Employ-ment	**Wages**	**Both**	**Employ-ment**	**Wages**	**Both**	**2014 region**	**2016 industry**	**2014 region**	**2016 industry**	**At least 3**
Khmelnytsky	39	23	14	34	13	5	15	10	17	12	7
Kiev city	48	78	33	43	27	6	34	24	45	44	23
Kiev oblast	28	55	14	53	22	6	33	29	33	30	20
Kirovograd	24	15	8	23	15	5	18	17	18	20	11
Lugansk	13	10	4	6	25	4	2	2	9	9	0
Lviv	36	38	10	57	54	18	32	35	28	26	19
Mykolaiv	22	16	8	25	24	9	17	19	16	17	9
Poltava	23	10	13	18	11	4	15	11	23	20	11
Rivne	30	17	12	27	22	7	18	16	20	20	14
Sumy	21	19	12	327	20	8	14	14	15	15	10
Ternopil	33	16	10	30	19	3	11	11	17	19	11
Vinnytsia	29	35	18	32	22	8	23	26	19	17	13
Volyn	34	21	10	23	17	7	11	12	13	10	7
Zakarpattia	26	13	9	18	5	3	10	8	13	9	7
Zhytomyr	44	31	22	25	17	6	24	20	31	27	18

Source: Authors.

<u>Assessment</u>

The 2019 update provides a coherent analysis for mapping the economic potential for regions in Ukraine. It combines both a static and a dynamic analysis to identify industries that already have a higher economic potential and those that are expected to increase their economic potential if relatively high growth rates continue. The methodology is comparable to that used in other studies and it provides a relatively large number of industries as input to the EDP process.

For mapping the innovation potential, the use of detailed innovation survey helps to identify industries which have both an economic and innovation potential, but the analysis suffers from a serious drawback that data are only available for NACE industries B to E, thereby excluding Construction and Services. Additional data would be needed to provide an analysis of the innovation potential of all industries, e.g., by increasing the sample of the national innovation survey to include more industries.

i) Kosovo[*]

The report on Kosovo* was funded by the Joint Research Centre and performed by an international expert (Hollanders, 2021b), with data being made available by the Kosovo Agency of Statistics.

[*] This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

Data availability

For mapping the economic potential, the following annual economic data for 2010-2020 were made available by the Kosovo Agency of Statistics:

- Number of active enterprises for 580 NACE 4-digit industries
- Turnover for 585 NACE 4-digit industries
- Number of employees for 578 NACE 4-digit industries
- Wages or salaries for 578 NACE 4-digit industries

An analysis using data for NACE 4-digit industries however would have been too detailed and the economic data were therefore aggregated to the NACE 3-digit level including 264 NACE 3-digit industries. Data for a particular industry and year were only included in the analysis if for that industry and year data were available for all four variables.

For mapping the innovation potential, no innovation survey data are available. Instead, the report used data from the following sources:

- Data on innovation activities from the 2016 to 2021 annual editions of the Balkan Business Barometer
- Data on innovation activities from the 2013 and 2019 edition of the World Bank Enterprise Survey
- Data of goods exports for 2012-2020 for 3-digit SITC product groups from the Kosovo Agency of Statistics

Data of goods exports have been recalculated into export data by industry using a correspondence table from Eurostat linking 5-digit SITC Rev. 3 product groups to 4-digit ISIC Rev. 3 industries. ISIC, the International Standard Industrial Classification of All Economic Activities, is very similar but not identical to the NACE classification. As export data are available at the 3-digit SITC level, an ad-hoc approach was used in the report to link these data to ISIC/NACE 3-digit industries (cf. **Box 2**).

Methodology

Whereas previous studies (from a chronological perspective) compared the industries in an economy with those in the EU, for this study a different approach was taken for selecting the **benchmark economy**. Instead of comparing Kosovo* to the EU, which includes countries of different economic size and different economic structures, it was decided to compare Kosovo* with a selected number of neighbouring economies. Using data from Eurostat, a comparison was made with Bosnia and Herzegovina, Croatia, North Macedonia, Bulgaria and Greece. For Albania and Montenegro no data were available from Eurostat and for Serbia data were not available for enough years.

Industries in Kosovo* have a **current economic potential** if they pass the following criteria for at 7 (out of 9) years:

- Employment: Specialisation > 1.1
- Employment: Size > 0.1%
- Turnover: Specialisation > 1.1
- Turnover: Size > 0.1%
- Average wages > 0.8 * average wages in Kosovo*
- Average wages > 0.5 * average wages in benchmark countries

Box 2. Methodology for matching export data by SITC product groups to NACE industries

The following methodology can be used to match 3-digit SITC product groups to 3-digit ISIC industries:

• First, each SITC 5-digit product group to ISIC 4-digit industry correspondence pair was transformed into a corresponding SITC 3-digit product group to ISIC 3-digit industry correspondence pair by shortening the 5-digit SITC codes to their first 3 digits and the 4-digit ISIC codes to their first 3 digits. E.g., the correspondence pair SITC 27231 – ISIC 1421 was transformed into SITC 272 – ISIC 142.

• Second, the SITC-ISIC 3-digit correspondence pair was reversed into an ISIC-SITC 3-digit correspondence pair.

• Third, for each unique SITC-ISIC 3-digit correspondence pair the number of times such a pair occurs in the reversed correspondence table was counted. E.g., the table below shows the number of occurrences for all ISIC-SITC correspondence pairs including ISIC 011 (Meat of bovine animals, fresh, chilled or frozen).

ISIC	SITC	ISIC-SITC	# Occurrences	ISIC	SITC	ISIC-SITC	# Occurrences
11	41	11-41	2	11	75	11-75	12
11	42	11-42	1	11	81	11-81	3
11	43	11-43	1	11	121	11-121	2
11	44	11-44	2	11	222	11-222	9
11	45	11-45	7	11	223	11-223	5
11	54	11-54	23	11	231	11-231	4
11	57	11-57	29	11	263	11-263	1
11	71	11-71	1	11	264	11-264	1
11	72	11-72	1	11	265	11-265	6
11	74	11-74	3	11	292	11-292	11

• Fourth, the contribution of each 3-digit SITC product group to an ISIC 3-digit industry was 100% if there was only one unique combination, otherwise the contribution of SITC xxx to ISIC yyy was equal to the percentage share calculated as the number of times the correspondence pair SITC xxx to ISIC yyy occurs of all correspondence pairs including SITC xxx. E.g., there are 4 occurrences of SITC-ISIC 231-11 and 1 occurrence of SITC-ISIC 231-20. SITC 231 was thus included in 5 occurrences in total. 80% of exports in SITC 231 were then allocated to ISIC 11 and 20% of exports in SITC 231 to ISIC 20.

Source: Hollanders, H., Quantitative mapping for Smart Specialisation in Kosovo, Report for the EC Joint Research Centre, 2021.

Industries in Kosovo* have an **emerging economic potential** if they pass at least four of the following criteria:

- Employment share: The trend for 2012-2020 should be positive and at least 1.5 times as high as the trend for total employment for Kosovo*
- Specialisation in employment: The trend for 2012-2018 should be positive and statistically significant
- Turnover share: The trend for 2012-2020 should be positive and at least 1.5 times as high as the trend for total turnover for Kosovo*
- Specialisation in turnover: The trend for 2012-2018 should be positive and statistically significant
- Average wages relative to Kosovo*: The trend for 2012-2020 should be positive and statistically significant
- Average wages relative to the same industry in the selected benchmark countries: The trend for 2012-2018 should be higher than the trend for total average wages relative to total average wages in the benchmark countries

Trends are defined as the ratio between the slope of a linear regression over the period 2012-2020 and are statistically significant if the adjusted R^2 is at least 0.70.

For identifying the **innovation potential**, a different approach had to be used given the fact that detailed innovation survey data were not available. Data from the Balkan Business Barometer are available for

NACE 1-digit industries and shares of product and process innovators can be compared with those in the benchmark economies.

For export performance, an industry has a current goods export specialisation if the degree of specialisation is above 1.5 for at least 7 out of 9 years from 2012 to 2020. An industry has an emerging goods export specialisation if there is a positive and significant trend in the degree of specialisation. Trends are defined as the ratio between the slope of a linear regression over the period 2012-2020 and the average value for the degree of specialisation for the same years. The trend should be statistically significant with the adjusted R^2 being at least 0.70.

Results

The analysis for the current economic potential showed that 108 industries passed the size criterion, and 47 industries passed the specialisation criterion for employment, 84 industries passed the size criterion, and 34 industries passed the specialisation criterion for turnover, 80 industries passed the criterion for average wages relative to those in Kosovo*, and 66 industries passed the criterion for average wages relative to those in the same industry in the benchmark economies. Only 9 industries passed all 6 criteria and would have a current economic potential.

The analysis for the emerging economic potential showed that 84 industries passed the trend criterion for the size of employment, 44 industries passed the trend criterion for the specialisation of employment, 65 industries passed the trend criterion for the size of turnover, 29 industries passed the trend criterion for the specialisation of turnover, 48 industries passed the trend criterion for average wages relative to those in Kosovo*, and 22 industries passed the trend criterion for average wages relative to those in the same industry in the benchmark economies. In total 18 industries passed at least 4 criteria and would have an emerging economic potential.

For the innovation potential, only a comparative analysis was possible using the data on innovation activities from the Balkan Business Barometer and World Bank Enterprise Survey.

Using data from the Balkan Business Barometer, an industry has a significant amount of innovation activities if results are available for at least 3 surveys and if average shares for product and process innovators are at least equal to 80% of the average share of all industries combined. Significant innovation activities for product innovators are observed in: Manufacturing (NACE C), Wholesale and retail trade; repair of motor vehicles and motorcycles (NACE G), Accommodation and food service activities (NACE I), and Information and communication (NACE J). Significant innovation activities for process innovators are observed in: Manufacturing (NACE C), Construction (NACE F), Wholesale and retail trade; repair of motor vehicles and motorcycles (NACE G), and Accommodation and food service activities (NACE I).

Data from the World Bank Enterprise Survey are available for a limited number of NACE 2-digit industries. The 2013 Enterprise Survey included four questions on innovation: 1) During the last three years, has this establishment introduced new or significantly improved products or services, 2) During the last three years, has this establishment introduced any new or significantly improved methods for the production or supply of products or services, 3) During the last three years, has this establishment introduced any new or significantly improved organizational or management practices or structures, and 4) During the last three years, has this establishment introduced new or significantly improved marketing methods? A new variable was constructed by combining all questions to identify enterprises having introduced at least one type of innovation. Overall, 71% of enterprises introduced at least one type of innovation.

The 2019 Enterprise Survey included two questions on innovation: 1) During the last three years, has this establishment introduced new or improved products or services, and 2) During the last three years, has this establishment introduced any new or improved process? A new variable was constructed by combining both questions to identify enterprises having introduced at least one type of innovation. Overall, 29% of enterprises introduced at least one type of innovation.

Industries have a high share of firm with innovation activities if results are available for both Enterprise Surveys and if the average share of enterprises with innovation activities is higher than the average share for all industries for at least one Enterprise Survey. In total 11 NACE 2-digit industries have high shares of innovation activities and an innovation potential.

A more detailed analysis was possible using the recalculated SITC export data to exports by industries. In total 10 industries have a current goods export specialisation, and 12 industries have an emerging goods export specialisation. It is assumed that these industries have an innovation potential as these industries are competitive on the international market.

The report combines the results of the analysis of the economic and innovation potential, but results are not discussed in this study.

Assessment

The mapping of the economic potential is comparable to that used in other studies by using time series data for employment, turnover and average wages to identify current and emerging specialised industries in Kosovo* compared to a select number of benchmark economies. There are no clear improvements needed to the applied methodology as the analysis is at a sufficiently detailed level.

For the mapping of the innovation potential the study suffers from the lack of detailed industry data from a national innovation survey. Instead, a more fragmented approach was used combining aggregate data on innovation activities from the Balkan Business Barometer and World Bank Enterprise Survey. The drawback of these two surveys is that sample sizes are too small to be able to have representative results for (all) NACE 2-digit industries. The only solution would be to run a full innovation survey in Kosovo* comparable to the Community Innovation Survey used in most European countries. A second option is to run a more limited innovation survey using only a few questions to identify firms with different innovation activities, e.g., following the Non-response survey used in those European countries where the CIS is not mandatory. Responses to Question 1 could be used to calculate shares of enterprises that introduced an innovation, where question 1a corresponds to product innovators and questions 1b to 1h to business process innovators. Questions 2a and 2b could be used to calculate shares of enterprises that were involved in R&D activities. Enterprises could also have innovation activities that are incomplete. Question 3 asks enterprises about such activities, where question 3a asks about innovation activities that were not yet completed, question 3b about innovation activities that have been abandoned or postponed (suspended), and question 3c asks about completed innovation activities that have not yet resulted in the introduction of a product or business process innovation.

The study is one of the few that makes use of detailed data on exports by SITC product groups by transforming these data into exports by NACE industries. Industries with high export performance can be considered as innovative as these industries are able to compete with foreign industries. The drawback is that export data cover exports of goods only. Detailed data on services exports are not available. The use of export data by industries is highly recommended for future mapping studies.

Box 3. A short survey to collect data on innovation activities

Definitions: An innovation is the introduction of a new or improved product or business process, or combination thereof, that differs significantly from your enterprises' previous products or business processes, and which has been introduced on the market or brought into use by your enterprise.

A product is introduced when it is made available for use by its intended users. A business process is introduced when it is brought into actual use in your enterprises' operations.

The minimum requirement for an innovation is that the product or business process must have one or more characteristics that are significantly different from those contained in the products or business processes previously offered by or used by your enterprise. These characteristics must be relevant to your enterprise or to external users.

An innovation needs only be new or significantly improved for your enterprise. It could have been originally developed or used by other enterprises or organisations.

Question 1. During the three years 20XX to 20XX, did your enterprise introduce any of the following types of innovations?

		Yes	No
a.	New or improved goods or services	☐	☐
b.	New or improved methods for producing goods or providing services	☐	☐
c.	New or improved logistics, delivery or distribution methods for your inputs, goods, or services	☐	☐
d.	New or improved methods for information processing or communication	☐	☐
e.	New or improved methods for accounting or other administrative procedures	☐	☐
f.	New or improved business practices for organising procedures or external relations	☐	☐
g.	New or improved methods of organising work responsibility, decision making or human resource management	☐	☐
h.	New or improved marketing methods for promotion, packaging, pricing, product placement or after sales services	☐	☐

Definition: Research and Development (R&D) comprises creative and systematic work undertaken to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.

Question 2a. At some time during the three years 20XX to 20XX, did your enterprise perform its own R&D to develop or improve goods, services, or business processes?

Yes	☐
No	☐

Question 2b. Did your enterprise also contract out R&D to other enterprises or to public or private research organisations?

Yes	☐
No	☐

Question 3. Did your enterprise have any innovation activities that did not lead to any innovation introduced during the years 20XX to 20XX:

•	•	• Yes	• No
• a.	• Ongoing innovation activities at the end of 20XX, i.e., the innovation activity was not completed at the end of 20XX and will be continued in the following year	• ☐	• ☐
• b.	• Abandoned or suspended innovation activities, i.e., the innovation activity was discontinued during 20XX and 20XX either with plans to resume the activity later ('suspended activity') or without such plans ('abandoned activity')	• ☐	• ☐
• c.	• Completed innovation activities, i.e., the innovation activity was completed at the end of 20XX but has not resulted in the introduction of an innovation by the end of 20XX, e.g., because it concerned only a part of a new or improved product or business process, or because the introduction is foreseen to happen later	• ☐	• ☐

Source: Hollanders, H., Quantitative mapping for Smart Specialisation in Kosovo, Report for the EC Joint Research Centre, 2021

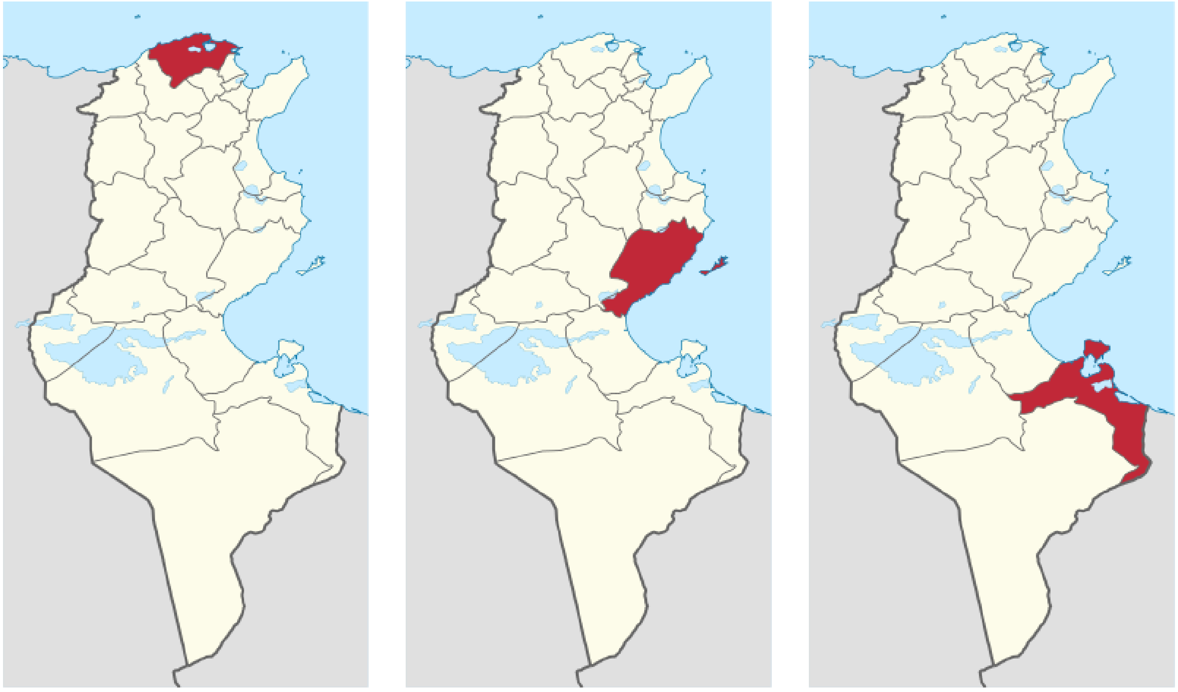
j) Tunisia

Two studies were performed on Tunisia, both funded by the Joint Research Centre. The first study focused on 3 pilot regions in Tunisia (Hollanders, 2021a), the second study compared Tunisia with a selected group of European Mediterranean countries (Hollanders and Tolias, 2022).

- *Report on 3 pilot regions in Tunisia*

The first study focused on 3 pilot governates or regions, Bizerte, Sfax, and Medenine. For each region industries with an economic potential were identified using a methodology comparable to that used in other studies.

Figure 3. Three pilot regions of Tunisia



Bizerte is the northernmost governorate of Tunisia with a population of almost 590,000.

Sfax is along the east coast of Tunisia with a population of almost 1,000,000.

Medenine encloses the south-easternmost coastal strip with a population of just above 500,000.

Source: Tunisia Regional Data Portal (http://regions.ins.tn/)

Data availability

Data for this study were provided by the National Institute of Statistics (Institut National de la Statistique) (INS), Institut National de la Normalisation et de la Propriété Industrielle (INNORPI), and the Agency for Promotion of Industry and Innovation (APII).

The analysis of the **economic potential** was done using economic data on employment and wages. The following economic data, for NACE 3-digit industries, were made available by the INS:

- Number of enterprises for 2012-2019
- Employment for 2012-2019
- Total wages for 2012-2019

Data on employment and total wages were used to calculate Average wages for 2012-2019 for all NACE 3-digit industries.

For mapping the **innovation potential**, innovation survey data by region were not available. Only a limited amount of regional data for patents and designs was available for mapping the innovation potential. The following data were available by INNORPI:

- Total number of patents for 2017-2019
- Patents for 8 IPC sections for 2017-2019
- Total number of designs for 2017-2019

Methodology

An industry in a region has a **current economic potential** if it passes all of the following criteria for at least 6 (out of 8) years:

- Specialisation > 1.25

- Size > 0.1%
- Average wages > average wages in the region
- Average wages > 80% of average in the same industry in Tunisia

An industry in a region has an **emerging economic potential** if it passes all of the following criteria:[23]

- Employment: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive
- Specialisation: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive
- Average wages: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive

For identifying industries with an **innovation potential**, the available data are not sufficient to analyse industries at the NACE 3-digit level.

Results

Combining the different selection criteria results in the selection of 10 industries with a current economic potential in Bizerte accounting for 24% of total employment in the region, 23 industries in Sfax accounting for 23% of total employment, and 9 industries in Medenine accounting for 31% of total employment.

Table 16. Tunisian pilot regions: number of industries with current economic potential

	Size	Specialisation	Average wages relative to region	Average wages relative to same industry in Tunisia	Total number of selected industries
Bizerte	70	21	37	49	10
Sfax	96	64	56	85	23
Medenine	76	51	24	35	9

Source: Hollanders, H., Mapping of the economic and innovation potential of three regions in Tunisia, Report for the EC Joint Research Centre, 2021.

Combining the different selection criteria results in the selection of 22 industries with an emerging economic potential in Bizerte, 33 industries in Sfax, and 24 industries in Medenine. The change in average wages is the criterion, which is least strict as, on average, more than 100 industries passed this criterion whereas for the change in employment and change in specialisation, on average, about 50 industries passed each criterion.

Table 17. Tunisian pilot regions: number of industries with emerging economic potential

	Change in employment	Change in specialisation	Change in average wages	Total number of selected industries
Bizerte	48	46	95	22
Sfax	68	53	128	33

[23] Similar criteria could be used for Average wages relative to the region and Average wages relative to the same industry in Tunisia but adding these would have resulted in a too small number of industries with an emerging economic potential.

Medenine	45	39	87	24

Source: Hollanders, H., Mapping of the economic and innovation potential of three regions in Tunisia, Report for the EC Joint Research Centre, 2021.

Assessment

The report provides an analysis of the economic potential using a methodology comparable to that used in other studies. But due to a lack of detailed data, an analysis of the innovation potential at the same industry level (NACE 3-digit) was not possible. Data availability is already challenging at the country level in Tunisia and requiring that country level data are also made available for 24 governates is reducing data availability even more. Among others for this reason, an update of the report was foreseen for 2022 focusing on Tunisia, and not on the regions within the country.

- *Report on Tunisia*

The 2022 report (Hollanders and Tolias, 2022) analyses Tunisia at the country level by comparing its industries to several EU Member States that also heavily rely on the primary sector including Croatia, Cyprus, Greece, Malta and Portugal.

Data availability

Economic data were made available by the National Institute of Statistics (Institut National de la Statistique: INS) for NACE Rev.2 3-digit industries for 2012-2019 for the following variables:

- Number of enterprises
- Employment
- Nominal wages in Tunisian Dinar

Average wages in PPP Dollars were calculated by combining the data on employment and nominal wages in Tunisian Dinar with data from the World Bank's World Development Indicators on Purchasing Power Parities (PPPs) between the Tunisian Dinar and Dollar.

Data for EU Member States for NACE. Rev.2 4-digit industries in the business sector were extracted from Eurostat's *Annual detailed enterprise statistics*. This database does not include data for Agriculture, forestry, and fishing (NACE A) and public services (NACE O-U) and these industries are therefore not included in the specialisation analysis.

Data on innovation activities were extracted from the World Bank Enterprise Survey. For Tunisia firm-level data are available from the 2013 and 2020 edition of the Enterprise Survey including identifiers for different industries. Data from the 2020 edition were compared with the most recent data for the benchmark countries: 2018 data for Greece, and 2019 data for Croatia, Cyprus, Malta and Portugal.

Data on **product exports** were used to assess the competitiveness of industries. These data were extracted from UN Comtrade for 2012-2019 for Tunisia and the benchmark countries for SITC rev. 4 commodity groups. Data by commodity groups were converted into export data by NACE Rev. 1.1 industries using a correspondence table from WITS[24].

Patent data can be used as an alternative for measuring innovation activities. Data on PCT publications that originated in the country for 4-digit IPC classes were extracted for Tunisia and the benchmark countries from the World Intellectual Property Office (WIPO). Patent classes have a current potential if, for two time periods 2010-2014 and 2015-2019, they pass the following criteria:

- Specialisation > 1.25
- Size > 2.5%

Patent classes have an emerging potential if specialisation is below 1.25 for 2010-2014 and above 1.25 for 2015-2019. Results for patent classes are not discussed in this report but are available in Hollanders and Tolias (2022). Patent publications by NACE industries were then calculated by matching NACE

[24] http://wits.worldbank.org/data/public/concordance/Concordance_S3_to_NC.zip

industries to those patent classes with a current or emerging scientific potential using a correspondence table from Eurostat matching IPC 4-digit codes to NACE Rev. 2 3-digit codes[25].

Trademark data were also used as another, but imperfect, proxy for innovation activities. Data were extracted for 2010-2019 from WIPO for EUIPO-registered trademarks (WIPO indicator 4: total registrations by class-direct and via the Madrid system, counting by filing office (EUIPO) and applicant's origin (Tunisia and the benchmark countries)). Trademarks are classified by NICE class and, similar as for patents, Trademark classes have a current potential if, for two time periods 2010-2014 and 2015-2019, they pass the following criteria:

- Specialisation > 1.25
- Size > 2.5%

Trademark classes have an emerging potential if specialisation is below 1.25 for 2010-2014 and above 1.25 for 2015-2019. Results for trademark classes are not discussed in this report but are available in Hollanders and Tolias (2022). No formal correspondence table between NICE and NACE classes is available, instead a correspondence table issued by the Spanish Patent and Trademark office[26] was used to match the results by NICE class to industries.

Methodology

An industry in Tunisia has a **current economic potential** if it passes all of the following criteria for at least 6 (out of 8) years:

- Specialisation > 1.25
- Size > 0.1%
- Average wages > average wages in Tunisia
- Average wages in PPP dollars > 40% of average in the benchmark countries

In addition, also industries that pass only three criteria but that do perform very strongly on at least two criteria, have a current economic potential. An industry performs very strongly for a particular criterion if it passes the following criteria for at least 6 (out of 8) years and for the average for the 2012-2019 period:

- Specialisation > 2
- Size > 2%
- Average wages > 150 of average wages in Tunisia
- Average wages in PPP dollars > 60% of average in the benchmark countries

An industry in a region has an **emerging economic potential** if it passes all of the following criteria:

- Employment: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive
- Specialisation: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive
- Average wages relative to those in Tunisia: Annual changes between two years should be positive for at least 5 (out of 7) years and the change between 2012 and 2019 should be positive

For identifying industries with an **innovation potential**, a new variable was constructed to identify innovative firms using responses to two questions in the Enterprise Survey:

- During the last three years, has this establishment introduced new or improved products or services?
- During the last three years, has this establishment introduced any new or improved process?

