Study on prioritisation in Smart Specialisation Strategies in the EU

Final Report

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ABSTRACT

Keywords: smart specialisation, regional funding, innovation policy, prioritisation

This study is about "Prioritisation in Smart Specialisation in the EU". It systematically screens and assesses all available S3 strategies across the EU to discover the respective approaches to prioritisation, to analyse if priorities set within the strategies correspond to innovation capabilities and if these were translated into concrete projects.

A complex and multi-faceted picture regarding prioritisation and implementation of smart specialisation strategies in the EU emerges: Priority areas of S3 strategies in the EU are largely based on objective data-driven identification processes. The EDP processes are appreciated by stakeholders but also illustrate room for improvement regarding continuous dialogue and data analysis on a granular level. This has led to prioritisation approaches across EU Member States/regions that define a limited, but often broad set of priority areas oriented towards R&D and more technology driven themes. In a majority of cases, a linkage between ERDF-funded projects in the field of R&I and associated S3 priority areas exists. An investment volume of approximately EUR 20 billion in S3 priority areas is indicative of the fact that the prioritisation approach was mostly effectively implemented in funding procedures. However, more than 25% of the S3 strategies do not match well with their endogenous innovation potential, while the remaining strategies only match well with a single element of the innovation ecosystem.

The study highlights that a better, more holistic delineation and specification of S3 priority areas is necessary to increase the effectiveness of smart specialisation along the different elements of the intervention logic.

ZUSAMMENFASSUNG

Schlagwörter: intelligente Spezialisierung, Regionalpolitik, Innovationspolitik, Priorisierung

Diese Studie befasst sich mit der "Prioritätensetzung im Rahmen der intelligenten Spezialisierung in der EU". Sie bewertet systematisch alle verfügbaren S3-Strategien in der EU, um die jeweiligen Ansätze zur Priorisierung zu entdecken, zu analysieren, ob die in den Strategien gesetzten Prioritäten den Innovationsfähigkeiten entsprechen und ob diese in konkrete Projekte umgesetzt wurden.

Es ergibt sich ein komplexes und vielschichtiges Bild hinsichtlich der Priorisierung und Umsetzung von Strategien der intelligenten Spezialisierung in der EU: Die Prioritätsbereiche der S3-Strategien in der EU basieren weitgehend auf objektiven, datengetriebenen Identifikationsprozessen. Die EDP-Prozesse werden von den Stakeholdern geschätzt, zeigen aber auch Verbesserungspotenziale hinsichtlich eines kontinuierlichen Dialogs und der Datenanalyse auf granularer Ebene auf. Dies hat zu Priorisierungsansätzen in den EU-Mitgliedstaaten/Regionen geführt, die eine begrenzte, aber oft breite Palette von Prioritätsbereichen definieren, die auf F&E und eher technologieorientierte Themen ausgerichtet sind. In den meisten Fällen besteht eine Verknüpfung zwischen EFRE-finanzierten Projekten im Bereich F&I und damit verbundenen S3-Schwerpunktbereichen. Ein Investitionsvolumen von ca. 20 Mrd. EUR in S3-Schwerpunktbereichen ist ein Indiz dafür, dass der Priorisierungsansatz in den Förderverfahren meist effektiv umgesetzt wurde. Allerdings stimmen mehr als 25 % der S3-Strategien nicht gut mit dem endogenen Innovationspotenzial überein, während die übrigen Strategien nur gut mit einem einzelnen Element des Innovationsökosystems übereinstimmen.

Die Studie unterstreicht, dass eine bessere, ganzheitlichere Abgrenzung und Spezifizierung der S3-Schwerpunktbereiche notwendig ist, um die Wirksamkeit der intelligenten Spezialisierung entlang der verschiedenen Elemente der Interventionslogik zu erhöhen.

RÉSUMÉ

Mots clés : spécialisation intelligente, financement régional, politique d'innovation, hiérarchisation des priorités.

Cette étude porte sur la "hiérarchisation des priorités dans la spécialisation intelligente dans l'UE". Elle passe en revue et évalue systématiquement toutes les stratégies S3 disponibles dans l'UE afin de découvrir les approches respectives de la hiérarchisation, d'analyser si les priorités fixées dans les stratégies correspondent aux capacités d'innovation et si elles ont été traduites en projets concrets.

Une image complexe et à multiples facettes concernant la priorisation et la mise en œuvre des stratégies de spécialisation intelligente dans l'UE émerge: Les domaines prioritaires des stratégies S3 au sein de l'UE sont largement fondés sur des processus d'identification basés sur des données objectives. Les processus informatiques sont appréciés par les parties prenantes, mais illustrent également les possibilités d'amélioration en matière de dialogue continu et d'analyse des données à un niveau granulaire. Cela a conduit à des approches de priorisation dans les États membres/régions de l'UE qui définissent un ensemble limité, mais souvent large, de domaines prioritaires orientés vers la R&D et des thèmes plus technologiques. Dans la majorité des cas,il existe un lien entre les projets financés par le FEDER dans le domaine de la R&I et les domaines prioritaires associés à la S3. Un volume d'investissement d'environ 20 milliards d'euros dans les domaines prioritaires de la S3 indique que l'approche de priorisation a été, pour la plupart, efficacement mise en œuvre dans les procédures de financement. Toutefois, plus de 25 % des stratégies S3 ne correspondent pas à leur potentiel d'innovation endogène, tandis que les autres stratégies ne correspondent qu'à un seul élément de l'écosystème de l'innovation.

L'étude montre qu'une meilleure délimitation et une spécification plus holistique des domaines prioritaires de la S3 est nécessaires pour augmenter l'efficacité de la spécialisation intelligente le long des différents éléments de la logique d'intervention.

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GLOSSARY

BERD	Business enterprise expenditure on R&D
CPR	Common Provisions Regulation (for the structural funds)
DG	Directorate-General
EC	European Commission
EDP	Entrepreneurial Discovery Process
EIP	European Innovation Partnership
EPO	European Patent Office
ERDF	European Regional Development Fund
ESIF	European Structural and Investment Funds
EU	European Union
EU13	EU13 Member States are meant as Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
EU15	The EU15 comprises the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, and the former EU Member State United Kingdom.
ExACs	Ex ante conditionalities
FG	Focus group
FI	Financial Instrument
FOR	Field of Research
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GPT	General purpose technology
GRID	Global Research Identifier Database
GVC	Global value chains
H2020	Horizon 2020
ICT	Information and Communication Technology
IPC	International Patent Classification
JRC	Joint Research Centre
LDA	Latent Dirichlet Allocation
LFS	Labour Force Survey
LQ	Location quotient

MA	Managing Authority (in the case of AMIF this term is used to designate the responsible authority)
MFF	Multi-annual financial framework
NACE	Statistical classification of economic activities in the European Community
NUTS	Nomenclature of Territorial Units for Statistics
OP	Operational Programme
R&D	Research & Development
R&I	Research & Innovation
RIS	Regional Innovation Scoreboard
S3	Regional innovation strategy for smart specialisation
RQ	Research questions
SDGs	Sustainable Development Goals
SRIPs	Strategic Research and Innovation Partnerships
TO	Thematic Objective
TO1	Thematic Objective focussing on "Strengthening research, technological development and innovation"
WIPO	World Intellectual Property Organization

EXECUTIVE SUMMARY

Background and Objectives

This summary relates to the final report on the **Study on Prioritisation in Smart Specialisation Strategies in the EU**, undertaken in 2020/2021 by a team led by Prognos AG and experts from the Centre for Industrial Studies (CSIL).

The study systematically screened and assessed all available S3 strategies (185) across the EU that fulfil the ex-ante conditionality (ExAC 1.1). S3 strategies should foster the EU's innovation policy at a regional level and should channel ERDF funding into a region's priority areas. The study addressed the following three overarching questions:

- Has a prioritisation been achieved in the S3 strategies?
- To what extent do the selected priorities reflect the regional profile?
- How have the S3 strategies and the selected priorities been implemented?

Key Study Findings

These overarching questions have been further specified in 13 research questions. For some research questions, very comprehensive answers could be provided, for some others the base of evidence is less clear, in particular on the effectiveness of S3 strategies, and calls for further investigation in the future.

A. Strategy development & prioritisation approaches

The analysis of the strategy development is mainly based on stakeholder interviews as well as in depth research of the respective 185 S3 strategies. The analysis of prioritisation approaches builds on a matching approach, in which the respective priorities were linked to NACE sectors (economic sectors), FOR (scientific fields) or WIPO technology classes (technology fields).

1. Has the prioritisation been developed through an Entrepreneurial Discovery Process (EDP)? On which level and with what methodologies? How have economic/scientific/technological strengths been assessed?

Overall, **77% of the S3 strategies in the 2014-2020 period are based on an EDP** that has been specifically set up for the respective strategy. 12% of the S3 strategies have made use of an 'old' EDP, meaning that a process of involving stakeholders has taken place, but not specifically designed for the S3 strategy. Generally, most of the EDPs involve stakeholders from the research sector (90% of all identified S3 strategies), the private sector (90%) and the public sector (89%). 53% include stakeholders from a civil society organisation.

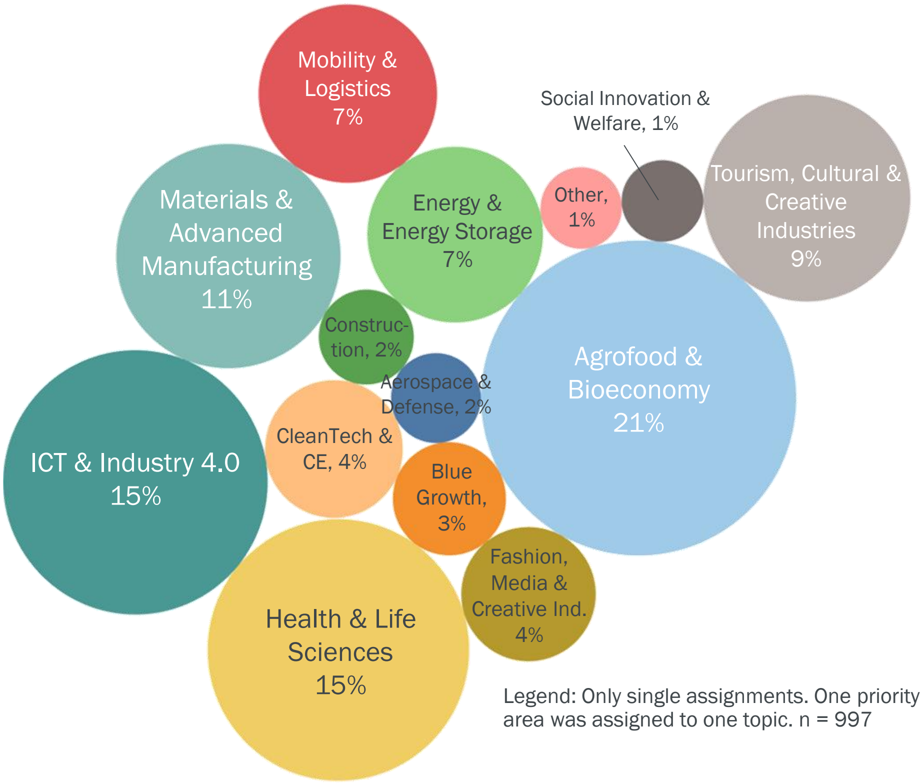
However, a **continuous EDP could not be established in many regions, although formal continuity was slightly higher in EU13/less developed regions.** The continuation of the EDP (involvement of stakeholder in the implementation and monitoring phases) are seen as important but difficult to achieve. Examples illustrate that involving cluster organisations can be an effective way to ensure a more continuous private sector involvement.

Finally, **data analysis to determine S3 priority areas has in many cases not been sufficiently granular.** For instance, regarding the analysis of the economic performance, only 12% of the S3 strategies make use of NACE-2/3-digit data. For the analysis of technological/scientific performance, only 19% use more in-depth data. Qualitative evidence shows that a too general data analysis or a sheer lack of data analysis are key obstacles when attempting to narrow down S3 priorities.

2. Is the prioritisation based on sectors or scientific and technology fields or was it an interdisciplinary/cross-sectoral approach?

Overall, we found that **Agrofood & Bioeconomy (21%), Health & Life Sciences (15%) and ICT & Industry 4.0** are topics that are addressed most by S3 strategies across the EU (see Figure 0-1). The single most related fields are engineering, information & computing science as well as agricultural and veterinary sciences for the scientific fields (FOR), and scientific R&D, computer programming & manufacture of computer, electronic and optical products for the economic sectors (NACE). Computer technology, digital communication and electrical machinery, apparatus and energy are the most matched technology fields. This also indicates that ICT is not only important as a priority area itself but also as a topic within other priority areas, confirming its role as a general-purpose technology (GPT).

Figure 0-1 (ex. sum.): Share of overarching topics addressed by S3 priority areas



Source: Prognos / CSIL (2021). Note: n= 185 regions. The is based on an LDA (Linear discriminant analysis) through which overarching topics were defined based on priority descriptions.

When comparing the **main selection approaches** of S3 priority areas, strategies refer to all approaches but especially economic sectors (64%), scientific fields (60%) and slightly less to technology fields (48%).[1] In fact, many Member States'/regions' priorities rather reflect a combined approach**.** 119 out of 185 S3 strategies (64%) contain scientific, technological, and economic selection approaches and are simultaneously linked to natural and cultural assets as well as specific societal goals.

Moreover, the study shows that **more than 90% of all S3 strategies** (168 out of 185; 91%) **contain an explicit reference to the societal challenge 'Climate action/resources'**. Similarly, the same figure points to a high rate of S3 linkages with the societal challenges subgroups 'Health' (79%), 'Agriculture' (76%), and 'Energy' (72%).[2] On a more granular level, the subgroups that are most often addressed are to

[1] Defined according to the NACE (economic sectors), FOR (scientific fields) or WIPO technology classes (technology fields)

[2] According to Gianelle et al. (2016), priorities could be framed in terms of knowledge fields or sectors that are particularly relevant to societal and environmental challenges.

ensure 'Sustainable consumption & production patterns', 'Good health and well-being' and 'Ensure access to affordable, reliable, sustainable & modern energy for all'. When assessing which cultural or natural resources the priority areas have been based upon most frequently, a region's cultural heritage is most prevalently identified – by 80 S3 strategies (43%).

3. How and with what outcome has prioritisation been achieved in the S3 strategies?

Almost all Member States/regions address highly complex technology fields and sectors. There are no significant differences between types of regions (less developed etc.), high technology domains are comparably emphasised. The similar preference for R&D- and high-tech intensive activities can however be seen as evidence that economically weaker regions (less developed) appear to use S3 to leapfrog into R&D-driven sectors.

In most of the Member States/regions (166/185), the share of technology fields in the strategies that are highly complex amounts to less than 50% (technological complexity). Concerning economic complexity, it can be seen that in most strategies (160/185) high-technology manufacturing or high-tech service sectors represent less than 50% (on average) of all addressed economic sectors.

4. At what level of granularity has this prioritisation taken place?

A granular approach to prioritisation allows for a greater impact by achieving critical mass and avoiding the spread of innovation funding too thinly across too many priority areas. One indicator is the number of priority areas per S3 strategy. **The number of priorities varies across regions**, ranging from as few as two to a maximum of 14 or 15. The average number of priorities per region is 5.5 and the median is five.

Table 0-1 (ex. sum.): Number of priority areas of the S3 strategies in Member States/regions (latest S3 strategy year)

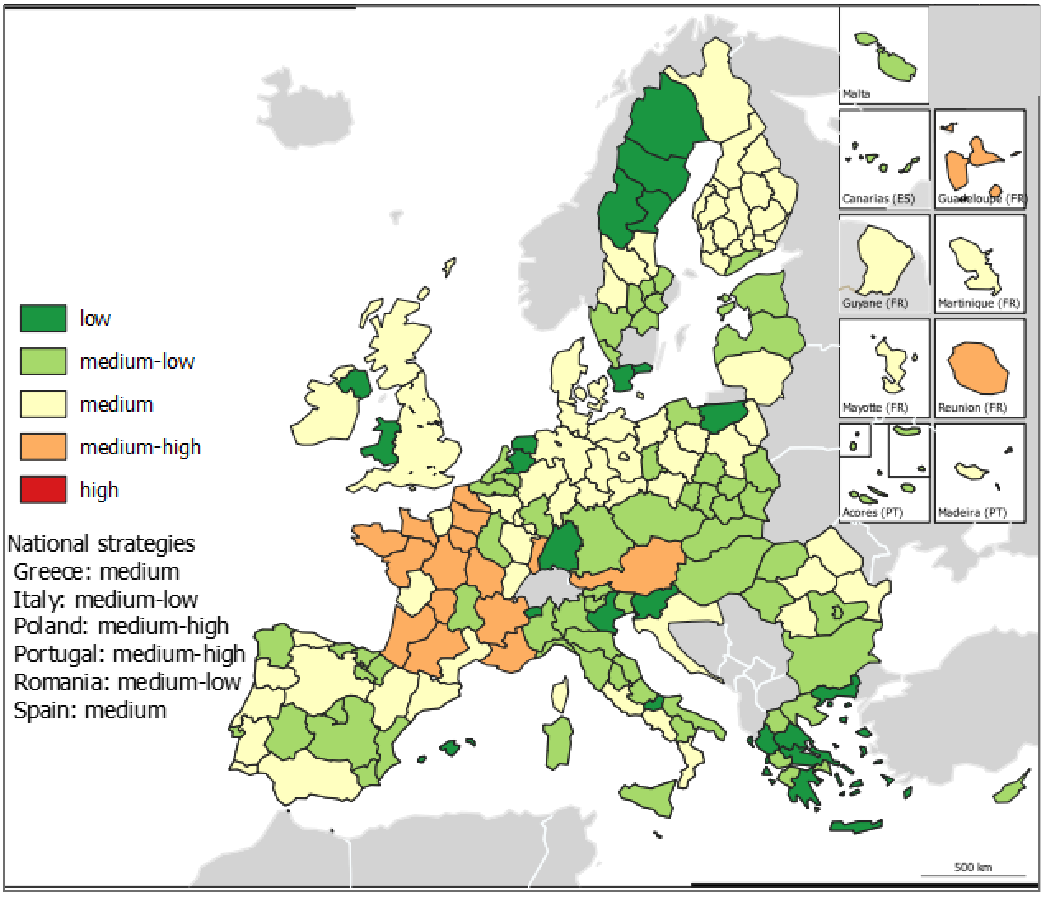
	All regions	Less developed	Transition	More developed
Total	1014	325	189	500
Average per region	5.5	5.6	5.4	5.4
Median	5.0	6	5	5
Range: MIN – MAX	2 -15	2 – 15	2 – 8	2 – 15

Source : Prognos / CSIL (2021). Note : n=185 regions.

However, **the absolute number of priority areas can be misleading** to determine if a S3 strategy's priorities are granular or not. This goes particularly for Member States/regions that use a multi-level structure with a few broadly defined main priority areas and several sub-priorities. A further indication of the granularity can be drawn from the analysing the thematic broadness (analysed through the thematic bandwidth index). About 75% of the S3 strategies fall into the medium-low to medium bandwidth category (i.e., bandwidth index between 20-60%, EU average = 38%). Member States/regions with particularly broad S3 strategies are Portugal (bandwidth index of 76%), Poland (66%), and Austria (63%; all national S3 strategies) as well as a number of French regions such as Bretagne (80%), Limousin (74%) or Pays de la Loire (70%).

Furthermore, the **analysis on the correlation between the S3 strategies' number of priority areas, their thematic bandwidth and concentration with some regional characteristics** has shown that the granularity and selectivity of S3 strategies seem to be at least partially related to the Member States'/regions' size.

Map 0-1 (ex. sum.): Bandwidth index of the S3 strategies in the EU Member States/regions (latest S3 strategy year)



Source: Prognos / CSIL (2021). n = 165 Member States/regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania. Data for Swedish and Finish regions aggregated at the NUTS2 level. The index of bandwidth indicates the thematic broadness that a S3 strategy covers. It is measured by the degree to which the strategy targets all the possible economic sectors, scientific and technological fields. It is defined as a %-share, where the number of economic sectors, scientific and technological fields targeted by the strategy is divided by the total number of existing economic sectors, scientific or technological fields (respectively 88 economic sectors, 22 scientific fields, 35 technology fields). Hence the share ranges between 0% and 100%.

B. Correspondence of regional profiles with selected priority areas

The correspondence between S3 priority areas and the Member States'/regional profiles was investigated mainly through in-depth analysis. For each S3 strategy, we analysed variables capturing S3 priorities and variables capturing the economic, scientific, and technological profiles and strengths of the Member Stages/regions, as measured by employment, publication, and patent-based indicators, respectively. Findings were then enriched and validated using econometric models, cluster analyses and qualitative case studies.

5. Which rationale (economic, scientific, or technological) prevailed, i.e., better explains the chosen set of priorities?

Overall, priorities reflect scientific and technological profiles of Member States/regions better than they do with economic profiles. This might be due to a plethora of reasons, related for example to copycat behaviours that did not take into account endogenous capacities or the ambitions to develop new sectors. A stronger correspondence between the S3 priorities and the scientific and technological capabilities of the Member States/regions may indicate that the strategy aims at affecting the most knowledge or technology-intensive sectors of the economy, or to trigger a knowledge or technological upgrade process which could eventually lead to the emergence of new market niches or fuel structural transformation.

6. How does the prioritisation reflect the current economic structure of the region? How does the prioritisation reflect ongoing changes and future developments of the economic structure?

S3 strategies generally do not match the economic profiles of the Member States/regions (as reflected by employment data by NACE economic activity). The regions that best match economic profiles are mostly transition and less developed regions. Among them, we find various Greek regions that prioritised agro-food and tourism sectors, which employ large shares of their populations. The analysis also shows that while few regions stand out for prioritising current economic structures, slightly more chose priorities in line with sectors in transformation, as measured by growth rates of employment in the three years before or after the publication of the S3 strategy. This indicates that, at least to some extent, **some S3 strategies considered ongoing processes of structural transformation**.

7. How does the prioritisation reflect scientific strengths of the region? How have scientific strengths been assessed (based on public institutions only or including private organisations/research capacity of business)?

S3 priorities match well the scientific profiles of EU Member States/regions. In general, many Member States/regions selected S3 priorities in areas of strong scientific production, as measured by numbers of publications by FOR in each Member State/region. However, these were not necessarily areas of scientific excellence on an international level.

A key question of this study concerned the degree to which both public *and* private technological capacities were reflected in the prioritisation exercise. On average, **strategies match well the publication profile of both the private organisations (companies) and the public sector**. This finding is in line with the fact that both public and private sector stakeholders have been involved in the EDP of most of the S3 strategies. The strategies that match better their public scientific profile, instead, are mostly from less developed and transition regions and Member States, also classified as moderate or modest innovators.

8. How does the prioritisation reflect technological strengths of the region? How have technological strengths been assessed (based on business capacities only or including public institutions)?

S3 priorities match relatively well technological profiles of Member States/regions, as proxied by patent shares across the different technological fields. Most of the Member States/regions that better reflected their technological profile in the S3 are more developed, also classified as innovation leaders or strong innovators. In line with what was observed for scientific profiles, **strategies seem to reflect better private technological profiles and strengths** than public ones, although the difference is small.

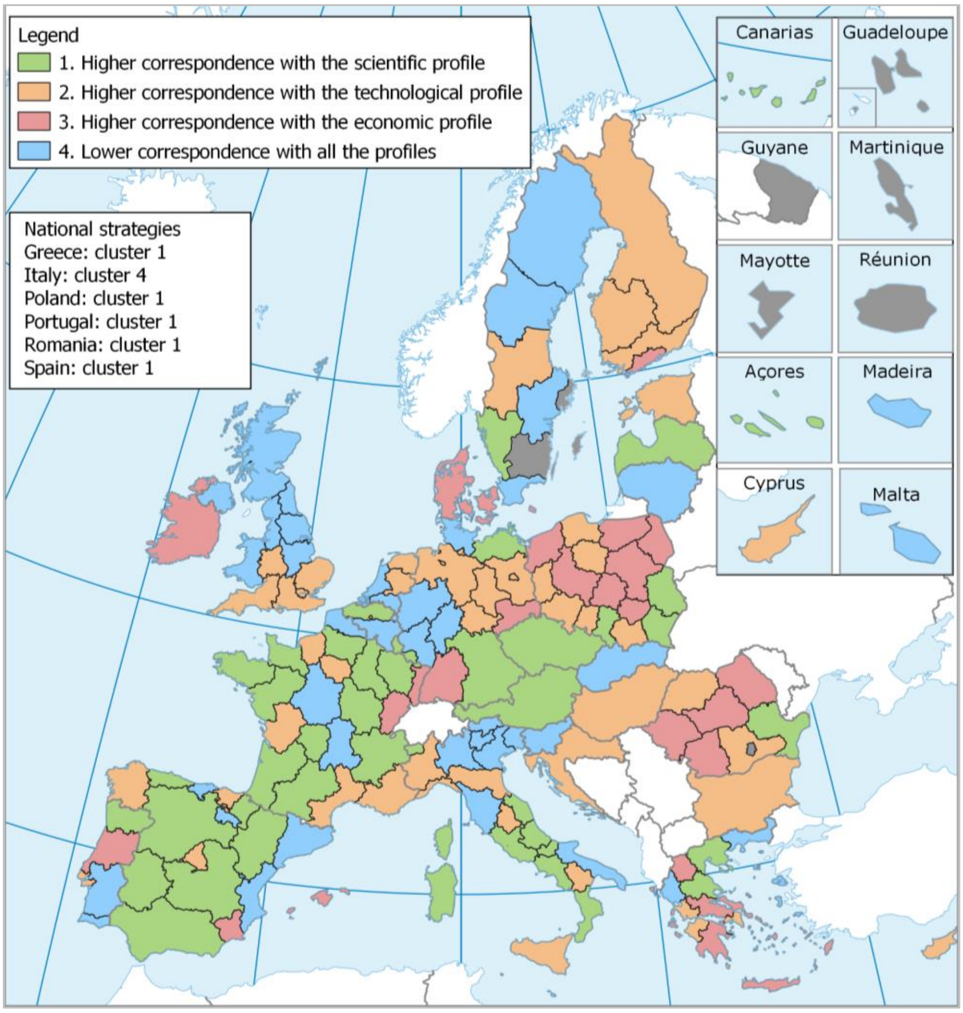
9. To what extent does the prioritisation address issues such as diversification, specialisation, upgrading and related variety?

To explore this issue, this study computed and used the indexes of technological relatedness density and technological complexity developed in the literature. The correlation analysis shows that **several Member States/regions chose fields closer to their knowledge space**. This approach was followed by more and less developed regions alike, and no clear-cut categorisation can be found in terms of innovation profiles. To better characterise the S3 strategies adopted, we compute a **metric of the degree of ambition of the strategy**, reflecting the degree to which a strategy has selected priority areas that can be regarded as overly or underly complex as compared to the mix of technologies already mastered by the Member State/region. Based on these new metrics, a strategy that aimed at unrelated diversification and targeted complex technologies is marked as an ambitious strategy (see Chapter 5 for detailed maps). Even if some S3 strategies followed a more ambitious approach, by selecting unrelated and quite complex technologies, more research would be needed to understand whether such an approach can be considered still feasible, rather than over-ambitious for the specific Member State /region.

10. How was the information on the economic structure, scientific strengths and technological strengths combined in the overall strategy? Are there common traits among regions that allow categorising their heterogeneous experiences?

We identified **four groups of strategies**, each one characterised by a relatively similar prioritisation approach in the correspondence of the S3 strategies with the regional profiles:

Map 0-2 (ex. sum.): Groups of S3 strategies according to the correspondence of their S3 priority areas with the regional/national profiles



Source: Prognos / CSIL (2021). Note: The map shows the specific cluster to which the latest S3 strategies belong. Grey coloured regions are excluded from the analysis because of missing data.

1. **61 S3 strategies (29%) show a higher correspondence with the scientific profile**: this group is characterised by a prevalence of EU15 Member States, transition regions, and moderate or modest innovators, with a low share of the population engaged in Science and Technology, and quality of government index below the EU average. One interpretation of these results could lead us to presume that this group of Member States and regions has some scientific competencies which are not effectively translated into technological competencies within firms, yet.