[25] https://ec.europa.eu/eurostat/ramon/documents/IPC_NACE2_Version2_0_20150630.pdf

[26] http://www.oepm.es/export/sites/oepm/comun/documentos_relacionados/varios_todas_modalidades/Concordancia_CNAE_NIZA.pdf

Industries have an innovation potential using Enterprise Survey data if they pass the following criterion:

- Specialisation > 1.25

Industries have a **competitive potential** if they pass the following criteria for at least 7 (out of 8) years using data on product exports by industry:

- Specialisation > 1.25
- Size > 0.1%

Results

In total 40 industries have a current economic potential. Of these, 22 industries have passed all 4 selection criteria and 18 industries have passed 3 selection criteria and perform very strongly on at least 2 of these.

In total 11 industries pass all criteria for having an emerging economic potential, but 6 industries were already identified as having a current economic potential. Therefore, 5 industries were identified as having an emerging economic potential.

Using data from the World Bank Enterprise Survey, 7 NACE Rev 1.1 industries have a specialisation above 1.25 and thus an innovation potential. Using data on product exports, 23 NACE Rev. 1.1 industries have an innovation potential. Based on patent data, 5 NACE Rev. 2 industries are associated to IPC classes in which Tunisia has a current or emerging specialisation. Based on trademark data, 14 NACE Rev. 2 industries are associated to NICE trademark classes in which Tunisia has a current or emerging specialisation.

Assessment

The analysis of the economic potential follows a methodology comparable to that used in other studies, but a new feature is the addition of a second set of industries that do not pass all the selection criteria but that do pass almost all of which at least two at higher thresholds. This new feature allows to include industries that are highly specialised and/or have high average wages, but that fail to pass all the selection criteria.

This study is, as most other studies, hampered by a lack of data to analyse the innovation potential as there are no detailed data from an innovation survey comparable to the CIS used in most European countries. Instead, the study makes the best possible use of the data that are available by combining results using 4 types of data: data on innovative firms from the World Bank Enterprise Survey, and data on product exports, patent publications, and trademarks, where results based on patent, product, and trademark statistical classifications have been recalculated or linked to NACE industries. The approach followed in this study using data from different data sources to make up for the non-availability of detailed national innovation survey data, is highly recommended for future mapping studies.

k) Bosnia and Herzegovina

The study on Bosnia and Herzegovina (BiH) by Galic and Hollanders (2022) and funded by the Joint Research Centre, focused on 12 administrative units. Data were collected from the Agency for Statistics of BiH, the Institute for Statistics of Federation of BiH, Institute for Statistics of Republika Srpska (RS) and the Branch Office of Agency for Statistics of Bosnia and Herzegovina in Brcko District and Institute for Intellectual Property of Bosnia and Herzegovina.

Table 18. Administrative units in Bosnia and Herzegovina: descriptive statistics

Administrative unit	Area (km2)	Population	Population density
Una Sana Canton	4,125	266,500	65
Posavina Canton	325	41,000	126
Canton Tuzla	2,649	437,600	165
Zenica Doboj Canton	3,344	357,300	107

Administrative unit	Area (km2)	Population	Population density
Bosna Podrinje Canto	505	22,800	45
Central Bosnia Canton	3,189	249,100	78
Herzegovina Neretva Canton	4,404	216,200	49
West Herzegovina Canton	1,362	93,200	68
Canton Sarajevo	1,277	421,600	330
Canton 10	4,934	79,400	16
Republika Srpska	24,857	1,136,300	47
Brcko district	493	82,700	189

Source: Galic, M., and H. Hollanders, Final Report on the Quantitative analysis for Smart Specialisation in Bosnia and Herzegovina, Report for the EC Joint Research Centre, 2022.

Data availability

For the mapping of the economic potential, data for 2017-2020 at the regional level are available from the Structural Business Statistics for NACE 3-digit industries for the following variables:

- Employment
- Value added

Data are also available for 2010-2020 for product exports by SITC product classes which are used to measure the competitiveness of industries. As results were not calculated for NACE industries, they will not be discussed in this report.

Regional data for mapping the innovation potential are not available. Instead, the report uses the classification of high-tech and knowledge-intensive industries from Eurostat[27] to differentiate between what could be more innovative and less innovative industries.

Methodology

An industry has an economic potential if it passes the following criteria for at least 3 (out of 4) years for both employment and value added:

- Specialisation > 1.25
- Size > 0.1%

Results

For almost all administrative units of Bosnia and Herzegovina, the identified industries with an economic potential include activities in industries which are considered – by international standards – as less technology intensive and less knowledge intensive. Only in Canton Sarajevo, there is a high share of industries that are considered as knowledge intensive. Bosnia and Herzegovina and its administrative units cover mostly industries in low and medium-low manufacturing and less knowledge-intensive services. There is a lack of industries which are technology or knowledge intensive.

Assessment

The report on Bosnia and Herzegovina suffers from a lack of data which is partly due to analysing too many administrative units in a country with a total population of about 3.4 million. The average size of each of the 12 administrative units is less than 300,000, which is far below the average population size

[27] https://ec.europa.eu/Eurostat/cache/metadata/en/htec_esms.htm

of other studies analysing the economic and innovation potential at the level of regions[28]. Only economic data are available for employment and value added but not for wages, and the methodology for mapping the economic potential could not include performance on average wages. Data on innovation for the 12 administrative units was completely missing. Results of the analysis are therefore much less detailed (and useful for policy) compared to most other studies reviewed in this report.

- ***Western Balkan economies***

The Joint Research Centre funded two studies on the Western Balkan economies, both performed by experts from Maastricht University (Hollanders et al. (2018), Hollanders and Merkelbach (2020)).

Data availability

With no harmonized data available for all six Western Balkan economies (Eurostat provides detailed industry-level data for Bosnia and Herzegovina and North Macedonia and to a limited extent also for Serbia), an no time to request harmonized data using the same definitions and statistical classifications from the different national statistical offices, industry data at the NACE 3-digit level were calculated based on firm-level data from the Orbis database for turnover and number of employees. As Orbis data contain many missing values, data were imputed in three steps. First, averages were used between observed data points for which information is missing in-between. Second, the last observed values were carried forward for each firm in each economy provided the firm was still economically active. Third, the first observed values were carried backwards until the firm's date of incorporation. For both reports, data availability improved substantially after the imputation of missing data. E.g., for Albania the share of missing data for employment declined from 83% to 37% in the 2018 report and from 76% to 20% in the 2020 report.

Data on innovation activities were not available for both studies.

Table 19. Western Balkan economies: data availability before and after imputation

Economy	**Variable**	**2018 report - # Obser-vations**	**%-share missing observations**		**2020 report - # Obser-vations**	**%-share missing observations**	
			Before imputatio n	**After imputatio n**		**Before imputatio n**	**After imputatio n**
Albania	Employment	3,330	82.9%	37.2%	3,650	76.0%	28.9%
	Turnover		72.4%	9.0%		67.3%	25.6%
Bosnia and Herzegovina	Employment	149,900	35.8%	1.9%	222,070	28.5%	10.8%
	Turnover		34.7%	1.4%		25.9%	9.9%
Kosovo*	Employment	3,160	83.6%	43.2%	383,770	43.7%	16.6%
	Turnover		68.6%	27.2%		89.7%	34.1%
Montenegro	Employment	41,400	71.0%	20.2%	120,820	46.7%	17.7%
	Turnover		70.8%	19.4%		46.7%	17.7%
	Employment	136,010	37.6%	8.0%	659,910	42.6%	16.2%

[28] The average population size of the 5 regions in Moldova was about 850,000, for the 4 regions in Serbia almost 1.8 million, and for the 25 regions in Ukraine almost 1.7 million.

North Macedonia	Turnover		54.3%	6.5%		41.0%	15.6%
Serbia	Employment	321,550	37.9%	20.5%	1,950,260	67.5%	25.7%
	Turnover		37.9%	15.1%		67.5%	25.8%

Sources: Hollanders, H., G. Ndubuisi, and S. Owusu, Mapping of the economic potential in Western Balkan economies, Study for the European Commission's Joint Research Centre, 2018 & Hollanders, H., and I. Merkelbach, Mapping of the economic potential in Western Balkan economies, Study for the European Commission, DG Joint Research Centre, 2020.

Methodology

For the 2018 report the following methodology was used to identify industries with a current or emerging economic potential. For all industries the following indicators were calculated for both employment and turnover:

- average degree of specialisation for 2010-2017
- average relative size in national economy for 2010-2017
- rate of change between degree of specialisation in 2010 and 2017
- rate of change between relative size in national economy between 2010 and 2017

Comparisons are made with the aggregate industry data for all Western Balkan economies combined. An industry has a current economic potential if:

- Specialisation for employment > 1.5
- Size for employment > 0.5%
- Specialisation for turnover > 1.5
- Size for turnover > 0.5%

Different thresholds were used for determining industries with an emerging economic potential to ensure comparable numbers of such industries for each Western Balkan economy. An industry has an emerging economic potential if:

- For Albania
    - Change in specialisation > 0
    - Change in size > 0
- For North Macedonia and Serbia:
    - Change in specialisation > 0.05
    - Change in size > 0.00025
- For Montenegro:
    - Change in specialisation > 0.05
    - Change in size > 0.00025
- For Bosnia and Herzegovina and Kosovo*:
    - Change in specialisation > 0.1
    - Change in size > 0.0005

For the 2020 report the following methodology was used to identify industries with a current or emerging economic potential. For all industries the following indicators were calculated for both employment and turnover:

- average degree of specialisation for 2012-2019
- average relative size in national economy for 2012-2019

- rate of change between degree of specialisation in 2012 and 2019
- rate of change between relative size in national economy between 2012 and 2019

Comparisons are made with the aggregate industry data for all Western Balkan economies combined. An industry has a current economic potential if:

- Specialisation for employment > 1.5 (1.25 for Serbia)
- Size for employment > 0.5%
- Specialisation for turnover > 1.5 (1.25 for Serbia)
- Size for turnover > 0.5%

Different thresholds were used for determining industries with an emerging economic potential to ensure comparable numbers of such industries for each economy. An industry has an emerging economic potential if (for all economies):

- Change in specialisation > 0
- Change in size > 0

Results

For all economies in both reports there are several industries that have been identified as having a current economic potential. But there are also differences in the results between both reports, which are mainly due to an update of the data as the methodologies in both reports were almost identical (only for Serbia a lower criterion was used for specialisation).

For industries with an emerging economic potential there are only a few industries identified in both reports. A possible explanation could be the use of different time periods in both reports, 2010-2017 versus 2012-2019. As there is an overlap of six years between both time periods, results for the mapping of industries with a current economic potential are expected to be relatively similar. But for the mapping of industries with an emerging economic potential, the shift in two years for both the start and end year used for calculating rates of change, is expected to have a substantial impact on the comparability of the results due to differences in where economies are in their business cycle. Another explanation is that for all economies, except Albania, lower thresholds were used for the criteria for identifying industries with an emerging economic potential. These lower thresholds were used as using the same thresholds in the 2020 report as those used in the 2018 report, would have resulted in only a small number of industries with an emerging economic potential.

Assessment

The methodology used for identifying industries with a current or an emerging economic potential are comparable to those used in other reports. Both reports use comparable economic data for all six economies, but there are differences in overall data availability between these economies, and there will also be (substantial) differences in data availability for NACE 3-digit industries. For the mapping of an emerging economic potential, an alternative methodology which stresses less the start and end year might improve the comparability of results between both reports, e.g., using trend rates based on linear regressions which put more emphasis on the years between the start and end year of the time periods considered in both reports.

A concern though is the use of aggregated firm-level data from Orbis, as there are substantial differences in the number of firms for which Orbis provides data between economies and between industries within the same economy. Comparisons between Orbis aggregated data and industry aggregates using official statistics, show that there can be large differences between both for the same industry. Results based on aggregate Orbis data will thus be different from those based on official statistics and it is recommended to use official statistics if available.

l) ***Eastern Partnership countries***

Bigas et al. (2022) analyse the economic and innovation potential of 6 Eastern Partnership countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine. The study was funded by the Joint Research Centre.

Data availability

For the analysis of the economic potential industry level data for turnover, number of employees, and wages were constructed by aggregating firm-level data included in the Orbis database. Orbis data however contain a lot of missing values and missing values were imputed using the same approach as in the two studies on the Western Balkan economies. First, the average was taken between observed data points for which information is missing in-between. Second, the last observed value for each firm was carried forward provided the enterprise was still economically active. Third, the first observed value was carried backward until the firm's date of incorporation.

Despite imputing missing data, data availability for Armenia, Azerbaijan and Georgia, was extremely low with data being available for only a few firms. These countries were therefore not included in the analysis using Orbis data.

Table 20. Data availability for the Eastern Partnership countries using the Orbis data

- Number of enterprises for which at least one data observation is available for 2011-2019 -

Country	Employees	Turnover	Wages	Employees & Turnover	Employees & Wages	Turnover & Wages	Employees & Turnover & Wages
Armenia	15	15	3	15	3	3	3
Azerbaijan	12	12	0	12	0	0	0
Belarus	34	34	1	34	1	1	1
Georgia	180,442	180,442	0	180,442	0	0	0
Moldova	45,882	45,882	1	45,882	1	1	1
Ukraine	411,779	411,779	30,993	411,779	30,993	30,993	30,993

Source: Bigas et al. (2022)

The report also uses data from industries in Manufacturing only from the UNIDO Industrial Statistics Database at the NACE 4-digit level (INDSTAT4)[29], which includes disaggregated economic data for the Manufacturing sector from 1990 onwards. Belarus was not included in this analysis due to insufficient data. For the other 5 countries NACE 3-digit industries in Manufacturing were identified using a similar methodology as used for the aggregated Orbis data. Results are not discussed here as the analysis is a partial analysis only, but the use of UNIDO data is an alternative option which could be used if data from national data sources or Orbis are not available.

The report also uses data on goods exports from the UN Comtrade database[30]. This database includes data on export values for 278 3-digit commodity groups using the Standard International Trade Classification (SITC) Rev. 4 classification[31]. These export data were not detailed enough to recalculate them to NACE industries (cf. the studies on Kosovo* and Tunisia). The study identified SITC 3-digit commodity groups with a current or emerging specialisation, but results are not discussed here. Similar for the data on exports services which were also extracted from the UN Comtrade database as these were not detailed enough and could not be recalculated to NACE industries.

For mapping the innovation potential, detailed industry level data from national innovation surveys were not available and there was insufficient time to collect these data from those countries which had conducted at least one innovation survey. Instead, the study used more highly aggregated data from the most recent World Bank Enterprise Survey, including results for 2018 for Belarus, 2019 for

[29] UNIDO (2020), INDSTAT 4 Industrial Statistics Database at 3- and 4-digit level of ISIC Revision 3 and 4. Vienna. Available from http://stat.unido.org.

[30] https://comtrade.un.org/

[31] https://unstats.un.org/unsd/trade/sitcrev4.htm

Azerbaijan, Georgia, Moldova and Ukraine, and 2020 for Armenia. Firm-level data were extracted from the Enterprise Survey data portal[32] and aggregated to NACE 2-digit industries.

Methodology

Using aggregate Orbis data for Georgia, Moldova, and Ukraine, an industry has a **current economic potential** if:

- Number of employees:
  - Specialisation > 1.5 for at least 6 years for 2012-2019
  - Size > 0.1% for at least 6 years for 2012-2019
- Turnover:
  - Specialisation > 1.5 for at least 6 years for 2012-2019
  - Size > 0.1% for at least 6 years for 2012-2019

An industry has an **emerging economic potential** if:

- Change in specialisation for number of employees is positive for at least 2 of the following 3 time periods: between 2012 and 2015, between 2014 and 2017, and between 2016 and 2019
- Change in specialisation for turnover is positive for at least 2 of the following 3 time periods: between 2012 and 2015, between 2014 and 2017, and between 2016 and 2019

For the mapping of the **innovation potential**, results from two questions from the Enterprise Survey were merged into one variable measuring if a firm had introduced at least one type of innovation:

- H.1 During the last three years, has this establishment introduced new or improved products or services?
- H.5 During the last three years, has this establishment introduced any new or improved process? These include:
  - methods of manufacturing products or offering services
  - logistics, delivery, or distribution methods for inputs, products, or services
  - or supporting activities for processes

For each NACE 2-digit industry degrees of specialisation were calculated compared to the unweighted average of the Eastern Partnership countries and industries were identified to have an innovation potential if the degree of specialisation was above 1.25.

Results

For Georgia, 28 industries have been identified as having a current economic strength and 35 industries have been identified as having an emerging economic strength. For Moldova, 15 industries have been identified as having a current economic strength and 16 industries have been identified as having an emerging economic strength. For Ukraine, 35 industries have been identified as having a current economic strength and 30 industries have been identified as having an emerging economic strength.

For most countries, only a limited number of industries were identified to have an innovation potential. This is a direct result of the limited sample size in the Enterprise Survey restricting the number of industries for which aggregate results could be calculated. Also, that there are only two industries with an innovation potential in Ukraine, is a direct result of the fact that the number of enterprises is much higher in Ukraine than in the other countries with a more equal distribution of enterprises across the different industries making it more difficult for an industry in Ukraine to have a specialisation above 1.25.

Assessment

[32] https://login.enterprisesurveys.org/content/sites/financeandprivatesector/en/signin.html

This study has done well in bringing together data from different sources, including firm-level data from Orbis and the World Bank Enterprise Survey, industry-level data for the Manufacturing sector from UNIDO, and export data for both goods and services from the UN.

The methodologies used for mapping industries with an economic and innovation potential are comparable to those used in other studies. Unfortunately, data availability using Orbis data was too poor to include all countries in the analysis and export data were not detailed enough to recalculate them from products (SITC) and services (EBOPS) classifications to NACE industries.

The report has made it very clear that data availability is the main issue (and challenge) for multi-country studies where harmonized data for all countries are not available from a single data source (like data for all Member States from Eurostat). Also, the lack of detailed and comparable data from innovation surveys has restricted the level of detail of the mapping of the innovation potential, as only more highly aggregated data could be used from the World Bank Enterprise Survey.

Combining the results of the economic and innovation analysis was also hampered by the difference in detail of the results, with economic results available for NACE 3-digit industries and innovation results available for NACE 2-digit industries, or even a combination of NACE 2-digit industries.

Given the lack of detailed and comparable data, one may question the policy use of the results of this multi-country study (and also those for the Western Balkan economies). But the study is very useful for highlighting the need for more and better data and clearly shows what could be done if such data were available.

3 Lessons learned and recommendations on improvements of the mapping methodology for scientific potential

3.1 Overview of mapping experiences

The table below provides a summary of the science mapping experiences discussed in detail in this section. All of them were financially supported by the European Commission and were implemented by teams of international experts. Two of them were complex and large studies (Western Balkans Science & Technology Panorama and Eastern Partnership mapping), while the rest have been smaller-scope studies. The Eastern Partnership is included in this report as it extends the methodology applied for Western Balkans and it also covers Armenia. Thus, we can readily assess the results of two different mapping approaches (purely taxonomical and topic modelling) and discuss the relevant advantages and disadvantages.

Below is the summary of the methodological approaches in the best possible manner, based on the published reports (Duran, et al., 2022; Bigas, et al., 2022)). However, some aspects of the implementation cannot be fully reconstructed. The interested reader is referred to the authors of these reports for further details.

Table 21. Summary of the mapping experiences discussed in this report

Project	***Duration***	***Data sources***	***Methods***
1. Western Balkans Science & Technology Panorama	First version: Nov 2018-Mar 2019 Updated version: Nov 2021-Feb 2022	PUB: Scopus PAT: EPO DOCDB TM: EUIPO PRJ: Cordis & Creative Europe …	Taxonomical & Topic Modeling Co-occurrence analysis (institutions, economies)
2. Eastern Partnership	2020-2021	PUB: Scopus PAT: EPO DOCDB TM: EUIPO PRJ: Cordis & Creative Europe	Topic Modeling Co-occurrence analysis (institutions, countries)
3. Tunisian Regions	Nov 2020-Mar 2021	PUB: Scopus PAT: WIPO, PATSTAT TM: WIPO, EUIPO, WBDB	Taxonomical STI Maps
4. Tunisia	Dec 2021-Apr 2022	PUB: Web of Knowledge PAT: WIPO TM: WIPO	Taxonomical Co-occurrence analysis (countries)
5. Armenia	Dec 2020-Apr 2021	PUB: Web of Knowledge PAT: WIPO, PATSTAT TM: WIPO, EUIPO, WBDB	Taxonomical STI Maps Co-occurrence analysis (countries)

Source: Authors.

m) Western Balkans

The first version of the Science and Technology Panorama of the Western Balkans (S&T PANORAMA) was finalised in February 2019 covering a ten-year period of observation between 2008 and 2017 (Duran, Fuster, Massucci, Quinquillà, & Tolias, 2019). An updated version was delivered in October 2022 (Duran, et al., 2022) covering an observation period from 2011 to 2020. Both versions aimed at:

1. The identification of possible preliminary specialisation domains for the Western Balkans and its six composing economies at a fine grain.
2. The relevant distribution and specialisation indicators by domain.
3. The identification and the characterization of relevant actors, from each Western Balkan economy, for each domain.
4. The mapping of collaboration patterns among these actors.
5. The identification of key foreign partners.
6. The provision of insight to support strategic and operational decision-making in economic specialisation and public support to private R&D investment, and in science and innovation policies and capacity-building.

Data and data availability

The analysis was based exclusively on international data sources, thus there were no issues regarding data provision by national sources. The S&T PANORAMA used the most granular data available, i.e., each single record for each Western Balkan economy's publication, patent, project and trademark in the covered period was used to extract quantitative and semantic information. Science and innovation activities and ecosystems in the whole Western Balkan region and for each Western Balkan economy were explored through the following sources:

- 95 373 internationally indexed scientific publications (from Elsevier's Scopus® database)
- 675 competitive research and innovation European projects (from European Union research and innovation framework programmes FP7 and Horizon 2020)
- 355 competitive creative, cultural and media European projects (from Creative Europe)
- 2933 international patents[33] from the European Patent Office's DOCDB database via the Open Patent Services (OPS)
- 25 387 European Union trademarks and registered Community designs registry (EUIPO)
- Cluster organisations, present in the Cluster Organisations Mapping Tool of the European Cluster Collaboration Network
- Science parks and areas of innovation belonging to the International Association of Science Parks and Areas of Innovation (IASP).

Methodology

By the time the first S&T PANORAMA was drafted, no preliminary specialisation domains or preliminary mapping of scientific potentials towards economic potentials were available. Therefore, the methodology entailed an initial first step to identify the *candidate* domains of interest and to classify all outputs within those domains using standard specialisation analysis (calculation of location quotients (Schubert & Braun, 1986) and benchmarking) using EU-27 as the reference[34] and the data sources' original taxonomies[35]. In all cases, the specialisation threshold was set at LQ = 1.50. This analysis resulted into the identification of the Subject Areas, or IPC two-level codes, or Nice Classes that were continuous, emerging, declining or non-existing specialisations over two consecutive 5-year intervals.

[33] For international patent applications, the 2010-2019 time window was analysed, due to the 18-months filing-publication delay and in order to mitigate as much as possible missing data due to delays in communications from national patent offices to the European Patent Office, from where patent data were collected.

[34] In the first version of the S&T Panorama, specialization analysis was also performed using the Western Balkan economies as the reference. The results did not appear in the report since they were inconclusive due to the dominance of Serbia's output in all datasets used.

[35] 26 Scopus Subject Areas, two-level International Patent Classification (IPC) codes for patents and 45 Nice Classification codes for trademarks.

In the second step, specialisation topics were automatically extracted from the text fields of the records describing science and innovation activities and results, with no recourse to any preliminary specialisation domain. Topic Modelling, a machine learning text mining technique, was implemented in this work through the Latent Dirichlet Allocation (LDA) algorithm. Topics were extracted from the titles, the abstracts, and the associated keywords, i.e., the common text elements across all data sources. Each topic consists of an ordered and weighted list of all the words that appear in the text elements. Since this method links each publication, project and patent with a certain weight[36] to any given topic, in a continuous space, the result of this effort does not consist in a categorical classification: a publication can strongly belong to several topics, and weakly to others. In turn, all words in the text corpus may belong to several topics, with different strengths (from a negligible to a strong relationship).

The third step comprised a qualitative manual alignment between the specialisation areas obtained at the first step, the topics obtained at the second step and the current & emerging strengths identified in a report prepared by UNU-MERIT for the JRC and was published in JRC's report 'Supporting an Innovation Agenda for the Western Balkans: Tools and Methodologies' (European Commission, DG Joint Research Centre, 2018). The step enabled the definition of ad-hoc research and innovation domains[37] that were used throughout the analysis. In the revised version of the S&T PANORAMA (Duran, et al., 2022), a second, complementary Topic Modelling process was applied to provide more granularity to the research and innovation domains. A Deep Learning framework. the BERT[38] algorithm, using a version implemented by the Allen Institute of AI, which is trained on a massive dataset of scholarly publications - SPECTER[39]. This model translates entire short texts into vectors that may be treated by a machine. Semantically, similar texts will have close positions in the vector space and thus form thematic clusters. Using the K-Means[40] clustering algorithm we can cluster the vector space where the texts are represented according to their thematic content and obtain a list of thematics representing the whole corpus of texts. At the end of the process, each document is clustered into one topic, out of the 60 that emerged from the analysis. Human intervention was needed to label the 60 topics.

To allow further exploitation of the findings uncovered and to enable connection with economic activities, the research and innovation domains defined at the third step were manually mapped onto NACE Rev.2 two-digit sectors in qualitative fashion, using the JRC-developed eye@RIS3 tool: Each identified domain has been manually looked for and matched to the S3 priorities listed in the tool. All connected NACE codes were then collected, and, for each domain, we retained the most frequent ones.