2. **62 S3 strategies (30%) have a higher correspondence with the technological profile**: this cluster is typically made of highly diversified Member

States/regions with a good innovation profile (classified as an innovation leader, strong or moderate innovator) and a high share of population employed in Science and Technology. Member States and regions that adopted this prioritisation approach can be found in various parts of the EU, with a significant share of them from Central Eastern, Northern, and Western Europe.

3. **33 S3 strategies (16%) have a higher correspondence with the economic profile**: this prioritisation approach seems more spread across transition regions and modest innovators, with a low degree of economic diversification, often in Central and Eastern Europe.

4. **53 S3 strategies (25%) exhibit a relatively low correspondence with any profile**: this prioritisation approach was followed by many EU15 Member States/regions, often characterised by high economic diversification, a strong innovation profile, and high-quality government. The strategies that belong to this group also seem to rank high in terms of their ambition, aiming at unrelated diversification and relatively complex technologies.

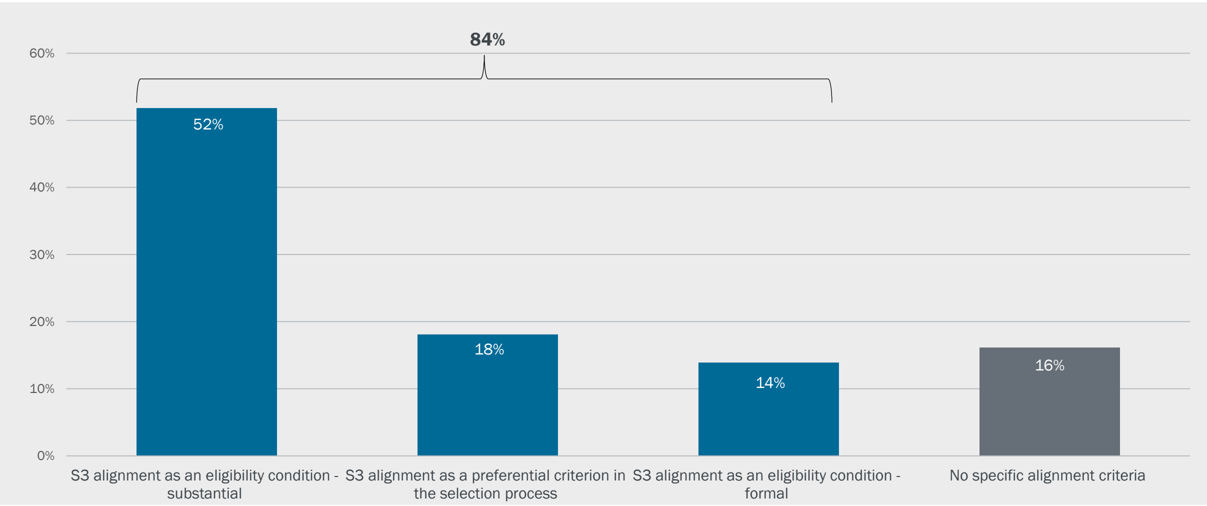
C. Implementation of S3 strategies

The analysis of the implementation of S3 strategies was conducted through collection of ERDF-TO1 relevant calls for proposals and the respective ERDF funded R&I projects. It was investigated to what extent calls for proposals contain strict alignment criteria with the S3 strategies and if projects are thematically linked to the priorities of the respective regions.

11. How was the prioritisation reflected in the preparation and implementation of calls?

As Figure 0-2 shows, **almost all (84%) of the over 2,300 ERDF-TO1 calls for proposals foresee an alignment with the S3 strategies**. Correspondingly, only 16% do not require such an alignment. The analysis further reveals that with 52% most of the calls require a substantial alignment to the S3. Calls that prefer S3-related proposals in the selection process account for 18% of the collected calls. Moreover, 14% of the calls are characterised by a formal S3 alignment condition.

Figure 0-2 (ex. sum.): S3 alignment criteria (all regions)



Source: Prognos / CSIL (2021). Note: To account for large variations in the number of calls between the Member States/regions the share in each region was computed and then averaged out. N=2,324

The finding that most of the calls require an alignment to the S3 is further substantiated by the interviews that were held with the respective S3 managing authorities. From among

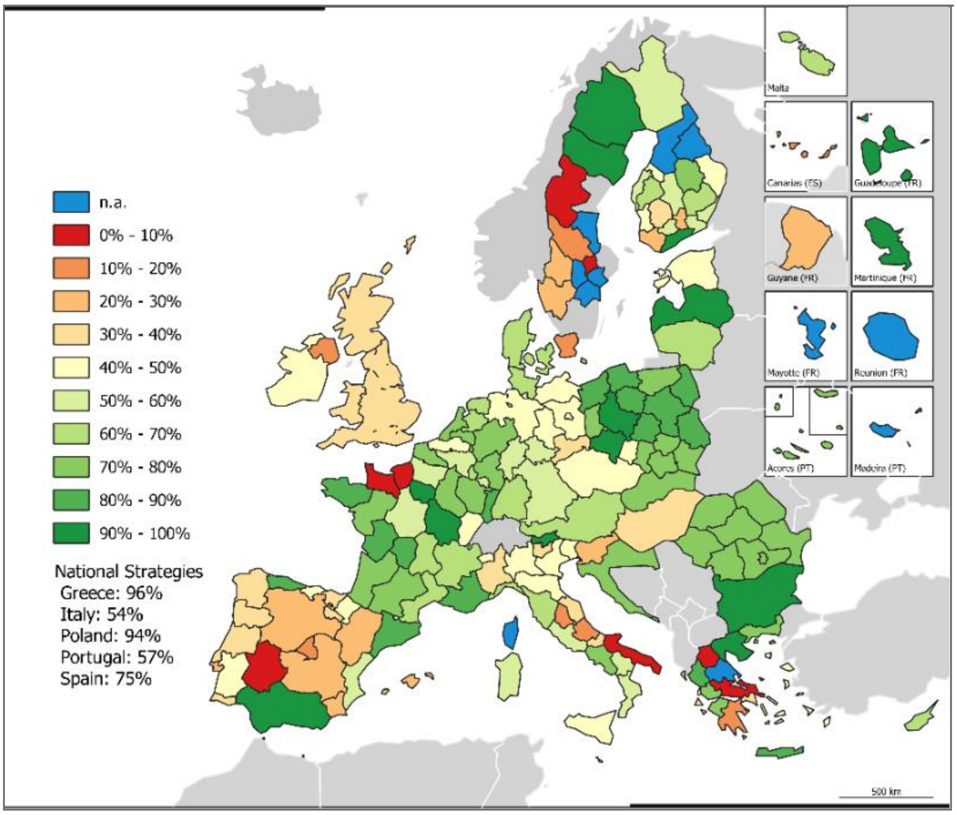
176 interviewees[3], 95% indicated that the priorities as outlined in the S3 strategies were reflected in the preparation and implementation of the programmes and/or calls for proposals.

The majority of the S3 related calls for proposal address all priority areas at the same time. A subset of priority areas is addressed in 15% and only one priority area in 11% of all collected calls which fall under TO1. However, there exist some noticeable regional differences as less developed regions have a higher percentage of calls that address all priority areas at the same time (broader calls) compared to transition and more developed regions. The latter indicates that transition/more developed regions seem to use more tailored calls to develop their S3 priority areas.

12. How did the project selection process reflect the prioritisation? Has the selection process led to the projects' implementation in the priority areas?

The analysis finds that **on average 57% of ERDF R&I projects are connected to the priority areas** as outlined in the S3 strategies.[4] In total, **EUR 19.6 billion have been spent on R&I projects linked to S3 priority areas**, 62% of the budget that has been identified for all R&I projects. However, as the map below shows, there are **major differences between Member States/regions** regarding the degree to which ERDF R&I projects correspond with S3 priorities: While only 54% of the projects from EU15 Member States/regions are corresponding to the S3 priorities, the share in EU13 Member States/regions is 65%. Interestingly, less developed regions show on average more projects connected to their S3 priorities (average of 60%), compared to transition (58%) and more developed regions (54%).

Map 0-3 (ex. sum.): Share of projects and budget that are linked to priority areas



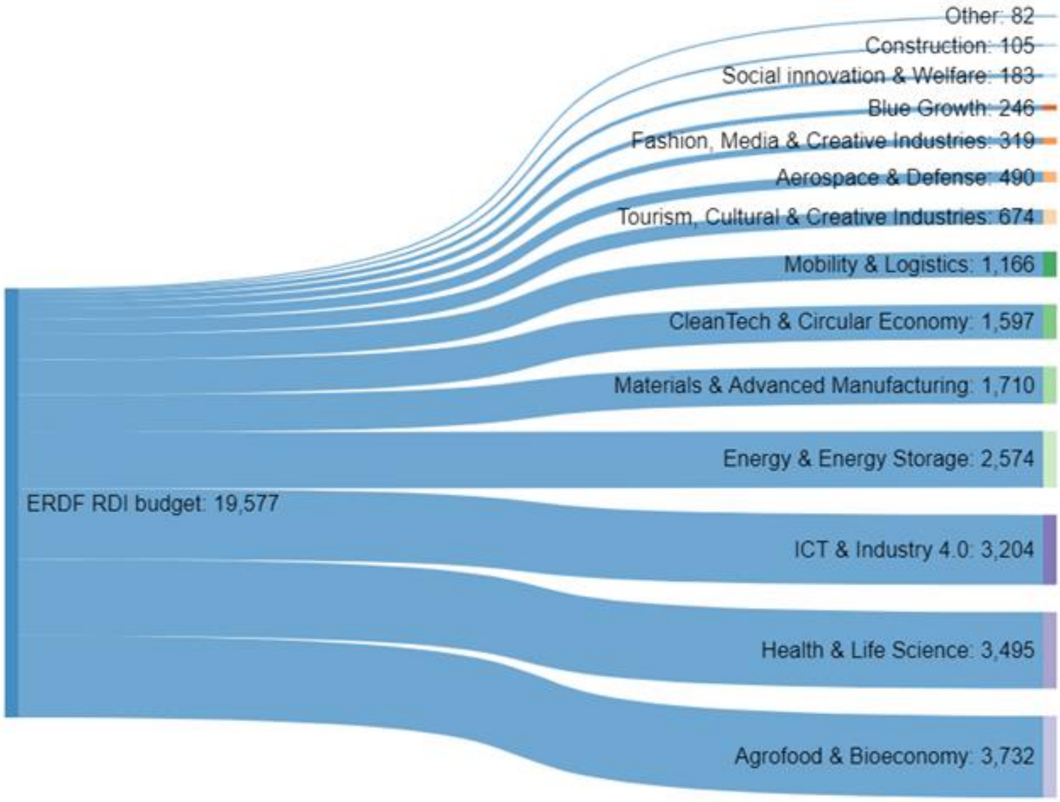
Source: Prognos / CSIL (2021). n = 167 regions.

[3] 176 interviewees out of a total of 181 interviewees gave an answer to this question.
[4] Here it is referred to the initial S3 strategies of 167 Member States/regions. The difference between the number of S3 strategies (185) and the total number of Member States/regions that are used for this section exists because some regions did not record any projects (Thessaly, several Finnish and Swedish regions, Mayotte, Martinique) or there were no projects on the NUTS level of the S3 strategy (regions in Romania, OP only on a national level).

13. Has the selection process led to focus on specific smart specialisation areas?

Below the volume of ERDF funding that has been spent on projects with S3 linkage in the different thematic domains of S3 strategies across the EU Member States/regions is presented.[5] Altogether almost EUR 19,6 billion have been channelled into R&I projects in the S3 priority areas. Around 50% of these project budgets have been directed towards three thematic domains, namely **'Agrofood & Bioeconomy' (EUR 3.7 billion; 19%), 'Health and Life Sciences' (EUR 3.5 billion; 17.9%) and 'ICT & Industry 4.0' (EUR 3.2 billion; 16.3%)**.

Figure 0-3 (ex. sum.): Overarching thematic domains and budget that was spent on these in the course of ERDF projects



Source: Prognos / CSIL (2021). Note: The numbers are based on the projects that were successfully connected with the priority areas of 167 regions, meaning that projects that potentially fell into a certain overarching thematic area, were however not connected with a priority field, are not included here. The overall budget that has been linked to these and which is the basis for this figure is EUR 19.6 billion.

Headline Conclusions

Strengths and weaknesses of prioritisation and implementation of S3 strategies in Europe

1. A broad stakeholder process has been applied in the majority of Member States/regions.
2. Member States/regions have used a wide range of different instruments and processes when it comes to the EDP and data analysis.
3. A continuous EDP could not be established in many regions, although formal continuity was slightly higher in EU13/less developed regions.
4. Data analysis to determine S3 priority areas has in many cases not been sufficiently granular.

[5] Therefore, this means that this is not an overview thematic distribution of ERDF R&I funding overall but rather an overview of the thematic distribution of ERDF R&I funding that is linked to the S3 priorities.

Prioritisation approaches used in S3 strategies

5. The most prevalent topics addressed in the S3 priority areas are linked to engineering and ICT-related fields.
6. Priority areas are mostly based on a combined priority-setting approach and are generally not framed in terms of single scientific, economic, or technological fields.
7. There are only very minor regional differences regarding the degree of complexity of S3 strategies and their priority areas.
8. Referring to the absolute number of priority areas is misleading, especially for Member States/regions that use a multi-level (tree-shaped) structure with a few broadly defined main priority areas and several sub-priorities.
9. Larger and economically stronger Member States/regions seem to prioritise less compared to smaller regions.

Correspondence of the S3 strategies with the regional profile

10. Even if S3 priority areas may be defined in terms of economic sectors, S3 priority areas generally do not match the economic profiles of the Member States/regions (according to any employment-based indicator used).
11. Priority areas of S3 strategies more often match the scientific profiles of EU countries and regions.
12. S3 priorities generally match the technological profiles of Member States/regions
13. Both public and private-sector scientific and technological strengths seem to be reflected quite well in the S3 strategies.
14. Several S3 strategies selected priority areas closer to their knowledge space
15. In synthesis, four groups emerge when considering the overall correspondence of S3 priorities with the national/regional profiles: 61 S3 strategies *match particularly well* with their scientific profile (29%); 62 S3 strategies *match particularly well* with their technological profile (30%); 33 S3 strategies have a *good level* of correspondence with the economic profile (16%); 53 S3 strategies *do not match well* with any profile (scientific, economic, technological), but reveal higher ambition in terms of technological innovation and diversification goals (25%).

Implementation of the selected S3 priorities

16. ERDF funded calls/programmes predominantly require an alignment to the S3 strategies.
17. Linkages between ERDF-funded projects and S3 priorities were found for 57% of the projects but there are substantial differences among MS/regions.
18. Overall, strict S3 eligibility criteria seem to be well applied in the project selection processes and support the selection of projects linked to priority areas.
19. The most frequently addressed priority areas of S3 strategies are also reflected in the implemented projects.

Outlook and the S3 Scoreboard 2021

The findings of this study include **several key lessons and recommendations** that policy makers can draw upon in the continuation of S3 implementation, the entrepreneurial discovery process, and in fostering innovation-based growth in their territory beyond the specific S3 strategy. While this study did not, or only partially, cover all challenges related to S3 design & implementation (e.g., with regards to the design of policy instruments, S3 governance, etc.), several important learnings at the core of the S3 concept are put forward that can help Member States/regions respond better to the challenges ahead and can effectively contribute to a sustainable, post-pandemic recovery.

The following **key recommendations** can be outlined:

Recommendations on the identification of S3 priority areas

Identification of econ. / scient. / techn. potentials

1. The identification of potential priority areas requires a more **holistic, fine-grained and dynamic perspective**
2. Potential priority areas of S3 strategies need to be positioned in a **global perspective**

Identification of cross-sectoral & transformative areas

1. Identifying innovation strengths by using data from competitive **public funding programmes**
2. Mapping and profiling S3 priority areas using **unstructured data and semantic analysis**
3. Analysing the **related variety** of potential specialisation domains

Recommendations on S3 governance, EDP and implementation as well as monitoring & evaluation

Governance and EDP / Implementation

1. Build up **more effective and participatory governance** structures for the implementation of S3 strategies
2. Enlarge and improve the **outcomes of the EDP**
3. Enhance the promotion of supra-regional and international forms of **cooperation and networking**
4. Optimise the process from S3 strategy to implementation through **"transformation roadmaps"**
5. Reshape the **policy mix & funding instruments** for the support of S3 priority areas

Monitoring and evaluation

1. **Upgrade and fine-tune** S3 monitoring systems, establish thorough S3 evaluation plans
2. Aim for more **holistic communication** on S3 strategies

Finally, the study developed a **"S3 Scoreboard"** as a comparative assessment of all 185 smart specialisation strategies in EU Member States and regions based on a novel methodology. More precisely, the S3 Scoreboard covers **163 regions across 28 European countries**. In addition, S3 strategies at the **country level,** like in Malta, Luxembourg, or Cyprus, are included. It provides a detailed breakdown of performance groups with contextual data, including the share of ERDF budget linked to S3 priority areas, the continuity of the EDP or the strictness of selection criteria for S3 related calls under ERDF 2014-2020, that can be used to analyse and compare the sophistication of S3 strategies across the EU now and in the future.

Overall, the **S3 Scoreboard 2021 shows a stark variation** reflecting the different starting points for smart specialisation in terms of the strength of the research and innovation system, the amount of resources available compared to national resources and levels of aid intensity. Many S3 Leaders can be found in Less Developed Regions, whereas the Nordic Countries, the UK or some German, French, and more developed Spanish regions show rather modest S3 strategies. The 22 national S3 strategies across the EU perform relatively well.

ZUSAMMENFASSUNG

Hintergrund und Ziele

Diese Zusammenfassung bezieht sich auf den Abschlussbericht zur **Studie "Prioritisation in Smart Specialisation Strategies in the EU**", die 2020/2021 von einem Team unter Leitung der Prognos AG und Experten des Centre for Industrial Studies (CSIL) durchgeführt wurde.

In der Studie wurden alle verfügbaren S3-Strategien (185) in der EU systematisch gescreent und bewertet, die die Ex-ante-Konditionalität (ExAC 1.1) erfüllen. S3-Strategien sollen die Innovationspolitik der EU auf regionaler Ebene fördern und EFRE-Mittel in die Spezialisierungsfelder einer Region lenken. Die Studie befasste sich mit den folgenden drei übergreifenden Fragen:

- Wurde in den S3-Strategien eine Priorisierung vorgenommen?
- Inwieweit spiegeln die gewählten Prioritäten das regionale Profil wider?
- Wie wurden die S3-Strategien und die gewählten Prioritäten umgesetzt?

Zentrale Ergebnisse der Studie

Diese übergreifenden Fragen wurden in 13 Forschungsfragen weiter spezifiziert. Für einige Forschungsfragen konnten umfassende Antworten gegeben werden, für einige andere ist die Evidenzbasis weniger klar, insbesondere zur Wirksamkeit von S3-Strategien. Weitere Untersuchungen werden in Zukunft hierzu notwendig sein.

A. Strategieentwicklung & Priorisierungsansätze

Die Analyse der Strategieentwicklung basiert im Wesentlichen auf Stakeholder-Interviews sowie einer Tiefenrecherche der jeweiligen 185 S3-Strategien. Die Analyse der Priorisierungsansätze baut auf einem Matching-Ansatz auf, bei dem die jeweiligen Prioritäten mit NACE-Sektoren (Wirtschaftsbereiche), FOR (Wissenschaftsbereiche) oder WIPO-Technologieklassen (Technologiebereiche) verknüpft wurden.

1. Wurde die Priorisierung durch einen Entrepreneurial Discovery Process (EDP) entwickelt? Auf welcher Ebene und mit welchen Methoden? Wie wurden die wirtschaftlichen / wissenschaftlichen / technologischen Stärken bewertet?

Insgesamt basieren **77 % der S3-Strategien im Zeitraum 2014-2020 auf einem EDP**, das speziell für die jeweilige Strategie aufgesetzt wurde. 12 % der S3-Strategien haben auf einen "alten" EDP zurückgegriffen, was bedeutet, dass ein Prozess der Einbeziehung von Stakeholdern stattgefunden hat, der jedoch nicht speziell für die S3-Strategie konzipiert wurde. Im Allgemeinen beziehen die meisten EDPs Stakeholder aus dem Forschungssektor (90% aller identifizierten S3-Strategien), dem privaten Sektor (90%) und dem öffentlichen Sektor (89%) ein. 53 % der S3-Strategien schließen Stakeholder aus einer zivilgesellschaftlichen Organisation mit ein.

Ein **kontinuierlicher EDP konnte** jedoch **in vielen Regionen nicht etabliert werden, wenngleich die formale Kontinuität in den EU13/weniger entwickelten Regionen etwas höher war.** Die Kontinuität des EDP (Einbindung der Stakeholder in die Umsetzungs- und Überwachungsphasen) wird als wichtig angesehen. Allerdings wird die Umsetzung als schwierig zu erreichen eingeschätzt. Beispiele zeigen, dass die Einbeziehung von Clusterorganisationen ein effektiver Weg sein kann, um eine kontinuierlichere Beteiligung des Privatsektors zu gewährleisten.

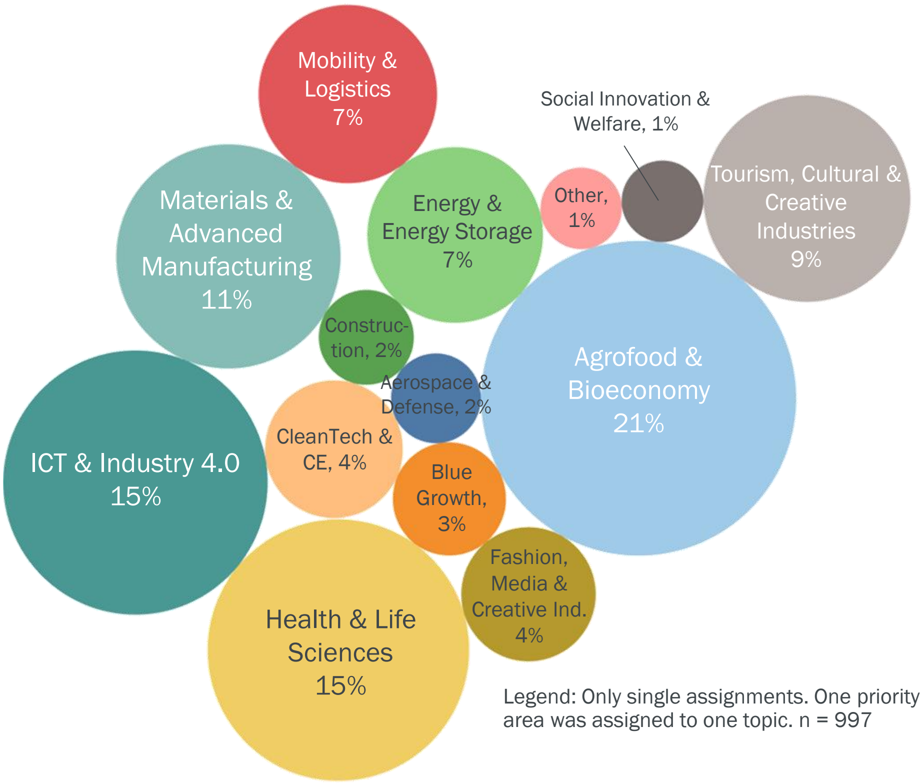
Schließlich war die **Datenanalyse zur Bestimmung der S3-Spezialisierungsfelder in vielen Fällen nicht ausreichend granular. So nutzen z.B.** nur 12 % der S3-Strategien für die Analyse der wirtschaftlichen Leistung Daten auf NACE-2/3-Steller-Basis. Für die Analyse der technologischen/wissenschaftlichen Leistung verwenden nur 19 %

detailliertere Daten. Qualitative Belege zeigen, dass eine zu allgemeine Datenanalyse oder ein schierer Mangel an Datenanalyse die Haupthindernisse sind, wenn es darum geht, die S3-Prioritäten einzugrenzen.

2. Basiert die Priorisierung auf Sektoren oder Wissenschafts- und Technologiefeldern oder war es ein interdisziplinärer/sektorenübergreifender Ansatz?

Insgesamt haben wir festgestellt, dass **Agrofood & Bioeconomy (21 %), Gesundheit & Biowissenschaften (15 %) sowie IKT & Industrie 4.0** die Themen sind, die EU-weit am häufigsten von S3-Strategien adressiert werden (siehe Abbildung 01). Die einzelnen Bereiche, die am häufigsten adressiert werden, sind Ingenieurwesen, Information & Informatik sowie Agrar- und Veterinärwissenschaften für die wissenschaftlichen Bereiche (FOR) und wissenschaftliche FuE, Computerprogrammierung & Herstellung von Datenverarbeitungsgeräten, elektronischen und optischen Erzeugnissen für die Wirtschaftssektoren (NACE). Computertechnik, digitale Kommunikation und elektrische Maschinen, Apparate und Energie sind die am häufigsten adressierten Technologiefelder. Dies zeigt auch, dass die IKT nicht nur als Schwerpunktbereich selbst, sondern auch als Thema innerhalb anderer Spezialisierungsfelder wichtig ist, was ihre Rolle als General Purpose Technology (GPT) bestätigt.

Abbildung 0-1 (Zusammenfassung): Anteil der übergreifenden Themen, die durch S3-Spezialisierungsfelder adressiert werden



Quelle: Prognos / CSIL (2021). Anmerkung: n= 185 Regionen. Die basiert auf einer LDA (Lineare Diskriminanzanalyse), durch die übergreifende Themen auf Basis von Prioritätsbeschreibungen definiert wurden.

Vergleicht man die **wichtigsten Auswahlansätze** der S3-Spezialisierungsfelder, so beziehen sich die Strategien auf alle Ansätze, vor allem aber auf Wirtschaftsbereiche (64 %), Wissenschaftsbereiche (60 %) und etwas weniger auf Technologiebereiche (48 %).[6] In der Tat spiegeln die Prioritäten vieler Mitgliedstaaten/Regionen eher einen kombinierten Ansatz wider**.** 119 von 185 S3-Strategien (64 %) enthalten wissenschaftliche,

[6] Definiert nach NACE (Wirtschaftszweige), FOR (Wissenschaftsbereiche) oder WIPO-Technologieklassen (Technologiebereiche)

technologische und wirtschaftliche Auswahlansätze und sind gleichzeitig mit Natur- und Kulturgütern sowie spezifischen gesellschaftlichen Zielen verbunden.

Darüber hinaus zeigt die Studie, dass **mehr als 90 % aller S3-Strategien** (168 von 185; 91 %) **einen expliziten Bezug zur gesellschaftlichen Herausforderung "Klima/Ressourcen" enthalten**. Ebenso weist die gleiche Zahl auf eine hohe Rate an S3-Verknüpfungen mit den gesellschaftlichen Herausforderungen der Untergruppen "Gesundheit" (79 %), "Landwirtschaft" (76 %) und "Energie" (72 %) hin.[7] Auf einer detaillierteren Ebene sind die Untergruppen, die am häufigsten angesprochen werden, die Sicherstellung von "Nachhaltigen Konsum- und Produktionsmustern", "Gesundheit und Wohlbefinden" und "Sicherstellung des Zugangs zu erschwinglicher, zuverlässiger, nachhaltiger und moderner Energie für alle". Bei der Frage, auf welche kulturellen oder natürlichen Ressourcen sich die Prioritätsbereiche am häufigsten stützen, wird das kulturelle Erbe einer Region am häufigsten genannt – von 80 S3-Strategien (43 %).

3. Wie und mit welchem Ergebnis wurde die Priorisierung in den S3-Strategien erreicht?

Fast alle Mitgliedstaaten/Regionen befassen sich mit hochkomplexen Technologiefeldern und -sektoren. Es gibt keine signifikanten Unterschiede zwischen den; Hochtechnologiebereiche werden vergleichbar stark betont. Die ähnliche Bevorzugung von FuE- und Hochtechnologie-intensiven Aktivitäten kann jedoch als Beleg dafür gesehen werden, dass wirtschaftlich schwächere (weniger entwickelte) Regionen S3 zu nutzen scheinen, um sich in FuE-getriebene Sektoren zu entwickeln.

In den meisten Mitgliedstaaten/Regionen (166/185) beträgt der Anteil der Technologiefelder in den Strategien, die hochkomplex sind, weniger als 50 % (technologische Komplexität). Hinsichtlich der wirtschaftlichen Komplexität ist festzustellen, dass in den meisten Strategien (160/185) Hochtechnologiebereiche des Verarbeitenden Gewerbes oder Hochtechnologie-Dienstleistungsbereiche weniger als 50 % (im Durchschnitt) aller angesprochenen Wirtschaftsbereiche ausmachen.

4. Auf welcher Ebene der Granularität hat diese Priorisierung stattgefunden?

Ein granularer Ansatz zur Priorisierung ermöglicht eine größere Wirkung, indem eine kritische Masse erreicht und eine zu breite Verteilung der Innovationsförderung auf zu viele Spezialisierungsfelder vermieden wird. Ein Indikator ist die Anzahl der Spezialisierungsfelder pro S3-Strategie. Die **Anzahl der Schwerpunkte variiert von Region zu Region** und reicht von nur zwei bis zu maximal 14 oder 15. Die durchschnittliche Anzahl der Schwerpunkte pro Region liegt bei 5,5 und der Median bei 5.

Tabelle 0-1 (Zusammenfassung): Anzahl der Spezialisierungsfelder der S3-Strategien in den Mitgliedstaaten/Regionen (letztes S3-Strategiejahr)

	Alle Regionen	Weniger entwickelt	Übergangsregionen	Stärker entwickelt
Gesamt	1014	325	189	500
Durchschnitt pro Region	5,5	5,6	5,4	5,4
Median	5.0	6	5	5
Bereich: MIN - MAX	2 -15	2 – 15	2 – 8	2 – 15

Quelle: Prognos / CSIL (2021). Anmerkung: n=185 Regionen.

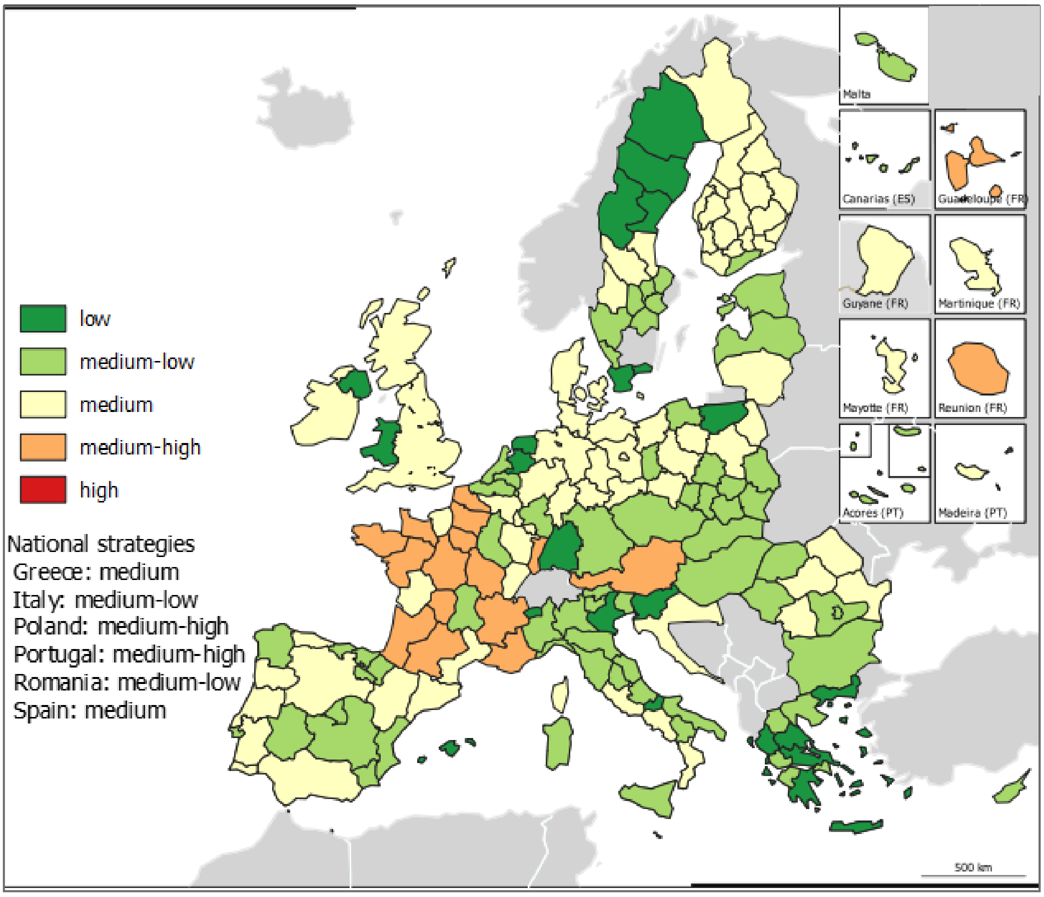
Die absolute Anzahl der Spezialisierungsfelder kann jedoch irreführend sein, um festzustellen, ob die Prioritäten einer S3-Strategie granular sind oder nicht. Dies gilt insbesondere für Mitgliedstaaten/Regionen, die eine mehrstufige Struktur mit einigen breit definierten Hauptprioritätsbereichen und mehreren Unterprioritäten verwenden. Ein weiterer Hinweis auf die Granularität kann aus der Analyse der thematischen Breite

[7] Nach Gianelle et al. (2016) könnten die Prioritäten in Bezug auf Wissensfelder oder Sektoren gesetzt werden, die für gesellschaftliche und ökologische Herausforderungen besonders relevant sind.

(analysiert durch den thematischen „Bandbreitenindex") gezogen werden. Etwa 75% der S3-Strategien fallen in die Kategorie mittlere bis geringe Bandbreite (d.h., Bandbreitenindex zwischen 20-60%, EU-Durchschnitt = 38%). Mitgliedstaaten/Regionen mit besonders breiten S3-Strategien sind Portugal (Bandbreitenindex von 76%), Polen (66%) und Österreich (63%; alle nationalen S3-Strategien) sowie eine Reihe französischer Regionen wie Bretagne (80%), Limousin (74%) oder Pays de la Loire (70%).

Darüber hinaus hat die **Analyse der Korrelation zwischen der Anzahl der Spezialisierungsfelder der S3-Strategien, ihrer thematischen Bandbreite und Konzentration mit einigen regionalen Merkmalen** gezeigt, dass die Granularität und Selektivität der S3-Strategien zumindest teilweise mit der Größe der Mitgliedstaaten / Regionen zusammenzuhängen scheint.

Karte 0-1 (Zusammenfassung): Bandbreitenindex der S3-Strategien in den EU-Mitgliedstaaten/Regionen (letztes S3-Strategiejahr)



Quelle: Prognos / CSIL (2021). n = 165 Mitgliedsstaaten/Regionen. Hinweis: Wenn eine Region sowohl von einer nationalen Strategie als auch von einer subnationalen Strategie abgedeckt wird, bezieht sich die farbige Fläche der subnationalen Region auf die Entsprechung der subnationalen Strategie. Die Werte für die nationalen Strategien sind in der Legende angegeben. Diese Regionen sind Italien, Griechenland, Spanien, Polen, Portugal und Rumänien. Die Daten für die schwedischen und finnischen Regionen wurden auf der NUTS2-Ebene aggregiert.

B. Korrespondenz der regionalen Profile mit ausgewählten Spezialisierungsfeldern

Die Korrespondenz zwischen den S3-Spezialisierungsfeldern und den Profilen der Mitgliedstaaten/Regionen wurde durch neuartige Analysen untersucht. Für jede S3-Strategie wurden Variablen analysiert, die die S3-Prioritäten erfassen, und Variablen, die die wirtschaftlichen, wissenschaftlichen und technologischen Profile und Stärken der Mitgliedstaaten/Regionen erfassen, gemessen durch beschäftigungs-, publikations- und patentbasierten Indikatoren. Die Ergebnisse wurden dann durch ökonometrische Modelle, Clusteranalysen und qualitative Fallstudien angereichert und validiert.

5. Welche Logik (ökonomisch, wissenschaftlich oder technologisch) hat sich durchgesetzt, d.h. erklärt die gewählten Prioritäten besser?

Insgesamt spiegeln die Prioritäten die wissenschaftlichen und technologischen Profile der Mitgliedsstaaten/Regionen besser wider als die wirtschaftlichen Profile. Dies könnte auf eine Vielzahl von Gründen zurückzuführen sein, die z.B. mit dem Nachahmungsverhalten zusammenhängen, bei dem endogene Kapazitäten oder die Ambitionen zur Entwicklung neuer Sektoren nicht berücksichtigt wurden. Eine stärkere Übereinstimmung zwischen den S3-Prioritäten und den wissenschaftlichen und technologischen Fähigkeiten der Mitgliedstaaten/Regionen kann darauf hindeuten, dass die Strategie darauf abzielt, die wissens- oder technologieintensivsten Sektoren der Wirtschaft zu beeinflussen oder einen Prozess der Wissens- oder Technologieaufwertung auszulösen, der schließlich zur Entstehung neuer Marktnischen führen oder den Strukturwandel vorantreiben könnte.

6. Wie spiegelt die Priorisierung die aktuelle Wirtschaftsstruktur der Region wider? Wie spiegelt die Priorisierung laufende Veränderungen und zukünftige Entwicklungen der Wirtschaftsstruktur wider?

Die **S3-Strategien passen im Allgemeinen nicht zu den Wirtschaftsprofilen** der Mitgliedstaaten/Regionen (wie aus den Beschäftigungsdaten nach NACE-Wirtschaftszweigen hervorgeht). Die Regionen, die den Wirtschaftsprofilen am besten entsprechen, sind meist Übergangs- und weniger entwickelte Regionen. Unter ihnen finden wir verschiedene griechische Regionen, die den Schwerpunkt auf die Sektoren Agrar- und Ernährungswirtschaft und Tourismus legen, in denen ein großer Teil der Bevölkerung beschäftigt ist. Die Analyse zeigt auch, dass sich zwar nur wenige Regionen dadurch auszeichnen, dass sie den aktuellen Wirtschaftsstrukturen den Vorrang geben, aber etwas mehr Regionen haben Prioritäten gewählt, die mit den Sektoren im Wandel übereinstimmen, gemessen an den Wachstumsraten der Beschäftigung in den drei Jahren vor oder nach der Veröffentlichung der S3-Strategie. Dies deutet darauf hin, dass **einige S3-Strategien zumindest** bis zu einem gewissen Grad **laufende Prozesse des Strukturwandels berücksichtigten**.

7. Wie spiegelt die Prioritätensetzung die wissenschaftlichen Stärken der Region wider? Wie wurden die wissenschaftlichen Stärken bewertet (nur basierend auf öffentlichen Einrichtungen oder unter Einbeziehung privater Organisationen/Forschungskapazitäten der Wirtschaft)?

Die **S3-Prioritäten stimmen gut mit den wissenschaftlichen Profilen der EU-Mitgliedstaaten/Regionen überein**. Im Allgemeinen wählten viele Mitgliedstaaten/Regionen S3-Schwerpunkte in Bereichen mit starker wissenschaftlicher Produktion, gemessen an der Anzahl der Publikationen in jedem Mitgliedstaat/jeder Region. Allerdings handelte es sich dabei nicht unbedingt um Gebiete mit wissenschaftlicher Exzellenz auf internationaler Ebene.

Eine Schlüsselfrage dieser Studie betraf das Ausmaß, in dem sowohl die öffentlichen *als auch die* privaten technologischen Kapazitäten in der Prioritätensetzung berücksichtigt wurden. Im Durchschnitt stimmen die **Strategien gut mit dem Publikationsprofil sowohl der privaten Organisationen (Unternehmen) als auch des öffentlichen Sektors überein**. Dieses Ergebnis steht im Einklang mit der Tatsache, dass sowohl die öffentlichen als auch die privaten Akteure am EDP der meisten S3-Strategien beteiligt waren. Die Strategien, die besser mit ihrem öffentlichen wissenschaftlichen Profil übereinstimmen, stammen hingegen meist aus weniger entwickelten Regionen und Mitgliedstaaten, die ebenfalls als mäßig oder bescheiden innovativ eingestuft werden.

8. Wie spiegelt die Prioritätensetzung die technologischen Stärken der Region wider? Wie wurden die technologischen Stärken bewertet (nur auf Basis von Unternehmenskapazitäten oder unter Einbeziehung öffentlicher Einrichtungen)?

Die Prioritäten der S3 stimmen relativ gut mit den technologischen Profilen der Mitgliedstaaten/Regionen überein, wie sie sich aus den Patentanteilen in den verschiedenen Technologiebereichen ergeben. Die meisten Mitgliedstaaten/Regionen, die ihr technologisches Profil in der S3 besser widerspiegeln, sind weiterentwickelt und werden auch als Innovationsführer oder starke Innovatoren eingestuft. In Übereinstimmung mit dem, was für wissenschaftliche Profile beobachtet wurde, **scheinen die Strategien private technologische Profile und Stärken besser widerzuspiegeln** als öffentliche, obwohl der Unterschied gering ist.

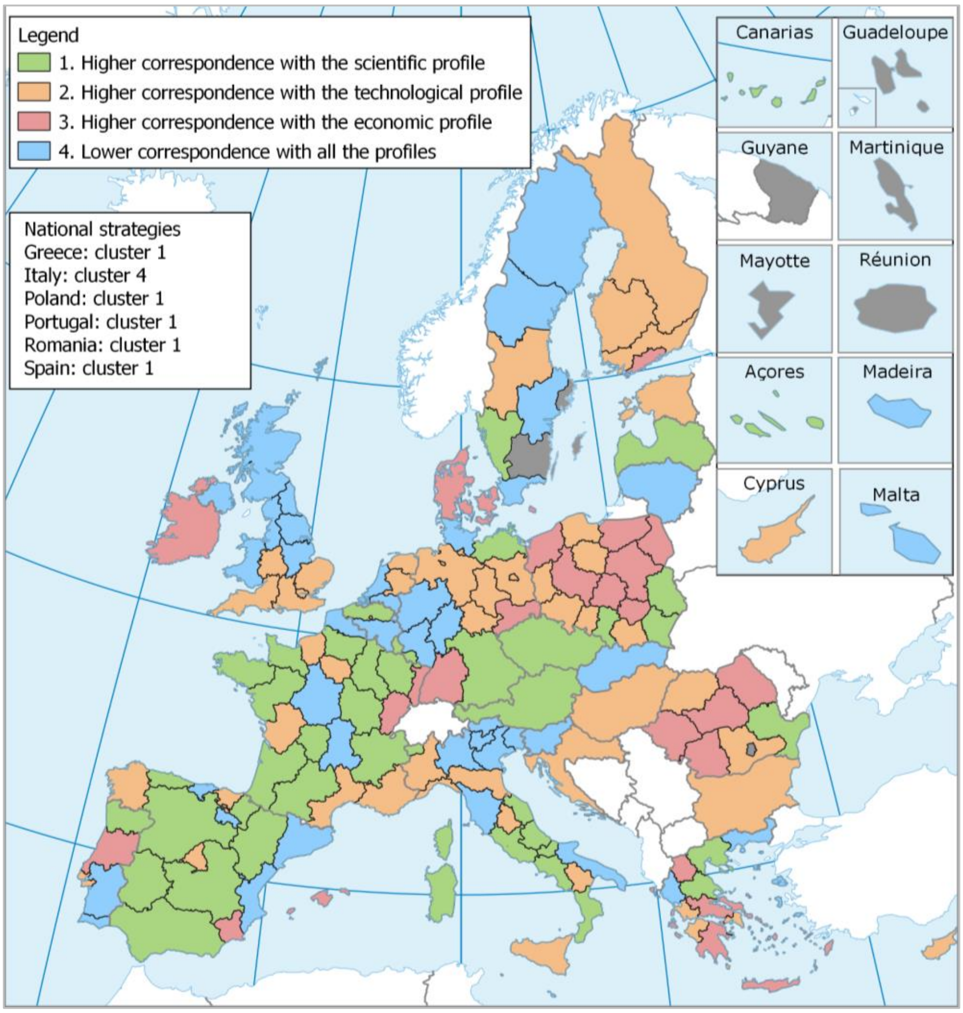
9. Inwieweit berücksichtigt die Priorisierung Themen wie Diversifizierung, Spezialisierung, Upgrading und damit verbundene Vielfalt?

Um diese Frage zu untersuchen, wurden in dieser Studie die in der Literatur entwickelten Indizes der technologischen „Relatedness" und der technologischen Komplexität berechnet. Die Korrelationsanalyse zeigt, dass **mehrere Mitgliedstaaten/Regionen Felder wählten, die ihrem sog. „Knowledge Space" näher sind**. Dieser Ansatz wurde von mehr und weniger entwickelten Regionen gleichermaßen verfolgt, und es lässt sich keine eindeutige Kategorisierung in Bezug auf die Innovationsprofile feststellen. Um die S3-Strategien besser zu charakterisieren, berechnen wir eine **Metrik für den Ambitionsgrad der Strategie**, die das Ausmaß widerspiegelt, in dem eine Strategie Spezialisierungsfelder ausgewählt hat, die im Vergleich zu dem von dem Mitgliedstaat/der Region bereits beherrschten Technologiemix als über- oder unterkomplex angesehen werden können. Basierend auf diesen neuen Maßstäben wird eine Strategie, die auf eine beziehungslose Diversifizierung abzielt und komplexe Technologien anvisiert, als ehrgeizige Strategie gekennzeichnet (siehe Kapitel 5 für detaillierte Karten). Selbst wenn einige S3-Strategien einen ehrgeizigeren Ansatz verfolgten, indem sie unverbundene und recht komplexe Technologien auswählten, sind weitere Untersuchungen erforderlich, um zu verstehen, ob ein solcher Ansatz als umsetzbar und nicht als zu ehrgeizig für den spezifischen Mitgliedstaat/die Region angesehen werden kann.

10. Wie wurden die Informationen über die Wirtschaftsstruktur, die wissenschaftlichen Stärken und die technologischen Stärken in der Gesamtstrategie kombiniert? Gibt es gemeinsame Merkmale zwischen den Regionen, die eine Kategorisierung ihrer heterogenen Erfahrungen erlauben?

Wir haben **vier Gruppen von Strategien** identifiziert, die jeweils durch einen relativ ähnlichen Priorisierungsansatz bei der Übereinstimmung der S3-Strategien mit den regionalen Profilen gekennzeichnet sind:

Karte 0-2 (Zusammenfassung): Gruppen von S3-Strategien nach der Übereinstimmung ihrer S3- Spezialisierungsfelder mit den regionalen/nationalen Profilen



Quelle: Prognos / CSIL (2021). Hinweis: Die Karte zeigt den spezifischen Cluster, zu dem die neuesten S3-Strategien gehören. Grau gefärbte Regionen sind wegen fehlender Daten von der Analyse ausgeschlossen.

1. **61 S3-Strategien (29 %) zeigen eine höhere Übereinstimmung mit dem wissenschaftlichen Profil**: Diese Gruppe ist durch eine Prävalenz von EU15-Mitgliedstaaten, Übergangsregionen und mäßigen oder bescheidenen Innovatoren gekennzeichnet, mit einem geringen Anteil der Bevölkerung, der sich mit Wissenschaft und Technologie beschäftigt, und einem Qualitätsindex der Regierung, der unter dem EU-Durchschnitt liegt. Eine Interpretation dieser Ergebnisse könnte zu der Vermutung führen, dass diese Gruppe von Mitgliedstaaten und Regionen über einige wissenschaftliche Kompetenzen verfügt, die jedoch noch nicht effektiv in technologische Kompetenzen innerhalb der Unternehmen umgesetzt werden.

2. **62 S3-Strategien (30 %) weisen eine höhere Übereinstimmung mit dem technologischen Profil auf**: Dieser Cluster besteht typischerweise aus stark diversifizierten Mitgliedstaaten/Regionen mit einem guten Innovationsprofil (eingestuft als Innovationsführer, starker oder mäßiger Innovator) und einem hohen Anteil der in Wissenschaft und Technologie beschäftigten Bevölkerung. Mitgliedstaaten und Regionen, die diesen Priorisierungsansatz gewählt haben, sind in verschiedenen Teilen der EU zu finden, wobei ein signifikanter Anteil von ihnen aus Mittelost-, Nord- und Westeuropa stammt.

3. **33 S3-Strategien (16 %) weisen eine höhere Übereinstimmung mit dem wirtschaftlichen Profil auf**: Dieser Priorisierungsansatz scheint eher in Übergangsregionen und bescheidenen Innovatoren mit einem geringen Grad an

wirtschaftlicher Diversifizierung verbreitet zu sein, häufig in Mittel- und Osteuropa.

4. **53 S3-Strategien (25 %) weisen eine relativ geringe Übereinstimmung mit irgendeinem Profil auf**: Dieser Priorisierungsansatz wurde von vielen EU15-Mitgliedstaaten/Regionen verfolgt, die häufig durch eine hohe wirtschaftliche Diversifizierung, ein starkes Innovationsprofil und eine qualitativ hochwertige Regierung gekennzeichnet sind. Die Strategien, die zu dieser Gruppe gehören, scheinen auch in Bezug auf ihren Ehrgeiz hoch zu sein, da sie auf eine nicht verwandte Diversifizierung und relativ komplexe Technologien abzielen.

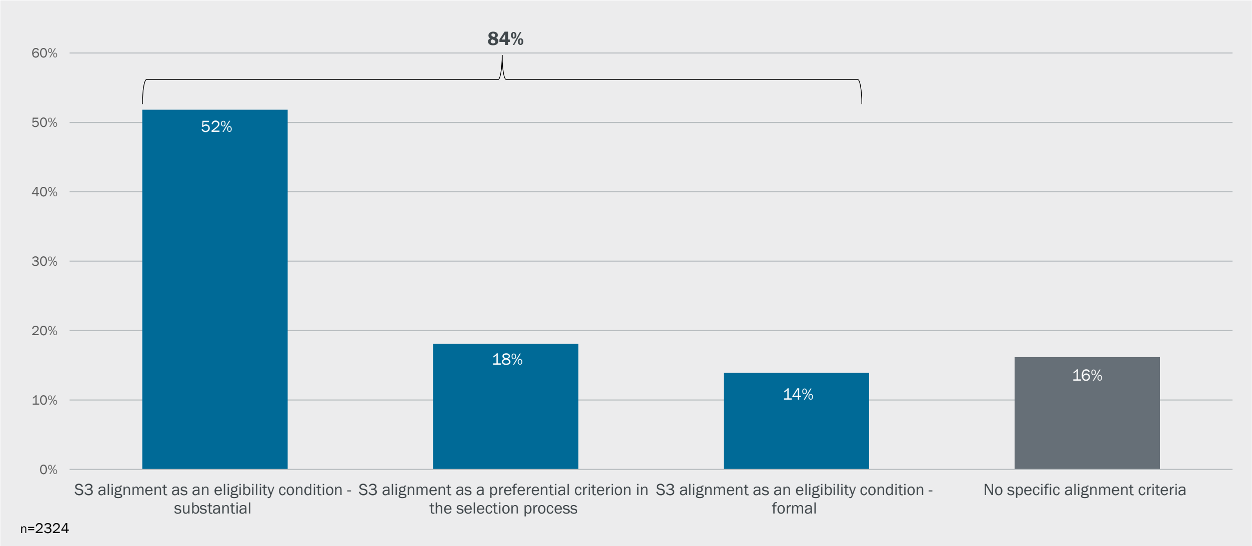
C. Implementierung von S3-Strategien

Die Analyse der Umsetzung der S3-Strategien wurde durch die Sammlung von EFRE-TO1 relevanten Ausschreibungen und den jeweiligen EFRE-geförderten F&I-Projekten durchgeführt. Es wurde untersucht, inwieweit Ausschreibungen strikte Abgleichkriterien mit den S3-Strategien enthalten und ob Projekte thematisch mit den Prioritäten der jeweiligen Regionen verknüpft sind.

11. Wie wurde die Priorisierung bei der Vorbereitung und Durchführung von Aufrufen berücksichtigt?

Wie Figure 0-2 zeigt, **sehen fast alle (84%) der über 2300 EFRE-TO1-Ausschreibungen einen Abgleich mit den S3-Strategien vor**. Dementsprechend verlangen nur 16% keine solche Ausrichtung. Die Analyse zeigt weiterhin, dass mit 52% die meisten Ausschreibungen eine substanzielle Ausrichtung an der S3 verlangen. Ausschreibungen, die S3-bezogene Vorschläge im Auswahlprozess bevorzugen, machen 18% der gesammelten Ausschreibungen aus. Darüber hinaus sind 14 % der Ausschreibungen durch eine formale S3-Alignment-Bedingung gekennzeichnet.

Abbildung 0-2 (Zusammenfassung): S3-Alignment-Kriterien (alle Regionen)



Quelle: Prognos / CSIL (2021). Hinweis: Um die großen Unterschiede in der Anzahl der Anrufe zwischen den Mitgliedstaaten/Regionen zu berücksichtigen, wurde der Anteil in jeder Region berechnet und dann gemittelt. N=2324

Die Feststellung, dass die meisten Aufforderungen eine Anpassung an die S3 erfordern, wird durch die Interviews, die mit den jeweiligen S3-Verwaltungsbehörden geführt wurden, weiter untermauert. Von den 176 Befragten[8] gaben 95 % an, dass sich die in den S3-Strategien dargelegten Prioritäten in der Vorbereitung und Durchführung der Programme bzw. Aufforderungen zur Einreichung von Vorschlägen widerspiegeln.

[8] 176 Befragte von insgesamt 181 Befragten gaben eine Antwort auf diese Frage.

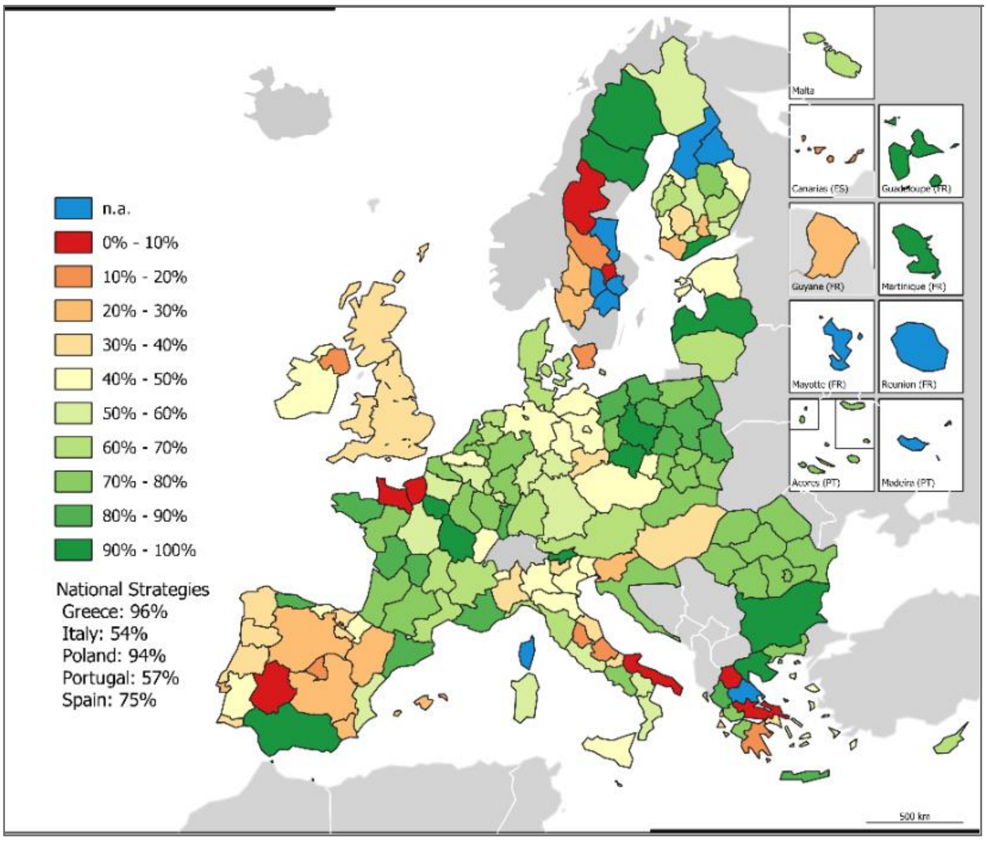
Die Mehrheit der S3-bezogenen Aufforderungen zur Einreichung von Vorschlägen spricht alle Spezialisierungsfelder gleichzeitig an. Eine Untergruppe von Spezialisierungsfeldern wird in 15 % und nur ein Spezialisierungsfeld in 11 % aller gesammelten Aufforderungen, die unter TO1 fallen, angesprochen. Es gibt jedoch einige bemerkenswerte regionale Unterschiede, da weniger entwickelte Regionen einen höheren Prozentsatz an Aufforderungen aufweisen, die alle vorrangigen Bereiche gleichzeitig ansprechen (breitere Aufforderungen), verglichen mit Übergangs- und stärker entwickelten Regionen. Letzteres deutet darauf hin, dass Übergangs- bzw. stärker entwickelte Regionen anscheinend mehr maßgeschneiderte Aufrufe verwenden, um ihre S3-Spezialisierungsfelder zu entwickeln.