Results

Descriptive statistics were discussed for all data sources and timeseries trends were presented for each type of outputs (scientific publications, patents, trademarks, projects). Specialisation analysis was conducted for the Western Balkans area and for each one of the six economies covering scientific publications, patents and trademarks. The graph below shows the specialisation analysis for scientific publications of the aggregate Western Balkans area. The location quotients were calculated over two five-year time windows with the EU-27 as the baseline. In this figure, the top-right quadrant (green discs; LQ >= 1 for both axes) is linked to persistent specialisation Subject Areas, the top-left quadrant (blue discs; LQ>=1 on the y-axis) encloses emerging areas of specialisation, the bottom-left quadrant (red discs; LQ < 1 for both axes) is related with those areas of persistent low specialisation and finally, the

---

[36] The weight is computed by numerically maximising a mathematical model, based on the Dirichlet probability distribution. In a nutshell, the model assumes that every document in the corpus is associated with a weight ranging from 0 to 1 to each of the topics. Weights close to zero denote a weak linkage between a given document and a certain topic, while weights close to one indicate a strong connection between a document and a topic. Working with topics and weights requires technical analyses that are beyond the scope of the present work, therefore topics and weights are not discussed in this document.

[37] The topics used were: Better societies-governance, culture, education and the economy, Electric and Electronic Technologies, Energy, Environmental Sciences and Industries, Food, Health & Wellbeing, Heavy Machinery, ICT, Process industries and materials, and Transport.

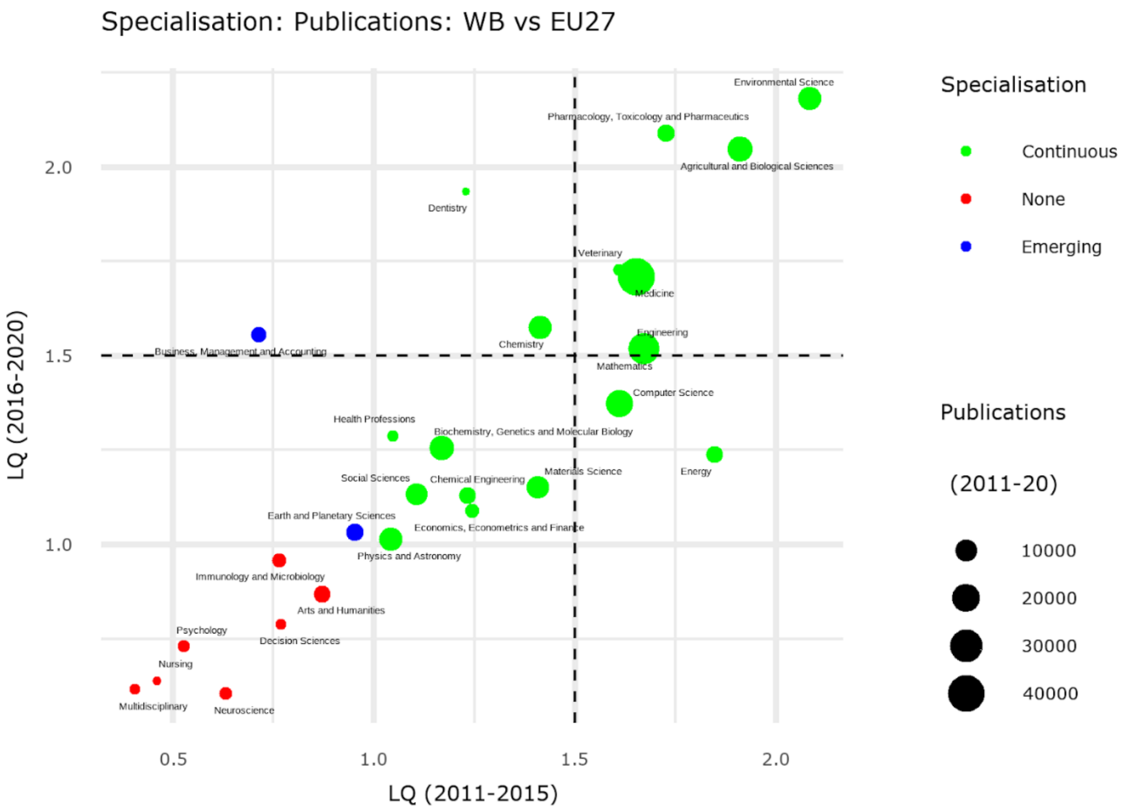
[38] Jacob Devlin, Ming-Wei Chang, Kenton Lee, Kristina Toutanova. "BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding". NAACL-HLT (1) 2019: 4171-4186

[39] Cohan, A., Feldman, S., Beltagy, I., Downey, D., & Weld, D. S. "Specter: Document-level representation learning using citation-informed transformers". 2020

[40] J. Macqueen: "Some methods for classification and analysis of multivariate observations. Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability". Volume 1: Statistics Vol. 5.1, 1. 1967

bottom-right (purple discs; LQ < 1 on the x axis) features the declining specialisation areas. Two dotted lines are included, demarcating the specialisation thresholds of LQ = 1.5 for both periods. Everything above these lines can be considered as an area of strong specialisation in both 5-year intervals. Finally, the size of discs corresponds to the number of publications for each label. This type of visualisation was used consistently throughout the S&T PANORAMA reports.

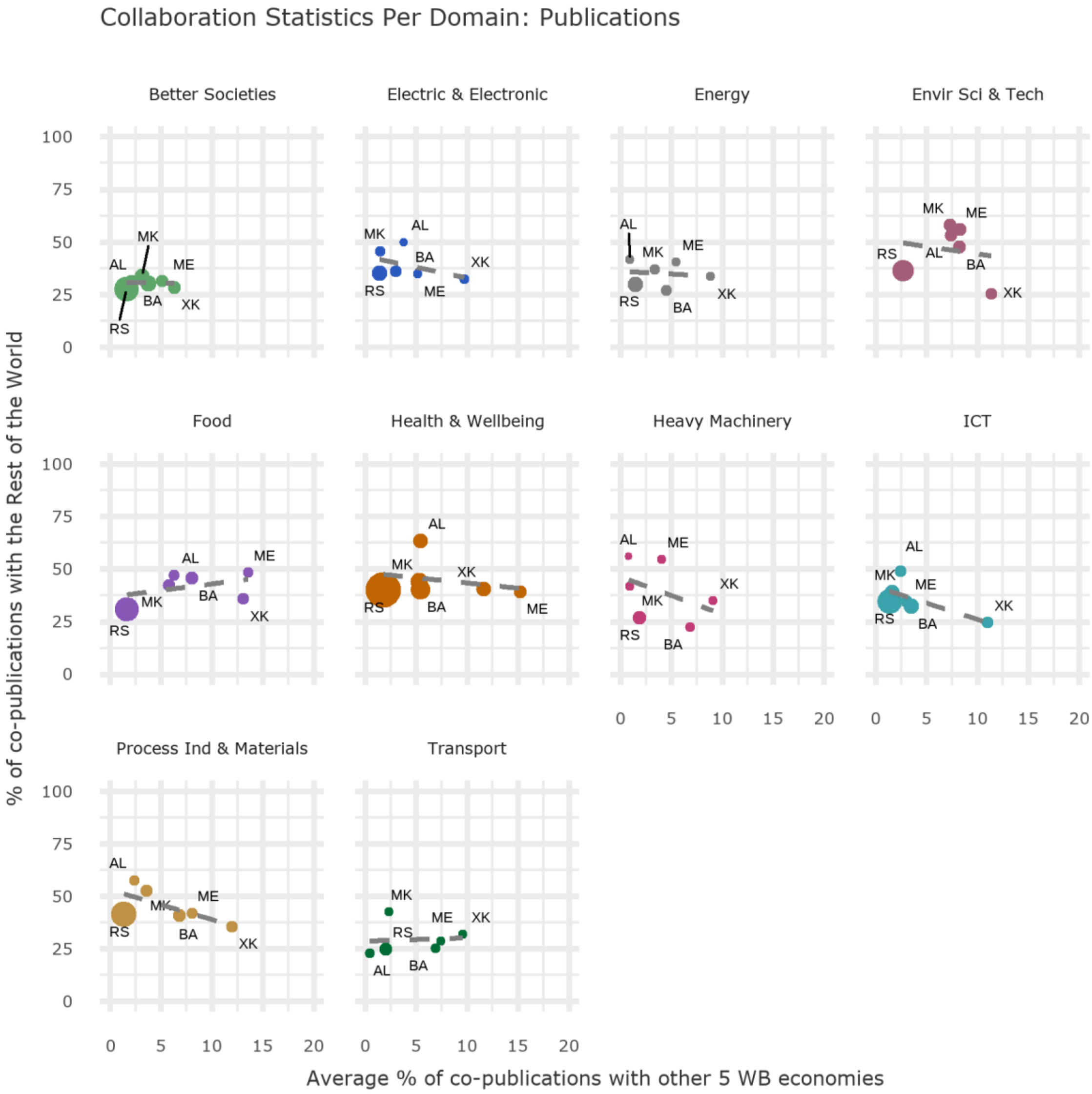
Figure 4. Specialisation trends for all subject areas calculated over two 5-year periods



Source: *Scopus.*

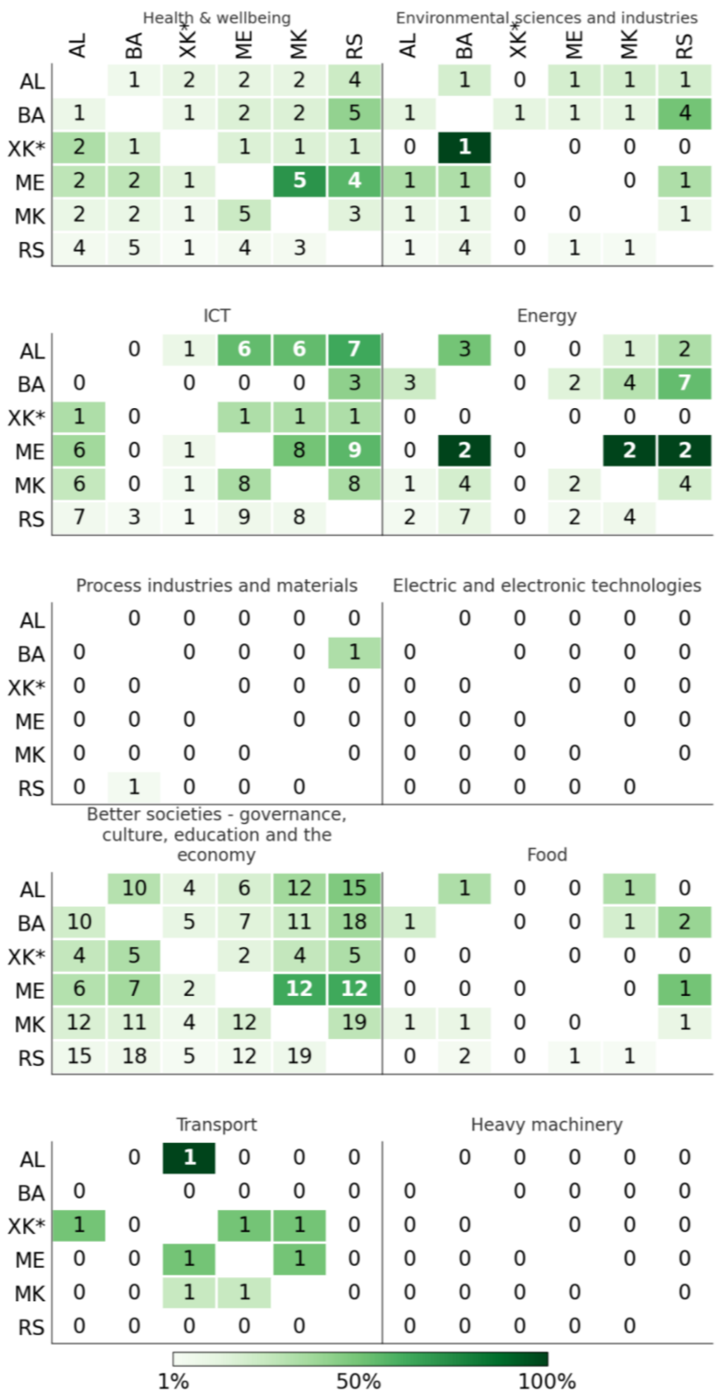
Intra- and extra-regional collaboration statistics were calculated for scientific publications and research projects to identify the intensity of collaborations within the Western Balkan region and the key partners in neighbouring countries and the rest of the world. The graph below presents the ten preliminary domains that were identified by exploiting the results of Topic Modelling, and the temporal evolution of the percentage of records associated with them.

Figure 5. Collaboration intensity per domain in terms of publications



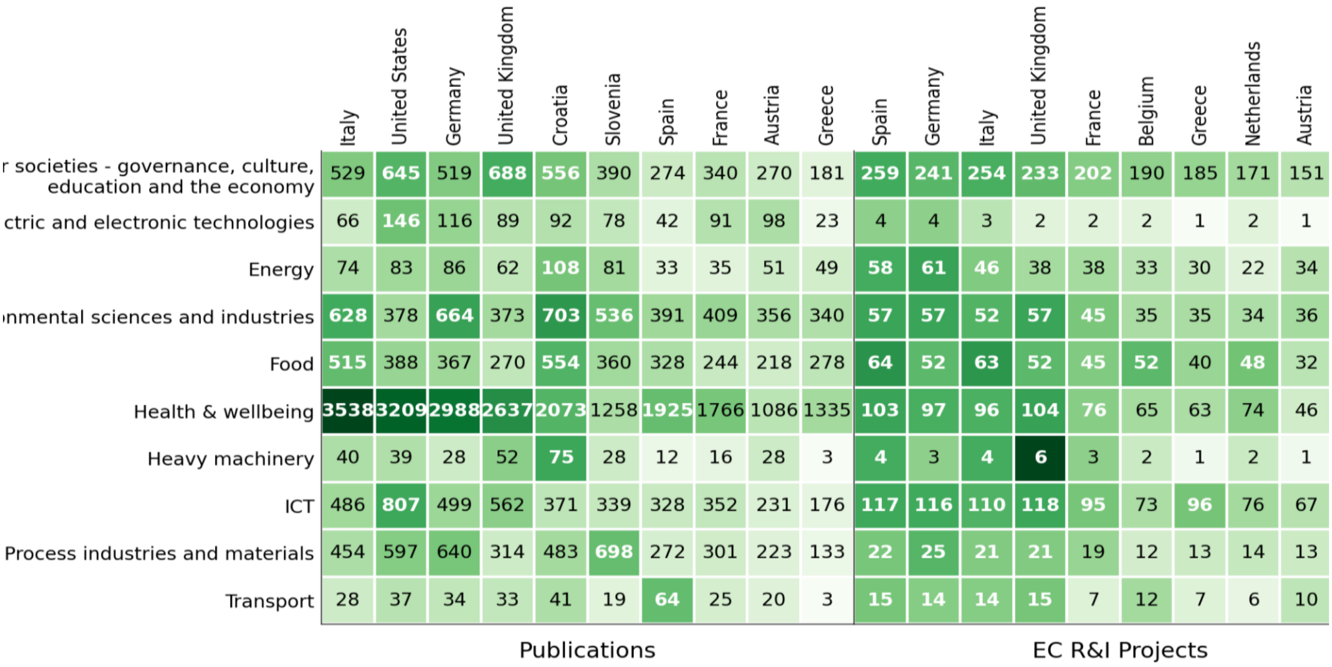
Source: S&T Panorama.

Figure 6. Number of projects in collaboration across WB economies, by domain and pair of economies



Source: S&T Panorama.

Figure 7. Aggregate WB number of internationally co-authored publications and collaborative projects, by domain and with top-10 countries per source



Source: S&T Panorama.

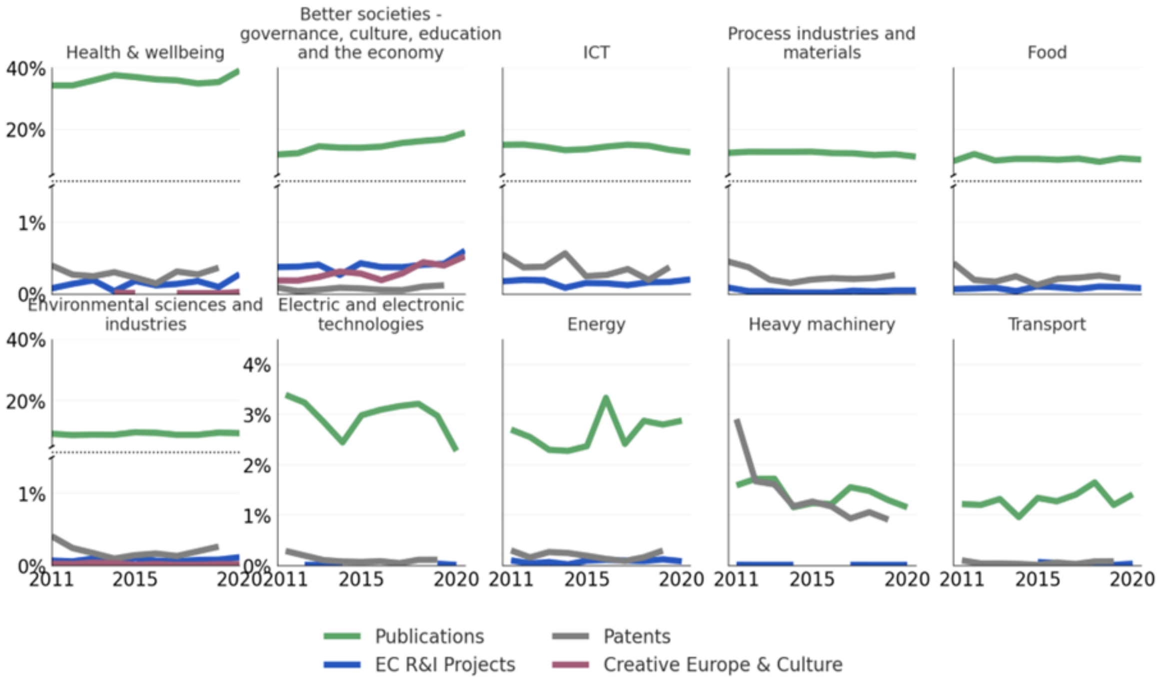
Table 22. Overview of semantic content of each preliminary domain identified in the S&T Panorama

Domain	Keywords
Better societies - governance, culture, education and the economy	management, education, development, system, business, economic, urban, process, European, social, learning, new, model, analysis, data, systems, waste, countries, tourism, market
Electric and electronic technologies	power, voltage, system, electrochemical, distribution, current, electrode, carbon, systems, network, grid, circuit, voltammetry, electric, energy, fault, control, method, electrical, quality
Energy	energy, power, system, solar, gas, renewable, thermal, consumption, systems, heat, combustion, production, plants, efficiency, plant, electricity, oil, heating, fuel, sources
Environmental sciences and industries	water, species, river, soil, quality, air, pollution, samples, plant, new, forest, climate, heavy, filter, natural, different, environmental, system, metals, metal
Food	acid, food, plant, activity, oil, production, antioxidant, different, content, fruit, phenolic, species, quality, essential, wheat, total, products, cultivars, meat, extracts
Health & wellbeing	disease, cancer, patients, health, clinical, cell, treatment, human, study, syndrome, heart, risk, chronic, coronary, care, therapy, blood, stress, diseases, system

Heavy machinery	motor, power, system, magnetic, wheel, gear, rotor, induction, machine, control, speed, drive, je, energy, vibration, turbine, analysis, systems, electrical, electric
ICT	system, network, systems, data, networks, power, sensor, control, wireless, image, algorithm, model, neural, time, mobile, software, analysis, different, signal, language
Process industries and materials	properties, process, steel, surface, materials, different, ray, sup, laser, structure, thermal, analysis, metal, alloy, mechanical, acid, material, composite, nanoparticles
Transport	traffic, network, road, system, networks, vehicle, transport, railway, safety, routing, simulation, control, vehicles, mesh, wireless, air, model, urban, accidents, rail

Source: Authors.

Figure 8. Percentage of records in each preliminary specialisation domain, segmented by source, showing the temporal evolution of their relative importance in the Western Balkan region



Source: Authors.

The table below presents a second level taxonomy based on the results of the application of a Deep Learning Topic Modelling framework on the same data set. The most statistically representative topics are represented and those without significance are considered as "Others". In the case of the Food domain, the aligned topics are related with agroindustry, agriculture and the more research focused topics related with medicine and plant sciences.

Table 23. Results of the application of BERT in the Food domain

Food		
Topic	**Documents (n)**	**Top 20 Words**

Food industry - Animal husbandry and health (30)	2176	food meat milk production products quality acid dairy flour cows wheat content fatty protein cheese feed different samples composition fat
Bio-based, medicinal and food chemistry (36)	2145	antioxidant activity phenolic oil extracts essential compounds total oils content plant extract antimicrobial species composition medicinal properties extraction bioactive acid
Agriculture (51)	1773	plant soil fruit cultivars wheat seed plants yield production maize different quality crop species growth grain cultivar content crops root
Agriculture and plant science (22)	873	species plant cultivars genetic plants fruit breeding wheat maize yield sunflower pollen traits genotypes seed populations production diversity grapevine different
Others	4451	

Source: Authors.

Table 24. Mapping of the domains

	NACE		Strength	
Domain	**code**	**Description**	**C**	**E**
Better societies - governance, culture, education and the economy	I.55	Accommodation	X	
	J.63	Information service activities		
	K.64	Financial service activities, except insurance and pension funding	X	
	P.85	Education		
	R.90	Creative, arts and entertainment activities		
	R.91	Libraries, archives, museums and other cultural activities		
	R.93	Sports activities and amusement and recreation activities		
Electric and electronic technologies	C.26	Computer, electronic and optical products		
	C.27	Electrical equipment		
	C.28	Machinery and equipment n.e.c.		
	J.61	Telecommunications	X	
Energy	D.35	Electricity, gas, steam and air conditioning supply	X	X
Environmental sciences and industries	A.02	Forestry and logging	X	
	E.36	Water collection, treatment and supply		
	E.37	Sewerage		
	E.38	Waste collection, treatment and disposal activities; materials recovery		

	M.72	Scientific research and development		
Food	A.01	Crop and animal production, hunting and related service activities	X	
	A.03	Fishing and aquaculture	X	
	C.10	Food products		X
	C.11	Beverages		
Health & wellbeing	C.21	Basic pharmaceutical products and pharmaceutical preparations		
	J.63	Information service activities		
	Q.86	Human health activities	X	
	Q.87	Residential care activities		
Heavy machinery	C.28	Machinery and equipment n.e.c.		
	M.72	Scientific research and development		
ICT	J.61	Telecommunications	X	
	J.62	Computer programming, consultancy and related activities	X	
	J.63	Information service activities		
Process industries and materials	C.20	Chemicals and chemical products		
	C.28	Machinery and equipment n.e.c.		
	C.32	Other manufacturing		
	M.72	Scientific research and development		
Transport	C.29	Motor vehicles, trailers and semi-trailers		X
	C.30	Other transport equipment		
	H.49	Land transport and transport via pipelines	X	X
	H.51	Air transport	X	
	M.71	Architectural and engineering activities; technical testing and analysis		X

Note: Mapping of the domains defined the S&T PANORAMA to NACE, Rev. 2 sectors at two-digit level. The last two columns denote if the respective activity was identified as a current (C) or emerging (E) strength, respectively, in the report "Mapping of the economic potential in the Western Balkans economies".

Source: Authors.

Once the relevant domains for the scientific and innovative potential of the Western Balkan region have been established, they were mapped to a set of qualitatively matching economic and industrial sectors, as framed by NACE, rev 2, 2-digit codes. As stated in the S&T PANORAMA, "…*the whole procedure (and therefore the final mapping obtained) is purely qualitative and thus that the domain to NACE mappings are approximate and do not aspire to be rigorous in any way.*" The results of the mapping effort are summarised in the table below. Several NACE codes are associated with each of the preliminary priority domains. Of these categories, 14 were identified as either a current or an emerging strength in the report "Mapping of the economic potential in the Western Balkans economies", while 19 were not. Among the sectors not listed in the report, the greatest part falls in the "Better societies - governance, culture, education and the economy" domain: these missing sectors are mainly linked with educational and cultural activities.

<u>Assessment</u>

The identification of possible preliminary specialisation domains for the Western Balkans and its composing economies followed two paths that were eventually merged: first, an exploratory specialisation analysis was carried out in terms of scientific publications, patents and trademarks using EU-27 as the reference; second, the application of topic modelling on the corpus (titles, abstracts, keywords, project descriptions) of all records that were retrieved from heterogeneous data sources. The merging process was *purposeful* to be in line with the results of previous reports (including "Mapping of the economic potential of the Western Balkan economies" and "Supporting an innovation agenda for the Western Balkans") and required both considerable computational resources in optimising the number of topics and human intervention in finalising the so-called stopwords (terms that are not taken into account in topic modelling).

Once domains were finalised and each record was characterised as belonging to a domain, the process of calculating the relevant distribution and specialisation indicators by domain, the identification and the characterisation of the relevant actors and the mapping of the collaboration patterns among the actors is rather straightforward.