12. Wie hat der Projektauswahlprozess die Priorisierung widergespiegelt? Hat der Auswahlprozess zur Umsetzung der Projekte in den Spezialisierungsfeldern geführt?

Die Analyse ergibt, dass **im Durchschnitt 57 % der EFRE-F&I-Projekte mit den** in den S3-Strategien dargestellten **Spezialisierungsfeldern verbunden sind**. [9] Insgesamt **wurden 19,6 Mrd. EUR für F&I-Projekte ausgegeben, die mit den S3-Spezialisierungsfeldern verknüpft sind, das sind 62 %** des Budgets, das für alle F&I-Projekte ermittelt wurde. Wie die nachstehende Karte zeigt, gibt es jedoch **große Unterschiede zwischen den Mitgliedstaaten/Regionen**, was den Grad der Übereinstimmung der EFRE-F&I-Projekte mit den S3-Prioritäten betrifft: Während nur 54% der Projekte aus EU15-Mitgliedstaaten/Regionen den S3-Prioritäten entsprechen, liegt der Anteil in EU13-Mitgliedstaaten/Regionen bei 65%. Interessanterweise weisen weniger entwickelte Regionen im Durchschnitt mehr Projekte auf, die mit ihren S3-Prioritäten verbunden sind (durchschnittlich 60 %), verglichen mit Übergangsregionen (58 %) und stärker entwickelten Regionen (54 %).

[9] Hier wird auf die ursprünglichen S3-Strategien von 167 Mitgliedstaaten/Regionen Bezug genommen. Die Differenz zwischen der Anzahl der S3-Strategien (185) und der Gesamtzahl der Mitgliedstaaten/Regionen, die für diesen Abschnitt verwendet werden, besteht darin, dass einige Regionen keine Projekte erfasst haben (Thessalien, mehrere finnische und schwedische Regionen, Mayotte, Martinique) oder es keine Projekte auf der NUTS-Ebene der S3-Strategie gab (Regionen in Rumänien, OP nur auf nationaler Ebene).

Karte 0-3 (Zusammenfassung): Anteil der Projekte und des Budgets, die mit Spezialisierungsfeldern verknüpft sind



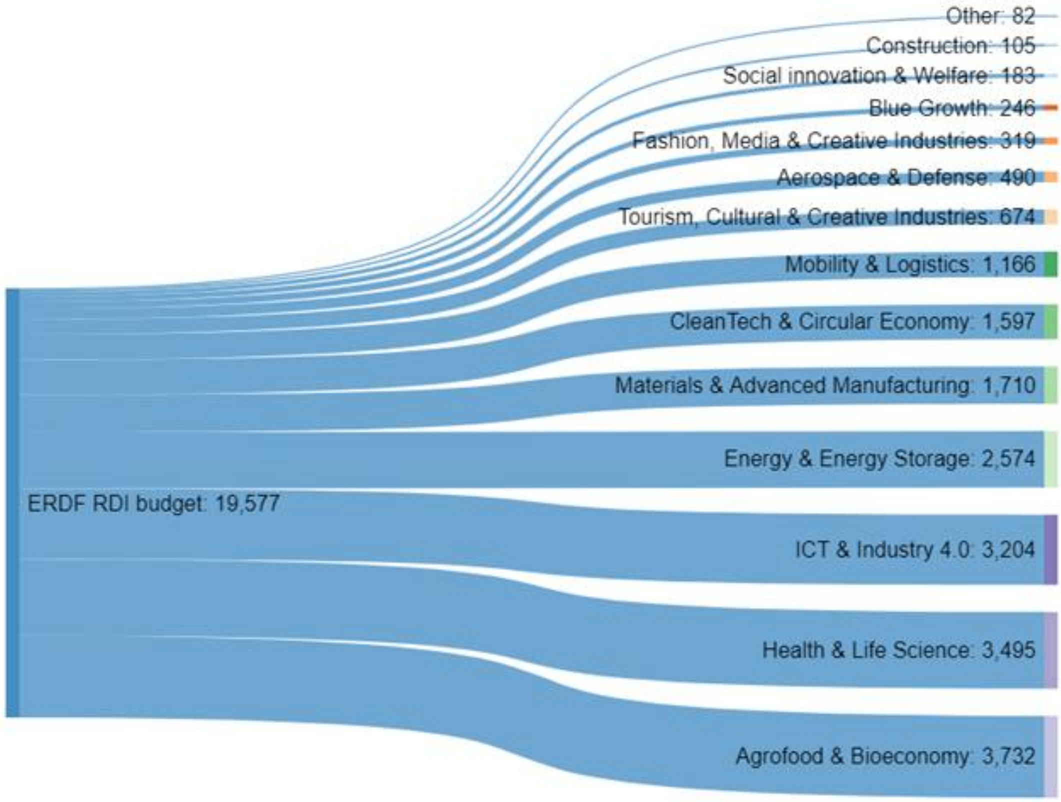
Quelle: Prognos / CSIL (2021). n = 167 Regionen.

13. Hat der Auswahlprozess zu einer Fokussierung auf bestimmte Smart-Spezialisierungsbereiche geführt?

Im Folgenden wird das Volumen der EFRE-Mittel dargestellt, die für Projekte mit S3-Bezug in den verschiedenen Themenbereichen der S3-Strategien in den EU-Mitgliedstaaten/Regionen ausgegeben wurden.[10] Insgesamt sind fast 19,6 Mrd. EUR in F&I-Projekte in den S3- Spezialisierungsfeldern geflossen. Rund 50 % dieser Projektbudgets flossen in drei Themenbereiche, nämlich **"Agrofood & Bioeconomy" (3,7 Mrd. EUR; 19 %), "Health and Life Sciences" (3,5 Mrd. EUR; 17,9 %) und "ICT & Industry 4.0" (3,2 Mrd. EUR; 16,3 %).**

[10] Es handelt sich also nicht um einen Überblick über die thematische Verteilung der EFRE-F&I-Förderung insgesamt, sondern um einen Überblick über die thematische Verteilung der EFRE-F&I-Förderung, die mit den S3-Schwerpunkten verknüpft ist.

Abbildung 0-3 (Zusammenfassung): Übergreifende Themenbereiche und Budget, das dafür im Rahmen von EFRE-Projekten ausgegeben wurde



Quelle: Prognos / CSIL (2021). Hinweis: Die Zahlen basieren auf den Projekten, die erfolgreich mit den Spezialisierungsfeldern von 167 Regionen verknüpft wurden, d.h. Projekte, die potenziell in einen bestimmten übergreifenden Themenbereich fielen, jedoch nicht mit einem Schwerpunktfeld verbunden waren, sind hier nicht enthalten. Das Gesamtbudget, das damit verknüpft wurde und das dieser Zahl zugrunde liegt, beträgt 19,6 Mrd. EUR.

Übergeordnete Schlussfolgerungen der Studie

Stärken und Schwächen der Priorisierung und Umsetzung von S3-Strategien in Europa

1. Ein breit angelegter Stakeholder-Prozess wurde in den meisten Mitgliedsstaaten/Regionen angewandt.
2. Die Mitgliedstaaten/Regionen haben ein breites Spektrum an unterschiedlichen Instrumenten und Verfahren eingesetzt, wenn es um den EDP und die Datenanalyse geht.
3. Eine kontinuierliche EDP konnte in vielen Regionen nicht festgestellt werden, obwohl die Kontinuität in den EU13/weniger entwickelten Regionen etwas höher war.
4. Die Datenanalyse zur Bestimmung der S3-Prioritätsbereiche war in vielen Fällen nicht ausreichend granular.

Priorisierungsansätze der S3-Strategien

5. Die häufigsten Themen, die in den S3-Schwerpunktbereichen angesprochen werden, sind mit technischen und IKT-bezogenen Bereichen verbunden.
6. Die Schwerpunktbereiche basieren meist auf einem kombinierten Ansatz zur Prioritätensetzung und sind in der Regel nicht in einzelne wissenschaftliche, wirtschaftliche oder technologische Bereiche unterteilt.
7. Es gibt nur sehr geringe regionale Unterschiede hinsichtlich des Komplexitätsgrades der S3-Strategien und ihrer Schwerpunktbereiche
8. Der Verweis auf die absolute Anzahl von Prioritätsbereichen ist irreführend, insbesondere für Mitgliedstaaten/Regionen, die eine mehrstufige (baumförmige)

Struktur mit einigen breit definierten Hauptprioritätsbereichen und mehreren Unterprioritäten verwenden.

9. Größere und wirtschaftlich stärkere Mitgliedsstaaten/Regionen scheinen im Vergleich zu kleineren Regionen weniger Priorität zu haben.

Übereinstimmung der S3-Strategien mit dem regionalen Profil

10. Selbst wenn die S3-Schwerpunktbereiche in Bezug auf die Wirtschaftssektoren definiert werden können, stimmen die S3-Schwerpunktbereiche im Allgemeinen nicht mit den Wirtschaftsprofilen der Mitgliedstaaten/Regionen überein (gemäß jedem verwendeten beschäftigungsbasierten Indikator).
11. Prioritätsbereiche der S3-Strategien entsprechen häufiger den wissenschaftlichen Profilen der EU-Länder und -Regionen.
12. S3-Prioritäten entsprechen im Allgemeinen den technologischen Profilen der Mitgliedsstaaten/Regionen
13. Sowohl öffentliche als auch privatwirt. wissenschaftliche und techn. Stärken scheinen sich in den S3-Strategien recht gut widerzuspiegeln.
14. Mehrere S3-Strategien wählten Schwerpunkte, die ihrem Wissensraum näher sind.
15. In der Synthese ergeben sich vier Gruppen, wenn man die Gesamtübereinstimmung der S3-Prioritäten mit den nationalen/regionalen Profilen betrachtet: 61 S3-Strategien *passen besonders gut* zu ihrem wissenschaftlichen Profil (29,2 %); 62 S3-Strategien *passen besonders gut* zu ihrem technologischen Profil (29,7 %); 33 S3-Strategien haben einen *guten* Übereinstimmungsgrad mit dem wirtschaftlichen Profil (15,8 %); 53 S3-Strategien *passen* zu keinem Profil (wissenschaftlich, wirtschaftlich, technologisch), zeigen aber höhere Ambitionen in Bezug auf technologische Innovation und Diversifizierungsziele (25,4 %).

Umsetzung der ausgewählten S3-Prioritäten

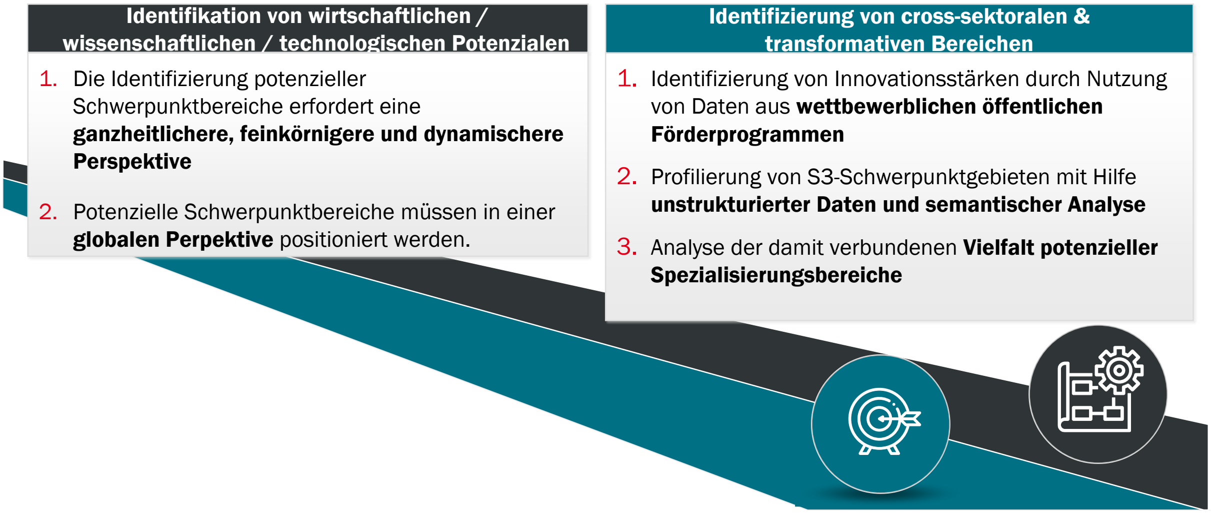
16. EFRE-geförderte Aufrufe/Programme erfordern überwiegend eine Ausrichtung an den S3-Strategien.
17. Verknüpfungen zwischen EFRE-finanzierten Projekten und S3-Prioritäten wurden bei 57 % der Projekte festgestellt, aber es gibt erhebliche Unterschiede zwischen den MS/Regionen.
18. Insgesamt scheinen die strengen S3-Förderkriterien bei den Projektauswahlverfahren gut angewandt zu werden und unterstützen die Auswahl von Projekten, die mit Schwerpunktbereichen verbunden sind.
19. Die am häufigsten angesprochenen Schwerpunktbereiche der S3-Strategien spiegeln sich auch in den umgesetzten Projekten wider.

Ausblick und der S3-Scoreboard 2021

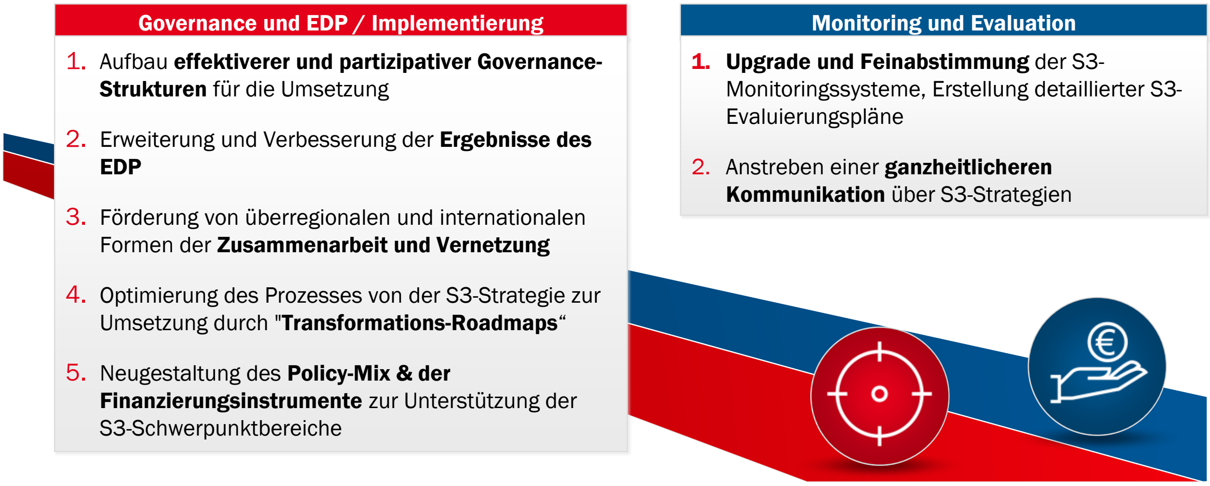
Die Ergebnisse dieser Studie beinhalten **mehrere wichtige Erkenntnisse und Empfehlungen**, auf die sich politische Entscheidungsträger bei der Fortsetzung der S3-Implementierung, dem unternehmerischen Entdeckungsprozess und der Förderung von innovationsbasiertem Wachstum in ihrem Gebiet über die spezifische S3-Strategie hinaus stützen können. Auch wenn diese Studie nicht oder nur teilweise alle Herausforderungen im Zusammenhang mit der S3-Konzeption und -Umsetzung abdeckt (z. B. in Bezug auf die Gestaltung der politischen Instrumente, die S3-Governance usw.), werden mehrere wichtige Erkenntnisse zum Kern des S3-Konzepts dargelegt, die den Mitgliedstaaten/Regionen helfen können, besser auf die anstehenden Herausforderungen zu reagieren, und die effektiv zu einer nachhaltigen Erholung nach der Pandemie beitragen können.

Es ergeben sich die folgenden **Handlungsempfehlungen**:

Verbesserung der Priorisierungsansätze in zukünftigen S3-Strategien



Bessere Nutzung der Innovationskraft und verbessertes Monitoring



Schließlich entwickelte die Studie ein **"S3-Scoreboard"** als vergleichende Bewertung aller 185 intelligenten Spezialisierungsstrategien in den EU-Mitgliedstaaten und Regionen auf der Grundlage einer neuartigen Methodik. Genauer gesagt, deckt das S3 Scoreboard 163 Regionen in 28 europäischen Ländern ab. Darüber hinaus sind S3-Strategien auf Länderebene, wie in Malta, Luxemburg oder Zypern, enthalten. Der Anzeiger bietet eine detaillierte Aufschlüsselung der Leistungsgruppen mit kontextuellen Daten, einschließlich des Anteils des EFRE-Budgets in Verbindung mit S3-Schwerpunktbereichen, der Kontinuität des VÜD oder der Strenge der Auswahlkriterien für S3-bezogene Ausschreibungen im Rahmen des EFRE 2014-2020, die verwendet werden können, um die Ausgereiftheit der S3-Strategien in der gesamten EU jetzt und in Zukunft zu analysieren und zu vergleichen.

Insgesamt zeigt das **S3-Scoreboard 2021 eine starke Variation**, die die unterschiedlichen Ausgangspunkte für intelligente Spezialisierung in Bezug auf die Stärke des Forschungs- und Innovationssystems, die Höhe der verfügbaren Ressourcen im Vergleich zu den nationalen Ressourcen und die Höhe der Beihilfeintensität widerspiegelt. Viele S3-Leader sind in weniger entwickelten Regionen zu finden, während die nordischen Länder, das Vereinigte Königreich oder einige deutsche, französische und stärker entwickelte spanische Regionen eher bescheidene S3-Strategien aufweisen. Die 22 nationalen S3-Strategien in der EU schneiden relativ gut ab.

SYNTHESE

Contexte et objectifs

Ce résumé concerne le rapport final de l'**étude sur la hiérarchisation des priorités dans les stratégies de spécialisation intelligente dans l'UE**, entreprise en 2020/2021 par une équipe dirigée par Prognos AG et des experts du Centre d'études industrielles (CSIL).

L'étude a systématiquement examiné et évalué toutes les stratégies S3 disponibles (185) dans l'UE et qui remplissent la conditionnalité ex-ante (ExAC 1.1). Les stratégies S3 doivent favoriser la politique d'innovation de l'UE au niveau régional et canaliser les fonds du FEDER vers les domaines prioritaires d'une région. L'étude a abordé les trois questions primordiales suivantes :

- Un ordre de priorité a-t-il été établi dans les stratégies S3 ?
- Dans quelle mesure les priorités sélectionnées reflètent-elles le profil régional ?
- Comment les stratégies S3 et les priorités sélectionnées ont-elles été mises en œuvre ?

Principaux résultats de l'étude

Ces questions primordiales ont été précisées en 13 questions de recherche. Pour certaines questions de recherche, des réponses très complètes ont pu être fournies, pour d'autres, la base de preuves est moins claire, notamment en ce qui concerne l'efficacité des stratégies S3, et appelle à de plus amples investigations à l'avenir.

A. Approches de développement de stratégie et de priorisation

L'analyse du développement de la stratégie est principalement basée sur des entretiens avec les parties prenantes ainsi que sur une recherche approfondie des 185 stratégies S3 respectives. L'analyse des approches de priorisation repose sur une approche de mise en correspondance, dans laquelle les priorités respectives ont été liées aux secteurs NACE (secteurs économiques), aux FOR (domaines scientifiques) ou aux classes technologiques de l'OMPI (domaines technologiques).

1. La hiérarchisation des priorités a-t-elle été élaborée par le biais d'un Processus de Découverte Entrepreneuriale (PDE) ? À quel niveau et avec quelles méthodologies ? Comment les atouts économiques/scientifiques/technologiques ont-ils été évalués ?

Dans l'ensemble, **77% des stratégies S3 de la période 2014-2020 sont basées sur un PDE** qui a été spécifiquement mis en place pour la stratégie respective. 12 % des stratégies S3 ont eu recours à une "ancienne" PDE, ce qui signifie qu'un processus d'implication des parties prenantes a eu lieu, mais qu'il n'a pas été spécifiquement conçu pour la stratégie S3. En général, la plupart des PDE impliquent des parties prenantes du secteur de la recherche (90% de toutes les stratégies S3 identifiées), du secteur privé (90%) et du secteur public (89%). 53% incluent des parties prenantes d'une organisation de la société civile.

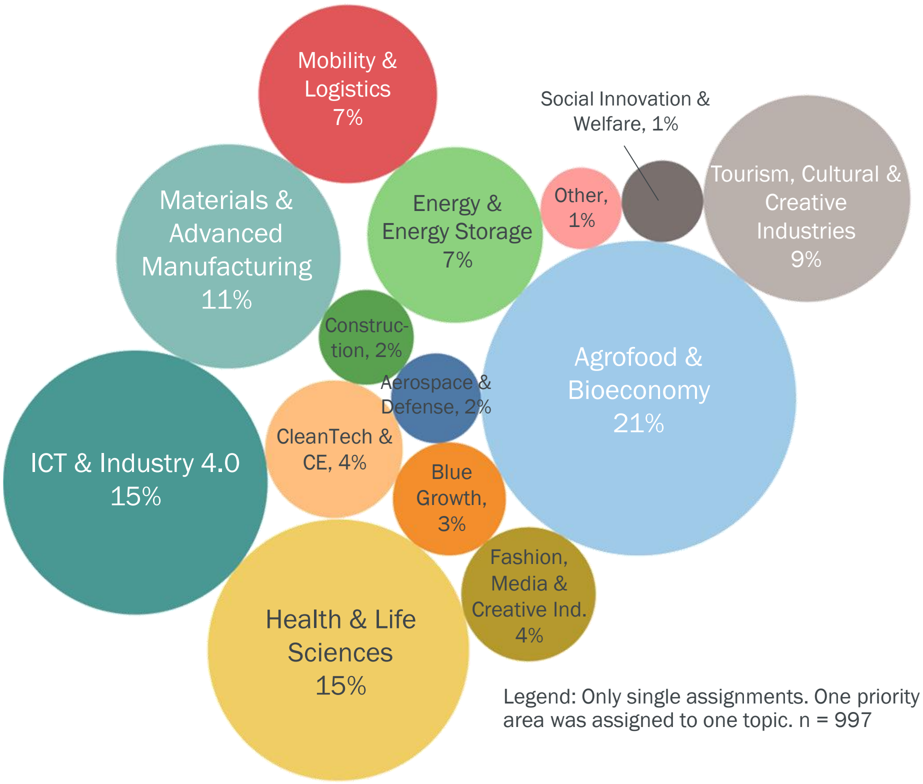
Cependant, une **PDE continue n'a pas pu être établie dans de nombreuses régions, bien que la continuité formelle soit légèrement plus élevée dans l'UE13/les régions moins développées. La** continuité de la PDE (implication des parties prenantes dans les phases de mise en œuvre et de suivi) est considérée comme importante mais difficile à réaliser. Les exemples illustrent que l'implication des organisations de clusters peut être un moyen efficace d'assurer une participation plus continue du secteur privé.

Enfin, **dans de nombreux cas, l'analyse des données pour déterminer les domaines prioritaires de la S3 n'a pas été suffisamment granulaire.** Par exemple, en ce qui concerne l'analyse des performances économiques, seuls 12 % des stratégies S3 utilisent des données NACE-2/3. Pour l'analyse des performances technologiques/scientifiques, seuls 19% utilisent des données plus approfondies. Les preuves qualitatives montrent qu'une analyse trop générale des données ou un manque pur et simple d'analyse des données constituent des obstacles majeurs lorsqu'il s'agit d'affiner les priorités de la S3.

2. L'établissement des priorités est-il basé sur des secteurs ou des domaines scientifiques et technologiques ou s'agit-il d'une approche interdisciplinaire/transsectorielle ?

Dans l'ensemble, nous avons constaté que l'**agroalimentaire et la bioéconomie (21%), la santé et les sciences de la vie (15%) et les TIC et l'industrie 4.0 sont les thèmes** les plus abordés par les stratégies S3 dans l'UE (voir figure 01). Les domaines les plus liés sont l'ingénierie, l'information et l'informatique ainsi que les sciences agricoles et vétérinaires pour les domaines scientifiques (FOR), et la R&D scientifique, la programmation informatique et la fabrication de produits informatiques, électroniques et optiques pour les secteurs économiques (NACE). L'informatique, la communication numérique et les machines, appareils et énergie électriques sont les domaines technologiques les plus connectés. Cela indique également que les TIC ne sont pas seulement importantes en tant que domaine prioritaire en soi, mais aussi en tant que thème au sein d'autres domaines prioritaires, ce qui confirme leur rôle de technologie à usage général (GPT).

Figure 0-1 (synthèse) : Part des thèmes primordiaux abordés par les domaines prioritaires de la S3



Source : Prognos / CSIL (2021). Note : 185 régions concernées. L'analyse est basée sur la méthode LDA (Linear discriminant analysis) à travers laquelle des sujets primordiaux ont été définis sur la base de descriptions prioritaires.

Lorsque l'on compare les **principales approches de sélection** des domaines prioritaires de la S3, les stratégies se réfèrent à toutes les approches mais surtout aux secteurs économiques (64%), aux domaines scientifiques (60%) et un peu moins aux domaines technologiques (48%).[11] En fait, les priorités de nombreux États membres/régions

[11] Définis selon la NACE (secteurs économiques), le FOR (domaines scientifiques) ou les classes technologiques de l'OMPI (domaines technologiques).

reflètent plutôt une approche combinée**.** 119 des 185 stratégies S3 (64%) contiennent des approches scientifique, technologique et économique dans leur sélection et sont simultanément liées au contexte naturel et culturel ainsi qu'à des objectifs sociétaux spécifiques.

En outre, l'étude montre que **plus de 90 % de toutes les stratégies S3** (168 sur 185 ; 91 %) **contiennent une référence explicite au défi sociétal "Action climatique/ressources"**. De même, le même chiffre indique un taux élevé de liens S3 avec les sous-groupes de défis sociétaux "Santé" (79 %), "Agriculture" (76 %) et "Énergie" (72 %).[12] À un niveau plus granulaire, les sous-groupes les plus souvent abordés sont les suivants : "Modes de consommation et de production durables", "Santé et bien-être" et "Accès à une énergie abordable, fiable, durable et moderne pour tous". Lorsque l'on évalue les ressources culturelles ou naturelles sur lesquelles les domaines prioritaires se fondent le plus souvent, le patrimoine culturel d'une région est le plus souvent identifié - par 80 stratégies S3 (43%).

3. Comment et avec quels résultats la hiérarchisation des priorités a-t-elle été réalisée dans les stratégies S3 ?

Presque tous les États membres/régions abordent des domaines et secteurs technologiques très complexes. Il n'y a pas de différences significatives entre les types de régions (moins développées, etc.), les domaines de haute technologie sont comparativement mis en avant. De façon similaire, la préférence pour les activités à forte intensité de R&D et de haute technologie peut toutefois être considérée comme une preuve que les régions économiquement plus faibles (moins développées) semblent utiliser la S3 pour passer à la vitesse supérieure dans les secteurs axés sur la R&D.

Dans la plupart des États membres/régions (166/185), la part des domaines technologiques dans les stratégies qui sont très complexes s'élève à moins de 50% (complexité technologique). En ce qui concerne la complexité économique, on constate que dans la plupart des stratégies (160/185), les secteurs manufacturiers de haute technologie ou les secteurs de services de haute technologie représentent moins de 50% (en moyenne) de tous les secteurs économiques abordés.

4. À quel niveau de granularité cette hiérarchisation a-t-elle eu lieu ?

Une approche granulaire de la hiérarchisation des priorités permet d'obtenir un impact plus important en atteignant une masse critique et en évitant de répartir les fonds d'innovation sur un trop grand nombre de domaines prioritaires. Un indicateur est le nombre de domaines prioritaires par stratégie S3. **Le nombre de priorités varie d'une région à l'autre**, allant d'un minimum de deux à un maximum de 14 ou 15. Le nombre moyen de priorités par région est de 5.5 et la médiane est de 5.

Tableau 0-1 (synthèse) : Nombre de domaines prioritaires des stratégies S3 dans les États membres/régions (dernière année de la stratégie S3)

	Toutes les régions	Moins développées	En transition	Plus développées
Total	1014	325	189	500
Moyenne par région	5.5	5.6	5.4	5.4
Médiane	5.0	6	5	5
Gamme : MIN - MAX	2 -15	2 – 15	2 – 8	2 – 15

Source : Prognos / CSIL (2021). Note : n=185 régions.

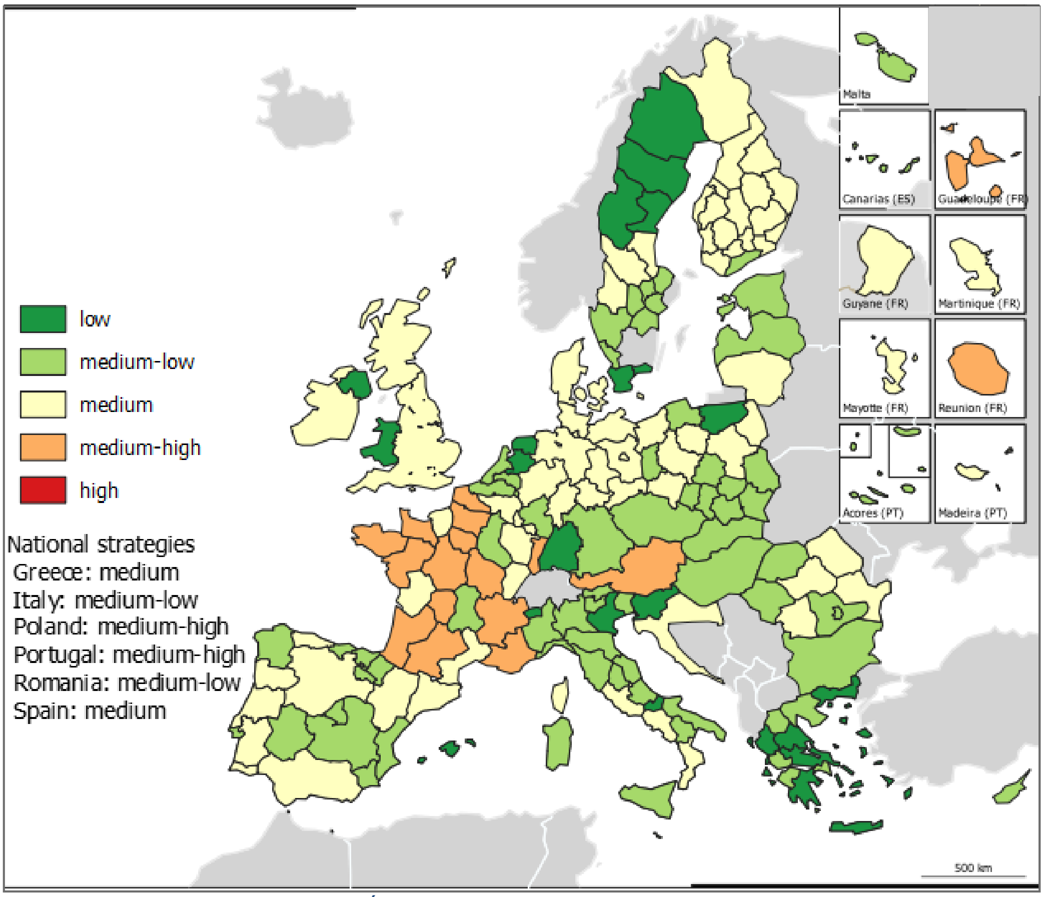
Cependant, le **nombre absolu de domaines prioritaires peut être trompeur** pour déterminer si les priorités d'une stratégie S3 sont granulaires ou non. Cela vaut particulièrement pour les États membres/régions qui utilisent une structure à plusieurs

[12] Selon Gianelle et al. (2016), les priorités pourraient être formulées en termes de domaines ou de secteurs de la connaissance qui sont particulièrement pertinents pour les défis sociétaux et environnementaux.

niveaux avec quelques domaines prioritaires principaux largement définis et plusieurs sous-priorités. Une autre indication de la granularité peut être tirée de l'analyse de la largeur thématique (analysée par l'indice de largeur de bande thématique). Environ 75 % des stratégies S3 se situent dans la catégorie de largeur de bande moyenne-faible à moyenne (c'est-à-dire un indice de largeur de bande compris entre 20 et 60 %, moyenne européenne = 38 %). Les États membres/régions ayant des stratégies S3 particulièrement larges sont le Portugal (indice de largeur de bande de 76%), la Pologne (66%) et l'Autriche (63% ; toutes les stratégies S3 nationales) ainsi qu'un certain nombre de régions françaises telles que la Bretagne (80%), le Limousin (74%) ou les Pays de la Loire (70%).

En outre, l'**analyse de la corrélation entre le nombre de domaines prioritaires des stratégies S3, leur largeur de bande thématique et leur concentration avec certaines caractéristiques régionales** a montré que la granularité et la sélectivité des stratégies S3 semblent être au moins partiellement liées à la taille des États membres/régions.

Carte 0-1 (synthèse) : Indice de largeur de bande des stratégies S3 dans les États membres/régions de l'UE (dernière année de la stratégie S3)



Source : Prognos / CSIL (2021). n = 165 États membres/régions. Note : Lorsqu'une région est couverte à la fois par une stratégie nationale et une stratégie infranationale, la zone colorée de la région infranationale fait référence à la correspondance de la stratégie infranationale. Les valeurs des stratégies nationales sont indiquées dans la légende. Ces régions sont l'Italie, la Grèce, l'Espagne, la Pologne, le Portugal et la Roumanie. Les données pour les régions suédoises et finlandaises sont agrégées au niveau NUTS2.

B. Correspondance des profils régionaux avec les domaines prioritaires sélectionnés

La correspondance entre les domaines prioritaires de la S3 et les profils des États membres/régions a principalement fait l'objet d'une analyse approfondie. Pour chaque stratégie S3, nous avons analysé les variables capturant les priorités de la S3 et les variables capturant les profils et les forces économiques, scientifiques et technologiques des États membres/régions, telles que mesurées par les indicateurs d'emploi, de publication et de brevet, respectivement. Les résultats ont ensuite été enrichis et validés à l'aide de modèles économétriques, d'analyses en grappes et d'études de cas qualitatives.

5. **Quel raisonnement (économique, scientifique ou technologique) a prévalu, c'est-à-dire qu'il explique mieux l'ensemble des priorités choisies ?**

Dans l'ensemble, les priorités reflètent mieux les profils scientifiques et technologiques des États membres/régions qu'elles ne le font avec les profils économiques. Cela peut être dû à une pléthore de raisons, liées par exemple à des comportements de mimétisme qui n'ont pas pris en compte les capacités endogènes ou les ambitions de développer de nouveaux secteurs. Une correspondance plus forte entre les priorités de la S3 et les capacités scientifiques et technologiques des États membres/régions peut indiquer que la stratégie vise à toucher les secteurs de l'économie à plus forte intensité de connaissances ou de technologies, ou à déclencher un processus de mise à niveau des connaissances ou des technologies qui pourrait éventuellement conduire à l'émergence de nouvelles niches de marché ou alimenter une transformation structurelle.

6. **Comment la hiérarchisation des priorités reflète-t-elle la structure économique actuelle de la région ? Comment l'établissement des priorités reflète-t-il les changements en cours et les développements futurs de la structure économique ?**

Les stratégies S3 ne correspondent généralement pas aux profils économiques des États membres/régions (comme le montrent les données sur l'emploi par activité économique NACE). Les régions dont le profil économique correspond le mieux sont principalement des régions en transition et moins développées. Parmi elles, on trouve plusieurs régions grecques qui ont donné la priorité aux secteurs de l'agroalimentaire et du tourisme qui emploient une grande partie de leur population. L'analyse montre également que, si peu de régions se distinguent par la priorité qu'elles accordent aux structures économiques actuelles, un peu plus nombreuses sont celles qui ont choisi des priorités en lien avec les secteurs en transformation, comme le montrent les taux de croissance de l'emploi au cours des trois années précédant ou suivant la publication de la stratégie S3. Cela indique que, du moins dans une certaine mesure, **certaines stratégies S3 ont pris en compte les processus de transformation structurelle en cours**.

7. **Comment la hiérarchisation des priorités reflète-t-elle les atouts scientifiques de la région ? Comment les forces scientifiques ont-elles été évaluées (en se basant uniquement sur les institutions publiques ou en incluant les organisations privées/capacité de recherche des entreprises) ?**

Les priorités S3 correspondent bien aux profils scientifiques des États membres/régions de l'UE. En général, de nombreux États membres/régions ont sélectionné des priorités S3 dans des domaines de forte production scientifique, mesurée par le nombre de publications de FOR dans chaque État membre/région. Cependant, il ne s'agissait pas nécessairement de domaines d'excellence scientifique au niveau international.

Une question essentielle de cette étude concernait la mesure dans laquelle les capacités technologiques publiques *et* privées étaient reflétées dans l'exercice de hiérarchisation des priorités. En moyenne, les **stratégies correspondent bien au profil de publication des organisations privées (entreprises) et du secteur public**. Cette constatation est conforme au fait que les parties prenantes des secteurs public et privé ont été impliquées dans l'EDP de la plupart des stratégies S3. En revanche, les stratégies qui correspondent le mieux à leur profil scientifique public proviennent pour la plupart de régions et d'États membres moins développés et en transition, également classés comme innovateurs modérés ou modestes.

8. **Comment la hiérarchisation des priorités reflète-t-elle les atouts technologiques de la région ? Comment les atouts technologiques ont-ils été**

évalués (sur la base des capacités des entreprises uniquement ou en incluant les institutions publiques) ?**

Les priorités de la S3 correspondent relativement bien aux profils technologiques des États membres/régions, tels que représentés par les parts de brevets dans les différents domaines technologiques. La plupart des États membres/régions qui ont mieux reflété leur profil technologique dans la S3 sont plus développés, et sont également classés comme des leaders de l'innovation ou des innovateurs forts. Conformément à ce qui a été observé pour les profils scientifiques, les **stratégies semblent mieux refléter les profils et les forces technologiques privés** que les publics, bien que la différence soit faible.

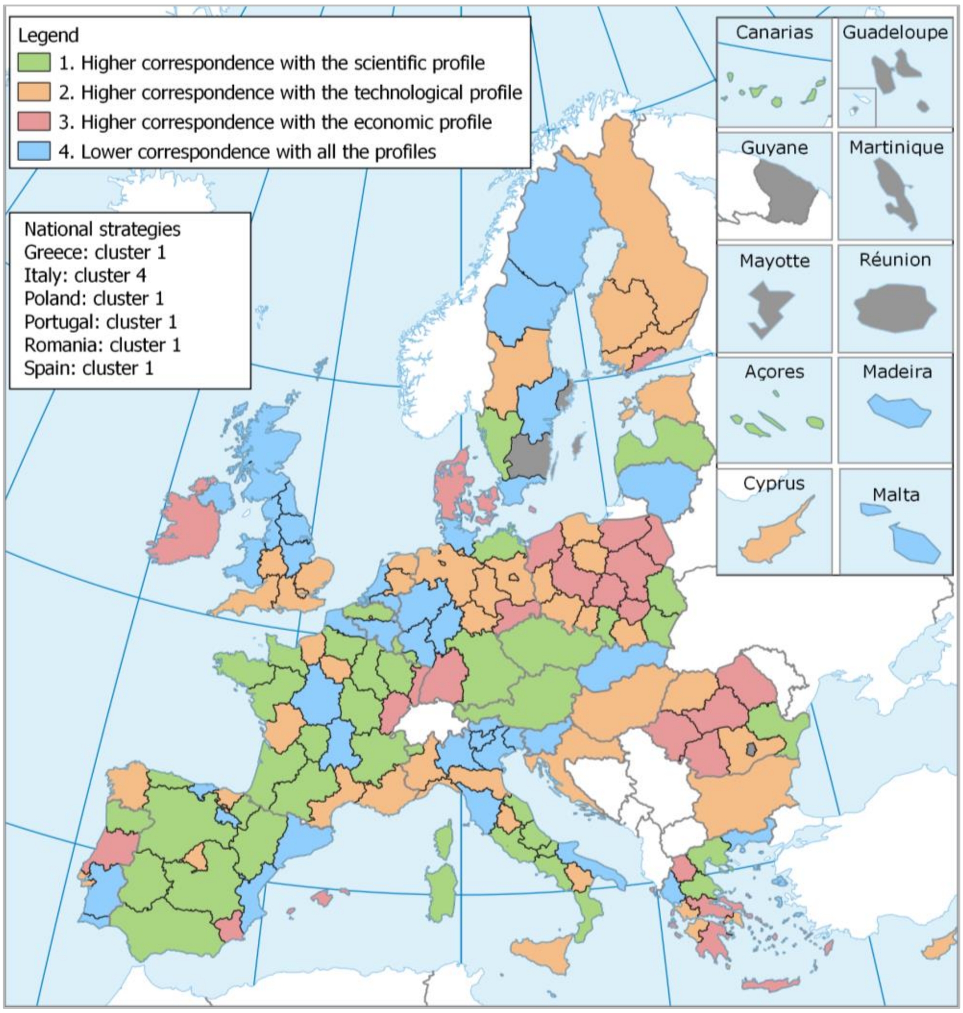
9. Dans quelle mesure l'établissement des priorités aborde-t-il des questions telles que la diversification, la spécialisation, la mise à niveau et la variété connexe ?

Pour explorer cette question, cette étude a calculé et utilisé les indices de densité de parenté technologique et de complexité technologique développés dans la littérature. L'analyse de corrélation montre que **plusieurs États membres/régions ont choisi des domaines plus proches de leur espace de connaissance**. Cette approche a été suivie par des régions plus ou moins développées, et aucune catégorisation claire ne peut être trouvée en termes de profils d'innovation. Pour mieux caractériser les stratégies S3 adoptées, nous calculons une **mesure du degré d'ambition de la stratégie**, reflétant la mesure dans laquelle une stratégie a sélectionné des domaines prioritaires qui peuvent être considérés comme trop ou pas assez complexes par rapport au mélange de technologies déjà maîtrisé par l'État membre/la région. Sur la base de ces nouveaux paramètres, une stratégie qui vise une diversification non liée et qui cible des technologies complexes est marquée comme une stratégie ambitieuse (voir le chapitre 5 pour des cartes détaillées). Même si certaines stratégies S3 ont suivi une approche plus ambitieuse, en sélectionnant des technologies non liées et assez complexes, des recherches supplémentaires seraient nécessaires pour comprendre si une telle approche peut être considérée comme réalisable, plutôt que trop ambitieuse pour l'État membre/la région spécifique.

10. Comment les informations sur la structure économique, les forces scientifiques et les forces technologiques ont-elles été combinées dans la stratégie globale ? Existe-t-il des traits communs aux régions qui permettent de catégoriser leurs expériences hétérogènes ?

Nous avons identifié **quatre groupes de stratégies**, chacun caractérisé par une approche de hiérarchisation relativement similaire dans la correspondance des stratégies S3 avec les profils régionaux :

Carte 0-2 (synthèse) : Groupes de stratégies S3 en fonction de la correspondance de leurs domaines prioritaires S3 avec les profils régionaux/nationaux.



Source : Prognos / CSIL (2021). Note : La carte montre le cluster spécifique auquel appartiennent les dernières stratégies S3. Les régions en gris sont exclues de l'analyse en raison de données manquantes.

1. **61 Les stratégies S3 (29%) présentent une correspondance plus élevée avec le profil scientifique** : ce groupe est caractérisé par une prédominance d'États membres de l'UE15, de régions en transition et d'innovateurs modérés ou modestes, avec une faible proportion de la population engagée dans la science et la technologie et un indice de qualité du gouvernement inférieur à la moyenne de l'UE. Une interprétation de ces résultats pourrait nous amener à supposer que ce groupe d'États membres et de régions possède certaines compétences scientifiques qui ne se traduisent pas encore efficacement en compétences technologiques au sein des entreprises.

2. **62 stratégies S3 (30%) ont une correspondance plus élevée avec le profil technologique** : ce groupe est généralement composé d'États membres/régions très diversifiés ayant un bon profil d'innovation (classé comme leader de l'innovation, innovateur fort ou modéré) et une part élevée de la population employée dans les sciences et la technologie. Les États membres et les régions qui ont adopté cette approche de hiérarchisation se trouvent dans différentes parties de l'UE, avec une part importante d'entre eux en Europe centrale et orientale, en Europe du Nord et en Europe occidentale.

3. **33 Les stratégies S3 (16%) ont une correspondance plus élevée avec le profil économique** : cette approche de priorisation semble plus répandue dans les régions en transition et les innovateurs modestes, avec un faible degré de diversification économique, souvent en Europe centrale et orientale.

4. **53 Les stratégies S3 (25 %) présentent une correspondance relativement faible avec tout profil** : cette approche de hiérarchisation a été suivie par de nombreux États membres/régions de l'UE15, souvent caractérisés par une forte diversification économique, un profil d'innovation solide et un gouvernement de qualité. Les stratégies qui appartiennent à ce groupe semblent également être très ambitieuses, car elles visent une diversification non liée et des technologies relativement complexes.

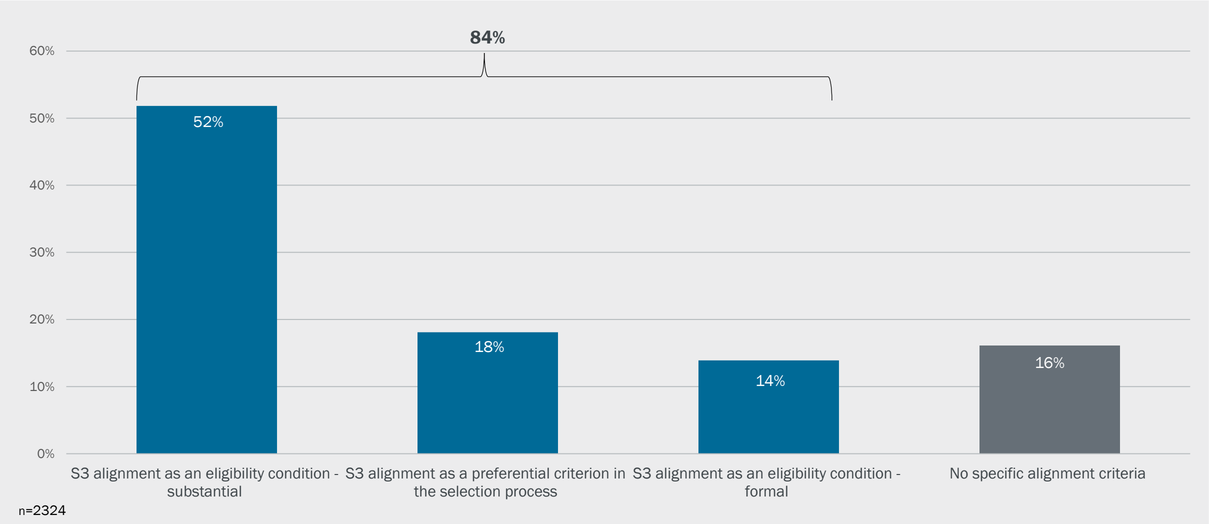
C. Mise en œuvre des stratégies S3

L'analyse de la mise en œuvre des stratégies S3 a été menée à travers la collecte des appels à propositions pertinents du FEDER-TO1 et des projets de R&I respectifs financés par le FEDER. On a cherché à savoir dans quelle mesure les appels à propositions contiennent des critères stricts d'alignement sur les stratégies S3 et si les projets sont thématiquement liés aux priorités des régions respectives.

11. Comment la hiérarchisation des priorités s'est-elle reflétée dans la préparation et la mise en œuvre des appels ?

Comme le montre la Figure 0-2, la **quasi-totalité (84%) des plus de 2300 appels à propositions FEDER-TO1 prévoient un alignement sur les stratégies S3**. En revanche, seuls 16% n'exigent pas un tel alignement. L'analyse révèle en outre que la plupart des appels (52%) exigent un alignement substantiel sur la S3. Les appels qui privilégient les propositions liées à la S3 dans le processus de sélection représentent 18% des appels collectés. En outre, 14% des appels sont caractérisés par une condition formelle d'alignement sur la S3.

Figure 0-2 (synthèse) : Critères d'alignement S3 (toutes les régions)



Source : Prognos / CSIL (2021). Note : Pour tenir compte des grandes variations du nombre d'appels entre les États membres/régions, la part de chaque région a été calculée, puis la moyenne a été calculée. N=2324

La conclusion selon laquelle la plupart des appels exigent un alignement sur la S3 est corroborée par les entretiens menés avec les autorités de gestion de la S3. Parmi les 176 personnes interrogées[13], 95 % ont indiqué que les priorités définies dans les stratégies de la S3 se reflétaient dans la préparation et la mise en œuvre des programmes et/ou des appels à propositions.

La majorité des appels à propositions liés à la S3 abordent tous les domaines prioritaires en même temps. Un sous-ensemble de domaines prioritaires est abordé dans 15% et un seul domaine prioritaire dans 11% de tous les appels collectés qui relèvent du TO1. Cependant, il existe des différences régionales notables : les régions moins

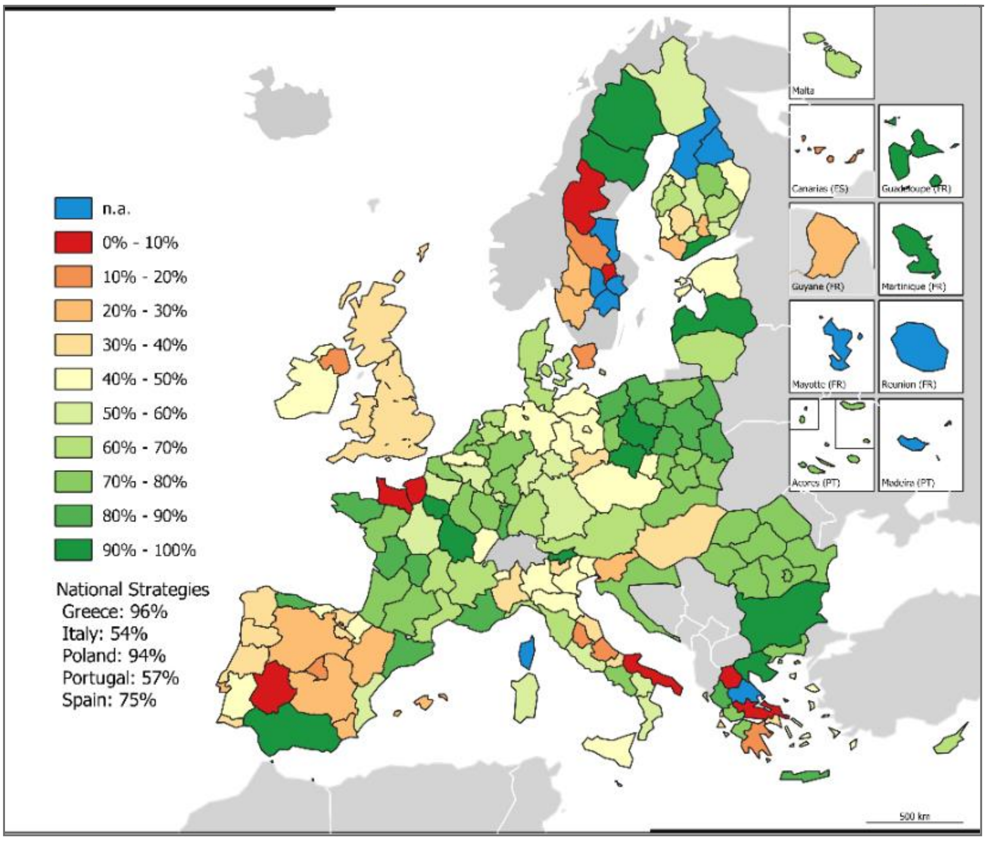
[13] 176 personnes interrogées sur un total de 181 personnes ont répondu à cette question.

développées ont un pourcentage plus élevé d'appels qui traitent tous les domaines prioritaires en même temps (appels plus larges) par rapport aux régions en transition et plus développées. Ce dernier point indique que les régions en transition/plus développées semblent utiliser des appels plus personnalisés pour développer leurs domaines prioritaires S3.

12. Comment le processus de sélection des projets a-t-il reflété la hiérarchisation des priorités ? Le processus de sélection a-t-il conduit à la mise en œuvre des projets dans les domaines prioritaires ?

L'analyse révèle qu'**en moyenne 57 % des projets de R&I du FEDER sont liés aux domaines prioritaires** définis dans les stratégies S3.[14] Au total, **19,6 milliards d'euros ont été dépensés pour des projets de R&I liés aux domaines prioritaires de la S3, soit 62%** du budget qui a été identifié pour l'ensemble des projets de R&I. Toutefois, comme le montre la carte ci-dessous, il existe de **grandes différences entre les États membres/régions** quant au degré de correspondance des projets de R&I du FEDER avec les priorités de la S3 : Alors que seulement 54% des projets des États membres/régions de l'UE15 correspondent aux priorités de la S3, la part des États membres/régions de l'UE13 est de 65%. Il est intéressant de noter que les régions moins développées présentent en moyenne plus de projets liés à leurs priorités S3 (moyenne de 60%), par rapport aux régions en transition (58%) et aux régions plus développées (54%).

Carte 0-3 (synthèse): Part des projets et du budget qui sont liés aux domaines prioritaires



Source : Prognos / CSIL (2021). n = 167 régions.