A set of limitations and considerations that can affect the specialisation and policy conclusions of the S&T PANORAMA were identified as follows (Duran, et al., 2022):

1. *Bias against lower-technology sectors, traditional sectors, non-technological innovation*: Most records compiled in the international data sources listed above belong to the natural sciences and to technological innovation, partly due the nature of the sources of information used, partly due to the specialisation of the Western Balkan's science and innovation ecosystem and the region's science and innovation policies. The relative absence of non-technological research and innovation activities (i.e., design or experience-based industries), which can have an important role in specialisation strategies, and the lower propensity to publish, protect intellectual property or participate in EU projects of lower-technology and traditional sectors has to be taken into account. The relative absence of non-technological research and innovation activities (such as design-based industries or tourism) shouldn't be taken as fact, and a more holistic view of Western Balkan economies' capacities and opportunities for innovation must be measured with other indicators and explored in the EDP Process. Furthermore, creative and experience-based industries, and more generally, the value of non-technological innovation in all sectors, could have an important role in specialisation strategies of the Western Balkan economies.
2. *Uneven number of records across the analysed data sources which overrepresents scientific outputs:* relative number or production of records in the different data sources (projects, patents, publications) is very different, with a much larger number of publications than the other two. To avoid manipulation of the raw numbers, no normalisation has been performed to control for this disparity. Nevertheless, this must be considered when interpreting the results and conclusion of the analysis, particularly when there is a specific interest in technological innovation and the role of companies and other non-academic actors.
3. *Low number of records hindering a deeper characterisation of some preliminary specialisation domains:* The low number of records in some domains and/or economies may prevent a richer/finer characterisation of preliminary priority domains and could provide unreliable indicators at the second level of analysis.
4. *Uneven representation of institutional typologies, overrepresentation of academic actors and underrepresentation of companies, NGOs, governments, etc., developing innovation or applying technology:* as a consequence of the limitations above, it can be expected that companies, NGOs, governments, etc., are under-represented in the data sources and thus in the results of the analysis. Additional care must be taken when analysing results and interpreting conclusions related to priority-setting and the market or society-oriented innovation and application capacity of the preliminary priority domains.
5. *Large number of individual patent applicants jeopardising a representative characterisation of patenting activity of the Western Balkan organisations.* The six Western Balkan economies present a very large number of individual persons as applicants in the patent data source, amounting to 84%. That is, only 16% of the patents from the Western Balkan economies can be directly connected to academic institutions, companies or some other organisation. Certainly, there can be a number of individual inventors and patent agents, but there are also cases where university staff, for instance, applies to patents as individuals. Regional legislation as well as the internal regulations and organisation of academic institutions and R&D grants could facilitate and incentivise institutional patent applications, always guaranteeing the intellectual and economic rights of the inventors.
6. *Bias in the coverage of the Western Balkan's economies' scientific publications in local journals, local languages and some disciplines:* Scopus indexes a fairly large selection of international journals. However, Scopus coverage of WB based publishers is relatively small, consisting of the

0.31% of its listed sources (compared with the 50% for EU-27 countries). Therefore, science and innovation fields that tend to publish in local journals and/or in local languages (typically within the domains of law, social sciences and the humanities) are not covered as extensively as those fields that publish in international journals.

7. *Relative weight of Serbia in trans-regional analyses:* From each data source, the number of records available for Serbia outnumbers those for the rest of the Western Balkan economies combined. This means that statistics and record figures for the whole region are almost congruent with those of Serbia; as a consequence, the analyses carried out at the entire regional level are inevitably skewed towards the Serbian profile.
8. *Presence of Kosovo* in the data sources:* For trademarks, patents and publications, it is not possible to search for Kosovo as an economy from the data sources, preventing an all-round characterisation of Kosovan outputs in research and innovation. The issue was mitigated as much as possible for trademarks and publications by searching records by city, state and postcode of the applicant or the affiliation, respectively. Nevertheless, some records lack this information and not all documents effectively produced by Kosovan actors are granted to have been retrieved.

n) Eastern Partnership

The objective of S3 in the Eastern Partnership Countries report (Bigas, et al., 2022) was to apply and further develop a series of indicators originally proposed in the Smart Specialisation Framework for EU Enlargement and Neighbourhood Region (Matusiak, Radovanovic, Nauwelaers, Kaczkowska, & Kramer, 2022) to enable policymakers and stakeholders to comprehensively assess the economic, innovation, scientific and technological (EIST) specialisations of the Eastern Partnership (EaP) countries and their potential for knowledge-based economic cooperation and the development of Smart Specialisation Strategies (S3) in the region. Five research questions were explicitly defined in the context of this mapping:

1. What are sub-sectoral specialisations of EaP countries in terms of economic critical mass, emerging sectors and companies' innovative activities?
2. Which of these specialisations are common in the EaP region and which specific to each country?
3. What are the areas of specialisation and excellence in EaP STI systems that can be mobilised to support knowledge-based economic transformation?
4. How are the international and national STI collaboration networks structured and who are the main stakeholders?
5. Are there synergies/concordances between the countries' economic, innovation, scientific and technological specialisations?

Data and data availability

The mapping of scientific and technological potential is obtained by harvesting data from the following sources with the observation period being 8 years, from 2012 to 2019:

- Scopus by Elsevier, for scientific publications produced by the EaP countries. 131 179 publications were classified according to the All Science Journal Classification Codes (ASJC) taxonomy;
- The Community Research and Development Information Service (CORDIS), for 324 research and innovation projects funded by the European Commission through the FP7 and H2020 framework programmes;
- The DOCDB database of the European Patent Office, for 61 997 patents whose applicant and/or inventors were based in an EaP country, with no restriction of the issuing patent office. In this case, the textual data of each single record was used, while only aggregate data was analysed for the E&I potential.

Methodology

The methodology tackled the research questions mentioned in the previous section transversally and, to address question number 5, linked information from economic and innovation data sources and science and technology data sources.

To identify the scientific and technological potential of the EaP countries, the different S&T data sources were cross analysed using topic modelling. The corpus of textual fields of all the different records from the sources mentioned in section 0 above were used to extract recurring topics of research and technological development. This lead to the identification of S&T domains of relative importance for the EaP as a whole and for each single country, across sources and without relying on the original taxonomies of each data source. The approach is similar to the one used in step 2 of the S&T PANORAMA report.

The topic modelling exercise yielded a series of topics consisting of groups of relevant words having a much finer granularity than the S&T priority domains we would typically define in the design of a Smart Specialisation Strategy. Therefore, manual merging was required to reduce overlaps in topics and several topics were discarded to address the so-called 'topic drift', i.e., topics related to transversal methods and instruments used in multiple areas of science. This topic grouping and cleaning process resulted to 14 groups of topics that were manually labelled. Finally, to reduce the number of domains associated with single record, records were associated with a specific topic (=domain) if the respective weight exceeded the average weight of the topic across records plus one standard deviation.

Critical mass, specialisation and excellence were calculated using the domains identified as described above instead of using the original taxonomies of the respective data sources. In this case, the reference was the EaP region as a whole.

Moreover, to assess scientific excellence, the EaP report used the normalised citation index (NCI) calculated for each bibliometric category that Scopus adopts to classify scientific publications and a weighted average is performed to obtain the final indicator. In line with what was done for the location quotients, the average number of citations per publication for the EaP region within each bibliometric category is used as a baseline to compute the NCI.

Results

The results of the EaP report shown in this section correspond to Armenia so that they can be compared with the results of another mapping exercise carried out for this country using a different approach (see section below). From the following table it is evident that fundamental physics and mathematics is the domain with the most records (with a total of 4 262), followed by Health and wellbeing (1 436), Nanotechnology and materials (1 326), Governance, culture, education and the economy (731) and Chemistry and chemical engineering (632). The first one accounts for almost half the total number of records (45%).

Table 25. Number of records and 8-year CAGR for S&T domains in Armenia

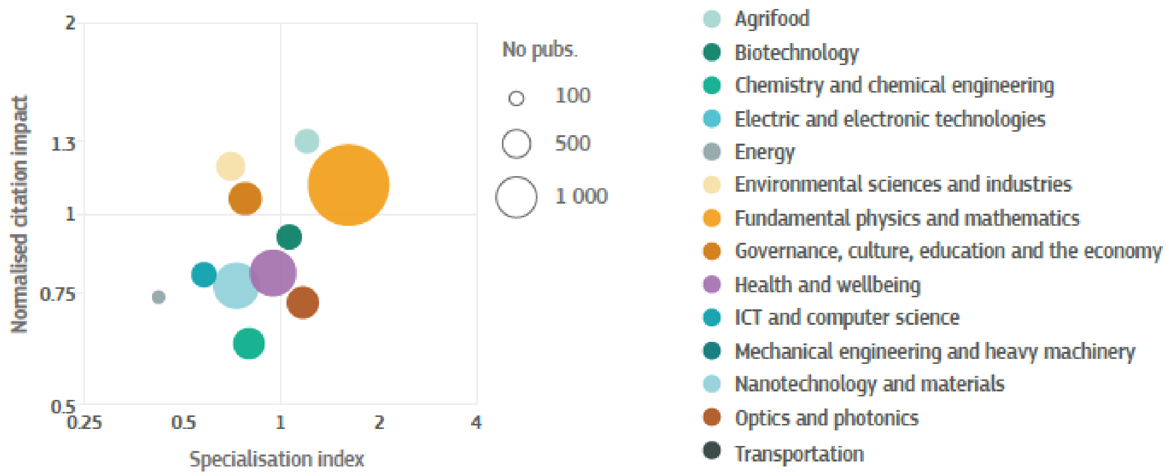
	Publications (critical mass | CAGR)		Patents	EC projects	Total
Fundamental physics and mathematics	4 200	-0.6%	58	3	4 261
Health and wellbeing	1 411	7.5%	22	4	1 437
Nanotechnology and materials	1 265	-1.6%	58	5	1 328
Governance, culture, education and the economy	680	9.5%	14	33	727
Chemistry and chemical engineering	595	2.6%	35	1	631
Optics and photonics	603	-2.5%	9	1	613
Environmental sciences and industries	482	16.3%	27	1	510
Biotechnology	442	4.0%	5	3	450
Agrifood	331	8.6%	62	2	395
ICT and computer science	351	18.6%	29	15	395
Electric and electronic technologies	30	2.6%	102	0	132
Mechanical engineering and heavy machinery	56	-5.6%	64	0	120
Energy	98	3.8%	8	5	111

Source: Authors.

Source: Authors.

Table 26 indicates that Armenia's publications are specialised (versus the group of EaP countries) in Fundamental physics and mathematics (with an SI of 1.6), Optics and photonics (1.2), Agrifood (1.2) and Biotechnology (1.1). Moreover, Armenian publications present a lower normalised citation impact than the EaP average. Four domains, however, stand out: Agrifood (with an NCI of 1.3), Environmental sciences and industries (1.2), Fundamental physics and mathematics (1.1) and Governance and culture (1.1). Thus, in terms of scientific publications, Fundamental physics and mathematics is a domain in which Armenia's S&T ecosystem simultaneously presents a high critical mass, relative specialisation, and scientific impact.

Figure 9. Armenia's Specialisation and NCI across domains using the EaP countries as the reference



Source: Authors.

The following table summarises the strengths of the S&T specialisation of Armenia versus the EaP countries. The country is specialised in Fundamental Physics and Mathematics and beyond this, it is S&T landscape is rather diversified.

Table 26. Final assessment of Armenia's S&T specialisation domains

ARMENIA	Critical mass		Specialisation		Excellence		Summary
S&T domain	Pubs.	Pat.	Pubs.	Pat.	NCI*	EC projects*	Total
Agrifood		✓	✓	✓	✓		4
Biotechnology			✓				1
Chemistry and chemical engineering							0
Electric and electronic technologies		✓		✓			2
Energy						✓	1
Environmental sciences and industries					✓		1
Fundamental physics and mathematics	✓	✓	✓	✓	✓		5
Governance, culture, education and the economy	✓				✓	✓	3
Health and wellbeing	✓		✓			✓	3
ICT and computer science						✓	1
Mechanical engineering and heavy machinery		✓			✓		2
Nanotechnology and materials	✓	✓				✓	3
Optics and photonics	✓		✓				2

*NCI = Normalised citation impact *EC projects = EU-funded R&I projects

Source: Authors.

Finally, the following table presents the results of linking the economic/innovation specialisations and the S&T specialisations of Armenia.

Table 27. Combined EIST specialisation domains in Armenia

ARMENIA		
Concordance between E&I analysis and S&T analysis		
Economic cluster	**E&I domains** (NACE sectors)	**S&T domains**
Food Processing and Manufacturing	10 Manufacture of food products 11 Manufacture of beverages	• Agrifood
Tobacco	12 Manufacture of tobacco products	
Information Technology and Analytical Instruments	26 Manufacture of computer, electronic and optical products	• Electric and electronic technologies • Nanotechnology and materials
Postal and Courier Activities	53 Postal and courier activities	
Hospitality and Tourism	55 Accommodation	
Communications Equipment and Services	61 Telecommunications	• ICT and computer science
Computer Programming and Information Services	62 Computer programming, consultancy and related activities 63 Information service activities	

Source: Authors.

Assessment

The identification of possible preliminary specialisation domains for the Eastern Partnership countries in terms of Science and Technology was carried out by applying topic modelling on the corpus (titles, abstracts, keywords, project descriptions) of all records that were retrieved from heterogeneous data sources (publications, patents, projects). The identification of 14 S&T priority domains[41] required both considerable computational resources in optimising the number of topics and human intervention in merging/dropping topics and in labelling the final results. Given the prevalence of scientific outputs in the dataset, the final set of priority domains closely matches the stronger research areas in the EaP countries.

Once domains were finalised and each record was characterised as belonging to one or more domains, the process of calculating the relevant distribution and specialisation indicators by domain, the identification and the characterisation of the relevant actors and the mapping of the collaboration patterns among the actors was rather straightforward. Contrary to the approach used for Western Balkans, in this case, specialisation was calculated with the EaP countries as the reference. This, as explicitly mentioned in the final report (Bigas et al., 2022), skews the results towards the biggest economy in the group (in this case, Ukraine) and cannot offer insights supporting differentiation versus European, Asian, or other global partners.

[41] Agrifood; Biotechnology; Chemistry and Chemical Engineering; Electric and Electronic technologies; Energy; Environmental sciences and industries; Fundamental Physics and Mathematics; Governance, Culture, Education and the economy; Health and Wellbeing; ICT and computer science; Mechanical Engineering and Heavy Machinery; Nanotechnology and materials; Optics and photonics; Transportation.

The EaP report marks the first attempt to link specialisation in S&T with excellence by introducing the normalised citation index (NCI) as a proxy for the latter. This is a much-needed dimension in S&T mappings that has to be adopted. In the EaP report, it was calculated in relation to the EaP countries, thus providing relative, instead of global, excellence assessments.

Overall, despite the quality of the results and the richness of the insights provided by the application of the topic modelling approach to S&T mappings, its very limited ability to scale-up or consider different reference scenaria inhibits its prospects for being used as the single tool for mappings.

o) Tunisia

The mapping of S&T&I comprised two phases. The first (Tolias, 2021), commissioned by DG JRC in November 2020, aimed to provide a preliminary overview of science and technology potential, based on the analysis of patents, scientific publications, trademarks for Tunisia as a country and Bizerte, Sfax, and Medenine regions. The analysis is to answer which patent, publication and trademark domains in the country and the chosen regions (the pilot regions following the smart specialisation process) can be considered their strengths/competitive niches. The second phase (Hollanders & Tolias, 2022), commissioned by DG JRC in December 2021, aimed to provide an analysis of scientific potential, using data on patents, scientific publications, trademarks for Tunisia as a country and benchmarking the results with other Mediterranean countries / Southern European countries.

Data and availability

The analysis was based exclusively on international data sources. The relevant national authorities were not able to provide data on national patents and trademarks at the level of detail needed for this assignment. For all cases, the observation window was a ten-year period from 2010 to 2019. Science and innovation activities in Tunisia were explored through the following sources:

- 70 000 scientific publications having at least one co-author from Tunisia, sourced from Elsevier's Scopus.
- Patents: Data was sourced from WIPO IP Statistics Database and EPO's PATSTAT Online database. According to WIPO data, there were missing data on patents grated to residents and non-residents for the years 2010, 2014-15 and 2017-2019. Of the 129 patent grants to Tunisian residents by international patent offices (i.e., excluding the Tunisian), WIPO provides summary statistics by field of technology for 103.
- Trademarks: Data was sourced from WIPO IP Statistics Database, WIPO's Global Brand Database and EUIPO. Data for registrations to the Tunisian trademark office are only available for the period between 2013 and 2017.

Methodology

Phase 1: Regional Specialisations in three pilot regions (Tolias, 2021)

By the time the report was drafted, no preliminary specialisation domains or preliminary mapping of scientific potentials towards economic potentials were available, both at the national and at the regional level. Therefore, the first step of the methodology was to perform standard specialisation analysis (calculation of location quotients (Schubert & Braun, 1986) and benchmarking) using Tunisia as the reference and the data sources' original taxonomies (Scopus' Subject Areas, IPC 4-digit codes and WIPO fields of Technology for patents, Nice Class for trademarks). In all cases, the specialisation threshold was set at LQ = 1.50.

The geolocalisation of scientific publications was implemented by controlling the Scopus' AFFIL and/or AFFILCITY fields, searching for scientific outputs at the city/town level after harvesting publicly available information from the Tunisian Ministry of Education regarding the sites/campuses of all higher education institutions.

Since PATSTAT Online does not contain the addresses of inventors, applicants, representatives, opponents or licensees with the exceptions of applicants which are identified as legal entities. Therefore, the geolocalisation of the above was performed by manual access to the latest application document per person and OpenStreetMap, which was very time consuming (4-5 addresses / h).

To provide a detailed mapping of the patenting activity in Tunisia and geolocalise the results so that we can identify the patent specialisations of the three pilot regions we retrieved from the European Patent Office's PATSTAT database (Autumn 2020 edition) all the patents granted to a Tunisian resident between 2010 and 2019. This resulted to 269 patents where a Tunisian resident was either inventor or applicant and 53 patents where a Tunisian resident was the applicant. We restricted our analysis to the latter dataset since the former includes persons of Tunisian origin working abroad. We used the internal associations of patent applications to NACEv2 sectors and fields of technology provided by PATSTAT Online to perform our calculations.

A similar approach was followed to geolocalise trademarks: the availability of open data that would allow the geolocalisation of the trademark activity at the level of the region was scarce. Therefore, we had to make an informed choice regarding the selection of sources and offices and manually process the available data. Our trademark processing strategy restricted our search to all active trademarks listed in WIPO's Global Brands Database[42] whose holder country is Tunisia that were registered between 2010 and 2019 with the major trademark offices in the world, that is, the European (EUIPO), the US (USPTO), the Canadian, the Australian, the Swiss and the World. This search does not include registered trademarks that have been left to lapse (and this is evidence of a valuable trademark) and the trademarks registered at the national or at the regional level (Africa, and the neighbouring countries of Tunisia). Thus, our sample is a measure of the trademark activity of extrovert enterprises targeting the major international markets. This search has resulted in 243 active trademarks registered in the aforementioned office. Using all available means[43] we have manually geolocalised the 104 holders of the 243 trademarks we have retrieved from WIPO's Global Brand Database at an average rate of 6 addresses / h.

Phase 2: National Specialisation versus a set of Mediterranean Countries

The second phase of Tunisia's S&T mapping exercise was about estimating the national areas of scientific and technological specialisation. The crucial question here was to select the set of peer countries that would serve as the reference when calculating the location quotients for scientific publications, patents and trademarks.

Twenty sovereign countries in Southern Europe, the Levant and North Africa regions border the sea itself, in addition to two island nations completely located in it (Malta and Cyprus). While not having a coastline in the Mediterranean, Portugal, Andorra, San Marino, Vatican City, Kosovo, Serbia, Bulgaria, North Macedonia, Romania, Mauritania, Western Sahara and Jordan are often included on the list of Mediterranean economies. Such classification is mostly based on their geographical, economic, geopolitical, historical, ethnic and cultural (language, art, music, cuisine) ties to the region as a whole.

The table 28 lists a set of key indicators for nineteen Mediterranean countries and Portugal. It is clear that there is a large diversity in all indicators, thus making the selection of a good group of peer economies impossible. Therefore, we had to rely on a heuristic, starting the specialisation analysis of scientific publications using some Mediterranean EU Member States that heavily rely on tourism and on the primary sector, such as Croatia, Cyprus, Greece, Croatia, Malta and Portugal. Using these, and Tunisia, as the baseline would provide a good understanding of Tunisia's specialisation versus 'peer' EU economies. Then, we extended our analysis by gradually including larger EU Member States in the Mediterranean, such as Italy and Spain. Finally, we performed a specialisation analysis of Tunisia versus all the Mediterranean countries and Portugal in terms of scientific publications, patents, and trademarks. In principle, domains of strong specialisation in most, or all four baselines should be considered as Tunisia's specialisations. We have found that when using the set of EU Member States comprising Croatia, Cyprus, Greece, Italy, Malta and Portugal as the baseline, we can effectively capture the strong specialisations of Tunisia across most of the four baselines we examined, and thus we used it as the baseline for all types of analyses included in this exercise.

To perform the specialisation analysis of Tunisia versus the baseline in terms of scientific publications, we used Scopus' internal analysis tools to calculate the number of publications classified in the Subject Areas, the internal taxonomy of scientific disciplines used by Scopus. The query to retrieve the records for the selected reference was:

AFFILCOUNTRY (Croatia OR Cyprus OR Greece OR Italy OR Malta OR Portugal OR Tunisia) AND PUBYEAR > 2009 AND PUBYEAR < 2020

[42] https://www3.wipo.int/branddb/en/

[43] Including trademark documents, Google searches and maps, and an online directory of Tunisian enterprises available at https://annuairepro-tunisie.com .

Following the same approach with all the other studies, we computed the LQs for two 5-year intervals, i.e., 2010-2014 and 2015-2019, by aggregating the annual outputs per interval for both the reference (Tunisia) and the baseline (all countries in the query above). In this way, we capture and compare the evolution of scientific output across two PhD epochs, and also compensate for the different publishing cycles across different subject areas.

The mapping exercise identifies Subject Areas as having a static or current scientific potential for which:

- Size is sufficiently high, i.e, Subject Areas should account for at least 2.5% of total number of publications co-authored by at least one author in Tunisia between 2010 and 2019;
- Specialisation (LQ) is sufficiently high, i.e., above a pre-defined threshold value ($LQ_i > 1.25$). Subject Areas with a degree of specialisation, for both 5-year periods, above 1.25 are defined as **continuously specialised**. Moreover, areas with a degree of specialisation above 1.25 in the second 5-year interval and below 1.25 in the first 5-year interval are considered as **emerging specialisations**.

Patents can be considered as a more than adequate, although not perfect, measure of innovative activity[44]. The World Intellectual Property Organisation (WIPO) provides country specific datasets that vary in terms of detail and coverage. In our analysis, we used:

- Patent grants to residents[45] by field of technology. The internal taxonomy of this dataset comprises 35 fields of technology. Data is available for all countries in our baseline, but coverage is restricted to major patent offices. This means that the data cannot capture the entire patent activity in Tunisia and the countries in the baseline, especially patents granted only by the respective national offices.
- PCT publications originated in Tunisia (or the baseline countries) by IPC class. The internal taxonomy of this dataset comprises all the 4-digit International Patent Classification Codes.

We computed the LQs for two 5-year intervals, i.e., 2010-2014 and 2015-2019, by aggregating the annual outputs per interval for both the reference (Tunisia) and the baseline (all countries in the query above).

The mapping exercise identifies Fields of Technology / IPC classes as having a static or current scientific potential for which:

- Size is sufficiently high, i.e., above a pre-defined threshold value. Fields of Technology / IPC classes should account for at least 2.5% of total number of the aggregate count between 2010 and 2019.
- Specialisation (LQ) is sufficiently high, i.e., above a pre-defined threshold value. Fields of Technology / IPC classes with a degree of specialisation above 1.25, for both 5-year periods, are defined as **continuously specialised**. Moreover, Fields of Technology / IPC classes with a degree of specialisation above 1.25 in the second 5-year interval and below 1.25 in the first 5-year interval are considered as **emerging specialisations**.

The analysis of the PCT dataset was further associated with NACE Rev. 2 industrial sectors by using a Eurostat- provided correspondebce table[46] that matches 4-digit International Patent Classification Codes (IPC V8) to 2-digit NACE Rev. 2 codes (i.e., IPC A47B is matched to NACE Rev. 2 31-Manufacture of Furniture) and in some cases, to 3-digit NACE Rev. 2 codes.

WIPO Trademark data is very spotty. WIPO's Total trademark registrations (direct and via the Madrid system) lacks information on residents for, among others, Greece (2010-2019), and Tunisia (2010-12 and 2018-19). To have a common dataset for all countries in our chosen baseline, we chose to limit our search to EUIPO-registered trademarks for which there is full data availability. Thus, we used indicator 4 (total registrations by class-direct and via the Madrid system), counting by filing office (EUIPO) and applicant's origin (Tunisia and the baseline countries) to perform our specialisation analysis. By

[44] Acs Z.J. and Audretsch D.B., (1989). "Patents' Innovative Activity", Eastern Economic Journal, Feb. 1989.

[45] A resident filing refers to an application filed in the country by its own resident; whereas a non-resident filing refers to the one filed by a foreign applicant.

[46] See https://ec.europa.eu/eurostat/ramon/documents/IPC_NACE2_Version2_0_20150630.pdf

considering trademarks granted by the European Intellectual Property Office (EUIPO) to Tunisian applicants, we can infer the propensity of Tunisian economic sectors to enter EU markets.

We computed the LQs for two 5-year intervals, i.e., 2010-2014 and 2015-2019, by aggregating the annual class counts per interval for both the reference (Tunisia) and the baseline (all countries in the query above).

The mapping exercise identifies Nice classes as having a static or current scientific potential for which:

- Size is sufficiently high, i.e., above a pre-defined threshold value. Nice classes should account for at least 2.5% of total number of the aggregate class count between 2010 and 2019.
- Specialisation (LQ) is sufficiently high, i.e., above a pre-defined threshold value. Nice classes with a degree of specialisation above 1.25, for both 5-year periods, are defined as **continuously specialised**. Moreover, Nice classes with a degree of specialisation above 1.25 in the second 5-year interval and below 1.25 in the first 5-year interval are considered as **emerging specialisations**.

The NICE Classification scheme categorises the entire business spectrum into 45 distinct classes: 1 to 34 for products and 35 to 45 for services. However, there is no formal correspondence table to match NICE classes to economic activities. Therefore, NICE classes will be used to qualitatively discuss linkages to economic activities. A correspondence table issued by the Spanish Patent and Trademark office[47] was also consulted to inform our analysis.