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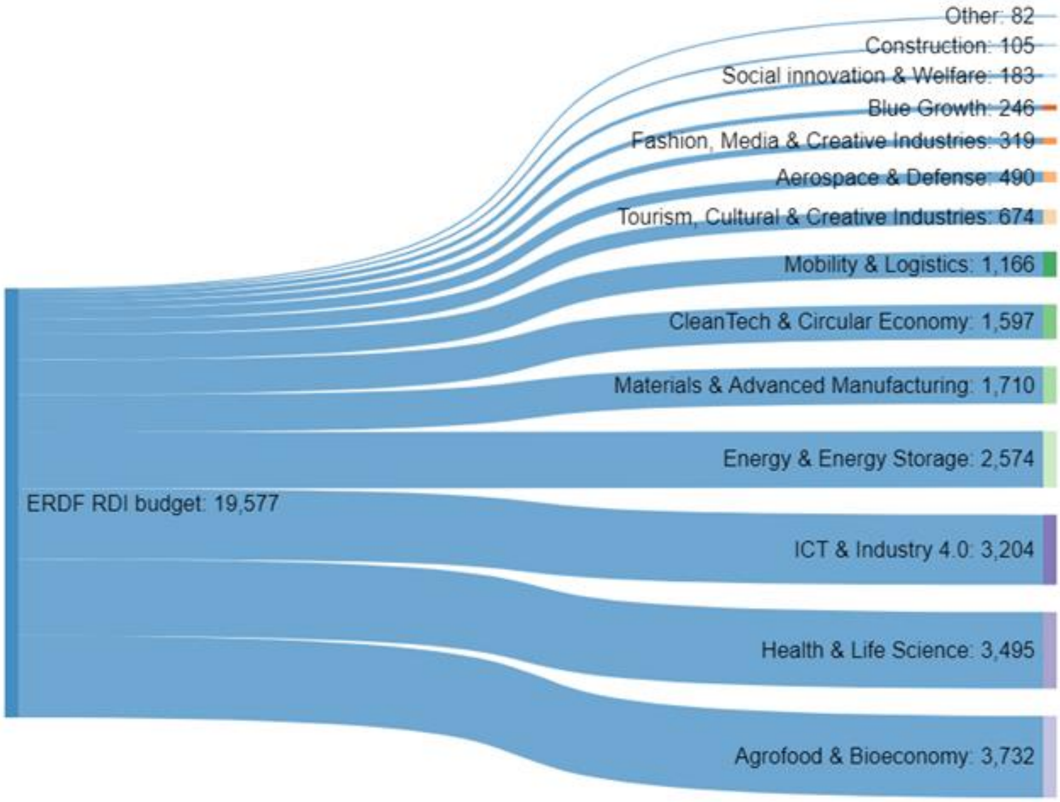
[14] Il est fait référence ici aux stratégies S3 initiales de 167 États membres/régions. La différence entre le nombre de stratégies S3 (185) et le nombre total d'États membres/régions qui sont utilisés pour cette section existe parce que certaines régions n'ont enregistré aucun projet (Thessalie, plusieurs régions finlandaises et suédoises, Mayotte, Martinique) ou qu'il n'y avait pas de projets au niveau NUTS de la stratégie S3 (régions de Roumanie, PO uniquement au niveau national).

13.Le processus de sélection a-t-il conduit à se concentrer sur des domaines spécifiques de spécialisation intelligente ?

Nous présentons ci-dessous le volume du financement FEDER qui a été consacré à des projets ayant un lien avec la S3 dans les différents domaines thématiques des stratégies S3 dans les États membres/régions de l'UE.[15] Au total, près de 19,6 milliards d'euros ont été consacrés à des projets de R&I dans les domaines prioritaires de la S3. Environ 50 % de ces budgets de projets ont été consacrés à trois domaines thématiques, à savoir **"Agroalimentaire et bioéconomie" (3.7 milliards d'euros ; 19 %), "Santé et sciences de la vie" (3.5 milliards d'euros ; 17.9 %) et "TIC et industrie 4.0" (3.2 milliards d'euros ; 16.3 %).**

Figure 0-3 (synthèse): Domaines thématiques primordiaux et budget qui leur a été consacré dans le cadre des projets FEDER



Source : Prognos / CSIL (2021). Note : Les chiffres sont basés sur les projets qui ont été reliés avec succès aux domaines prioritaires de 167 régions, ce qui signifie que les projets qui pourraient entrer dans un certain domaine thématique général, mais qui n'étaient pas reliés à un domaine prioritaire, ne sont pas inclus ici. Le budget global qui a été lié à ces projets et qui sert de base à ce chiffre est de 19,6 milliards d'euros.

Conclusion Générale

Forces et faiblesses de la hiérarchisation et de la mise en œuvre des stratégies S3 en Europe

1. Un large processus de consultation des parties prenantes a été appliqué dans la majorité des États membres/régions.
2. Les États membres/régions ont utilisé un large éventail d'instruments et de processus différents en ce qui concerne le processus de la « Découverte Entrepreneuriale » (PDE) et l'analyse des données.

[15] Cela signifie donc qu'il ne s'agit pas d'un aperçu de la répartition thématique du financement FEDER R&I dans son ensemble, mais plutôt d'un aperçu de la répartition thématique du financement FEDER R&I qui est lié aux priorités de la S3.

3. Un PDE continu n'a pas pu être établie dans de nombreuses régions, bien que la continuité formelle soit légèrement plus élevée dans les régions de l'UE13/moins développées.
4. Dans de nombreux cas, l'analyse des données pour déterminer les domaines prioritaires de la S3 n'a pas été suffisamment granulaire.

Les approches de priorisation utilisées dans les stratégies S3

5. Les sujets les plus fréquemment abordés dans les domaines prioritaires S3 sont liés aux domaines de l'ingénierie et des TIC.
6. Les domaines prioritaires reposent pour la plupart sur une approche combinée de fixation des priorités et ne sont généralement pas définis en termes de domaines scientifiques, économiques ou technologiques uniques.
7. Il n'existe que des différences régionales très mineures en ce qui concerne le degré de complexité des stratégies S3 et de leurs domaines prioritaires.
8. Il est trompeur de se référer au nombre absolu de domaines prioritaires, surtout pour les États membres/régions qui utilisent une structure à plusieurs niveaux (en forme d'arbre) avec quelques domaines prioritaires principaux largement définis et plusieurs sous-priorités.
9. Les États membres/régions plus grands et économiquement plus forts semblent accorder moins de priorité que les régions plus petites.

La correspondance des stratégies S3 avec le profil régional

10. Même si les priorités S3 peuvent être définies en termes de secteurs économiques (point 6 ci-dessus), les priorités S3 ne correspondent généralement pas aux profils économiques des États membres/régions (selon tout indicateur basé sur l'emploi utilisé).
11. Les domaines prioritaires des stratégies S3 correspondent plus souvent aux profils scientifiques des pays et régions de l'UE.
12. Les priorités de la S3 correspondent généralement aux profils technologiques des États membres/régions.
13. Les atouts scientifiques et technologiques des secteurs publics et privés semblent se refléter assez bien dans les stratégies S3.
14. Plusieurs stratégies S3 ont sélectionné des domaines prioritaires plus proches de leur domaine de connaissances
15. En synthèse, quatre groupes émergent lorsqu'on considère la correspondance globale des priorités de la S3 avec les profils nationaux/régionaux: 61 stratégies S3 *correspondent particulièrement bien* à leur profil scientifique (29,2 %); 62 stratégies S3 *correspondent particulièrement bien* à leur profil technologique (29,7 %); 33 S3 stratégies ont un *bon niveau de* correspondance avec le profil économique (15,8 %); 53 stratégies S3 *ne correspondent à aucun* profil (scientifique, économique, technologique), mais révèlent une plus grande ambition en termes d'innovation technologique et d'objectifs de diversification (25,4 %).

La mise en œuvre des priorités de la S3 sélectionnées

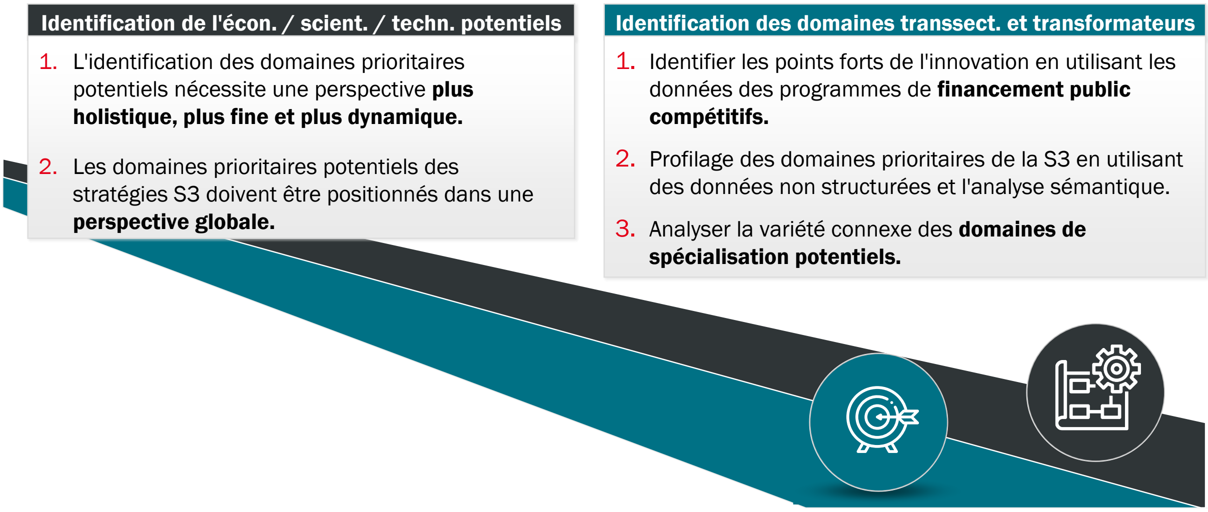
16. Les appels/programmes financés par le FEDER exigent principalement un alignement sur les stratégies S3.
17. Des liens entre les projets financés par le FEDER et les priorités de la S3 ont été trouvés pour 57% des projets, mais il existe des différences substantielles entre les États Membres/régions.
18. Dans l'ensemble, les critères d'éligibilité stricts de la S3 semblent être bien appliqués dans les processus de sélection des projets et favorisent la sélection de projets liés aux domaines prioritaires.
19. Les domaines prioritaires les plus fréquemment abordés dans les stratégies S3 se reflètent également dans les projets mis en œuvre.

Perspectives et tableau de bord S3 2021

Les résultats de cette étude comprennent **plusieurs leçons et recommandations clés dont les** décideurs politiques peuvent s'inspirer pour poursuivre la mise en œuvre de la S3, le processus de découverte entrepreneuriale, et pour favoriser la croissance basée sur l'innovation sur leur territoire au-delà de la stratégie S3 spécifique. Bien que cette étude n'ait pas couvert, ou seulement partiellement, tous les défis liés à la conception et à la mise en œuvre de la S3 (par exemple, en ce qui concerne la conception des instruments politiques, la gouvernance de la S3, etc.), plusieurs enseignements importants au cœur du concept de la S3 sont mis en avant et peuvent aider les États membres/régions à mieux répondre aux défis à venir et peuvent contribuer efficacement à une reprise durable post-pandémie.

Les recommandations clés suivantes peuvent être soulignées :

Recommandations sur l'identification des domaines prioritaires de la S3



Recommandations sur la gouvernance de la S3, l'informatique et la mise en œuvre, ainsi que le suivi et l'évaluation

Enfin, l'étude a développé un **"tableau de bord S3"** comme une évaluation comparative de l'ensemble des 185 stratégies de spécialisation intelligente dans les États membres et les régions de l'UE sur la base d'une nouvelle méthodologie. Plus précisément, le tableau de bord S3 couvre 163 régions dans 28 pays européens. En outre, les stratégies S3 au niveau national, comme à Malte, au Luxembourg ou à Chypre, sont incluses. Il fournit une ventilation détaillée des groupes de performance avec des données contextuelles, notamment la part du budget FEDER liée aux domaines prioritaires de la S3, la continuité de la PDE ou la rigueur des critères de sélection pour les appels liés à la S3 dans le cadre du FEDER 2014-2020, qui peuvent être utilisées pour analyser et comparer la sophistication des stratégies S3 dans l'UE aujourd'hui et à l'avenir.

Dans l'ensemble, **le tableau de bord de la S3 2021 montre une variation importante reflétant les différents** points de départ de la spécialisation intelligente en termes de force du système de recherche et d'innovation, de quantité de ressources disponibles par rapport aux ressources nationales et de niveaux d'intensité de l'aide. On trouve de nombreux leaders S3 dans les régions moins développées, tandis que les pays nordiques, le Royaume-Uni ou certaines régions allemandes, françaises et espagnoles plus développées présentent des stratégies S3 plutôt modestes. Les 22 stratégies nationales S3 de l'UE sont relativement performantes.

1 INTRODUCTION

1.1 Background and scope of the study

This study is about **"Prioritisation in Smart Specialisation in the EU"**. It systematically screens and assesses all available S3 strategies across the EU to discover the respective approaches to prioritisation, to analyse if priorities set within the strategies correspond to innovation capabilities and if these were translated into concrete projects.

Regional innovation policy in the EU has gained increasing importance in the context of global competition, while the demands on companies and regions to be "innovative" are increasing. Only Member States/regions that succeed in creatively channelling the knowledge available worldwide and successfully transforming it, in connection with the endogenous potential of science and industry, can use the drivers of innovation for sustainable growth, employment and social cohesion. This requires strategic and coordinated support for innovation ecosystems at European, national, and regional levels.

To foster a comprehensive innovation policy at a regional level, the EU set ex-ante conditionalities (ExAC) for the Cohesion Policy period 2014-2020. The development of a "national and regional research and innovation strategy for smart specialisation" ("S3 strategy" or "S3") constitutes such a conditionality (ExAC 1.1) and was a prerequisite for the approval of the Operational Programmes (OP) of the European Regional Development Fund (ERDF) that include investment into strengthening research, technological development, and innovation.[16] To generate the highest possible impact with these strategies, they should be "smart"[17] and prioritise.

In practical terms, **the smart specialisation approach concentrates resources into carefully defined "priority areas"**. These priority areas can be framed in terms of knowledge fields or activities (not only science-based but also social, cultural, and creative ones), sub-systems within an economic sector or cutting across sectors. They can also correspond to specific market niches, clusters, technologies, or ranges of application of technologies to specific societal and environmental challenges. These priority areas should be in line with the region's existing assets and be able to take advantage of innovation opportunities. The definition and choice of priority areas is as critical to the success of this strategy as is the process of translating these priorities into funding measures and projects. Priority areas selected for S3 should seek to diversify into innovation activities related to the existing economic structure and strengths of the region to generate social and economic territorial impact, and at the same time create new capabilities and sources of future competitive advantage (Foray et al., 2018).

In this context and based on literature review, comprehensive data analysis, stakeholder interviews and case studies, **this study informs the European Commission (EC) on the following three overarching questions**:

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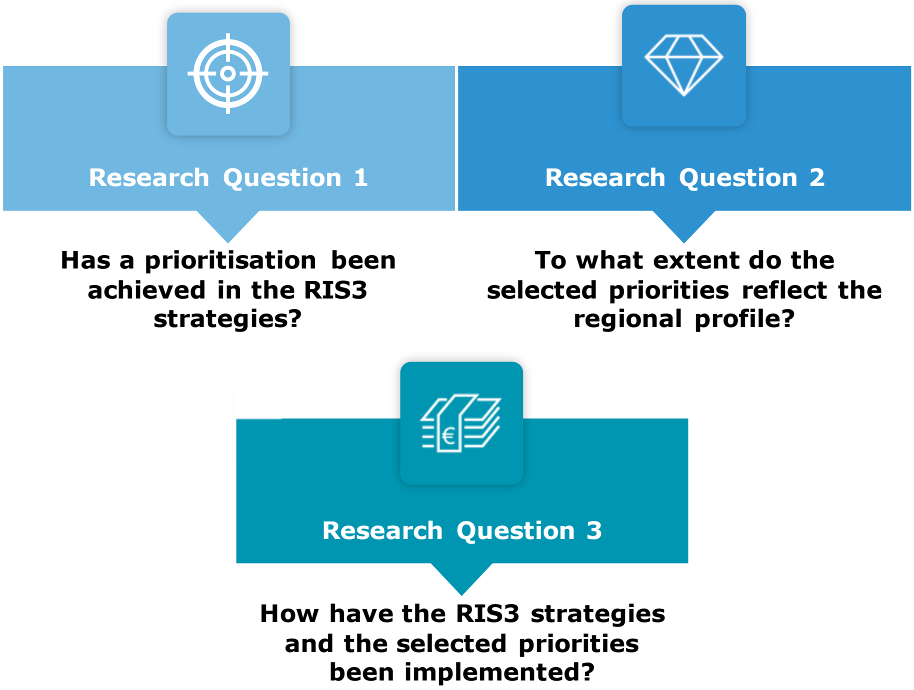
[16] I.e., Thematic Objective 1 (Article 9 CPR) (European Commission, 2012a).

[17] "Smart" relates to the four "Cs" of smart specialisation, namely that priorities be based on critical mass, shall contain critical advantage, shall be linked to clusters and other organisations and collaborative leadership.
https://ec.europa.eu/regional_policy/sources/docgener/presenta/smart_specialisation/smart_S3_2012.pdf

Figure 1-1: Overarching research questions



Source: Prognos / CSIL (2021)

The assessment is based on 185 S3 strategies at Member State level and their regions at NUTS 2 level or – where applicable – at NUTS 1 (e.g., in the case of the German – Länder) and NUTS 3 level (in Sweden and Finland) which have been prepared for the 2014-2020 programming period of Cohesion Policy and which have been considered by the Commission to fulfil the ExAC 1.1.[18] This ensures consistency throughout the study and effectively links the prioritisation area to ERDF funded projects.

1.2 Research question of the study

Based on the tender specifications, the three major study objectives outlined above are further detailed in the table below, comprising 13 specific research questions:

Table 1-1: Overall study objectives

Objectives regarding	Key research questions
1. Has a prioritisation been achieved in the S3 strategies?	a. How and with what outcome? b. At what level of granularity has this prioritisation taken place? c. Is the prioritisation based on sectors or scientific and technology fields or was it an interdisciplinary/cross-sectoral approach? d. Has the prioritisation been developed through an Entrepreneurial Discovery Process? On which level and with what methodologies?
2. To what extent do the selected priorities reflect the regional profile?	a. How does the prioritisation reflect the current economic structure of the region? How has the economic structure been assessed? b. How does the prioritisation reflect scientific strengths of the region? How have scientific strengths been assessed? c. How does the prioritisation reflect technological strengths of the region? How have technological strengths been assessed?

[18] Common Provision Regulation, EU/1303/2013. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1303&from=de

	d. How are the different strengths (economic, scientific, technological, cultural and environmental) combined in the strategy? e. To what extent does the prioritisation address issues such as diversification, specialisation, upgrading and related variety?
3. How have the S3 strategies and the selected priorities been implemented?	a. How was the prioritisation reflected in the preparation and implementation of calls? b. How did the project selection process reflect the prioritisation? Has the selection process led to the projects' implementation in the priority areas? c. Has the selection process led to focus on specific areas of smart specialisation? d. Have the experiences accumulated with the calls led to a revision or proposals for a revision of the prioritisation areas?

Source: Prognos / CSIL (2021).

1.3 What we know so far – main findings from the literature

During the inception phase of this study, a comprehensive literature review was completed, comprising more than **150 publications from academic journals to policy reports**. This literature review provides an overview of extant empirical literature on the topic of prioritisation in the framework of S3, and especially the contributions which help advance our understanding regarding the three key research questions mentioned above. Given the heterogeneity of regional pre-conditions and approaches adopted on the ground, emphasis was given on ensuring broad coverage of a wide variety of regions and EU Member States. Below, a **synthesis of the main results of the literature review** is provided, including several implications for the research performed in this study:

1. **There is a gap between the vivid conceptual debate around potential advantages and risks of the S3 approach to prioritisation** and the available empirical evidence to validate or refute hypotheses. Evidence is mostly qualitative and for research questions two and three we did not find clear answers based on the literature.
2. One difficulty in assessing the S3 policy process affects the precocity of the process (it is still early to collect sound data on the implementation and effects of S3). Furthermore, S3 strategies **in different Member States/regions were developed to comply with legal requirements (ex-ante conditionality) as a formal exercise**, which does not necessarily translate into impactful and more effective policymaking (Chrysomallidis and Tsakanikas, 2017). Most analyses rely on qualitative approaches with little systematic quantitative evidence available. There also seems to be an overemphasis in the literature on certain Member States/regions, which are "over-studied" at the expense of others.
3. Based on evidence from the existing literature, **clustering Member States/regions according to their prioritisation approach is difficult**. Possible discriminating criteria are not correlated and yield unclear categories. This reinforces an impression of highly *sui generis* patterns. For example, innovation capability and administrative capability are not *per se* sufficient to account for an effective prioritisation process. Also, prioritising poses challenges in both diversified and undiversified regions.
4. There is **a debate concerning the necessity for regions to have some prior levels of innovation capacity and research and development (R&D) strength to engage with S3**. For this reason, some have contended that S3 strategies are not suited to all types of regions (Hassink and Gong, 2019; Sörvik et al., 2019). Initially, Foray and his co-authors have reiterated the opposite (Foray et al., 2011, 2009). According to their original idea, S3 strategies could be formulated at different levels, or "orders of innovation", whereby more advanced regions could focus on the development of general-purpose technologies (GPTs) and less advanced regions could focus on the myriads of applications and related innovations that originate from GPTs (Foray et al., 2011, 2009). More recently, they have

acknowledged that the S3 approach might be most effective in a category of intermediate regions, with sufficient levels of diversification and average administrative capabilities (Foray, 2019). More advanced regions and lagging regions would still need innovation policies, but the basic elements of S3 (i.e., prioritisation and concentration of resources) have appeared less suited to these types of regions, based on the evidence from the policy experiences on the ground as reinterpreted by Foray and other authors (Foray, 2019; Hassink and Gong, 2019; Sörvik et al., 2019).

5. **Assessing the granularity of priorities is difficult because it depends on the specificities of the economy concerned**. Also, the level of granularity may vary in time (with increasingly refined definition) and space (with the adoption of multiple levels of priorities and sub-priorities). The same applies to the assessment of the selectivity of the prioritisation process (whether it is possible to concentrate resources). Referring to an absolute number of priorities to search for an optimum can be misleading, as much depends on the structure of the economy, but also on the level of priorities and the timing of the prioritisation process.
6. **Several priorities seem to be "popular" regardless of the presence of endogenous, regional strengths**. The current literature identifies a bias towards R&D-intensive and high-tech priorities, which would suggest that prioritisation within S3 might be an excessively R&D-focused process. At the same time, the literature review finds examples showing a certain tension between diversification towards related sectors and identification of new areas of specialisation, with regions often focusing excessively on their existing production structures. These are contradictory findings, which are difficult to put into perspective based on the evidence collected through the literature review.
7. **There are different levels of commitment to and acceptance of the Entrepreneurial Discovery Process (EDP)**. EDP seems to take as many shapes as there are documented examples (Blažek and Morgan, 2019). It can be driven in a top-down and bottom-up manner; it can involve a narrow range of stakeholders at the beginning and subsequently broaden its basis, or vice versa. It may be led by universities, government, or the private sector; it can happen at a point in time or be more continuous, as originally foreseen in the guidance provided by the EC to regions. In general, the EDP is not sufficient in defining priorities alone, but it is complementary. Often, EDP completes the prioritisation process, after the latter has been initiated based on formal methods and objective analyses. It is not excluded that the EDP in some regions remains a nominal process without impact.
8. **Based on empirical evidence in the available literature, it is hard to conclude if S3 priorities truly reflect areas of economic, scientific, and technological strength at the regional level**. In this regard, the literature points to a few instances that would justify an *imperfect correspondence* between priorities and assets on the ground. This is an important element for the analytical tasks of this study in Chapter 5: how to interpret a potentially low or imperfect correspondence between S3 priorities and the economic/scientific/technological structure (as well as perfect/high correspondence) of a region is not straightforward. It might reflect the attempt to diversify into new areas of specialisation or proof to poorly chosen priorities. There are examples where priorities broadly defined try to ensure the flexibility necessary to identify nascent niches of specialisation or foster unrelated diversification. At the same time, a too high correspondence might trigger lock-in effects and be a sign of a limited search for areas of diversification and upgrading.
9. **Prioritisation has a political dimension, which may consolidate or, on the contrary, impair its chances of success**. Lobbying might jeopardise an evidence-based prioritisation process, but political commitment is an important success factor too. Involving the private sector is politically challenging. Sometimes the private sector seems to lack interest, sometimes it shows too much interest. In this respect, being selective rather than overly inclusive seems to be a condition of effectiveness.

1.4 Structure of the report

As per the Tender Specifications, the study is based on six major tasks, comprising a literature review, a general assessment and information collection as regards the S3 strategies, specific assessments as regards prioritisation, an assessment as to whether priorities selected correspond to the structure of economic, scientific and technological opportunities in the Member State/region and a specific assessment as regards the implementation of S3 strategies via calls and their selection criteria. Finally, proposals for the future development of S3 strategies are to be developed. Considering these requirements, the Final Report is structured as follows:

Table 1-2: Structure of the report

Chapter	Title	Description
Chapter 1	Introduction	Providing an overview of the background and scope of the study as well as illustrating the objectives and related research questions.
Chapter 2	Methodological design and research limitations	Information on the data collection, descriptions of the methodologies used, research limitations
Chapter 3	Methodologies and tools used for S3 strategy development	Results from the EDP, including stakeholder involvement and data used
Chapter 4	Prioritisation approaches in the S3 strategies across the EU	Illustration and analysis of the prioritisation approach used, including granularity and complexity
Chapter 5	Regional innovation capabilities and their correspondence with selected S3 priority areas	Analysis of correspondence of regional capabilities and priority areas, including correspondence with economic, scientific, and technological profiles
Chapter 6	Implementation of S3 strategies across the EU	Illustration and analysis of ERDF funding, selection mechanisms of relevant calls and the correspondence between ERDF projects and priorities.
Chapter 7	Conclusions, lessons learned on the first cycle of S3 strategies and suggestions for the future	Summary of key findings and suggestions for the future

Source: Prognos / CSIL (2021).

2 METHODOLOGICAL DESIGN & RESEARCH LIMITATIONS

2.1 Overview of the approach and tools

The study follows the design of a comparative meta-analysis to provide a comprehensive overview of all S3 strategies in the 27 EU Member States and the UK. The aim is not to evaluate or rank the Member States/regions and their strategic approaches. Rather, it is the objectives of this study to classify and systematically assess the identified priorities and the means of strategy implementation in the Member States and regions within the framework of the S3 strategies and to understand the variety of approaches pursued.