[47] http://www.oepm.es/export/sites/oepm/comun/documentos_relacionados/varios_todas_modalidades/Concordancia_CNAE_NIZA.pdf

Table 28. Mediterranean countries: key indicators of economic, scientific and innovation outputs

Country	*Population (million, latest)*	*Density (persons/km²)*	*GDP (nominal, billion USD, latest)*	*GDP/capita (latest, USD)*	*Number of publications (2019)*	*Average number of patents granted per year (2010-2020)*	*Average number of trademark registrations per year (2011-2020)*	*Publications per million population*	*Patents granted per million population*	*Registered trademarks per million population*
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h) = (e) / (a)*	*(i) = (f) / (a)*	*(j) = ((g) / (a)*
Albania	2.8	98	16.8	5 847	570	4.57	457.25	200	1.61	161
Algeria	44.7	17.7	163.5	3 638	8 886	54.86	2 108.13	199	1.23	47
Croatia	3.9	73	63.0	15 807	8 407	16.40	1 201.82	2 155	4.20	308
Cyprus	1.2	123.4	26.6	29 486	3 525	19.00	1 227.80	2 964	15.98	1 032
Egypt	102.7	102	394.3	3 832	26 223	87.78	3 897.10	255	0.85	38
France	67.4	116	2 938.0	44 995	136 312	17 132.40	90 633.50	2 022	254.14	1 344
Greece	10.7	82	211.7	19 827	22 157	298.22	n)a	2 075	27.93	n)a
Israel	9.5	428	410.5	44 474	26 692	707.33	2 075.90	2 824	74.84	220
Italy	60.3	201.3	2 106.0	34 997	138 520	9 273.90	50 211.91	2 297	153.75	832
Lebanon	6.9	560	18.0	2 745	4 071	65.40	2 139.20	594	9.53	312
Libya	7.0	3.74	21.8	3 282	560	n)a	n)a	80	n)a	n)a
Malta	0.5	1633	15.5	32 021	1 045	34.30	750.40	2 029	66.60	1 457
Montenegro	0.6	45	4.8	7 688	672	13.33	70.90	1 081	21.44	114

Morocco	37.1	50	122.4	3 441	9 040	110.25	5 660.18	244	2.97	153
Portugal	10.3	112.2	251.7	24 457	31 121	138.30	15 051.36	3 008	13.37	1 455
Slovenia	2.1	103	60.9	28 932	7 574	324.50	1 456.50	3 594	154.00	691
Spain	47.5	94	1 450.0	31 178	108 478	2 715.00	48 749.00	2 286	57.22	1 027
Syria	17.5	118.3	24.6	2 807	591	26.33	4 474.75	34	1.50	256
Tunisia	11.7	71.65	44.2	3 713	8 418	150.25	2 468.00	719	12.83	211
Turkey	83.6	109	794.5	9 327	51 289	1 749.90	66 589.36	613	20.93	796

Source: Wikipedia, Scimago Country Rankings, WIPO.

Results

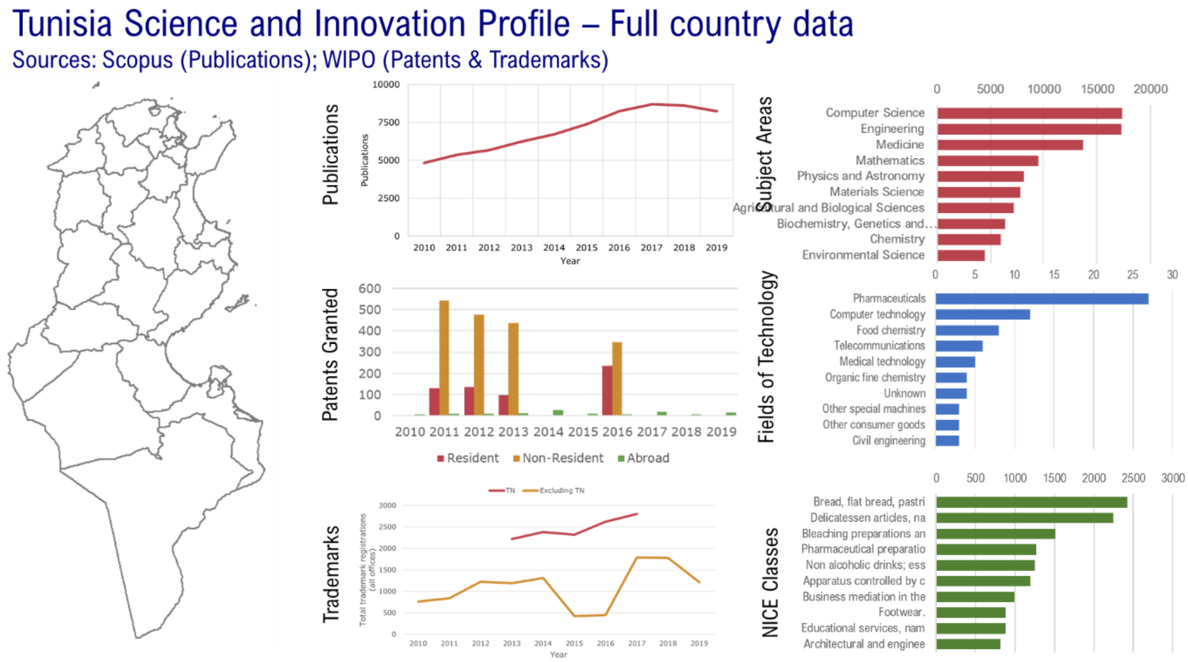
Phase 1: Regional Specialisations in three pilot regions (Tolias, 2021)

The scientific output of Tunisia is strong in the major research areas which are relevant for the industry such as Engineering, Computer Science, Materials Science, Agricultural and Biological Science, Biochemistry, Genetics and Molecular Biology. From a policy perspective, the existing scientific base should be leveraged to stimulate and support the innovative potential of the industry and thus drive higher value-added activities.

International patenting activity seems to be relatively strong in pharmaceuticals, biotechnology, food chemistry, textile and paper machines and medical technology. Although these sectors are not strong in terms of scientific output, they can easily be traced in the list of research areas, thus being good candidates for further investigation from the perspective of entrepreneurial discovery. However, knowledge supply and demand might not be co-located at the sub-national level.

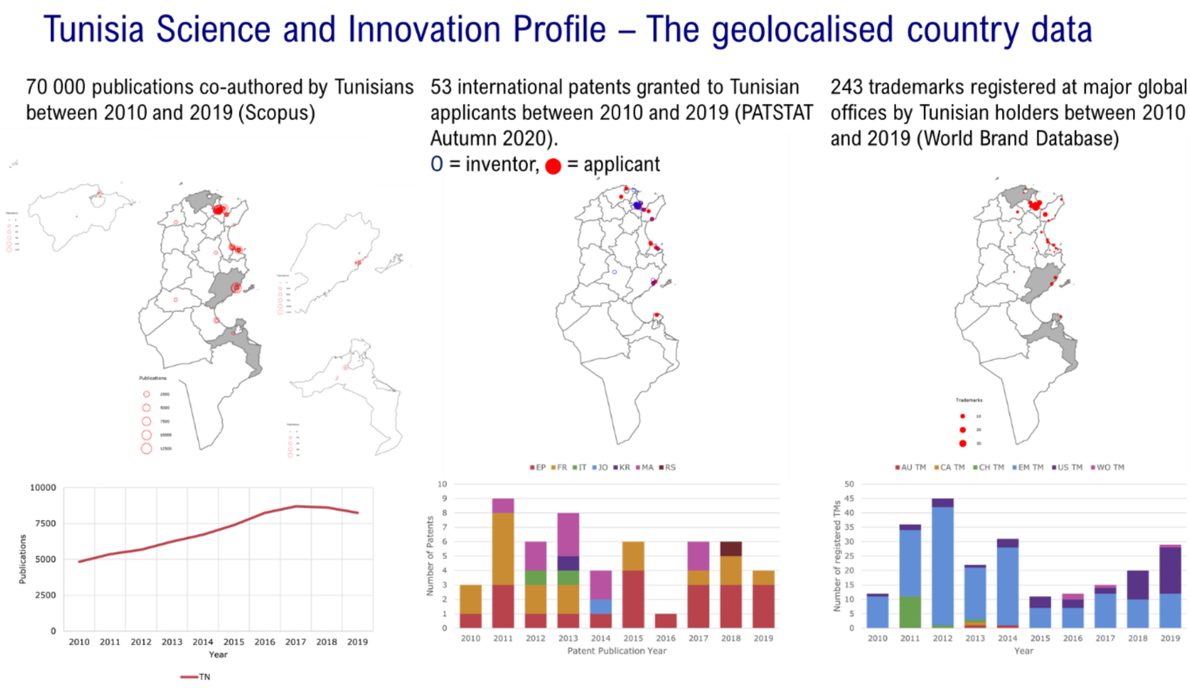
Worldwide trademark activity is mainly concentrated around agrifood, especially delicatessen-type of products, olives and olive oil. The latter, according to the atlas of economic complexity, brought to the Tunisian economy $770mil in 2018. This suggests that these two sectors have international aspirations for commerce and exports, but from a policy perspective require an entirely different approach than the sectors that are strong in patents, mainly support to diffuse process, organizational and marketing innovations. The scientific potential to support agrifood is also present in the country.

Figure 10. Summary of the publication, patent and trademark analysis for Tunisia



Source: Authors.

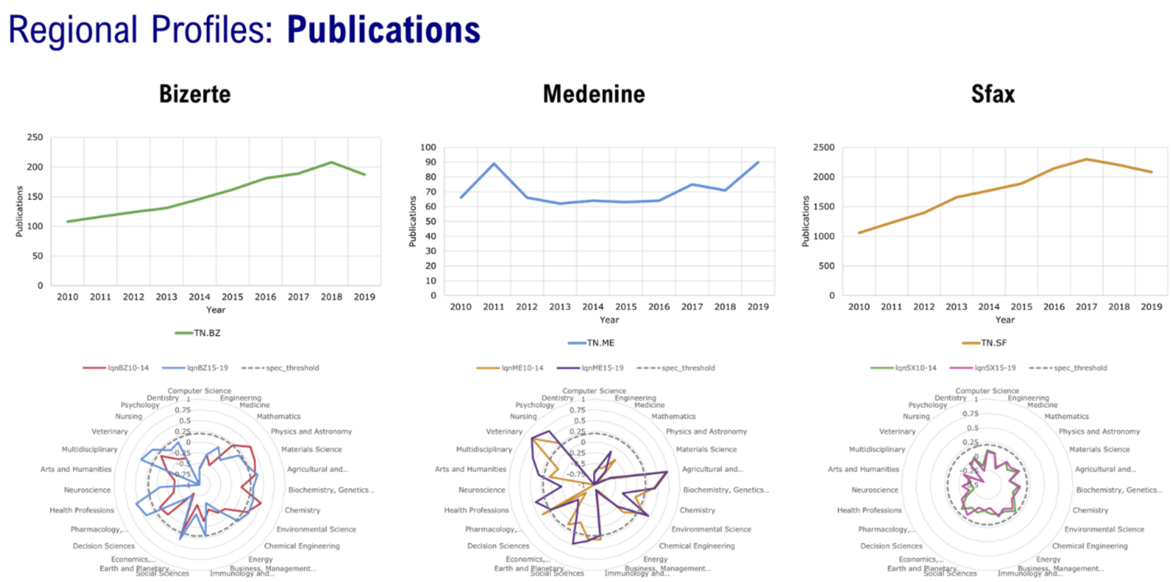
Figure 11. Scientific and technological activities in Tunisia



Source: Authors.

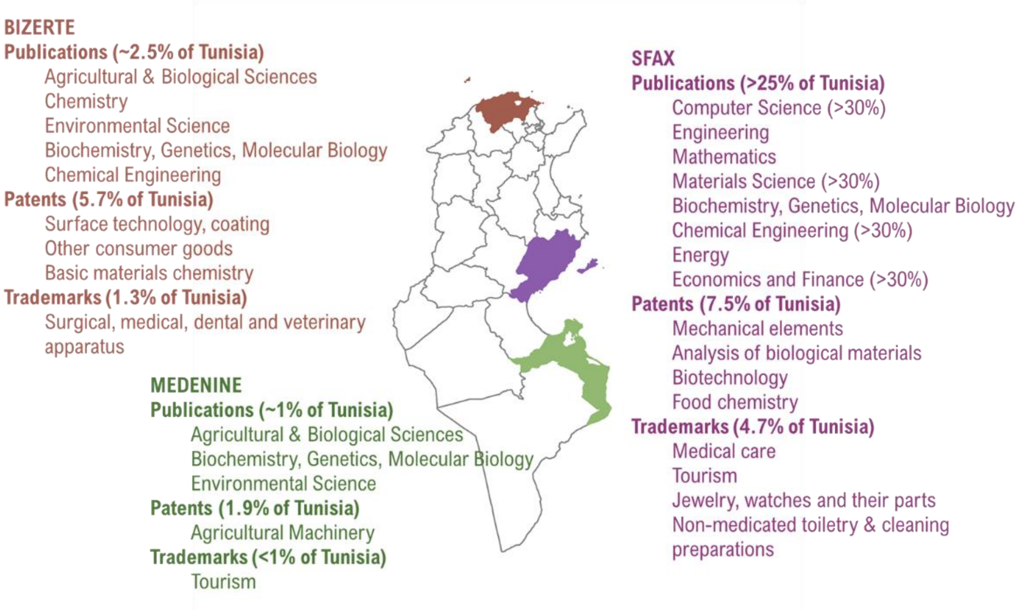
At the national level, we have found that the majority of the research (publications) and innovation activity (international patents and trademarks) is concentrated in or around Tunis, the capital region. This is a typical setting in highly centralised, small, and developing countries. In such cases it is important to focus on technology diffusion and on leveraging highly specialised activities such as marketing, new product development, design and IPR-related legal services that are usually located in or around capital regions.

Figure 12. Time-series of regional scientific output and specialisation analysis



Source: Authors.

Figure 13. Summary of the specialisation analysis of the three pilot regions (governorates).



Source: Authors.

In the three pilot regions, our evidence suggests that a regional innovation ecosystem is forming in Sfax, being centred around medicine. This is supported by a relatively strong supply of knowledge in fields like medicine, biochemistry/genetics/molecular biology that has already created technological innovations (analysis of biological materials, biotechnology) and are pursued for commercial exploitation beyond Tunisia (medical care). With the exception of chemical engineering, knowledge-provision in Bizerte seems to be unaligned with the innovative activity of its industrial base, thus suggesting that the regional specialisations should be driven by its economic specialisation. Finally, from the perspective of our analysis, Medenine is the least endowed with capabilities to drive technology-led innovation by itself and, unless the economic analysis finds strong sectoral specialisations, it should be considered as part of a wider area, probably in conjunction with neighbouring Gabes.

Phase 2: National Specialisation versus a set of Mediterranean Countries

Scientific potential:

From the evidence, we can assert that Tunisia, when compared to the baseline, exhibits:

Strong and continuous specialisation (i.e., LQ ≥ 1.25 for both observation windows) in

- Computer Science,
- Decision Sciences,
- Engineering,
- Materials Science, and
- Mathematics.

Emerging specialisation (LQ < 1.25 in 2010-2014 and LQ ≥ 1.25 in 2015-2019) in

- Business, Management and Accounting,
- Chemical Engineering and
- Energy.

Declining specialisation (LQ ≥ 1.25 in H1 2010-2014 and LQ < 1.25 in H22015-2019) in

- Agricultural and Biological Sciences,
- Immunology and Microbiology.

Patents: Overall, the number of Tunisian patents in the data is very low, therefore specialisation is very high in the fields of technology where activity is reported for Tunisia. The critical mass threshold would reject fields of technology with less than 3 patents. Therefore, we can assert that Tunisia exhibits:

- Strong and continuous specialisation (i.e., LQ ≥ 1.25 for both H1 and H2) in Pharmaceuticals, Computer technology, Food chemistry and Telecommunications.
- Emerging specialisation (LQ < 1.25 in H1 and LQ ≥ 1.25 in H2) in Medical technology, in Textile and paper machines and in Digital Communication.
- Declining specialisation (LQ ≥ 1.25 in H1 and LQ < 1.25 in H2) in Organic fine chemistry, and in Other consumer goods.

Moreover, the results of the specialisation analysis on IPC four-digit classes that belong to granted patents through the Patent Cooperation Treaty (PCT) suggest that Tunisia exhibits:

- Strong and continuous specialisation (i.e., LQ ≥ 1.25 for both H1 and H2) in three IPC classes, namely A01G, F03B and G06Q.
- Emerging specialisation (LQ < 1.25 in H1 and LQ ≥ 1.25 in H2) in two IPC classes, namely A61B and C05B.
- Declining specialisation (LQ ≥ 1.25 in H1 and LQ < 1.25 in H2) in three IPC classes, namely A61K, A23L and A61P.

Using the Eurostat-provided correspondence map, we find that the NACE Rev. 2 industries that are associated with the IPC classes that were characterised as continuous or emerging specialisations are:

- NACE Rev. 2: 20.1 Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C05B).
- NACE Rev. 2: 28.1 Manufacture of general-purpose machinery (F03B).
- NACE Rev. 2: 28.3 Manufacture of agricultural and forestry machinery (A01G).
- NACE Rev. 2: 32.5 Manufacture of medical and dental instruments and supplies (A61B)
- NACE Rev. 2: 62 Computer programming, consultancy and related activities (G06Q).

Trademarks: Overall, the number of Tunisian EUIPO trademarks in the data is low, therefore specialisation is very high in the Nice classes where considerable activity is reported for Tunisia. The critical mass threshold rejects Nice classes with less than 13 trademarks associated with them. On the basis of the data we can assert that Tunisia exhibits:

- Strong and continuous specialisation (i.e., LQ ≥ 1.25 for both H1 and H2) in Classes **29** (Delicatessen articles, namely olives with herbs and pickled in brine, sheep's cheese in brine and in herbal oil, cream cheese being filling for fruit, fruit filled with cream cheese, goats' milk cheese; pickled vegetables with various fillings and fruits; pulp concentrates; piccalilli; pickles; soups; vegetable pies; mince meat in pastry and in flat bread, included in class 29; edible oils and fats), **30** (Bread, flat bread, pastries; vinegar, relishes; chutneys (condiments); spices; dips; ketchup, mustard; pastes), **03** (Bleaching preparations and other substances for laundry use; Cleaning-, polishing, scouring- and abrasive preparations; soaps; perfumery) and **32** (Non-alcoholic drinks; essences for making beverages; non-alcoholic fruit extracts; non-alcoholic fruit drinks; non-alcoholic fruit nectars; non-alcoholic fruit juices; beverage preparations; liqueur preparations; lemonades; syrups for lemonade; fruit nectars; syrups for beverages; sorbets).
- Declining specialisation (LQ ≥ 1.25 in H1 and LQ < 1.25 in H2) in Class **33** (Alcoholic beverages, except beers; alcoholic preparations for making beverages), **24** (Textiles and substitutes for textiles; household linen; curtains of textile or plastic) 26 (Lace, braid and embroidery, and haberdashery ribbons and bows; buttons, hooks and eyes, pins and needles; artificial flowers; hair decorations; false hair) and 38 (Telecommunications services).

<u>Assessment</u>

Methodologically, Tunisia’s mapping exercise was straightforward after the two major technical challenges were addressed:

6. (Phase 1) The geolocalisation of scientific publications, patents and trademarks that was needed to calculate the regional specialisations. The percentage of addresses for which latitude/longitude

points were calculated automatically by OpenStreetMap was less than 15%, thus requiring manual effort for disambiguation at a rate of 5.5 addresses / h.

7. (Phase 2) The selection of an appropriate reference for performing the specialisation analysis of Tunisia with other peer countries. This issue has not been fully addressed so far, especially for countries that lie well beyond the EU borders. Of similar importance is the issue of using the same reference for calculating specialisations across very diverse dimensions (e.g., the economic and the scientific potential).

p) Armenia

The mapping for Armenia was commissioned by DG JRC in December 2020 and was delivered in April 2021 (Innovatia Systems, 2021). The objective of this mapping was to conduct a targeted analysis of patents, scientific publications and trademarks for Armenia as a country. The analysis was to answer which patent, publication and trademark domains in the Armenia are strong, attractive, and useful to concrete business sectors. Specifically, the analysis would include:

- A patent analysis for Armenia (whole country) and connection of the identified international patent classifications (IPC) with business/industrial sectors (NACE 3 digit classification),
- Scientific publications analysis for Armenia (whole country),
- Trademark analysis for Armenia (whole country),
- Appropriate maps and visualisations for each section.

Data and data availability

The analysis was based exclusively on international data sources, thus there were no issues regarding data provision by national sources. For all cases, the observation window was a ten-year period from 2010 to 2019. Science and innovation activities in Armenia were explored through the following sources:

- 11 344 Scientific publications having at least one co-author from Armenia, sourced from Thompson/Reuters' Web of Knowledge.
- Patents: Data was sourced from WIPO IP Statistics Database and EPO's PATSTAT Online database.
- Trademarks: Data was sourced from WIPO IP Statistics Database and EUIPO.

Methodology

By the time the report was drafted, no preliminary specialisation domains or preliminary mapping of scientific potentials towards economic potentials were available. Therefore, the first step of the methodology was to perform standard specialisation analysis (calculation of location quotients (Schubert & Braun, 1986) and benchmarking) using EU-27 as the reference and the data sources' original taxonomies (Web of Knowledge Research Areas, IPC 4-digit codes and WIPO fields of Technology for patents, Nice Class for trademarks). In all cases, the specialisation threshold was set at LQ = 1.50.

To identify the loci of innovation in Armenia, the main actors in scientific research, international patenting and trademark activities were established by manual geolocalisation of the most productive research organisations (publications), the Armenia-based inventors and applicants that were granted a European patent between 2010 and 2019, and the Armenian owners of active EUIPO-registered trademarks. Geolocalisation was performed using OpenStreetMap.

Results

Descriptive statistics were discussed for all data sources and timeseries trends were presented for each type of outputs (scientific publications, patents, and trademarks). Specialisation analysis was conducted for Armenia covering scientific publications, patents and trademarks. **Figure 15.** Spatial distribution of (a) major research organisations in Armenia and of their scientific output between 2011 and 2020; (b) all Armenian inventors and applicants with an EPO patent granted between 2010 and 2020; (c) active EU Trademark owners shows the specialisation analysis for scientific publications, using the same visualisation approach with that in section 0 above.

Figure 14. Specialisation trends for all research Areas calculated over two 5-year periods

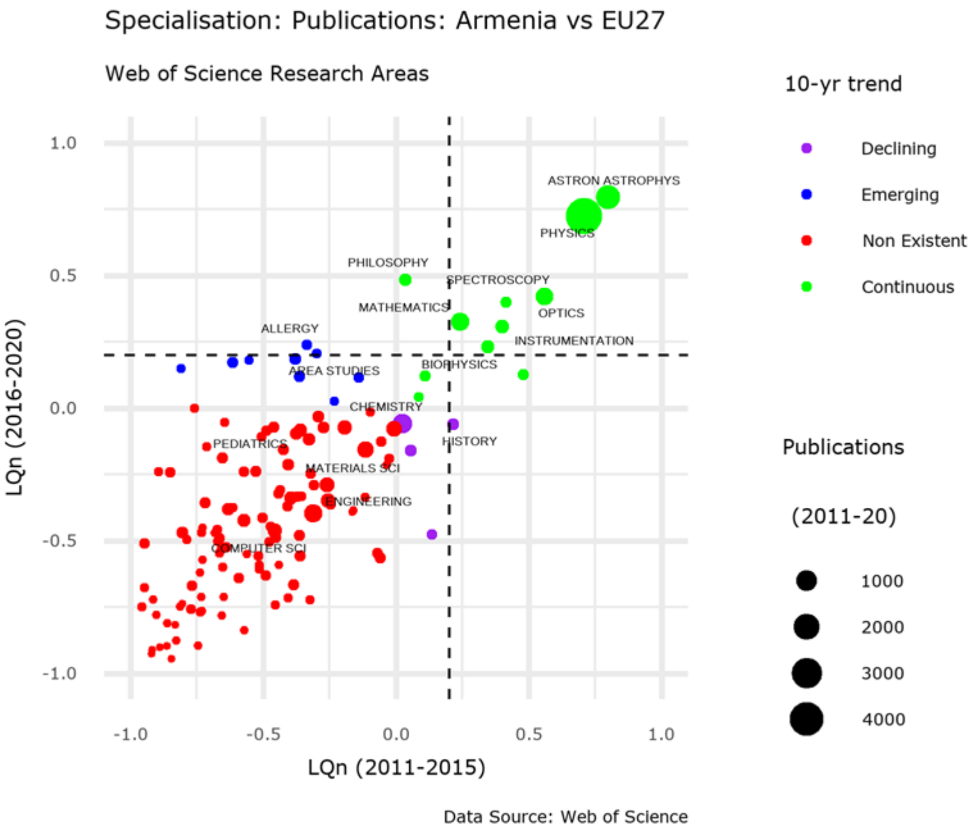
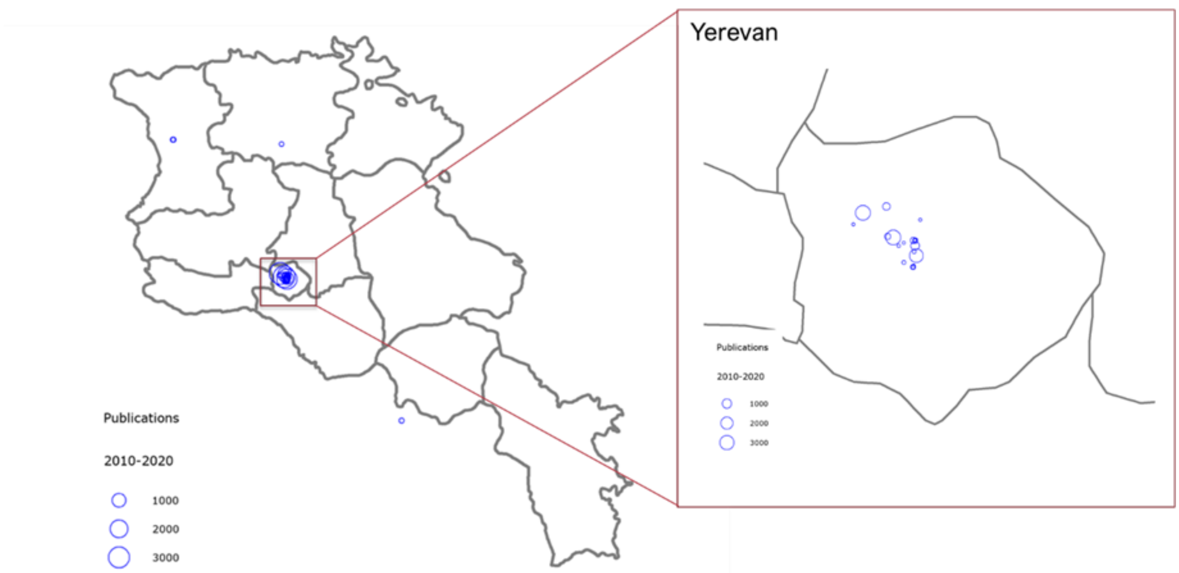


Figure 15. Spatial distribution of (a) major research organisations in Armenia and of their scientific output between 2011 and 2020; (b) all Armenian inventors and applicants with an EPO patent granted between 2010 and 2020; (c) active EU Trademark owners



(a)

(b)

(c)

Source: Authors.

The main conclusions from the evidence analysed in the report can be summarised as follows (Innovatia Systems, 2021, pp. 22-23):

1. Almost all of the research and innovation activity in Armenia is located in or around the capital area of Yerevan. This is a typical setting in highly centralised, small, and developing countries. In such cases it is important to focus on technology diffusion and on interactive learning than on R&D-based approaches. The identification of truly motivated actors is of high importance, as is the promotion of reflexive policies that also entail space for exploration and a learning-by-doing approach. The improvement process would start with trying to determine who is creating useful knowledge, who is using knowledge creatively, and who is disseminating knowledge. Instead of starting with the National Academy of Sciences and the Universities, scientists and researchers, the process should assess the interplay between institutions and industries and its effect on innovative behaviour within Armenia. In addition, identifying organisations or individuals that have insight into unique challenges or problems in the country may provide opportunities for collaboration and the development of creative local solutions that build trust, confidence, and stronger local networks. It is not about the presence of organisations, but about the dynamism between different actors and elements in the innovation system.
2. The scientific output of Armenia is strong in three major research areas: Physics and related disciplines (i.e., astronomy-astrophysics, optics, biophysics), Chemistry and Mathematics. Physics-related publications seem to drive the performance in international scientific collaboration. However, these research areas are rather general purpose, without any direct linkages to economic sectors. Therefore, from a policy perspective, the development of scientific research in areas that are more relevant for the national economy should be pursued, together with the facilitation of international scientific cooperation programmes in the same areas.
3. Worldwide patenting activity seems to be specialised in Food Chemistry, Civil engineering, Mechanical Engineering, Furniture-Games, special machinery and audio-visual technology. Of these, only Food Chemistry can be traced to a national specialisation in science.
4. Worldwide trademark activity is also concentrated around food and beverages and tobacco products and substitutes. This suggests that these two sectors have international aspirations for commerce and exports.
5. The main conclusion from the EU patents and EU trademarks granted to entities in Armenia is that there is no overlap in the organisations that both publish scientific publications and are granted EU patents. Moreover, there is no overlap between EU patent and EU trademark holders. Apart from two organisations, it is noteworthy that in the EU patents granted to applicants in Armenia, individuals are listed as both inventors and applicants and therefore we were not to track their institutional affiliations.

Assessment

This rapid and frugal mapping of Armenia's scientific and technological potential has drawn from internationally available data and produced some insights of the national innovation system of Armenia. It has also demonstrated that rapid reviews can be carried out at the national level without access to sophisticated analytical tools and state-of-the-art methodologies. By comparing the results of this exercise with those obtained by the EaP report, we can conclude that they are essentially the same.

The standard caveats (i.e., bias against lower-technology sectors, traditional sectors, non-technological innovation; bias in the coverage of scientific publications in local journals or in the local language, local patent and trademark data) still apply.

3.2 Main findings and discussion

Policymakers who have knowledge of the scientific specialisations of their territory can better formulate research policies and funding priorities, including by specific field, and can better assess the effectiveness of their initiatives in relation to strategic priorities. The approaches that were used to deliver the science mapping exercises, so far, can be classified in three major classes:

1. **Taxonomical specialisation analyses** using the taxonomies in the data sources (e.g., Armenia, Tunisia). The benefits of this approach are speed, flexibility in the selection of the observation time frame and the baseline, good data availability from international sources, low requirements in specialised programming skills and computing power. The shortcomings of this category are the lack of data availability at the sub-national level (which requires considerable disambiguation effort to be overcome, especially for patents and trademarks) and the difficulty in integrating the analyses of diverse sources (i.e., publications, patents, and trademarks) in a quantitative manner.

- **Purely topic modelling-based analyses** (e.g., EaP). The benefits of this approach are its ability to integrate heterogeneous data sources into a single set of topics using the exact terms used in the textual descriptions of the corpus, the possibility to identify transverse concepts contributing to several topics (Bigas, et al., 2022, p. 33). Moreover, they can overcome the barriers imposed by the various data-source-specific taxonomies, such as defined ex ante, and if reached, it is usually higher than a small number of priority areas sought by the concept of smart specialisation. Thus, as already mentioned in the methodology for both EaP and S&T PANORAMA, expert human intervention is needed in terms of pruning terms, merging or skipping topics, and finding appropriate names (labels) for the topics. In fact, Leydesdorff and Nerghes (2017) raised concerns regarding the ability to validate topic models due to their dependance on initial conditions and found that in cases of moderately sized sets of documents (less than 1000), co-word maps outperformed topic models. However, they did not validate this finding in larger sets, as in the case of EaP and S&T PANORAMA. Finally, topic models are tailored to the underlying data, which are purposefully place-specific, and thus do not allow comparisons (i.e., benchmarking, specialisation analysis) to territories beyond those which are the objective of analysis.

2. **Hybrid taxonomical and topic modelling-based analyses** (e.g., Western Balkans). Hybrid analyses use expert-provided or taxonomical information to inform the final selection of topics that are relevant to a territory. The same benefits and caveats mentioned in point 2 above still apply.

From a broader perspective, there is no standard way to perform the assessment of the status and the potential of the science / research sector to inform the elaboration of smart specialisation strategies. The field evolves in parallel with science mapping (Chen, 2017; Mingers & Leydesdorff, 2015) and the evolving theory and practice of smart specialisation.

RIS3KEY[48], a methodological guide provided by Joanneum Research and the Austrian Federal Ministry of Science and Research in 2012 listed several attributes that would lead to the *self-assessment* of the status and the potential of S&T in a territory, shown in the Box 4, which are still very relevant. From the perspective of RIS3KEY, the questions in the Box 4 would be answered by the relevant stakeholders of the S&T system, i.e., representatives of the territorial science, knowledge and creative sector, i.e., universities, research and technology organisations or innovation and design centres. Their answers would be cross-validated by stakeholders in the government and enterprise sectors.

---

[48] See https://era.gv.at/policies/regional-dimension/knowledge-innovation-driven-regional-growth-and-smart-specialisation/the-ris3-key-for-self-assessment/

In the terminology of S3 development, these questions would be addressed within the quantitative *and* the qualitative territorial analysis. The mapping experiences reviewed earlier answer only a few aspects of the self-assessment, highlighted in bold in the Box 4, focusing mainly on the outputs (i.e., scientific publications, patents) and missing the inputs (funding of S&T by source, personnel in S&T, investments in R&D in enterprises). Adding local data sources and repositories to the (mainly) international sources used in all mapping exercises can only enrich the quantitative analysis but cannot solve the issue.

Moreover, if we consider the whole process of scientific research production as a black box, the calculation of specialisation indices can also be carried out by considering input indicators alongside the output indicators. The former approach would trace the profile of a territory through the sectoral distribution of research investments; the latter through the relative distribution of its scientific production.

From an operational point of view, tracing the research profile of a territory on the basis of input indicators is a challenging task, because gathering input data disaggregated by field is formidable, even more so by univocal classification of those fields. Input data, or production factors according to the microeconomic theory of production, are labour and capital; that is, all resources other than labour used to conduct research activities (Abramo, D' Angelo, & Di Costa, 2022). Government budget appropriations to R&D (GBARD) as a percentage of GDP seems to be positively correlated with a territory's share in the top 10% of highly-cited scientific publications. Although this relationship cannot be interpreted as causal, it is an indicator to be considered in R&I policymaking (European Commission, 2022, p. 418). In essence, to change the territorial research profile towards alignment with strategic objectives, national and regional governments can act on two levers: differentiated allocation of public funds across fields, and/or differentiation of productivity incentives by scientific fields. The track record of such activities should therefore be part of any mapping exercise on science.

Therefore, despite the high quality of the insights provided by the state-of-the-art in S&T mappings, the fact is that they cover only a small part of the information needed to perform a *thorough* assessment of the status of science in a territory. The key argument here is that by collecting only output data, irrespective of their richness in terms of sources and details harvested from textual information, we cannot perform a thorough quantitative assessment of S&T in a territory and drive evidence-based choices.

Box 4. Assessment of the status and potential of the Science / Knowledge and Creative Sector (Source: RIS3KEY, pp. 10-11)

Q1. Considering both academic and non-academic skills, expertise and knowledge, name up to three fields/challenges in which your region already excels or has the potential to put itself on the map as a recognised world-class place of competence?

Q2. What are the specific scientific strengths and research specialisations in your region (i.e. in which science fields are R&D investments, R&D personnel, publications, and patent applications concentrated)? Please name up to five. How did these strengths evolve in the last decade?

Q3. Are these scientific activities competitive on a European or global level? Where are potential partners, where are the main competitors located?

Q4. Which emerging new scientific competences (other than mentioned above) can be spotted in your region? Which research issues and future technologies do you conceive as most promising for the regional science / knowledge & creative sector in the next decade?

Q5. Which lead institutions in the science / knowledge and creative sector (i.e. universities, research and technology organisations, innovation & design centres) are situated in your region? How would you describe their structural involvement in regional planning / innovation policy development? How do their strengths correspond with the regional economic specialisation and are they linked with the industrial base?

Q6. How do your strategic R&D priorities correspond to the top priority themes of your region? Are regional investments from both public and private side in place to complement your own resources and attract co-funding and risk-sharing from the national (and, if applicable, EU) level in joint regional priority areas?

Q7. What important research infrastructures and creativity hotspots are established in your region? What is their influence to create smart specialisations for your region? How can you benefit from nearby infrastructures/hotspots in other regions?

Q8. Which economic sectors in your region are strong in R&D investment and technology development? Where do they get their new scientific and technological knowledge? From regional universities or from international R&D partners?

Q9. How fit is your regional science/smart/creativity/skills base potential to address conjointly the grand challenges of society (health and ageing, climate change, urbanisation, energy, social inclusion etc)? How do regional lead institutions position themselves in global chains of knowledge and value (are they closely connected with institutions and companies in neighbour regions and internationally)?

Q10. How favourable are working conditions for researchers in your region? How much mobility between the public science and the private sector does exist in your region (i.e. are graduates/engineers/professors moving easily between universities and firms and back)? Do universities train scholars and graduates to become entrepreneurs?

Q11. Does current academic education fit to the needs of the regional economy – do regional employers absorb graduates or are graduates forced to look elsewhere?

Q12. How many permanent/temporary international research fellows, professors, and students do work in your region? What is the share of international staff in scientific/creative positions? How many co-operations with other international lead institutions does your region have?

The quantitative elements that are missing from current mappings include:

1. **Normalisation indicators** and their evolution with time to calculate the productivity of science and technology, such as population, number of researchers, expenditure on R&D by sector of performance (ideally broken down by NACEv2 for the business-enterprise sector). They are usually found in official statistics.
2. **Excellence indicators.** The Normalised Citation Index calculated at the global level and/or the share of a territory's publications in the top x% of highly cited papers can be proxies of scientific impact. Secondary data sources such as Ioannidis, Boyak, & Baas (2020) can also be used to identify highly cited researchers. University rankings can also be a source, especially when analysing institutional collaboration.
3. **Patent Quality indicators.** Squicciarini, Dernis, & Criscuolo (2013) discuss several metrics of patent quality that would complement patent counts to determine their importance and/or impact.
4. **Knowledge flow indicators**, beyond co-authorship / co-invention / project collaborations, such as survey data and case studies, patent citations to non-patent literature, labour force surveys and flow of human capital from higher education to industry (Paunov, Planes-Satorra, & Moriguchi, 2017).
5. **Non-institutional funding for R&D&I** is another proxy for determining both the strength of linkages among research & enterprise, the relative competitiveness of the actors in attracting competitive funding. It can be calculated by examining the relative share of the actors in project budgets.

- **Centrality measures** (e.g., degree, closeness, betweenness and eigenvector centrality, especially the latter) derived from the network analysis of the participants in FP7, Horizon2020, HorizonEurope and other EU-funded projects (Calvo-Gallardo, Arranz, & de Arroyabe, 2021; Kang & Hwang, 2016) can provide valuable insights regarding the relative position of territorial actors in global research networks. However, this requires analysing the full datasets of projects and participating organisations and of course, the relative positions may change by the time of data harvesting. The same concept could be applied to co-author analysis (persons or affiliations) in academic publications, but again, it would require a very extensive dataset.

On top of the above, the value of mapping the loci of research and/or innovation activity should also be strongly emphasised. The seminal work of de Rassenfosse, Kozak, & Seliger (2019), who geocoded inventor and applicant locations in more than 18 million patents from all major offices around the world spanning more than 30 years, to draw a world map of invention has inspired the author to do the same in the cases of Tunisia and Armenia. As suggested by de Rassenfosse et. al., obtaining precise geographic information is important for several reasons. First, since knowledge spillovers are concentrated locally and decay fast with geographical distance. Second, innovative activity is usually distributed very unequally within countries and a small number of cities and regions account for most of the patent applications. Third, policymakers are increasingly interested in location decisions of firms and high-skilled labor (and of course, in the case of smart specialisation, for place-based innovation policy).

For this purpose, it is important to know where the major innovation hubs are located. Obviously, the same approach can be used to map agglomerations of knowledge at various granularities as demonstrated by Catini, et al., (2015).

4 Findings from the workshop “Towards a challenge-led approach to measuring territorial innovation potential”

4.1 Introduction

In recent years, economies from the EU Enlargement and Neighbourhood Region (E&N) have significantly boosted their Smart Specialisation process. JRC has supported national governments in analyzing and strengthening regional ecosystems by providing the Smart Specialisation Framework for EU Enlargement and Neighbourhood Region (the S3 Framework) as a guideline for mapping the innovation potential of the territory. Furthermore, JRC has recently included the sustainability component in the Smart Specialisation approach, promoting its applicability on a global perspective, with a specific focus on Latin America and Africa. This led to an evaluation of the work done so far in the E&N region and a reconsideration of the appropriateness of the methods proposed by the S3 Framework in non-EU contexts. Nevertheless, new global challenges and geopolitical threats might affect the actual viability of the methods provided, and new techniques and tools might be further explored.

Operating in the context of weak institutional capacity represents one of the main challenges to having an evidence-based participatory process, and the attempt to search for more sustainable settings requires data-informed innovation policies. After applying the S3 Framework for the past five years in the EU Enlargement and Neighbourhood Region and investigating its suitability in Latin America and Africa regarding sustainability solutions, an in-depth reflection on the appropriateness of the methods detected becomes necessary.

For this reason, a pool of international experts who have been collaborating with JRC in recent years participated in a 2 half-day workshop to discuss main issues and challenges with mapping in the E&I region, considering potential practical guidelines for the future. The workshop, named "Towards a challenge-led approach to measuring territorial innovation potential," took place in Seville on 21 and 22 February 2023, including three sessions. The first focused on the implementation of the S3 Framework so far, the second looked closer at the sustainability component, and the third aimed at connecting the implementation of the S3 Framework with territories beyond the European Union.

Participation in the workshop was extended to other relevant professionals with sound experience on the topic worldwide, and their participation was ensured both in person and remotely. The workshop aimed at a wide-open discussion, bringing about interesting hints for the future refinement of the S3 Framework. Several issues were debated during the workshop, regarding both methods and their applicability. Not always did a common perspective emerge among participants, thus confirming the complexity of the topic and the difficulty of putting in place evidence-based approaches in contexts with weak institutional capacity. Constraints linked to the S3 Framework, as well as the lack of data availability, affected both the methodological settings and the practical implementation of mapping exercises.

The workshop's key objectives were:

- To consider the necessity to update the list of suggested techniques and metrics for the EU integration of Neighbourhood and Enlargement Region,
- To reflect on including a sustainability component in the framework,
- And to consider the potential worldwide guidance on metrics for place-based innovation initiatives to be suitably used at the global level.

Upcoming insights or recommendations from participants were expected to take into consideration both the low institutional capacity of many of the countries and economies investigated and the general aim of the S3 framework to lead to evidence-informed policy-making processes.

4.2 Main findings

Based on the methodologies used in different quantitative analyses in the region, several issues and challenges have been discussed.

- **Data Availability**: Although differences exist within the Enlargement and Neighborhood Region, all economies contend with missing data for relevant variables, particularly in the economic, scientific, and innovation domains. This results in considerable differences in time series lengths and reduces comparability between regions or countries. Innovation is the dimension most affected by the lack of data, as some economies lack innovation surveys and have insufficient data on R&D and patents. This necessitates the exploration of alternative sources such as the Balkan Business Barometer or the WB Enterprise Survey. Another issue is the lagging timeliness of the data, with the most recent economic data being, on average, at least two years old. While it takes time to collect data by statistical offices, improving the timeliness of official statistics may be achieved through the use of statistical techniques to nowcast economic data to the current year. Territorial coverage may also be critical as some data are not available at the subnational level.

- **Benchmarking**: In some cases, it may not be helpful to compare the national economy with the EU27 due to the considerable difference in critical mass that may lead to distortions. One option is to consider neighboring economies or comparable countries in the region as a benchmark, as was done in the case of Kosovo. Although the approach to focus on neighboring economies or countries is highly recommended, it requires additional quantitative and qualitative analysis to determine the most appropriate ones.
- **Selection of statistical variables**: Three different approaches have been used to identify emerging economic potential based on growth performance over time, annual percentage changes, and trends, respectively. It is recommended to adopt only one approach that can make use of data for the full time series. The second approach is easier to implement and more transparent.
- **Involvement of local authorities**: Adequate support from local stakeholders, including ministries and national statistical offices, is crucial. It should be noted that confidential data are not published by statistical offices and thus not available from their websites and databases. A main challenge remains access to data that can be used to assess the innovation potential of NACE 3-digit industries. Small sample sizes may prevent results from being representative for detailed industries at the country level and even more so at the regional level. Looking further into Intellectual Property Rights (IPRs) could provide a clearer picture of innovation and should be considered.
- **Focus on the scientific potential**: There is no standard way to assess the status and potential of the science/research sector. So far, three options have been used: Taxonomical specialisation analyses using the taxonomies in the data sources (e.g., Armenia, Tunisia), purely topic modelling-based analyses (e.g., Eastern Partnership), and hybrid taxonomical and topic modelling-based analyses (e.g., Western Balkans). Methods adopted are mainly linked to bibliographic, patents, trademarks, and research projects data. Despite providing an exhaustive amount of information, they are not enough to perform a quantitative assessment of Science and Technology in a territory and drive evidence-based choices. Main missing elements include normalization indicators to calculate the productivity of science and technology, such as the Excellence indicators. The Normalized Citation Impact should be checked at the global level to be a real measure for impact. Patent Quality indicators, Knowledge flow indicators beyond co-authorship, co-invention, and project collaborations, such as survey data and case studies, patent citations to non-patent literature, labor force surveys, and the flow of human capital from higher education to industry. Centrality measures for the participation of research organizations in FP7, Horizon2020, and other EU-funded projects. The same concept could be applied to academic publications.

A broader reflection pertains to the Science and Technological potential in a transitional context, specifically focusing on the analysis of "system delineation." This involves addressing technical, institutional, legal, spatial, and temporal boundaries of the system requiring transition. Unlike geographically bound system boundaries, missions and transitions encompass multiple socio-technical systems cutting across various industrial sectors, scientific disciplines, and technologies. Rather than analyzing the complete inventory of scientific and technological outputs produced in a territory, searches and analyses should be purposeful, offering information on pioneering actors, technologies, users, support coalitions, and initiatives of the "sunrise" regime within the existing system.

- **Mission-led policies for mapping**: The need to identify mission-led policies in a context of weak institutional capacity and lack of data was raised, focusing on contributing to a more flexible, integrated, and iterative approach. A preliminary analysis of the national innovation ecosystem and its structure could facilitate a stronger integration between quantitative and qualitative mapping.
- **Mapping of institutional capacity**: Collaborating on the actual ownership and tailoring the mapping exercise in a context-based manner is essential for this process. Having local data experts and relevant national stakeholders (e.g., representatives from statistical offices) on board from the early stages is important to respond more efficiently to requirements, better customize the process, and

seek additional relevant data and information. Obtaining policy feedback on analysis results is crucial to making them useful for the subsequent stages of the framework (namely qualitative exercise and EDP). To achieve this, the design and implementation process should be more integrated.

- **Combining quantitative and qualitative analytical approaches**: Given the constraints of data availability, quantitative analysis may have limitations due to mismatches among classifications, granularity of information, and the shortness and timeliness of time series. Qualitative approaches can offer a relevant contribution. Focusing on pockets of excellence may overcome misleading results from methodologies concentrating on specialisations and critical masses. The same consideration applies to the scientific potential, emphasizing the opportunity to delve into activities conducted by specific research groups and centers, as well as innovative activities beyond patents, publications, and research project data.

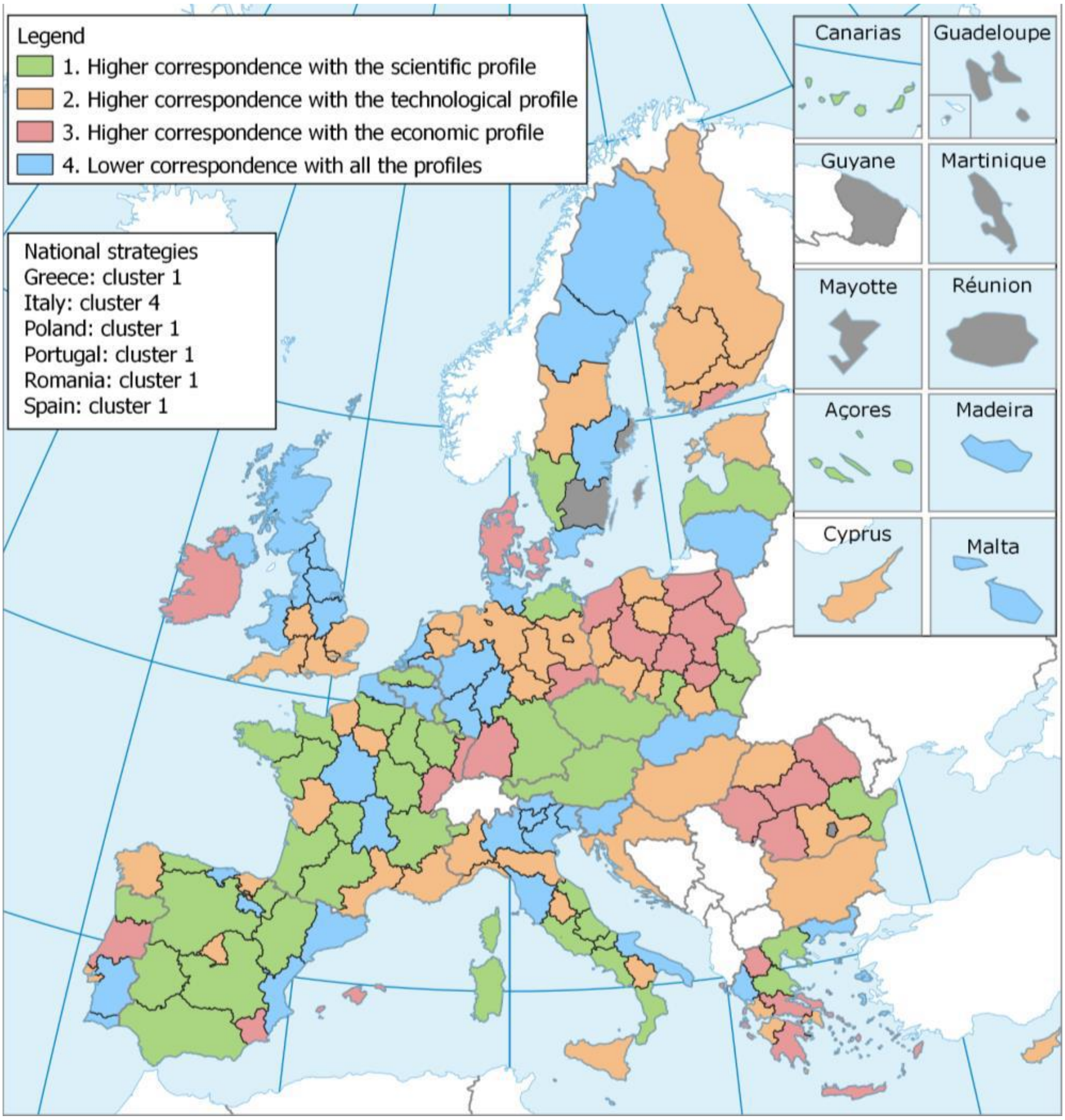
On this trajectory, exploring new data sources that provide semantic insights and transversality opportunities is essential. It is crucial to acknowledge that linguistic biases may hinder the discovery of local capabilities.

During the prioritization of Smart Specialisation Strategies (S3s) in the EU, covering the programming period from 2014-2020, the discussants observed that priority areas were predominantly determined by a combined priority-setting approach. These areas were generally not framed in terms of single scientific, economic, or technological fields. The findings revealed four distinct approaches for combining the economic structure, scientific strengths, and technological strengths of the territories in the overall strategies (see the following figure):

- 61 S3 strategies (29%) demonstrated a higher correspondence with the scientific profile, proxied by indicators such as the share of publications, publication LQ (computed with respect to the EU28 average), the share of top 10% most cited publications, and the relative scientific excellence (i.e., the ratio of most cited publications against the EU average).
- 62 S3 strategies (30%) exhibited a higher correspondence with the technological profile, proxied by indicators such as patent shares, patent LQ (computed with respect to the EU), and the regional technological relatedness index.
- 33 S3 strategies (16%) showed a higher correspondence with the economic profile, proxied by indicators such as the employment share and employment LQ vs the EU.
- 53 S3 strategies (25%) displayed a relatively low correspondence with any profile.

The proxies used to derive the findings in points 1-3 above are considered suitable candidates for future mappings for science, technological innovation, and economic structure, respectively. Furthermore, it is evident that, following the current methodology, the prioritization process across the EU was influenced by quantitative analyses but did not solely rely on them.