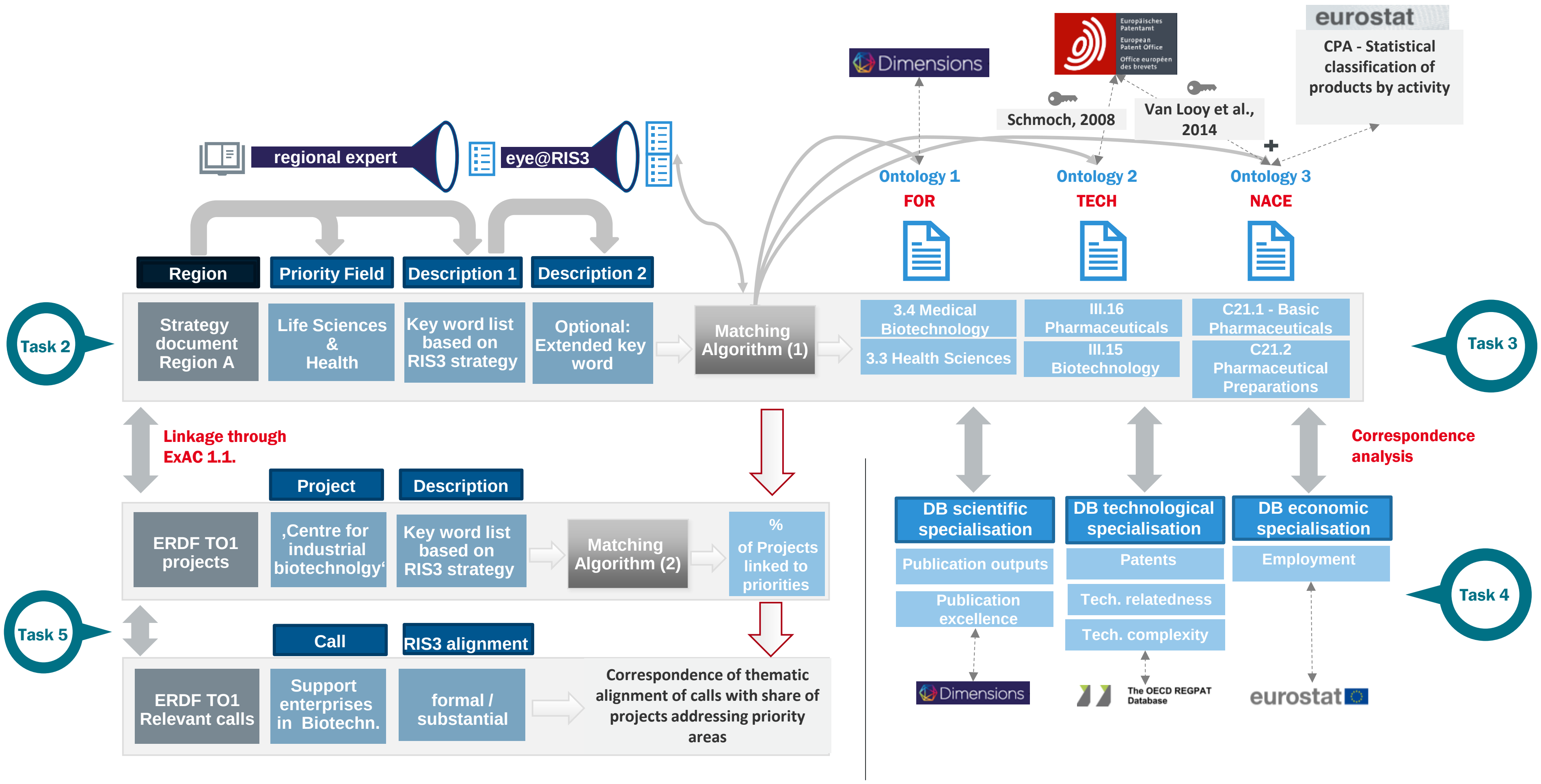
To answer the research questions outlined in Chapter 1, **this study relies on a comprehensive, unique empirical basis and data processing**, including a mapping of all S3 strategies in the EU, big data analysis using text mining, and econometric assessment as well as case studies. More specifically, the study relies on:

- **Collection of relevant S3 strategies:** In the context of this task, 185 S3 strategies and accompanying documents were collected. Based on the documents and the 181 interviews the relevant information was filled into a framework that was specifically designed for this study (→ **Task 2** in Figure 2-1).
- **Setting up of a S3 prioritisation database and analysing S3 priority areas:** A database was developed that structures the 1,006 priority areas (1,239 including updated S3 strategies) of the 185 regions into three classifications (Economic sectors: NACE 2-digit level- 88 sectors; Scientific fields: FOR 2-digit level– 22 dimensions; Technology fields / KETs: Technology classes by WIPO – 35 Technology fields). To translate the S3 priority areas into standardised classifications, an automated text analysis approach was used, which required the development of matching functions and constant refinements of the key word list (→ **Task 3** in Figure 2-1).
- **Conducting the correspondence analysis/case studies:** To lay the groundwork for the correspondence analysis, indicators of the economic, scientific, technological profiles and technological relatedness and complexity were constructed at a NUTS 0, NUTS 1 and NUTS 2 level for the relevant years of the initial and updated S3 strategies. These draw from four different sources: Eurostat for employment-related data, OECD-REGPAT and PATSTAT for patent data and the proprietary Global Research Identifier Database (GRID) owned by Dimensions for publication data (see Annex 9.3.2 for the details). Over twenty additional indicators were collected to be used as control variables in the econometric analysis. The constructed databases are rich and enable the matching with the largest majority of S3 priorities classification as illustrated in Chapter 4.[19] The quantitative analysis was complemented by case studies in ten selected strategies[20] (→ **Task 4** in Figure 2-1).
- **Analysis of the implementation of S3 strategies:** To analyse the implementation of the S3 strategies 186 ERDF project/beneficiary lists and 2876 ERDF relevant calls were collected and analysed by the experts. The information regarding the calls needed to be transmitted along with certain categories in a framework that was designed for this task. To match the projects to the priorities an automated text analysis approach was used, which required the development of matching functions and refinements of the key word list (→ **Task 5** in Figure 2-1).

[19] The employment and patent databases can be matched with 215 out of a total of 219 S3 documents (including strategies' updates), while the publication database can be matched with all the S3 strategies. The strategies that are excluded from the Task 4 analysis are: "Strategia Innowacyjności i Efektywności Gospodarki (SIiEG) - Krajowa inteligentna specjalizacja" from Poland; "Regionalna Strategia Innowacyjności Województwa Warmińsko-Mazurskiego do roku 2020" from Warmińsko-Mazurskie (Poland); "Smart Specialisation Strategy in the Helsinki-Uusimaa Region" from Helsinki-Uusimaa (Finland) and "An International Innovation strategy for Skåne 2012-2020" from Skåne län (Sweden). These are all updates of already existing S3. The analysis instead covers the respective initial strategies.

[20] The case studies will be included in the Final Report of this study.

Figure 2-1: Simplified overview of the construction of the prioritisation database and its linkage to correspondence analysis and project implementation

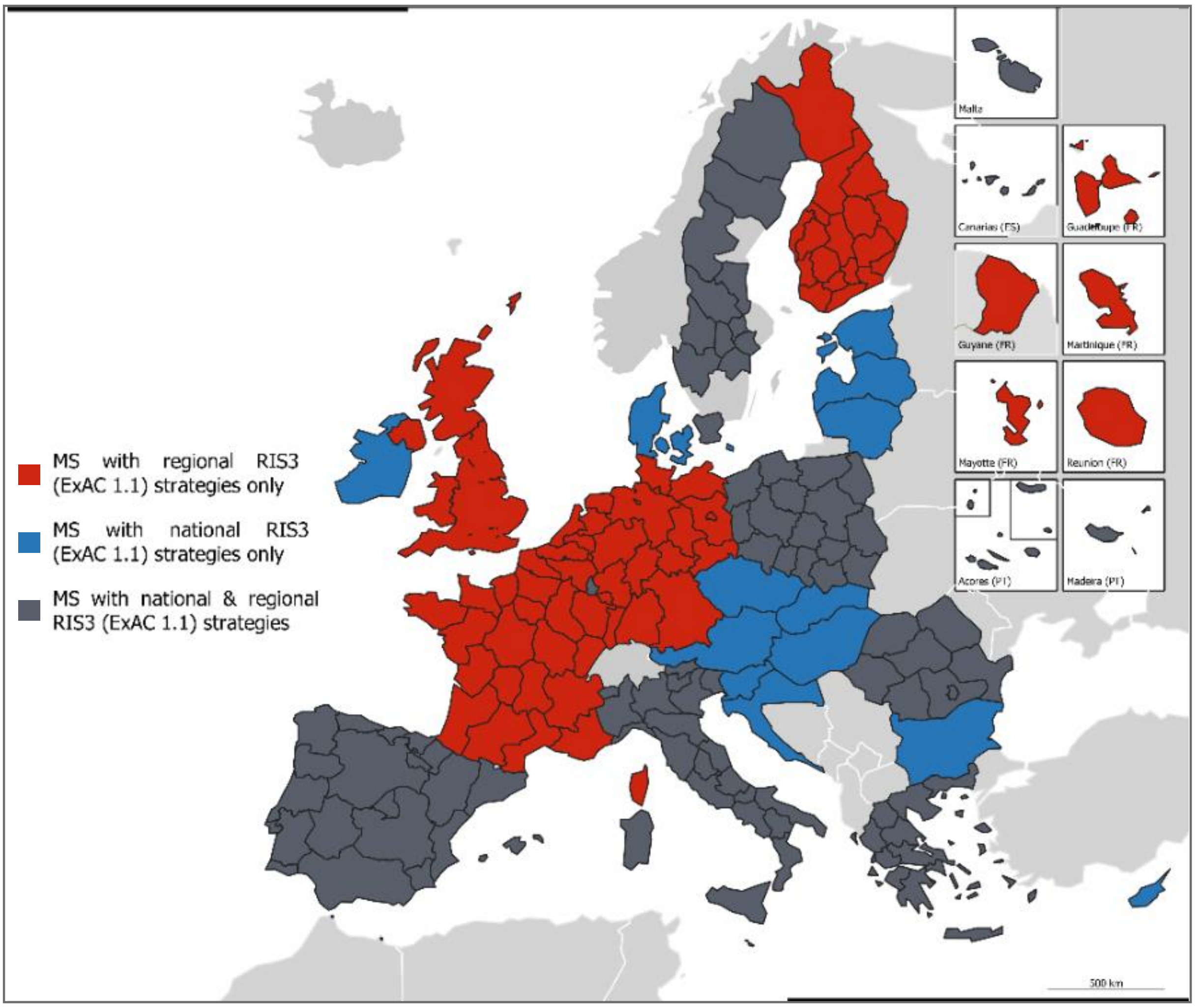


Source: Prognos / CSIL (2021).

2.1.1 *Regions and strategies considered for the analysis*

A total of 185 S3 strategies fulfilling ExAC 1.1. were identified in the study (see Section 2.1.2 on data collection below). The governance levels of the S3 strategies, measured according to the NUTS-classifications differ. While some Member States solely have strategies on the national level (for instance Latvia, Slovakia, etc.) or the regional level (for instance France, Germany, etc.), others have strategies at the regional as well as at the national level (Spain, Italy, Poland, etc.). An overview of this is provided in the map below. A more detailed overview and tables with the respective Member States/regions by their level of governance are presented in the Annex (see Map 9-1) and the tables thereafter.

Map 2-1: Overview S3 strategies according to their governance level



Source: Prognos / CSIL (2021). Note: the map refers to the latest available strategies

The first step to collect these strategies was to **generate a preliminary list** with all documents structured by Member State (NUTS 0) and region (NUTS 1, NUTS 2, and NUTS 3).[21] In this context, it was considered that S3 strategies are dynamic documents that are adapted and updated. Even though the JRC database might be regularly updated, it might not necessarily keep pace with the currently ongoing processes. Therefore, additional desk research was necessary to fill certain gaps.

As a second step, **the link between the S3 strategies and the ERDF OPs was ensured when possible.** This was imperative for the later stages of the study, especially for the

[21] https://s3platform.jrc.ec.europa.eu/map

analysis of the implementation of the strategies, particularly to connect the S3 strategies to the financial ERDF TO1. This was, however, not possible in each case, exceptions include among others Sweden, Finland, and Romania where the level of the ERDF OP deviates from the S3 strategies that are regarded as most significant. Ensuring the linkage between the OPs and the S3 strategies allowed for the connecting of the priority areas of the respective strategies with ERDF funded projects (implementation) and in turn, ensured that the study is built on a comprehensive database.

A third step was the validation of the preliminary list of S3 strategies by regional experts. Based on desk research on the websites of the respective Member State or region and the review of additional literature, the preliminary list identified was either confirmed or complemented with other relevant (new/updated) S3 strategies.

2.1.2 *Data collection in the regions*

The data collection was the basis for the conducted analysis displayed in the subsequent sections. In general, data collection can be distinguished between the one part that was linked to the S3 strategies (prioritisation, EDP, etc.) itself and another part concerned with implementation (projects, calls). The entire database is summarised in the following figure.

Figure 2-2: Empirical base

Task 2: Collection of RIS3 strategies

- **185 RIS3 strategies** and accompanying documents collected
- **Creation of a custom-made online questionnaire** that was filled in for all 185 RIS3-strategies
- **181 interviews conducted**

Task 3: Assessment of priorities

- **Prioritisation database** was developed (1,006 priorities) (88 NACE 2-digit level sectors, 22 FOR 2-digit level dimensions, 35 Technology fields)
- **An automated text analysis was applied**

Task 4: Analysis of correspondence

- **Datasets were created** (for economic, scientific, technological profiles and relatedness and complexity) on a NUTS 0,1,2 level for the relevant years
- **Correspondence and cluster analysis** completed
- **Ten case studies conducted,** each including 1-2 additional interviews

Task 5: Assessment of implementation

- **186 ERDF project/beneficiary lists** collected and connected to the JRC dataset
- **2,876 ERDF calls collected** and the relevant information transmitted into a framework

Source: Prognos / CSIL (2021).

Collection and identification of the priorities

The collection and identification of priorities was based on the information collected from the S3 strategies, additional documents, and interviews with managing authorities. General information was collected with regards to the S3 strategy (name, budget, etc.), the priority areas (number, description, etc.) and the Governance/EDP. These are illustrated in more detail in Figure 2-3. The information was collected for all 185 identified S3 strategies with the help of an online survey tool, which included a customized survey. This helped to translate the different categories (see Figure 2-1) into questions and answers. The main advantage of this was that the data could be collected in a pre-codified form easing the following analysis.

Figure 2-3: Categories to structure the information collection

General Information	Priority areas / Updates of priority areas	Governance & Entrepreneurial Discovery Process	
▪ Name of region / country ▪ NUTS-Level ▪ Name of initial strategy ▪ Year of publication ▪ Planned budget for the implementation ▪ Name updated strategy (if applicable) ▪ Name preceding strategy (if applicable)	▪ Number of priority areas ▪ Name of priority areas ▪ Number of sub-priority areas ▪ Description of priority areas ▪ Mentioning of specific target markets ▪ Relation of the priority areas to Societal Challenges ▪ Relation of the priority areas to cultural and natural resources ▪ Types of innovations addressed (filled in for strategy in general)	**Current Governance** ▪ Responsible authority/authorities **EDP process** ▪ New / old EDP process ▪ Type of involvement in EDP ▪ Type of stakeholders involved (main & sub-category) **Data used for determining priority areas (main & subcategory)** ▪ Economic output ▪ Data on technological/ scientific output	**Analytical tools used** ▪ Specific statistical approaches (main & sub-categories) ▪ Infrastructure mapping activities ▪ EDP approaches **Continuation of the RIS3 process** ▪ Existing process to update RIS3? ▪ Starting year of the process ▪ (Expected) year of release ▪ Leading authority/authorities ▪ New EDP process (Yes / No) ▪ Name (new) priority areas

Source: Prognos / CSIL (2021). Note: The EDP is understood as a bottom-up process consisting of different stakeholders (policy, business, research) that brings together fragmented and distributed knowledge.

181 interviews were held between May and August 2020 with the responsible managing authorities, which mainly served the following purposes:

- to fill information gaps, in cases when the S3 or other related documents did not contain all necessary information;
- to validate the information from the strategy and ask for more detailed information on certain approaches, processes, and priorities as well as
- to extract more detailed context information on the challenges, success factors etc. of the respective S3 strategy and to gather further information on the developments of the S3 strategies for the new funding period.

Collection of project lists and calls for proposals

The information collection concerning the implementation of the S3 strategies was divided into two essential steps: the identification of relevant calls for proposals or funding programmes and the collection of the relevant ERDF project lists.

With regards to the calls for proposals, all calls that were considered relevant for implementing the S3 strategy and which make use of ERDF funding in the funding period 2014-2020 were considered. This particularly included calls relevant to TO1, other calls (for instance TO3) were collected in instances. For all regions, a total number of 2876 ERDF relevant calls were identified, 2,332 particularly linked to TO1. This is outlined in further detail and with attention to the collection of data in the respective Member States/regions in the following Table 2-1.

Table 2-1: Collection of the ERDF TO1 calls and programmes (total number of calls collected / total number of TO1 calls collected

Member State	Data Collection		
	Total number of all ERDF relevant calls[22]	Total number of ERDF TO1 calls	Number of regions that the calls were collected for
Austria	19	19	1/1
Belgium	44	44	3/3
Bulgaria	37	11	1/1
Croatia	13	13	1/1
Cyprus	21	21	1/1
Czechia	67	67	1/1
Denmark	26	26	1/1 (+ 4 regions)
Estonia	6	3	1/1
Finland	80	24	18/18
France	206	206	27/27
Germany	133	133	16/16
Greece	79	61	14/14
Hungary	20	20	1/1
Ireland	10	10	1/1
Italy	225	225	22/22
Latvia	23	21	1/1
Lithuania	41	41	1/1
Luxembourg	4	4	1/1
Malta	47	36	1/1
The Netherlands	72	72	4/4
Poland	690	447	17/17
Portugal	313	137	8/8
Romania	20	20	8/8
Slovakia	30	30	1/1
Slovenia	19	19	1/1
Spain	310	302	18/18
Sweden	82	82	12/12
UK	239	238	3/4
Total	**2,876**	**2,332**	**185/186**

Source: Prognos / CSIL (2021).

The key information from these programmes/calls was extracted (i.e., type of funding, type of beneficiaries, project selection mode, criteria used to incentivise alignment with S3) and analysed, **specifically concerning the calls' selection criteria**. Due to the high number of calls, the focus of this step was on calls under ERDF TO1, for which the alignment criteria with the S3 strategy could be collected in all cases. The collection of calls was complicated in instances by the enormous heterogeneity in the structure, design, and specificity. Based on our analysis, a few general difficulties can be identified: in some Member States, the collection of the calls was complicated due to the country's administrative structure. In some cases, such as Romania and Spain, a multitude of different administrative units is involved in the management of the calls. In other cases, changes in the responsibilities within administrative management caused problems. In other Member States problems were encountered by dynamic management of the calls:

[22] The regional experts further collected 18 calls related to other sources of funding (ESF, national, regional). These are not considered in this table, can however be used for further analysis if necessary.

calls were frequently cancelled or updated throughout the funding period. In the case of Denmark, transitions in the ERDF governance structure did not allow us to fully retrieve calls for the previous year. For some regions (for instance regions of Greece and Romania) the number of calls has been relatively small. This is because the budgets for the respective regions are rather small and most of the calls are organised under the national OP (Greece) or because the respective ERDF OP was implemented relatively late (Romania and Greece). Sometimes overlapping regional programmes required special effort to avoid redundant information.

In the process of **categorising the calls** according to the Cohesion Regions, several challenges had to be met. First, the definition of the Cohesion Regions is on the NUTS-2 level. However, the calls that were collected are on the NUTS-0 or NUTS-1 level. For example, the 21 NUTS-2 regions of Italy are categorised heterogeneously ranging from less-developed over transition to more-developed regions. To categorise the calls for proposal of the Italian national operational programme into the Cohesion Groups the GDP of Italy was compared to the EU average since the Cohesion Regions are categorised by their GDP per capita in comparison to the EU-27 average[23]. In the example of Italy, the national GDP per capita amounted to more than 90% of the EU-27 average[24] and hence Italy as a whole was considered as a more-developed region. In other cases, such as Czechia where almost all regions are regarded as less developed, and Prague is the only outlier (more developed) the calls that address all regions were categorised as less developed. Calls that only address the region of Prague were categorised as more developed. Another challenge was found in eleven calls in France that simultaneously address two regions that consist of different ERDF regions. For instance, some calls addressed the regions Haute Normandie and Basse Normandie. However, the former is considered as more developed and the latter as a transition region. In those cases, the information of the call was duplicated, and the resulting two calls were categorised accordingly.

With regards to the collection of the **ERDF project lists** a mixed approach was applied. As a basis, the *Dataset of project co-funded by the ERDF during the multi-annual financial framework 2014-2020*[25] by the JRC was used. This dataset includes information regarding the OP (ensuring linkage to the S3 strategies), project descriptions in English and information on the respective budgets. Furthermore, it includes information on the categories of intervention, allowing us to interlink the projects to TO1 and to the S3 strategies (see Table 2-2). As the JRC dataset did not contain information for all relevant regions, the dataset was merged with project/beneficiary lists that were collected additionally. To gain further insight into the JRC dataset, it was compared to the ERDF TO1 funding data stemming from the ESIF Open Data Portal.[26] The sum of all JRC expenditure data for which corresponding data is available for R&I projects is EUR 31 billion, which compares to EUR 16.2 billion for TO1-related expenditure from ESIF Open Data. As such, JRC expenditures total around 1.9 times that of TO1 expenditures.

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[23] https://ec.europa.eu/eurostat/web/cohesion-policy-indicators/context/cohesion-regions
[24] https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=sdg_08_10&plugin=1
[25] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/dataset-projects-co-funded-erdf-during-multi-annual-financial-framework-2014-2020
[26] Process to compare JRC dataset to ESIF Open Data relating to ERDF TO1. The cut-off dates for the JRC data (provided by the technical specifications of the JRD Dataset) were used to determine the corresponding cut-off dates for the TO1 related data. The TO1 data cut-off date is always the end of the year. Thus, as an example, if a country in the JRC dataset had a cut-off date of 31.07.2019, this would be compared to the TO1 related data from 31.12.2019. As such, due to data limitations, this is an approximation between the two datasets.

Table 2-2: Intervention fields selected by programmes during implementation under TO1 (total amount of projects selected for funding)

Intervention field	Total amount decided	%
064 - R+I processes in SMEs (vouchers, process, design)	9,601,447,903	18.9%
058 - Research and innovation infrastructure (public)	7,555,499,269	14.9%
002 - Research and innovation processes in large enterprises	6,610,225,684	13.0%
062 - Tech-transfer & university-SME-cooperation	6,420,632,171	12.6%
060 - R+I activities in public research centres	6,400,641,632	12.6%
056 - Investment in SMEs directly linked to R+I activities	3,515,527,148	6.9%
061 - R+I activities in private research centres incl. networks	2,097,893,479	4.1%
057 - Invest. in large companies linked to R+I activities	2,086,229,334	4.1%
063 - Cluster support & business networks (SMEs)	1,989,619,901	3.9%
067 - SME business development, entrepreneurship & incubation	1,598,712,446	3.1%
065 - R+I processes, tech-transfer & cooperation in firms on LCE	957,127,927	1.9%
059 - R+I infrastructure (private, incl. science parks)	582,700,077	1.1%
Others	1,440,941,562	2.8%
Total	**50,857,198,534**	

Source: DG REGIO (2020), based on Open Data Portal.

2.1.3 *Automatic text mining approach*

In the following, the different phases for creating the prioritisation database are explained in more detail. In broad terms, the text mining approach developed for this study consisted of five main steps:

1. Delimitation of the prioritisation parameters

To connect the S3 priority areas to standardised categories allowing for a comparative assessment across strategies and regions, suitable parameters and classifications had to be selected – fulfilling both conceptual and methodological requirements.

As shown in Table 2-3, the text mining approach is focused on three main parameters and corresponding classifications. The choice for these parameters is based on a more detailed assessment of the feasibility and potential operability of the classifications for the automatic text mining approach.

Table 2-3: Key prioritisation parameters and standardised classifications

Parameters	Classification (most detailed level)
Economic sectors addressed (producers of innovations)	NACE (up to 2-Digit-Codes)
Scientific output	Field of Research/FOR-classification (22 divisions)
Technological output	Technology classes by WIPO/Schmoch (2008) (35 technology fields)

Source: Prognos / CSIL (2021).

2. Formulation of an ontology for each parameter and classification

The ontologies were used to summarise the activities and descriptions of a given term (e.g., the technological field "medical technology") and places them in connection to one another to arrive at a comprehensive definition of the term. In practice, this meant that for each classification (up to the most detailed level) a list of key words was generated that is related to this classification. This extensive definition of the term was important since it might be that the description of the priority area does not directly mention the word "medical technology". Instead, the description might refer to specific fields being part of an overarching technology classification (e.g., medical imaging or surgical robots) or uses related synonyms (e.g., health technology). These words, however, were then included in the ontology and hence allowed an attribution of the technology class (based on the work of Schmoch/WIPO, 2008) to the priority area (see also Phase 3). The same logic was applied to the other classifications.

The construction of the ontologies was not solely conducted by simple desk research but was primarily based on big data and automated text analysis approaches. The following explains how the ontologies are defined for the technological fields (Schmoch/WIPO (2008) & KETs), the economic sectors (NACE), and the scientific fields (FOR).

- **Technological sectors**: To create the ontologies for the different technology classes, as defined by Schmoch/WIPO (2008), patent abstracts (explaining the content of a specific patent) and the patent titles included in the European Patent Office (EPO) database were used. Based on the classification of Schmoch, it was identified which International Patent Classification (IPC) technology classes belong to which overarching technology field. By combining the information of the IPC technology classes with the abstracts and titles of the patents, a large amount of text explaining the various technology areas and fields was generated. To arrive at the ontology (i.e., list of key words), specific algorithms to extract those words that have the highest predictive value for the IPC codes to be part of the specific technology fields as defined by Schmoch (see explanation below) were created.

- **Economic sectors**: For the economic sector classification NACE, there is only one official list[27] that explains the various main and sub-categories. Therefore, EPO patent databases and the various patent titles and abstracts were included in it. Since there is no direct link between the IPC codes describing the patents and the NACE codes, a so-called "concordance table" to link both classifications was needed (i.e., explaining which IPC codes are linked to which NACE codes). For a consistent and well-founded conversion of technology classes into industry-relevant digitalisation values, a concordance table which has been developed by Lybbert and Zolas (2014) was used. In this paper, a probabilistic concordance table for technology classes (based on IPC codes) on the one hand and sectoral classification on the other hand, has been developed. [28] Once the IPC codes were assigned to the specific NACE sectors, the same procedure as for the technology fields (i.e., extracting key words form the patent titles and abstract to generate the ontology) was used.

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[27] See Eurostat (2008). NACE Rev. 2 - Statistical classification of economic activities in the European Community, Publications Office of the European Union, Luxembourg, 2008, ISBN 978-92-79-04741-1.

[28] The concordance proposed by Lybbert and Zolas (2014) is not a deterministic, but a probabilistic assignment. They used a keyword-based algorithm to make a probabilistic matching of patents to sectors, which leads to a probabilistic assignment (i.e., each patent has (a) certain weight(s) with which it is assigned to one or more sectors). However, it needs to be considered that the application of keywords makes it also necessary to constantly update the assignment since new or emerging fields, where the wording and use of terms are in flux, are not covered. Since to our knowledge no update has followed since 2014, their classification might be to some degree outdated. Moreover, since their approach is based on a keyword-based algorithm, a certain degree of error is in the assignments cannot be excluded (as for each text mining approach). A more recent discussion on the potentials and limitations of matching patent data with sectors, including a discussion of Lybbert's and Zolas' (2014) approach, is provided by Dorner and Harhoff (2017).

- **Scientific fields**: Regarding the generation of an ontology for the fields of research classification, the "Dimensions" database of Digital Science was used.[29] Similar to the approach with the patent database, abstracts and key words related to all (scientific) publications that can be found in the Dimensions database were integrated. As for the creation of the ontologies for the technology fields, specific algorithm, and methods (see explanation below) to extract those words that have the highest predictive value for the FOR codes were used.

3. Assessment and enhancement of the priority area descriptions

Before testing the ontology, **some additional checks of the quality of the priority area descriptions** as extracted from the S3 strategies were conducted. By using specific text analysis methods, Member States/ regions have rather generic definitions for their priority areas or have been very specific regarding the description of their investment priorities. For instance, a region might have chosen the priority area "Mobility & Logistics" when mentioning only some generic economic sectors that they want to focus on (e.g., car manufacturers, transport, logistics value chain, etc., whereas another region might also have decided to focus on "Mobility and Logistics" but with a much more specific description (e.g., connected driving, cloud computing for logistics, lightweight construction, and new materials for resource efficiency, etc.). Hence, this analysis gives first insights into the way regions describe (at least based on their strategy document and related sources) their priority areas.

4. Pilot testing and iterations for fine-tuning of the ontologies

The first test runs were done on a limited number of S3 strategies followed by test runs on the complete set of available S3 strategies. This helped to check if the matching procedure when using the ontologies, provided satisfactory results. Since no text mining process is instantly flawless, manual random checks were conducted and it was assessed whether the classifications of the priority areas, based on their extended descriptions, were correct. In case the classifications provided by the algorithm do not entirely match the description of the priority area, it was checked if the ontology needed to be adapted and if necessary, tested again. This iterative process was necessary to achieve a degree of refinement that provides the most precise classification of the priority areas.

5. Creation of the S3 prioritisation database

The ontologies for the different classifications (economic sectors, technological fields, scientific fields, etc.) **were applied to all strategies as well as the descriptions of their priority areas**. The final output of this fourth phase is the prioritisation database that relates each priority area of each strategy to several economic sectors, technological fields, and scientific fields.

2.1.4 *Correspondence between priorities and profiles*

To assess the correspondence between S3 priorities and the profiles of the Member States/regions, we relied on the classification of priorities according to the NACE, FOR and WIPO technological classification, that resulted from the automatic text analysis previously described. We consolidated the list of sectors, scientific and technological fields matched with the individual priority areas, to the strategy level. In the strategy-level prioritisation database, each S3 is matched with a list of sectors, scientific and technological fields with a share that reflects the measure of a good fit of the matched sector or field with the priority areas, as computed by the automated text analysis process. This measure looks at the overall number of terms provided in the priority area description that could be matched with the keywords list characterising the NACE, FOR or technological fields. Matches with a very low share were removed, as they are considered too imprecise. Specifically, we

[29] https://www.dimensions.ai/

removed all matches that fall into the fifth percentile of the weight distribution in each classification.[30]

The correspondence between priority areas and Member States'/regional profiles were investigated using a variety of methodological tools.