Figure 16. Groups of S3 strategies according to the correspondence of their S3 priority areas with the regional/national profiles



Source: Prognos AG and CSIL, 2021.

One of the proposed initiatives is to develop a comprehensive framework for mapping that integrates R&D-led innovation, systems of innovation-driven innovation, and innovation driven by socio-technical transformation towards greening and digitalization. The proposed methodology should be integrative, combining quantitative analysis with qualitative and fieldwork-based analysis. It should be iterative, using policy analysis as a tool to assist policy design, implementation, and monitoring/evaluation. The framework should recognize the ecosystem-based (or pockets of excellence-based) and global value chain-based nature of innovation processes. Additionally, it should explicitly consider institutional capacities for design and implementation. This framework could be applied in five steps as follows:

a. **Mapping of innovation capacities for growth and sustainable development**. This mapping should be based on the concept of technology upgrading, which comprises three components: (i) Mapping of production/services capabilities; R&D; technology, and innovation capacities; (ii) Mapping of structural features and directionality of technology upgrading for sustainable development; and (iii) Interaction with the global economy. Indicators for the three components have been proposed in a report co-authored by Slavo Radosevic (World Bank Group, 2019).

b. **Identification of potential ecosystems, including pockets of excellence and areas of socio-economic challenges**. This is a new concept. The inputs for the analysis should come from the previous step, fieldwork-based analysis, and additional sector-specific analyses. All three inputs should be done iteratively and inform each other. The number of areas should be limited to a feasible number considering policy capacities, the financial capacity of the economy, and the political willingness to engage in transformative innovation policy.

c. **Assessment of institutional capacities for socio-technical transformation in potential ecosystems, including pockets of excellence and areas of socio-economic challenges**. These capacities should be assessed in terms of institutional capacity for policy co-creation (EDP), institutional capacity for policy design, implementation capacity (operational, technical, political), and monitoring & evaluation capacity.

d. **EDP process in ecosystems, PoE, or socio-economic challenges in which step (c) has identified agents and capacities for change (product champions)**. Work should be confined only to selected sectors for which analysis shows the capacity and willingness of stakeholders to engage in the EDP and implementation process. If these two factors are absent, sectors are dropped despite their potential. The aim is to select institutional 'product champions' in the context of the assessment of the institutional capacity for design, implementation, and policy learning.

e. **Proposal of the S3-specific policy mix within the assessment of the overall innovation policy mix**. The final stage of the process is about selecting policy mixes to support the transformation of selected 'sectors' (ecosystems, Pockets of Excellence, or socio-economic challenges). This should be based on an analysis of the overall policy mix, as proposed in a recent paper by Slavo Radosevic[49].

It was also emphasized that the granularity of science mapping in smaller countries should be at the level of individual researchers so that the competences of researchers can emerge and be used to address societal challenges. Moreover, knowing the linkages between researchers and firms would also be valuable. These linkages can be found by combining collaborative projects' data.

Instead of using EU-27 as the baseline for specialisation analyses, one of the possibilities would be to use a set of peers, preferably from the same region. Moreover, to make any mapping sustainable and replicable, international experts should work together with the national analytical team during the mapping exercise. It was suggested that the analysis of the innovation potential in the enlargement neighborhood should be primarily based on the analysis of innovation projects funded by international or national funds, rather than survey data and patent analysis. The analysis should focus on the text elements (abstracts, keywords), using special software such as NVivo or ATLAS.ti. For the analysis of scientific potential, more detailed analyses should be considered that also assess the impact, in addition to paper count.

The need for a standardized approach in mapping, by invoking issues in data provision (availability, currency, and granularity) and interpreting the data by the local actors, was questioned at the workshop, as qualitative inputs might provide more relevant and context-aware answers. In practice, the data get old quite quickly; when it lands on the tables of the decision-makers, it can be just of trivial relevance (or a reason to postpone actions until they are updated). The country-tailored and specific approach solves the problem with data and understanding what is happening on the ground, but it prevents benchmarking options. In any case, the key issues should be keeping a balance between the complexity and speed of methods and providing opportunities for local capacity building in replicating and updating the mappings to inform the quasi-continuous entrepreneurial discovery process.

[49] Radosevic Slavo (2020) Benchmarking innovation policy in catching up and emerging economies: a methodology for innovation policy index, UCL Centre for Comparative Studies of Emerging Economies Working Papers 2020/1

5 Conclusion and recommendations

The review of the mapping studies for the Eastern Partnership countries, Western Balkan economies and Tunisia has shown that there are similarities between the different studies but also important differences, where these differences can be linked to differences in data availability.

5.1 Identifying industries with economic potential

For identifying industries with a current or already existing economic potential, variations on the following methodology have been used. Assuming that economic data are available for X years for the variables in the areas of employment, turnover, and average wages, an industry in a geographic area must pass the following criteria[50]:

- Specialisation (measured by Location Quotient) of employment > x_1
- Specialisation (measured by Location Quotient) of turnover > x_2
- Size or %-share of employment > y_1%
- Size or %-share of turnover > y_2%
- Average wages > z_1% of those in the whole geographic area
- Average wages > z_2% of those in the same industry in a benchmark geographic area

Industries should pass these criteria for all years or for at least X years, e.g. when data are available for 6 years for at least 4 years. The time periods used in the different studies were mostly determined by the available data shared by national statistical offices.

The choice of thresholds and, if time series data are available, the choice of number of years that criteria need to be passed, both have an impact of the number of industries with an economic potential. For industries with a current economic potential, too low thresholds will result in too many industries with such a potential. The size threshold should not be too small as it would identify too many small industries with a low impact on the regional or national economy. For industries with an emerging economic potential, using too low size thresholds could identify growing but less stable industries as limited time series data could overestimate the growth potential of these industries if the available time series data coincide with the upward phase in industries' business cycles. Depending on policy needs, thresholds could be adjusted such to exclude too small industries. The choice for these thresholds should be made in consultation with regional or national stakeholders including additional information on e.g. policy preferences or already existing regional or national development plans.

The choice of the benchmark geographic area also differs depending among others on whether an analysis is done for regions within a country or for a country in comparison with several benchmark countries. For the earliest studies at the country level, the EU was chosen as detailed economic and innovation data were available from Eurostat. Collecting data from e.g. neighbouring countries and economies would have been too difficult as it would have required not only interacting with the national statistical office to receive detailed economic and innovation data of the country being studied, but also with national statistical offices of neighbouring countries and economies. Even if data for other countries and economies would have been made available, issues about the comparability of the data would have emerged due to possible differences between them in e.g. definitions and data collection methods. However, with the EU economic composition being dominated by the economic composition of the largest Member States, the choice of comparing mostly smaller Western Balkan economies and Eastern Partnership countries (except Ukraine) with the EU became more questionable over time. With improved data availability as detailed economic and innovation data for several countries are available from Eurostat, in more recent studies a different approach was followed. Instead of comparing with the EU, it is recommended to compare countries and economies with more comparable countries and economies in their neighbourhood, as was done in the studies on Kosovo* and Tunisia.

For the 2021 study on Kosovo* this recommendation was applied for the first time. The preferred geographic area included other Western Balkan economies and EU Member States in Southeast

[50] Data on turnover and employment could be combined to calculate data on productivity, but as results would not take into account differences in capital and labour intensities between industries, most mapping studies instead use data on average wages per employee (or person employed) as a proxy for labour productivity.

Europe. However, due to limited data availability, not all countries/economies in this geographic area could be included. Only for Bosnia and Herzegovina, Bulgaria, Croatia, Greece, and North Macedonia – the countries in blue on the map – detailed data were available from Eurostat. For Albania, Montenegro no detailed data were available, and for Serbia detailed data were available for too limited number of years.

For the 2022 study on Tunisia, the selection of benchmark countries was guided by practical considerations, focusing on countries in Southern Europe and the Mediterranean. The first group included countries relying more strongly on the primary sector – Croatia, Cyprus, Greece, Malta, and Portugal (the countries in dark blue on the map on the right). The second group included these countries and two larger EU Member States – Italy and Spain – (the countries in light blue). Ideally, countries in Northern Africa should have been included, but detailed industry-level data for these countries are not available from an international data source. Approaching the different national statistical offices would have been too time-consuming and raised issues about the comparability of data due to possible differences in definitions and data collection processes.

Differences in methodologies between studies are mostly due to missing data for one or more economic variables, differences in the length of available time series, and differences in the selection of benchmark countries. Using customized methodologies is recommended, as this allows the best possible use of available data. For the studies reviewed in this report, those involving international experts mostly used the same indicators used in other studies. For the reports involving local experts, despite the expected more in-depth knowledge of additional country-level data by these experts, almost no additional efforts were made to add more data to the analysis and thereby customize the mapping methodology. Most likely, this is the result of local experts not being familiar with the details of the analyses of other studies and being less willing to experiment with new data without being able to build on what was done in previous studies. Most changes over time to the mapping methodology were introduced by international experts building on their experience from previous studies, recognizing areas for improvement based on improved data availability (including, for example, longer time series and detailed export data, which were not available for earlier studies).

Studies that focus on regions within a country compare industries in that region with the aggregate industries in the country. A point of discussion here could be whether the data for the industry of the region should be included in the data of the aggregate industry in the country. For countries with many regions, this should not be a major issue, but for countries with only a small number of regions and/or a highly skewed distribution of regions in that county, it will make a difference in the results if a larger region is included in the country aggregate or not. All mapping studies have ignored this issue, but it is recommended to explore for some of these studies what the impact would be if not the country aggregate is used but rather the aggregate of all other regions excluding the region that is analysed.

Studies that focus on countries used to compare the country to the EU aggregate, but over time it became clear that comparing mostly smaller countries in the 'periphery' of Europe with an EU aggregate that is dominated by the economic structures of larger Member States such as France, Germany, Italy, and Spain was not providing the most relevant benchmark. In more recent studies, therefore, instead, a selection of other neighbouring European countries/economies was used. However, due to the non-availability of data for some non-EU neighbouring countries/economies, not all neighbouring economies could be included in the studies on Kosovo* and Tunisia.

The approach to focus on neighbouring countries and economies is highly recommended for future studies, but it will require an additional quantitative and qualitative analysis to determine the most appropriate neighbouring countries/economies. For example, by using information on industry structures and trade relations. The reports on the Western Balkan economies and Eastern Partnership countries have shown that using economic data from alternative sources like aggregated Orbis firm-level data or data from UNIDO suffers from other issues, such as the poor coverage of certain industries or even countries/economies, making comparisons between industries and countries/economies less relevant due to missing data and non-representative results.

For identifying industries with **an emerging economic potential**, three main approaches have been used:

- Approach based on growth performance over time in employment, turnover and/or wages, by only using the change between the first and most recent year of the time series.
- Approach based on annual percentage changes in the economic variables. These annual percentage changes should be higher than a threshold value for a minimum number of years

and for the average over the whole period. E.g., if data are available for 2014 to 2020, there are six annual percentage changes (2014-2015, 2015-2016, 2016-2017, 2017-2018, 2018-2019, and 2019-2020) and, e.g., at least four of these should be higher than the threshold value. Also, the percentage change between 2014 and 2020 should be higher than the threshold value. The threshold value could either be 0% or the percentage change in the whole geographic area and/or the percentage change in the same industry in the benchmark geographic area. Threshold values should be decided by the study team in consultation with regional or national stakeholders to provide results which are perceived as being valuable for determining priority areas.

- Approach based on trends, where trends are calculated as the slope of a linear regression using the data for 2014 to 2020. An additional requirement could be that the explanatory power of the linear regression as measured by the adjusted R^2 should be sufficiently high.

It is recommended to use an approach that exploits all available time series data, and e.g. not only the data from the first and last year of the time series. One option is the second approach, using annual percentage changes, as it is easier to implement and more transparent. Combining annual percentage changes and the percentage change over the whole period ensures that data for all years will be used in the identification of industries that have an emerging economic potential. Calculating these percentage changes is also straightforward and easy to implement whereas calculating slopes of linear regressions is technically more challenging and these slopes are also more difficult to interpret and explain to policy makers.

The use of only using **Location Quotients** to measure relative specialisation can also be questioned. The main drawback is that Location Quotients are being measures in relation to the country (for regional analyses) or other countries (for country analyses). Results thus do not only depend on the structure of the regional/national economy, but also on that of the benchmark entities. Industries which account for a substantial share of the regional/national economy might not be identified as being specialised if the relative size of that same industry is even bigger in the benchmark entities. Also emerging industries might not be identified if the identification is based on faster growth compared to the same industries in the benchmark entities if growth is even higher in the benchmark entities. Location Quotients also do not consider the role of value chains, where industries also matter as their outputs are being used in other industries.

Statistical data should be used to better capture the importance of industries in the regional/national economy and in (global) value chains. One easy option is to also consider growth rates as such within regions or countries by identifying those industries which have grown faster in the region or an economy, without making any comparisons to growth performance in benchmark entities. This approach in fact has already been used in several of the reviewed studies to identify industries with an emerging economic specialisation (cf. Table 29).

Table 29. Methodologies used for identifying industries with emerging (growth) potential

Albania	**Kosovo**	**Tunisia**
An industry is identified as having an emerging economic potential if it fulfils the following criteria: • The average annual growth rate for Number of employees for 2011-2018 is at least 50% above the average annual growth rate for all industries combined • The average annual growth rate for Average wages per	An industry is defined as having an emerging economic potential if it passes the following criteria: • Employment/turnover share: the trend for both is positive and at least 1.5 times as high as the trend for total employment/turnover for the economy • Specialisation in employment/turnover: the trend is positive and statistically significant	An industry is defined as having an emerging economic potential if it passes the following criteria: • Employment: Annual changes should be positive for at least 5 (out of 7) years and the change for 2012-2019 should be positive • Specialisation: Annual changes should be positive for at least 5 (out of 7) years and the

Albania	Kosovo	Tunisia
employee for 2011-2018 is at least 25% above the average annual growth rate for all industries combined	• Average wages relative to Kosovo: the trend is positive and statistically significant *Trends are defined as the ratio between the slope of a linear regression over the period 2012-2020 and the average value for the variable for the same period. The trend is statistically significant if the adjusted* R^2 *is at least 0.70*	change for 2012-2019 should be positive • Average wages relative to those of Tunisia: Annual changes should be positive for at least 5 (out of 7) years and the change for 2012-2019 should be positive

Source: Authors.

More challenging is to use statistical data to account for the position of industries in (global) value chains as such data covering 3-digit NACE industries are currently not available. Here it is recommended to rely on using a qualitative approach by building on local and national stakeholders' more in-depth knowledge of the different industries.

For future mapping studies it is recommended to adopt a more interactive and integrative approach between the quantitative and qualitative mapping by using, in several iterative stages, the results of one mapping to feed into the other. Quite often the results from the quantitative mapping are met by scepticism of local and national stakeholders and these results do not match their perception of which industries are already important or becoming more important. There perceptions should be used to adjust to the results of the quantitative mapping, both to filter out industries considered not to be relevant and by adding non-identified industries perceived to be of important for the region or economy.

Another issue is the **lagging timeliness of the data**, with the most recent economic data being, on average, at least two years old. As it takes time to collect data by statistical offices, it will not be possible to improve the timeliness of official statistics. An alternative would be to use statistical techniques to nowcast economic data to the current year. Statistical nowcasting techniques will be resource intensive and require expert knowledge. Here we limit the discussion by referring the work done by the Nowcasting group at JRC.[51]

Instead, the possible use of more timely survey data will be discussed as surveys are a key complement to official statistics. The survey data from the **Joint Harmonised EU Programme of Business and Consumer Surveys**[52] are useful for monitoring economic developments at industry level given that surveys are conducted at high frequency providing timely data. The data are published every month by DG ECFIN and are derived from surveys conducted by national statistical institutes in Member States and candidate countries (Table 30). The survey results are used by DG ECFIN for economic analysis, surveillance and short-term forecasting.

Table 30. Business and consumer surveys: country coverage

EU	European Union	HR	Croatia	RO	Romania
EA	Euro area	IT	Italy	SI	Slovenia
BE	Belgium	CY	Cyprus	SK	Slovakia
BG	Bulgaria	LV	Latvia	FI	Finland
CZ	Czechia	LT	Lithuania	SE	Sweden
DK	Denmark	LU	Luxembourg	UK	United Kingdom

[51] https://joint-research-centre.ec.europa.eu/scientific-activities-z/macroeconomic-analysis-monitoring-eu-economic-stance/nowcasting_en

[52] https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/business-and-consumer-surveys_en

DE	Germany	HU	Hungary	ME	Montenegro
EE	Estonia	MT	Malta	MK	North Macedonia
IE	Ireland	NL	Netherlands	AL	Albania
EL	Greece	AT	Austria	RS	Serbia
ES	Spain	PL	Poland	TR	Turkey
FR	France	PT	Portugal		

The survey covers all NACE 3-digit industries in 5 broad sectors and includes different questions for each of them (a selection of variables of interest are included in Table 31). Accumulated forecasts on production and employment for the next 3 months could be used to calculate forecasts for the percentage increases for production and employment for 1 or 2 years for each 3-digit industry. As survey results are not available for regions within countries, the same percentage increases for industries at the country level would also have to be used for regions. For countries not covered in the survey, the survey results of neighbouring countries could be used to calculate forecasts for the percentage increases for production and employment for 1 or 2 years for each 3-digit industry.

Table 31. Business and consumer surveys: selected variables included by sector

Sector	Monthly questions
Industry	Production, past 3 months Production, next 3 month Selling prices, next 3 months Firm’s employment, next 3 months
Construction	Building activity, past 3 months Firm’s employment, next 3 months Selling prices, next 3 months
Retail trade	Business activity, past 3 months Business activity, next 3 months Firm’s employment, next 3 months Selling prices, next 3 months
Services	Business situation, past 3 months Demand/Turnover, past 3 months Demand/Turnover, next 3 months Firm’s employment, past 3 months Firm’s employment, next 3 months Selling prices, next 3 months
Financial services	Business situation, past 3 months Demand/Turnover, past 3 months Demand/Turnover, next 3 months Firm's employment, past 3 months Firm's employment, next 3 months

Source: The Joint Harmonised EU Programme of Business and Consumer Surveys: User Guide (updated January 2023)

An example of one of the questions for industry is as follows:

How do you expect your firm's total employment to change over the next 3 months? It will...

+ increase

= remain unchanged

− decrease

An aggregate balance (ABI) indicator can be calculated by taking the difference between the share of firms that answered positively ('increase') and the share of firms that answered negatively ('decrease'). The aggregate balance indicator can then be used to extrapolate past growth performance by assuming a distribution of how likely it will be that growth will continue at a higher, the same, or lower rate by assuming the following:

Forecasted trend = 1.5 * Past trend if ABI > z%

Forecasted trend = 1.25 * Past trend if y% < ABI < z%

Forecasted trend = 1 * Past trend if x% < ABI < y%

Forecasted trend = 0.75 * Past trend if w% < ABI < x%

Forecasted trend = 0.5 * Past trend if ABI < w%

The exact nature of the relationship between forecasted trend, past trend and ABI could be determined by surveying stakeholders for their opinion.

5.2 Identifying industries with innovation potential

For identifying industries with an innovation potential the review of studies has shown that there is a great variety in the availability of data. One of the best data sources to measure innovation activities in industries would be national innovation surveys like the Community Innovation Survey (CIS) used in all EU Member States and other European countries.

As shown in Table 32, innovation survey data were available for 6 countries: Albania, Georgia, Moldova, North Macedonia, Serbia, and Ukraine. But for several countries, sample sizes used for the national innovation survey were too small to allow for a representative breakdown of survey responses to NACE 3-digit industries at the economy level and regional level. Detailed innovation survey data for NACE 3-digit industries were available for regions in Moldova and Ukraine, but it can be questioned if the results from a national innovation survey broken down into detailed industries and regions are representative as the average number of firms per industry and region which have responded to the survey questions will be very small.

Table 32. Data sources used for mapping of innovation potential

Economy	Year	Unit of analysis	Data sources
Single-economy studies			
Albania	2020	Economy	None
Albania	2021	Economy	Innovation survey
Bosnia and Herzegovina	2022	Regions	None but uses OECD/Eurostat high-tech (R&D) classification
Georgia	2020	Region (1)	Innovation survey
Kosovo*	2021	Economy	Balkan Business Barometer, World Bank Enterprise Survey, Product exports

Moldova	2017	Regions	None
Moldova	2018 + 2021	Regions	Innovation survey, National patents granted
Montenegro	2018	Economy	Balkan Business Barometer
North Macedonia	2019	Economy	Innovation survey
Serbia	2017	Regions	Innovation survey, National patent applications
Tunisia	2021	Regions	None
Tunisia	2022	Country	World Bank Enterprise Survey, Product exports, PCT patent publications, Trademark applications
Ukraine	2017	Regions	Innovation survey
Ukraine	2019	Regions	Innovation survey
Multi-economy studies			
Western Balkan	2018 + 2020	Economy	None
Eastern Partnership	2021	Country	World Bank Enterprise Survey, Product exports

Source: Authors.

If detailed innovation survey data are available, industries with an innovation potential can be identified using a similar methodology as that used for identifying industries with an economic potential, i.e., using specialisation and size thresholds (but keeping in mind that the methodology based on Location Quotients might not always identify the 'right' industries as comparisons with other countries are based on relative performance differences of industries between countries and not between industries within the same country). Combining results over time will be difficult as not the same firms are sampled in consecutive innovation surveys – in most countries all large firms are included but for SMEs a stratified sample is used – and it will therefore be difficult to use innovation survey data to identify industries with an emerging innovation potential.

A further major drawback of innovation surveys is that they do not cover all industries but usually only Core NACE industries: NACE Rev. 2 sections & divisions B-C-D-E-46-H-J-K-71-72-73. Industries in Agriculture and many industries in the Services sector are not included.

Complimentary or supplementary to innovation survey data, other data should also be used to create a complete picture as possible as, e.g., other data sources cover more or even all industries. Important is to use statistics broken down by NACE 3-digit industries so that results can be combined with those of the analysis of the economic potential. Correspondence tables can be used to recalculate patents, trademarks, and product exports from their respective classifications to NACE industries, but this will require detailed data, e.g., patent data by 4-digit IPC classes, product exports by 5-digit SITC commodity groups, and trademark data by NICE classes. For analyses at the country level this breakdown should be possible, but it is more questionable at the regional level as for many countries the absolute numbers of patents and trademarks will be too small. Also, most countries do not provide export data for regions, and if they do, a question to be addressed is whether only exports to other countries should be included or also 'exports' to other regions in the same country.

One caveat to consider when analysing regions is that registrations of patents and trademarks often take place in the country's capital city and innovation activities measured by patents and trademarks might thus be overestimated in the region including the capital city and underestimated in other regions. There is no clear solution for this possible distortive effect. A similar problem also occurs when using regional innovation survey data, as for multi-establishment enterprises the innovation activities of all establishments might be recorded in the region where the headquarter of the enterprise is located. One possible, but partial, solution is to only use regional innovation survey data for SMEs, as SMEs are, on average, less likely to have establishments in more than one region.

5.3 Data challenges and the importance of support by local stakeholders

Timely access to detailed and up to date statistics is key to all mapping studies. The review of the different studies has shown that **it is crucial to receive adequate support from local stakeholders**, including ministries and national statistical offices. In most cases data for NACE 3-digit industries is adequate as NACE 4-digit industries are too small, in particular if the analysis focuses on regions within a country. Economic data should cover at least the number of firms per sector, the level of employment, turnover, and wages for all economic sectors, thus also including the Agricultural sector. The preferred data sources are data from the Structural Business Statistics and Labour Force Survey.

For several studies initially detailed data were not available as these data were confidential due to small numbers of firms in particular industries. Confidential data are not published by statistical offices and thus not available from their websites and databases. One solution here is to grant access to the expert(s) working on the mapping studies to anonymized firm-level data allowing the expert(s) to calculate industry aggregates. The statistical offices in both Albania and Georgia followed this approach making it possible to calculate and use data from NACE 3-digit industries which otherwise would not have been available. Granting access to anonymized firm-level data will require the possibility of a remote access to the data and will also require the expert(s) to treat and keep all data as confidential.

A main challenge remains the access to data that can be used to assess the innovation potential of NACE 3-digit industries. If innovation survey data are available, small sample sizes may mean that the results are not representative for sectors or sub-sectors at the country level but even more so at the regional level. A long-term solution could be to increase the sample size of an innovation survey so that more firms are being surveyed.

The use of other data sources that provide proxies for measuring the innovation potential is strongly recommended. This includes both data on innovation activities by a limited number of NACE industries from the World Bank Enterprise Survey, but also data on patents, product exports, and trademarks. Data on patents, product exports, and trademarks are collected using different statistical classifications and detailed data are required to recalculate to NACE 3-digit industries. Detailed country level data on patents and trademarks are available from WIPO and detailed country level data on products exports are available from UN Comtrade but support from statistical offices or other stakeholders will be crucial to also receive detailed data for regions which will allow to recalculate these into data for industries.

Support by local stakeholders also includes setting up a more iterative process with multiple phases of the quantitative and qualitative mapping where results of each phase feed into the next phase developing results that include all available information and that meet the expectations from stakeholders and thereby make it more likely that results will be used in the entrepreneurial discovery process. The exact nature of this iterative process cannot be determined up-front but will have to custom-made for a particular country or regions in a country based on data available and stakeholders' knowledge. Important will also be to improve stakeholders' knowledge of the statistical skills needed for the quantitative mapping such that these skills will be developed by local experts (with support of international experts).

5.4 Identifying industries with scientific potential

Mapping of the scientific potential is an indispensable input necessary for informing both the prioritisation and the entrepreneurial discovery processes. The mapping of the scientific potential should be driven by data and supported by contextualisation. The first iteration of data collection and analysis of the outputs can be performed by external or international experts. However, it is essential to have a local team participating in the process from day one, so that local capacity for data collection and analysis is built, and sustainability of the process is established. A Computer Science department at a local university or research centre would be able to support the initial data collection and analysis and eventually take the responsibility of maintaining and further analysing the data.

More detailed analyses will be possible after the local team builds capacity and self-confidence. Data collection, analysis and reporting routines, e.g., in an annual basis, are the key to keeping the leaders interested by providing a synthesis of the big picture on a regular basis and creating a sense of momentum. To overcome the need for very extensive datasets for some types of benchmarking, such as the share of a territory's papers in the top x% of global publications or the Normalised Citation Index or the centrality measures in EU-funded projects, the European Commission should collect provide such data on a regular basis for all economies in the Enlargement and Neighbourhood Region.

Simplicity is preferable to keep the time between data collection and informing decision-makers to a minimum. A plain taxonomical specialisation analysis supported by a network analysis of institutional collaborations and an impact/excellence analysis would suffice for most cases. Contextualization is also essential to understand how and why the observed outputs have been produced. This requires a rapid review of the territorial Science, Technology, and Innovation (STI) policy using the same time window used for data collection (i.e., 8-10 years). This review would focus on the inputs to the process (i.e., people, money) and on decisions that influence the operation of the STI system as a whole. This could be modelled in line with the JRC RIO reports or follow a more structured (and therefore easier) approach, such as the one suggested by Russo & Pavone (2021). The contextualization also needs data that are expected to be provided by the relevant statistics authorities. Depending on the maturity of the territorial statistics system, such data may not be fully available, or their granularity may vary. In such cases, qualitative methods should be used. In principle, contextualization should be performed in parallel with the collection and analysis of output data, with the involvement of local stakeholders representing the STI system (ministries, universities, research centres).

Using innovation to address a specific grand challenge, mission, or a sub-problem associated with a challenge has recently emerged as the key vehicle to maximize the impact of S&T policy. This framing of innovation policy, called transformative innovation policy (TIP), promotes the transformation and transition of socio-technical systems through an inclusive co-creation process. Socio-technical systems are complex systems composed of aligned technologies, knowledge, infrastructure, markets, governance and regulation, culture, and industry structures that interact, mutually reinforce, and co-evolve. In this framing of innovation policy, missions are one of the approaches that can be pursued. Missions are measurable, ambitious, and time-bound targets that have the potential to become one of the most significant vehicles for change. They work to tackle complex challenges such as climate change and global health challenges, by taking a purpose-oriented, market-shaping approach. By harnessing the directionality of innovation, we also harness the power of research and innovation to achieve wider social and policy aims as well as economic goals. Therefore, we can have innovation-led growth that is also more sustainable and equitable (Mazzucato, 2018).

Once the transition focus is defined, i.e., the nature of the problem that has to be addressed is understood, and the overall causes and consequences are mapped, the system delineation is the most critical aspect in need of mapping. System delineation means identifying the technical, institutional, legal, spatial, and temporal boundaries of the system in which a transition is needed to solve the identified problem. Contrary to geographically bound system boundaries that were the focus of S&T mappings in the first cycle of S3 strategies, missions and transitions involve multiple socio-technical systems that might cut across multiple industrial sectors, scientific disciplines, and technologies. Moreover, contrary to the approach of analysing the full inventory of scientific and technological outputs produced in a territory, searches and analyses should be purposeful: mapping mostly concerns the disposition of the "sunset" regime (old/established technologies and activities that are to be phased out) and the positioning of the pioneering actors, technologies, users, support coalitions, and initiatives of the "sunrise" regime within the existing system. The JRC-developed Projecting Opportunities for INdustrial Transitions (POINT) methodology provides a set of methodological guidelines for territorial reviews of industrial transitions (Pontikakis, et al., 2020). From this perspective, establishing the current state of the system involves a mapping of the relevant scientific fields that are needed to support the transition, the technological elements required, the system actors involved in relevant policy making and resource allocation, the market actors, and the products/services needed for the transition. A stylized summary mapping of the five inter-related subsystems was considered for the rapid review on the industrial transition of Greece in renewables, batteries, and their applications (Janssen, Tolias, & Pontikakis, 2021). Contrary to the approach employed in the first wave of Smart Specialisation strategies, where the entire spectrum of scientific and technological outputs was considered and analysed, in the case of mapping for transitions, we need to purposefully search for who is doing what in science and technology, in very relevant fields. For example, by examining the scientific endowment of a territory with respect to its ability to support research on batteries, we would purposefully search all the scientific publications in the (taxonomic) fields of materials science, electrochemistry, surfaces coatings and films for fuel cells, for various artifacts related to batteries such as fuel cells, anodes, primary cells, nickel-cadmium, nickel-metal hydride, lithium-ion, lithium polymer, and so on. Since the objective now is to classify scientific output in terms of fit with a solution direction that supports a grand challenge or a mission, search engineering is the key issue to retrieve the relevant output from the textual elements. An alternative approach would be to use specially developed controlled vocabularies (Fuster et al., 2020). Economies of scale can be created by carrying out (and updating in a regular manner) the mapping of transition-related scientific and technological potential on an EU plus E&N basis, e.g., by using relatedness-based approaches for key technologies (Panori et al., 2022; Natalicchio et al., 2022; Balland et al., 2019; European Commission, 2022) or scientific fields.

5.5 Further discussion

- **New framings and rationale of innovation policy**

At the mentioned workshop, the experts discussed growing expectations towards innovation policies to address increasingly urgent and interconnected societal challenges. The ambition to address societal challenges is not new for research and innovation policies. However, the European Green Deal (EGD) came with more ambitious policy targets and goals in the areas of sustainability than any previous EU strategy. The goals and targets of the EGD, such as the climate neutrality, cannot be met by the continuous investment in the existing economic system; they call for a deep and systemic transformation of functional systems of consumption and production. This overarching ambition has implications for innovation policy. The new ambitious strategy came at the time of economic crisis in the aftermath of the global pandemic and the radical shifts of geopolitical context caused by the ongoing Russian aggression on Ukraine.

This new rationale and framing of innovation policy have major implications for the design, implementation and evaluation of place-based innovation policies such as Smart Specialisation. With the transformative ambition underpinning new generation of policies comes the need to adjust the way policy makers analyse place-based innovation potential and evaluate outcomes and impacts of innovation policies.

Experts agreed there was a need to revisit and change the conventional approach to measuring economic, scientific and innovation potential of territories extending the focus from the territorial competitive advantage to understanding the fitness of innovation systems and policies to improve sustainability and resilience of regional economies and societies. The shift comes with many challenges for innovation policy makers and analysts involved in the policy process as it asks for new methodological approaches, engages new stakeholders and requires working across policy areas.

- **New policy objectives require new evidence and indicators**

Asking innovation policy to deliver on societal and environmental goals requires adding new indicators and data sources to the usual repertoire used in policy monitoring and evaluation of research and innovation policy. In the context of the S3 mapping framework this could mean extending it by adding selected indicators to measure inputs, outputs, and outcomes of S3 with positive and negative effects on localised environmental and social goals. The challenges of such as extension are manifold ranging from data availability to methodological difficulties with the attribution of the relevant environmental or social changes to the results of research and innovation policy.

One area of interest to innovation policy makers discussed during the workshop was “Just Transition”, an integral part of the EGD. It was presented one of the new Horizon Europe projects focused on localised Just Transitions. The project team will collaborate with regional and local stakeholders to address important questions such as how to localise Just Transitions and how to measure territorial effects of innovation on localised Just Transitions.

- **Measuring transformative change requires new methodological approach**

A more fundamental challenge from the theoretical and methodological point of view is defining and measuring transformative outcomes of place-based innovation policies, i.e. those outcomes and impacts of innovation policy that foster systemic changes, such as transformation of consumption and production systems. Identifying and measuring such results poses many challenges to the diagnostic and M&E tools applied in S3. Analysing and measuring policy impacts on systemic change requires testing new theoretical and methodological approaches whilst considering specificities of territories and places.

Experts discussed what the transformative lens means for the core objectives of S3 such as improving productivity and upgrading technological capacities of territories. The productivity lens remains relevant but there is a need to shift from the generic analysis of economic productivity to being able to analyse the importance of regional productivity gains and technological advance for addressing societal challenges, including local sustainability problems.

Similarly, the understanding of territorial competitiveness needs to be revisited to capture varying territorial potentials to address sustainability challenges (e.g. How does a region perform in research and innovation fostering local and global sustainability transitions compared to other regions? What are its research and innovation strengths and weakness along the innovation chain? Where are benefits of research and innovation distributed and captured?).

Experts discussed several conceptual approaches and methodologies which can underpin monitoring and evaluation of transformative outcomes of S3. Direct experiences in using Theory of Change approaches in design and evaluation of regional innovation strategies and policies were presented. Participatory and inclusive methods allow, first, to create a shared understanding of localised societal challenges and, second, to co-create place-based pathways of change towards the vision. Pathways can underpin the selection of methods and indicators for M&E process. The focus on transformative change requires formative ongoing evaluation. Experimental approaches, including action research methods, may be suitable to capture transformative effects of policies, including social learning.

An ESPON's research was shared, emphasising the critical role of interregional innovation collaboration and institutional capacities in mobilising research and innovation ecosystems to tackle societal challenges.

- **Dynamic nature of transitions requires investments in governance and new capacities**

The shift to challenge-led transformative innovation policy requires investment in building new collaboration capacities and analytical capacities to apply new methods to monitoring and evaluation.

The new framing opens the policy space to new stakeholders: new makers and users of innovation policies. Experts argued there was a need to invest not only in new diagnostic methods but also in inclusive governance and policy learning. Risks and uncertainties of transition means policy makers together with stakeholders need to critically reflect on desired and undesired effects of policies and ensure that findings and lessons learned are reflected in policy design and implementation.

- **Specialisation and prioritisation can play a central role in developing economies**

Smart Specialisation can provide a valuable framework to territories beyond the European borders for understanding the economic domains in which they can generate or strengthen competitive advantages for a sustainable future. Developing countries tend to face higher financial and human-resource constraints than developed ones, along with pressures to support specific sectors. Consequently, in these contexts, there is an even higher need to target public and private resources in a limited set of priorities that can effectively promote innovation-driven development.

Experts highlighted the specific interest of various middle-income economies in adopting innovation mapping frameworks such as the one developed for Smart Specialisation, as - unlike developed economies that can benefit from various measurement frameworks in this area - most of them lack sound frameworks that encompass a rich set of indicators and dimensions to assess innovation performance and potential. However, while having a common mapping framework is useful, it is crucial to appropriately adapt it to different territorial contexts.

- **Need to shift focus from innovation production to innovation adoption indicators**

Experts agreed that in order to apply the mapping framework in more countries, the current S3 mapping framework should move beyond innovation production indicators and incorporate indicators of innovation adoption, which are particularly relevant in developing countries and less advanced economies. Furthermore, additional efforts should be made to measure informal and frugal innovation. These types of innovations are key components of the innovation performances in developing and emerging economies. They primarily focus on solving practical day-to-day issues, and require different lenses than traditional approaches for adequate analysis and measurement.

- **Importance of identifying "pockets of excellence" early on**

Experts emphasized the significance of early identification of "pockets of excellence", i.e. economic or technological niches that exhibit growth potential, as these can play a vital role in driving economic transformation and upgrading. Conventional aggregate statistics often fall short in detecting these pockets, underscoring the need for more targeted measurement approaches. Certain regions in emerging economies may lack such pockets. In such cases, investing in universities and generating new knowledge becomes crucial for their potential generation. Therefore, analysing the allocation of funding and investments in universities across different research areas can aid in the early identification of potential future "pockets of excellence". Additionally, reevaluating the theory of change and adjusting outcome expectations can facilitate the development of new indicators that effectively capture these pockets of excellence.

- **Sustainability carries different meanings in different countries**

Sustainability is a concept that takes on various meanings in different countries. Developing and emerging economies face unique challenges when it comes to achieving sustainability goals. While these countries share an interest in promoting sustainability, they each face distinct practical issues that are specific to their unique circumstances. As a result, each country adopts its own interpretation of sustainability. This lack of a standardized approach means that there is no simple solution, and that global metrics are difficult to be universally applied. Furthermore, the definition of sustainability not only varies by country, but often also by the governing body in power at a given time. Therefore, a one-size-fits-all approach is impractical. To effectively measure sustainability, metrics must be tailored to the specific objectives and contextual factors of each country.

- **Need to stay informed and optimize the use of newly available granular information**

Experts observed, in the past two decades, a growing interest in innovation policies and metrics in middle-income and developing economies, including at the sub-national level. Innovation policies and metrics have increasingly become a priority for countries at all stages of development, as a way to identify and strengthen economic niches that hold potential for novelty and socio-economic gains. This shift has led to the generation of both national and subnational innovation statistics in countries that traditionally lacked them. At the same time, more recently, the emergence of AI/machine learning and the generation of new micro-data present an increasing number of opportunities to create new indicators, which can allow detecting products and services with growth potential, both in developing and developed contexts. The mapping framework should continuously made efforts to explore ways to integrate and use this new information.

- **Recognize the importance of diversity and inclusion**

Measuring diversity and inclusion in innovation, including the participation of female scientists and entrepreneurs from low socio-economic backgrounds, poses a challenge. However, it is an essential aspect to consider in both developing and developed countries. Incorporating these indicators into the current framework appears to be a crucial step towards making it more relevant and robust.

References

Abramo, G., D' Angelo, C., & Di Costa, F. (2022). Measuring and interpreting the differences of the nations' scientific specialization indexes by output and by input. *Quantitative Science Studies, 3*(3), pp. 755-775. doi:https://doi.org/10.1162/qss_a_00206

Balland, P.-A., Boschma, R., Crespo, J., & Rigby, D. L. (2019). Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional Studies, 53*(9), pp. 1252-1268. doi:https://doi.org/10.1080/00343404.2018.1437900

Bigas, E., Bovenzi, N., Fuster, E., Massucci, F. A., Hollanders, H., Matusiak, M., & Reimeris, R. (2022). *Smart Specialisation in the Eastern Partnership Countries.* Luxembourg: Publications Office of the European Union. doi:10.2760/520032

Calvo-Gallardo, E., Arranz, N., & de Arroyabe, J. (2021, May). Analysis of the European energy innovation system: Contribution of the Framework Programmes to the EU policy objectives. *Journal of Cleaner Production, 298*. doi:https://doi.org/10.1016/j.jclepro.2021.126690

Catini, R., Karamshuk, D., Penner, O., & Riccaboni, M. (2015, May 14). Identifying geographic clusters: A network analytic approach. *Research Policy, 44*, pp. 1749-1762. doi:10.1016/j.respol.2015.01.011

Chen, C. (2017). Science Mapping: A Systematic Review of the Literature. *Journal of Data and Information Science, 2*(2), pp. 1-40. doi:10.1515/jdis-2017-0006

de Rassenfosse, G., Kozak, J., & Seliger, F. (2019, November 6). Geocoding of worldwide patent data. *Scientific Data, 6*(260). doi:10.1038/s41597-019-0264-6

Duran, N., Fuster, E., Massucci, F. A., Quinquillà, A., & Tolias, Y. (2019). *Science and Technology Panorama of the Western Balkans: Final Report.* Seville: European Commission.

Duran, N., Fuster, E., Massucci, F. A., Quinquillà, A., Plazas, A., & Tolias, Y. (2022). *Science and Technology Panorama of the Western Balkans: Final Report.* Seville: European Commission.

European Commission. (2022). *Science, research and innovation performance of the EU 2022 – Building a sustainable future in uncertain times.* Luxembourg: Publications Office of the European Union. doi:10.2777/78826

European Commission, DG Joint Research Centre. (2018). *Supporting an innovation agenda for the western Balkans : tools and methodologies.* Luxembourg: Publications Office of the European Union. doi:https://data.europa.eu/doi/10.2760/771136

Fuster, E., Massucci, F. A., & Matusiak, M. (2020). Identifying specialisation domains beyond taxonomies: mapping scientific and technological domains of specialisation via semantic analyses. In R. Capello, A. Kleibrink, & M. Matusiak, *Quantitative Methods for Place-Based Innovation Policy* (pp. 195-234). Cheltenham, UK: Edward Elgar Publishing. doi:10.4337/9781789905519.00014

Fiori, G., Ukraine, a Smart Specialisation Approach: A data driven approach in building a regional Smart Specialization Strategy, Report for the EC Joint Research Centre, 2018

Galic, M., and H. Hollanders, Final Report on the Quantitative analysis for Smart Specialisation in Bosnia and Herzegovina, Report for the EC Joint Research Centre, 2022

Hollanders, H., Mapping economic and innovation potential in the Ukraine – A revised measurement framework: Results for 3 pilot regions Kharkiv, Odessa and Zaporizhia, Report for the EC Joint Research Centre, 2019

Hollanders, H., Mapping economic, innovation and scientific potential in Montenegro, Report prepared for the Ministry of Science of Montenegro, 2018a

Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova, Report for the EC Joint Research Centre, 2017

Hollanders, H., Mapping of economic, innovative and scientific potential in the Republic of Moldova - Update, Report for the EC Joint Research Centre, 2018b

Hollanders, H., Mapping of smart specialisation in Georgia: economic and innovation potential for Imereti region, Report for the EC Joint Research Centre, 2020

Hollanders, H., Mapping of the economic and innovation potential of three regions in Tunisia, Report for the EC Joint Research Centre, 2021a

Hollanders, H., Quantitative mapping for Smart Specialisation in Kosovo, Report for the EC Joint Research Centre, 2021b

Hollanders, H., and I. Merkelbach, Mapping of the economic potential in Western Balkan economies, Study for the European Commission, DG Joint Research Centre, Seville, 2020

Hollanders, H. and Y. Tolias, Specialisation analysis of Tunisia: Evidence on the economic, scientific and innovation potential, Report for the EC Joint Research Centre, 2022

Hollanders, H., G. Ndubuisi, and S. Owusu, Mapping of the economic potential in Western Balkan countries, Study for the European Commission's Joint Research Centre. Extract published in Matusiak M., Kleibrink A. (ed.), Supporting an Innovation Agenda for the Western Balkans: Tools and Methodologies, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-81870-7, doi:10.2760/48162, JRC111430

Hollanders, H., & Tolias, Y. (2022). *Evidence on Tunisia's Specialisation Potential.* Seville: European Commission.

Innovatia Systems. (2021). *Analytical Support and Guidance for Smart Specialisation in Armenia.* Seville: European Commission.

Ioannidis, J. P., Boyak, K. W., & Baas, J. (2020, 10 16). Updated science-wide author databases of standardized citation indicators. *PloS Biology, 18*(10). doi:10.1371/journal.pbio.3000918

Janssen, M., Tolias, Y., & Pontikakis, D. (2021). *POINT Review of Industrial Transition of Greece: Renewables, Batteries and their Applications in Mobility, Agriculture, Shipping and Defence.* Luxembourg: Publications Office of the European Union. doi:10.2760/321029

Kang, M., & Hwang, J. (2016, September). Structural dynamics of innovation networks funded by the European Union in the context of systemic innovation of the renewable energy sector. *Energy Policy, 96*. doi:https://doi.org/10.1016/j.enpol.2016.06.017

Kroll, H., P. Neuhäusler, A. Feidenheimer, and D. Horvat, RIS3 Mapping of Albania, Report for the ËU for Innovation Project" funded by European Union, GIZ Germany, and Swedish International Development Cooperation Agency (SIDA), 2020

Kroll, H., E. Schnabl, D. Horvat, Mapping of economic, innovative and scientific potential in Serbia, Report for the EC Joint Research Centre, 2017

Leydesdorff, L., & Nerghes, A. (2017). Co-word maps and topic modeling: A comparison using small and medium-sized corpora (N < 1,000). *Journal of the Association for Information Science and Technology, 68*(4), pp. 1024-1035. doi:10.1002/asi.23740

Matusiak, M., Radovanovic, N., Nauwelaers, C., Kaczkowska, K., & Kramer, J. (2022). *Smart Specialisation implementation framework for the EU Enlargement and Neighbourhood Region.* Luxembourg: Publications Office of the European Union. doi:10.2760/056593

Mazzucato, M. (2018). *Mission-oriented research & innovation in the European Union : a problem-solving approach to fuel innovation-led growth.* Luxembourg: Publications Office of the European Union. doi:10.2777/360325

Mingers, J., & Leydesdorff, L. (2015). A review of theory and practice in scientometrics. *European Journal of Operational Research, 246*(1), pp. 1-19. doi:10.1016/j.ejor.2015.04.002

Natalicchio, A., Mora, L., Ardito, L., & Messeni Petruzzelli, A. (2022). vidence-informed decision-making in Smart Specialisation Strategies: a patent-based approach for discovering regional technological capabilities. *Regional Studies, 56*(9), pp. 1442-1453. doi:10.1080/00343404.2021.1988551

National Center for Development of Innovation and Entrepreneurial Learning (NCDIEL), Mapping economic, innovative and scientific potential in the Republic of North Macedonia, Report for GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2019

Panori, A., Kakderi, C., & Dimitriadis, I. (2022). Combining technological relatedness and sectoral specialization for improving prioritization in Smart Specialisation. *Regional Studies, 56*(9), pp. 1454-1467. doi:10.1080/00343404.2021.1988552

Paunov, C., Planes-Satorra, S., & Moriguchi, T. (2017). *What role for social sciences in innovation?: Re-assessing how scientific disciplines contribute to different industries.* Paris: OECD Publishing. doi:10.1787/8a306011-en

Pontikakis, D., Fernández Sirera, T., Janssen, M., Guy, K., Marques Santos, A., Boden, M., & Moncada-Paternò-Castello, P. (2020). *Projecting Opportunities for INdustrial Transitions (POINT): Concepts, rationales and methodological guidelines for territorial reviews of industrial transition.* Luxembourg: Publications Office of the European Union. doi:10.2760/590389

Prognos AG and CSIL. (2021). *Study on prioritisation in Smart Specialisation Strategies in the EU.* Luxembourg: Publications Office of the European Union.

Russo, M. and Pavone, P. (2021, July). Evidence-based portfolios of innovation policy mixes: A cross-country analysis. *Technological Forecasting and Social Change, 168*. doi:10.1016/j.techfore.2021.120708

Russu, D. and H. Hollanders, 2021 Mapping of economic, innovation and scientific potential in the Republic of Moldova, 2021

Schubert, A. and Braun, T. (1986, May). Relative indicators and relational charts for comparative assessment of publication output and citation impact. *Scientometrics, 9*, pp. 281-291. doi:10.1007/BF02017249

Sinjari, I. and H. Hollanders, Mapping economic, innovative and scientific potential in the Republic of Albania, Report for the EC Joint Research Centre, 2021

Squicciarini, M., Dernis, H., & Criscuolo, C. (2013). *Measuring Patent Quality: Indicators of Technological and Economic Value.* Paris: OECD Publishing. doi:10.1787/5k4522wkw1r8-en

Tolias, Y. (2021). *H2020 Mapping and S3 assessment in Tunisia and three pilot regions: Patent, Publication and Trademark Analysis.* Seville: European Commission.

World Bank Group. (2019). *Path for Ukraine's Economic Growth: Technology Upgrading.* Washington, DC: The World Bank Group.

List of abbreviations and definitions

BERT	Bidirectional Encoder Representations from Transformers
EaP	Eastern Partnership countries
EU	European Union
E&N	Enlargement and Neighbourhood
LFS	Labour force survey
LQ	Location quotient
IPC	International Patent Classification
IPR	Intellectual property rights
ISIC	International Standard Industrial Classification
NACE	Nomenclature of Economic Activities
NCI	Normalised citation index
R&D	Research and development
SBS	Structural business statistics - Eurostat
SITC	Standard international trade classification
S&T	Science and technology

List of boxes

List of figures

List of tables

Annexes

Annex 1. Agenda of the Technical Workshop "Towards a challenge-led approach to measuring territorial innovation potential" held in Sevilla on 21 and 22 February 2023.

Day 1 – February 21, 2023

12:45-14:00	Registration and welcome lunch
14:00-14:15	**Welcome and opening remarks**
	Alessandro RAINOLDI, Head of Unit, Joint Research Centre (JRC), European Commission
14:15-14:45	**Setting the scene: experiences with the implementation of the S3 Mapping Framework for EU Enlargement and Neighbourhood Region**
	Nikola RADOVANOVIC, Team Leader, Joint Research Centre (JRC), European Commission
	Hugo HOLLANDERS, Senior Researcher, Maastricht University, UNU-MERIT
	Yannis TOLIAS, Managing Partner, Innovatia Systems
14:45-16:15	**Experts' experience with the S3 Mapping Framework**
	Slavo RADOSEVIC, Professor, University College London (UCL)
	Hugo HOLLANDERS, Senior Researcher, Maastricht University, UNU-MERIT
	Yannis TOLIAS, Managing Partner, Innovatia Systems
	Enric FUSTER, Consulting Director, Siris Academic
	Lazar ZIVKOVIC, Associate Research Fellow, Institute of Economic Sciences, Belgrade
	Zoran ARALICA, Senior Research Fellow, Institute of Economics, Zagreb
	Moderated by Nikola RADOVANOVIC, Team Leader, Joint Research Centre (JRC), European Commission
16:15-16:30	Coffee break
16:30-17:30	**New challenges and needs for the framework - Moderated group discussion**
	Moderated by Elisa GERUSSI, Joint Research Centre (JRC), European Commission

Day 2 - February 22, 2023

09:00-10:30	**New challenges and needs to align the mapping framework with the sustainability challenges**
	Alasdair REID, Policy Director, European Future Innovation System (EFIS) Centre
	Asel DORANOVA, Researcher, Tilburg University
	Vassilien IOTZOV, Research and Policy Manager, ESPON (*remote*ly)
	Moderated by Michal MIEDZINSKI, Economic and Policy Researcher, Joint Research Centre (JRC), European Commission
10:30-10:45	Coffee break
10:45-12:15	**New challenges and needs to make the S3 mapping framework suitable for territories further beyond the European Union**

Chux DANIELS, Research Fellow, University of Sussex SPRU

Jan-Phillip KRAMER, Vice-Director, PROGNOS AG

Muzio GRILLI, European Patent Office (EPO) (*remotely*)

Lorena RIVERA LEÓN, Economist, World Intellectual Property Organisation (WIPO) (*remotely*)

Fernando VARGAS, Competitiveness, Technology, and Innovation Specialist, Inter-American Development Bank (IDB)

Lukovi SEKE, African Union Development Agency-NEPAD (*remotely*)

Moderated by Simone SASSO, Economic and Policy Analyst, Joint Research Centre (JRC), European Commission

12:15-12:45 **Wrap-up and closing**

Moderated by Alessandro RAINOLDI, Joint Research Centre (JRC), European Commission

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

— by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

— at the following standard number: +32 22999696,

— via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

Open data from the EU

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society

EU Science Hub
joint-research-centre.ec.europa.eu

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

@eu_science

Publications Office
of the European Union