The **correlation analysis** represented the first analytical step towards the assessment of whether Member States/regions picked priorities in line with their economic, scientific, and technological profiles and strengths. This analysis consisted of the computation of Pearson's R correlation coefficients between variables capturing priorities (defined according to the NACE, FOR or WIPO technology classes) and variables capturing profiles and strengths of the Member Stages/regions. The unit of analysis here was the single S3 strategy. Therefore, correlation indexes were computed for both initial and revised strategies, at their corresponding geographical level (NUTS 0, NUTS 1 or NUTS 2).[31] Different variables were used to verify the correlation between the structure of S3 strategies in terms of their priorities and the structures of regions in terms of their economic, scientific, and technological profiles and areas of strength (see Annex 9.3.1).

Correlation coefficients express the direction (positive or negative) and strength of the relationship between S3 priorities and the regional profile. They range from a minimum of −1 to a maximum of +1 across all the Member States/regions and for all the dimensions considered (economic, scientific, and technological). A coefficient equal to 0 means that there is no correlation between selected priorities and the regional strengths reflected by employment, patent, and publication data. Positive coefficients indicate that the selected priorities match to some extent the regional areas of strengths. The closer the coefficient to 1, the stronger the correspondence. On the other hand, negative coefficients indicate that the S3 priorities target sectors or fields that do not represent areas of strengths for the region. The close the coefficient to -1, the weaker the correspondence.

The strength of these correspondences was corroborated by employing **linear regression models** (with panel data), that refined the estimation of the correlation coefficient by controlling for other possible confounding factors. To this end, we estimated simple econometric models that verify the significance and strength of the match between strategies and profiles, while explicitly accounting for other factors that could also affect these relationships (for details, see Annex 9.3.2).

For each profile, two main types of variables are computed: intra-regional or intra-country shares (e.g., employment shares in the economic sectors in each region); publication shares in the different FOR in each region; patent shares in the technology class in each region) and location quotients. These two types of variables have a very different interpretation that should be considered when analysing and comparing the correlation coefficients:

- **Shares aim at having a proxy for the regional profiles of the Member States/regions**, i.e., how their economic, scientific, and technological profiles are composed and what they produce or are engaged in: the perspective here is focused on the intra-regional structure.

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[30] This threshold means dropping the matches with a lower than or equal to 1% precision level in the technological classification, 0.9% in the NACE classifications and 2.4% in the FOR classification. This cleaning process mainly affects the strategies in Austria, Czechia, France and, to a minor extent, Poland and Portugal, by dropping up to 24% of the attributions made by the text analysis algorithm. The number of matches dropped with this cleaning procedure varies across classifications and countries/priority areas. In the technological classification, the fifth percentile threshold means removing 20% of the matches in the Czech strategy, 10% and 9% in France and Austria respectively, and 4% and 1% in Poland and Portugal. In the scientific classification (by FOR), the threshold affects 24% of matches in Czechia, 10% in the French strategies overall, 6% in the Austrian one, and 4% and 2% in the Polish and Portuguese, respectively. In the economic classification (by NACE), the threshold affects 22% of matches in Czechia, 10% in France, 9% in Austria, 8% in Poland, 2% and 1% in Poland and Germany, respectively.

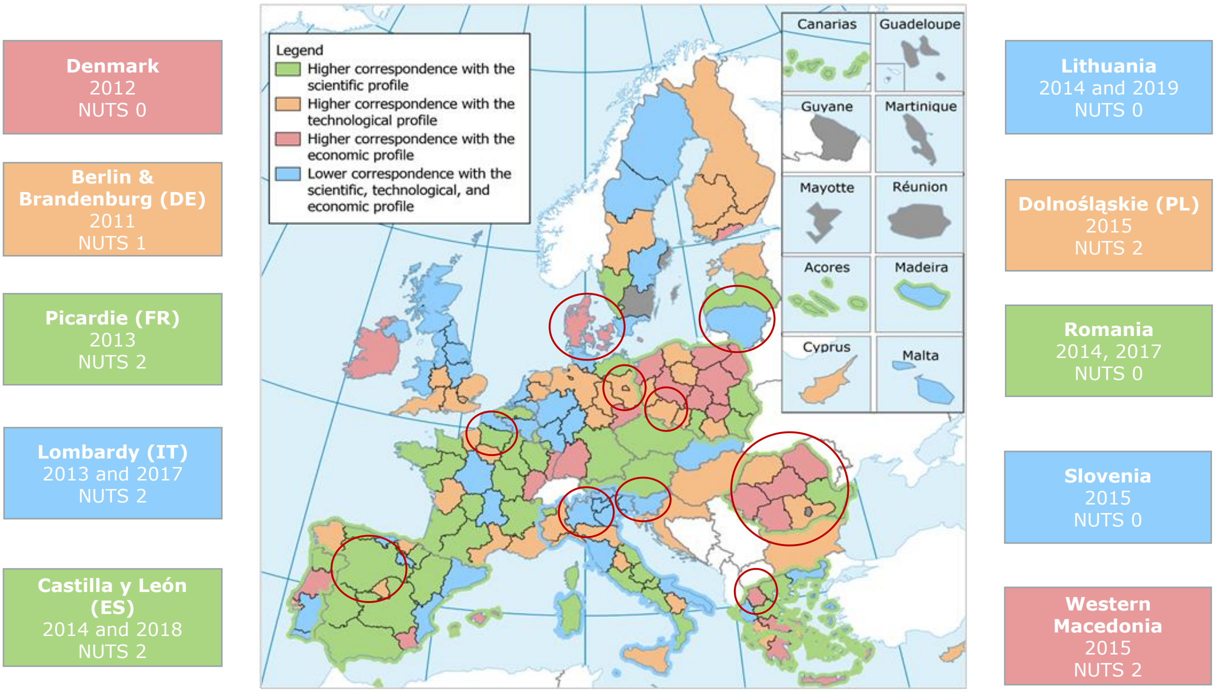
[31] 30 strategies in Sweden and Finland cover NUTS 3 level regions. Priorities defined at NUTS 3 level have been aggregated at the NUTS 2 level because of missing data at 3-digit level.

- **Location quotients compare the specialisations of the regions and countries to the EU**, i.e., what they are exceptionally good at (their areas of relative strength as compared to the EU average). The location quotient for a specific sector (field of research, or technological field) and a specific region (or country) is greater than 1 when employment in that sector is over-represented in the region. In these cases, we would say that a region or country is specialised in that sector. The same computations are also applied to publication and patent data.[32]

A **cluster analysis** was used to group strategies according to the degree of match between the S3 priorities and the regional or national profiles and strengths. This analysis was based on the previously computed Pearson's correlation coefficients. The methodology is fully described in Annex 9.3.3. Econometric models were used to test the statistical differences between groups of strategies and similarities within groups.

Qualitative case studies were used as a complementary tool to unveil important factors affecting and explaining the prioritisation process in the S3 design phase. They were informed by both the results of the quantitative analyses carried out in this study and findings from additional interviews with national and regional authorities and stakeholders (mainly policymakers and intermediate bodies responsible for the design and implementation of the strategy). The unit of analysis of each case study was a specific territory covered by the S3 (either a NUTS 0, NUTS 1 or NUTS 2 area). A total of ten different case studies were carried out, the selected Member States/regions are shown in the following map.

Map 2-2: Selected case studies



Source: Prognos / CSIL (2021).

[32] Location quotients versus the country level have also been computed, but these can be used only to analyse region-level strategies.

Case studies aimed at:

1. **understanding how the stakeholders perceived the process of prioritisation** in their regions and whether they thought that it reflected regional capabilities and strengths, as well as future opportunities for diversification;
2. **discussing the results of the correlation, econometric, and cluster analyses** and the degree to which the quantitative results match with the stakeholders' perception and opinions;
3. **identifying and examining the factors** that could explain the specific prioritisation approach adopted by the region. These factors could relate to, for example:
    - the set-up and role of the Entrepreneurial Discovery Process (EDP);
    - difficulties in prioritisation due to a lack of relevant critical mass in any domain or to limited knowledge of technologies and sectors;
    - significant changes in the economic context (whether inside or outside the region) which made some of the priorities identified no longer relevant or
    - low levels of engagement of the private sector or other stakeholders.

2.1.5 Implementation of S3 strategies

The assessment of the implementation of S3 strategies was in the first instance a data collection exercise, as all relevant calls for proposals and project lists needed to be gathered and in parts merged (see Section 2.1.2 for more detailed information). Thereafter, the main methodological step of this part was to connect the project lists of the different regions with the priorities, to analyse the correspondence between implemented projects and priorities.

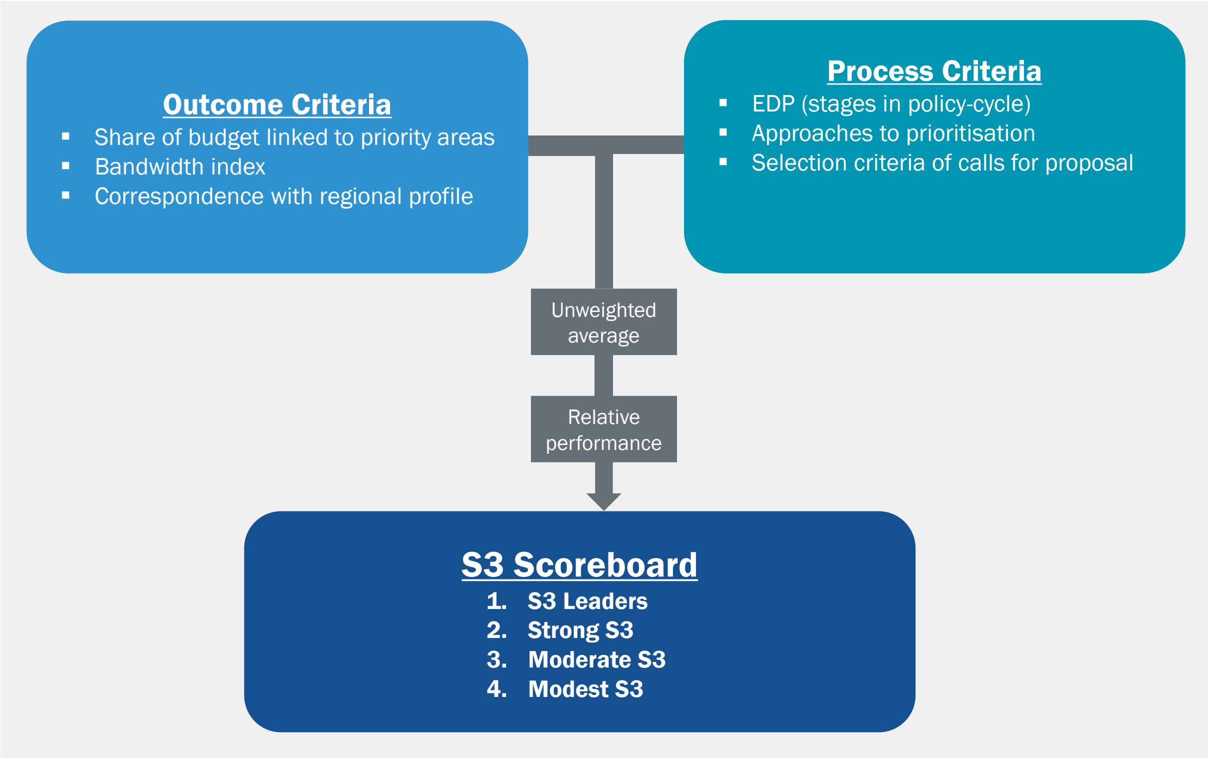
To match the projects with the priorities an **automated text analysis approach** was used. For this purpose, the respective project title and descriptions were merged to increase the number of matchable keywords. For the priorities, the name and the descriptions were used and enriched by adding the linked NACE / TECH / FOR fields (see Section 2.1.3). A match was then triggered when a keyword from the project list was found in the Member State's/region's respective priorities. A stop word list was created through multiple rounds of testing, meaning that words that were 'too generic' words were excluded from the matching procedure.

2.1.6 The "S3 Scoreboard"

To achieve a comparative assessment of all 185 smart specialisation strategies in EU Member States and regions a scoreboard was set up. It was constructed by using the data collected over the course of this study and follows the **concept of an "ideal" S3 process** (from the development of S3 strategies over the identification of priority areas and transformative activities & critical mass to the implementation of projects).

Overall, **six different indicators grouped into outcome and process criteria** are used in the S3 Scoreboard. A schematic overview over the methodology behind the S3 Scoreboard is displayed in Figure 2-4. Among the outcome criteria are the indicators for the share of budget linked to priority areas, the bandwidth index, and the correspondence with the respective regional profile. The number of stages in which the EDP was used in the policy cycle, the quality of the prioritisation approaches, and the selection criteria in the calls for proposals are part of the process criteria.

Figure 2-4: Schematic overview over the methodology behind the S3 Scoreboard



Source: Prognos / CSIL (2021).

Next, for each region an unweighted average of these six indicators was constructed. In order to identify the relative performance of each region, **each region is then compared to the average S3 strategy value of the rest of the group of regions they are associated to: less developed, transition, and more developed regions**. Thereby, a similar approach as in the Regional Innovation Scoreboard[33] was followed and the relative performances were categorised in the following four groups:

- **S3 Leader:** all strategies with a relative performance more than 25% above the average;
- **Strong S3:** all regions with a relative performance between 100% - 125% of the average;
- **Moderate S3:** all regions with a relative performance 70% - 100% of the average;
- **Modest S3:** all regions with a relative performance below 70% of the average.

Moreover, a **more detailed breakdown of these performance groups was introduced by splitting each group into thirds**. For instance, the performance group "Moderate S3" was divided in three subgroups: "Moderate S3+" for strategies between 90% and 100% of the average, "Moderate S3" for strategies between 80% and 90% of the average and "Moderate S3-" for strategies between 70% and 80% of the average.

Furthermore, **normalisation and transformation steps** for some of the indicators was applied to avoid a stronger impact of these indicators. This applies to the categorical indicators, i.e., the bandwidth index, the EDP and the selection criteria in the calls for proposal. These indicators were transformed to values between 0 and 1. For instance, the data for the bandwidth index covers five categories from narrow to broad bandwidth with a narrow bandwidth being the best and a broad bandwidth being the worst category. Here,

[33] https://ec.europa.eu/growth/industry/policy/innovation/regional_en

the best category (narrow bandwidth) received the value 1 and the worst (broad bandwidth) was labelled with 0. The categories in between received the quartiles between 0 and (i.e., 0.25, 0.50 or 0.75).

The **data coverage of the indicators in the S3 Scoreboard is high** and ranges from 89% to 100% depending on the indicator. While for some region data on certain indicators is not available (e.g. the budget linked to priority areas) in other regions the missing values are a result of limitations in the S3 governance (for instance, Member States/ regions in which there are many NUTS3 level strategies but no relevant ERDF budget allocation mechanism attached). Nonetheless, for regions in two Member States **missing values for one indicator were imputed through the construction of a synthetic national averages**. This means that due to challenges in the S3 governance structure in Finland and Sweden no regional data for the selection criteria in the calls for proposal was available. Here, the selection criteria in all Swedish / Finnish calls of proposal were used to calculate the values for the Swedish and Finnish NUTS 2 regions.

2.2 Research limitations

A complex empirical analysis as performed in this project needs to cope with various challenges in the research process. Moreover, there might be methodological limitations, which cannot fully be overcome. Below, we describe the key challenges observed in the research process which need to be considered when assessing and interpreting the results presented in Chapter 4, Chapter 5, and Chapter 6.

2.2.1 *Methodological considerations regarding the S3 prioritisation database (Chapter 4)*

Even though the matching approaches have been successful in assigning economic sectors, and scientific as well as technology fields, it is important to keep in mind some of the limitations of the approach. Issues that influence the quality of the matching are summarised below.

- **Limited descriptions of the priority areas**: To have qualitatively good matchings, the input in terms of keywords by the priority areas' descriptions is very important. Whereas for most fields a very detailed description was provided for the priority areas (on average 63 key words), there are some regions and priority areas where five or fewer keywords were provided. In these cases, a specific assignment of economic sectors, scientific fields or technology fields becomes much more difficult even if some words might be very specific like "Tourism". To tackle this issue several additional steps were undertaken. To limit the number of non-matchings due to limited priority area descriptions, the regional experts were contacted in those regions where only a few keywords were provided to extend the keyword list. For cases where the S3-strategy and related documents provided more information it was added.
- **Unspecific keywords**: Another issue concerns "unspecific" key words that can occur in the priority areas' descriptions and have little "informational content". For instance, keywords like "advanced business services", "innovative experience production" or "new technologies" are just some examples that occurred. In these cases, an assignment to several NACE classes would be possible as these are topics that occur in many economic branches and do not exist in this way in the standard classifications.
- **Semantic gap**: This issue is similar to the previous one and means that the vocabulary used by the S3 strategies and extracted by the experts to create the priority area descriptions might differ from the words and vocabulary used in the patents, scientific publications or product classifications that presented the basis for the different ontologies. The words mentioned in the strategies do not always have an analogy in terms of content in the classifications used. For instance, topics like

"fair trade", "servitisation"[34] or "support for start-ups" cannot be translated into the standardised classifications used.

- **Thematic gap**: As well as the semantic gap there is also the issue of the so-called "thematic gap". This means that, in some cases, specific keywords or even whole descriptions cannot always be matched with one of the three classifications because of their content. For instance, keywords like "marketing", "tourism" or "cultural heritage" do not have a thematic correspondence with the different technology fields. Given their non-technological orientation, this is neither logical nor surprising. These terms, however, can find some correspondence in the other classifications (i.e., FOR and NACE).
- **Different regional understandings of topics**: Currently, our approach defines the different classifications (NACE, FOR, technology fields) in terms of a "global understanding". This means, for instance that a topic like "clean technologies" is assigned to economic sectors that are globally seen as being related to it but in specific regions might have a somewhat different focus. In the case of "clean technologies" a sector that is, from a global perspective, quite important in this regard is "Manufacture of coke and refined petroleum products" (e.g., environmentally friendly coke production). However, in some regional contexts, the focus of clean technologies is different. In Bavaria, for instance, policymakers mean rather clean automotive technologies or new wind energy technologies when they mention clean technologies in the strategy document.

2.2.2 *Methodological considerations regarding the correspondence analysis (Chapter 5)*

While the research limitations regarding the prioritisation database affect all the subsequent steps of the analysis, some additional specific limitations can be highlighted regarding the approach used to verify the correspondence between priorities and regional or national profiles.

- **Proxy indicators to capture the regional profiles**: A set of indicators were collected and used to capture the economic, scientific, technological strengths and profiles of the Member States/regions. The selection of these indicators was constrained by the following factors:
  - the need to ensure a sufficient level of coverage and consistency across the EU regions, at least at NUTS2 level;
  - the need to use the same classifications adopted to categorise the S3 priorities (i.e., NACE sectors, FOR, and WIPO technology classes) and reach a sufficient level of granularity (at least 2-digit disaggregation for each classification);
  - the need to cover a sufficiently wide period, from 2008 to at least 2018 and 2019, to reflect the regional profiles in the different periods when the S3 were first drafted, or subsequently updated.

- **Employment**, **patents, and publications data** were the most appropriate indicators identified to fulfil the conditions above. These indicators should be regarded as proxy of the actual regional profiles. When selecting the S3 priority areas the Managing Authorities may have considered additional indicators, especially when assessing the economic profile of the region/country (e.g., on GDP, value-added, export, etc.), which could not however, be used in our analysis, due to quality or coverage limitations in the data.
- The **sensitivity of cluster analysis results**: The results of any cluster analysis can be influenced by the set of indicators considered to group the objects of analysis

[34] Servitisation is a business model innovation that is relevant to manufacturing companies and describes the change in the existing portfolio of products and services away from just tangible goods and towards a combination of tangible goods and services. It thus reflects the overall economic trend towards a service society at the corporate level.

(in our case, the S3 strategies) or the clustering technique employed. To overcome this limitation, we have tested the robustness of the results in different ways, as explained in Annex 9.3.3.

- The **interpretation of high or low correspondences**: The quantitative analysis of correspondence provides valuable insights into understanding the degree to which each strategy matches the regional/national performance. Thanks to the use of a coherent methodology and dataset, it is possible to compare results across the different strategies. However, the quantitative analysis is not sufficient to understand whether high or low correspondences are signs of good or badly designed S3 strategies. In principle, strategies showing high correspondence with the regional profile may indicate an effective selection process by the Managing Authority, focused on the actual areas of strengths; or rather it could rather indicate a not particularly ambitious strategy, with limited opportunities for innovative diversification towards higher-added value sectors. Conversely, low correspondence reflects the selection of priority areas that are not in the core of the regional economic, scientific, or technological profile; however, this might also be explained by a realistically ambitious strategy of diversification. Insights from the qualitative case studies allowed for complementing and enriching the results of the quantitative analysis and bringing new elements to help understand the rationale of the prioritisation approach adopted.

2.2.3 *Methodological considerations regarding the analysis of the implementation of S3 strategies (Chapter 6)*

While the research limitations regarding the prioritisation database affect all the subsequent steps of the analysis, some additional specific limitations can be highlighted about the approach used to the analysis of the implementation of S3 strategies.

- **The length, quality and structure of project descriptions vary:** The collected projects (JRC database as well as an additional list) display an enormous variety in project descriptions. Project descriptions between Member States/regions can differ in length. While in some instances the project descriptions were rather short (8eight to 30 words on average), the project description was relatively extensive in other cases (over 200 words). This was also affected by sometimes missing project descriptions or project titles also affected the amount of information collected. Regarding the quality of the project descriptions, it was found that some Member States/regions uploaded extremely technical descriptions (including project numbers, very technical terms), while others remained generic. To take account of those projects into account that are characterised with short descriptions, the matching approach for this task was kept simple to allow also for non-optimal descriptions to match.
- **The varying number of relevant projects:** The number of projects differs significantly between Member States/regions, which at times limits the comparability. in instances. While there are 549 relevant projects identified in Wielkopolskie only two were identified for Western Macedonia.
- **The translation of projects into English:** To allow the priority areas to match with the projects, all project descriptions were translated. The translation of the project descriptions in over 80.000 projects naturally entails room for error, which might lead to certain imprecisions.
- **The approximation of TO1 funding:** One central element of this task has been to illustrate the share of the TO1-budget that has gone to projects that are linked to priorities. The JRC database only allows us to approximate TO1 through the usage of the category of interventions. While this leads to a picture that does not exactly cover all TO1 funding, it has been identified as the best option to narrow it down.
- **Programmes/calls for proposals vary in their structures.** The collection of calls for proposals was challenging as the information available has varied enormously between Member States/regions. This leads in some cases to data that has not been very clear in terms of selection criteria (which priority areas are

addressed and so forth), which potentially leads to minor imprecisions when looking at over 2,800 calls for proposals.

Despite the outlined challenges outlined, the study was able to establish a profound strong basis to draw on with rich empirical evidence on prioritisation in S3 strategies in all Member States/regions, of both quantitative and qualitative nature. Through the innovative research approaches that were used, new answers to the complex research and policy questions in the field of smart specialisation were found.

3 METHODOLOGIES & TOOLS USED FOR S3 STRATEGY DEVELOPMENT

Overview of key findings

1. **A broad stakeholder process has been applied in the majority of Member States/regions.** This stakeholder process mostly consists of stakeholders from the private, public and research sectors and to a lesser extent those from civil society. While a broad stakeholder process is seen as a key success factor, some Member States/regions have encountered difficulties in this process, which are mostly attributed to different understanding/different interests when it comes to S3. A clear and, if possible, dedicated governance structure has proven to be important in this regard but difficult to implement in the light of a lack of human, budgetary and time resources.

2. **A continuous EDP could not be established in many regions, although formal continuity was slightly higher in EU13/less developed regions.** The continuation of the EDP (involvement of stakeholder in the implementation and monitoring phases) are seen as important but difficult to achieve. While the share of Member States/regions that use some sort of sustained EDP is slightly higher in EU13/less developed regions, it has proved difficult to continuously mobilise stakeholders, especially from the private sector to maintain dialogue. The involvement of network organisations such as cluster initiatives and business associations are mentioned as being supportive in this regard. A continuous EDP has particularly worked out well in Lombardy and Berlin/Brandenburg (confirmed in the case studies) and other Member States/regions such as Poland (national level). On the other side of the spectrum a limited/one-off EDP has been used in Western Macedonia (see case studies, Annex 9.6) and others such as Malta, East Netherlands, and Wales.

3. **Data analysis to determine S3 priority areas has in many cases not been sufficiently granular.** Regarding the analysis of the economic performance, only 12% of the S3 strategies make use of NACE-2/3-digit data. For the analysis of technological/scientific performance, only 19% use more in-depth data. In contrast to that, 47% of the S3 strategies are based on economic analysis of NACE-1-digit or the overall economy level and 41% of the S3 strategies on an analysis of the scientific/technological performance on a more general level. Qualitative evidence shows that a too general data analysis or a sheer lack of data analysis are key obstacles when attempting to narrow down S3 priorities.

4. **Member States/regions have used a wide range of different instruments and processes when it comes to the EDP and data analysis.** Most S3 strategies include EDP-related information gathering activities such as focus groups, workshops and interviews or mapping activities of, for instance, research centres. Similarly, many S3 strategies make use of information processing tools such as SWOT analysis. Information gathering activities such as the mapping of involvement in international R&D projects or technological foresight analysis that are far less common.

The development of S3 strategies consists of multiple tools that are considered as helpful elements to identify the strategies' respective priorities and to implement these accordingly. The **Entrepreneurial Discovery Process (EDP)** is one key feature of this and is the participation process for stakeholders from different backgrounds (business, policy, academia) that is supposed to enrich and enhance the prioritisation and implementation processes. Another key element can be **data analysis**, for instance, to measure the region's economic or scientific performance. Based on the analysis of the S3 strategy, additional documents, and interviews with managing authorities (see previous section for the data base), this section aims to answer to following **research questions**:

- Has the prioritisation been developed through an Entrepreneurial Discovery Process? On which level and with what methodologies?
- How have scientific/technological strengths been assessed?

- How has the economic structure been assessed?

To answer these questions, this section is structured as follows. Section 3.1 centres specifically around the application of the EDP processes and the involvement of stakeholders. This includes an analysis of the policy stages that the EDP was used for (Section 3.1.1) and an analysis of the type of stakeholders involved (Section 3.1.2). Subsequently, Section 3.2 illustrates the kind of data analysis that has been used (Section 3.2.1) and shows other approaches that have had an influence (Section 3.2.2). Overall, the section shows the data (1) aggregated for all regions; (2) aggregated on a EU13 and EU15 level; and (3) on a Cohesion Region level (less developed, transition, more developed) to scrutinise potential differences between newer and older Member States but also economically weaker and stronger regions/countries. These classifications take the relevant literature into account that shows that there have been specific challenges depending on the respective regions, especially in less developed regions (e.g., Marques and Morgan, 2018; McCann and Ortega-Argilés, 2016; Radosevic, 2017) but also in more developed ones (e.g., Iacobucci and Guzzini, 2016; Lefebvre, 2017; Pugh, 2018).

3.1 Application of EDP processes and involvement of stakeholders

3.1.1 *Stages of the S3 policy cycle and the EDP*

RQ: Has the prioritisation been developed through an Entrepreneurial Discovery Process? On which level and with what methodologies?

Overall, **77% of the S3 strategies in the 2014-2020 period are based on an EDP** that has been specifically set up for the respective strategy. In contrast, 12% of the S3 strategies have made use of an 'old' EDP, meaning that there has been some sort of stakeholder process that has taken place but was not specifically designed for the S3 strategy, 5% are not based on an EDP. Regarding the policy cycle, we differentiate between three stages:

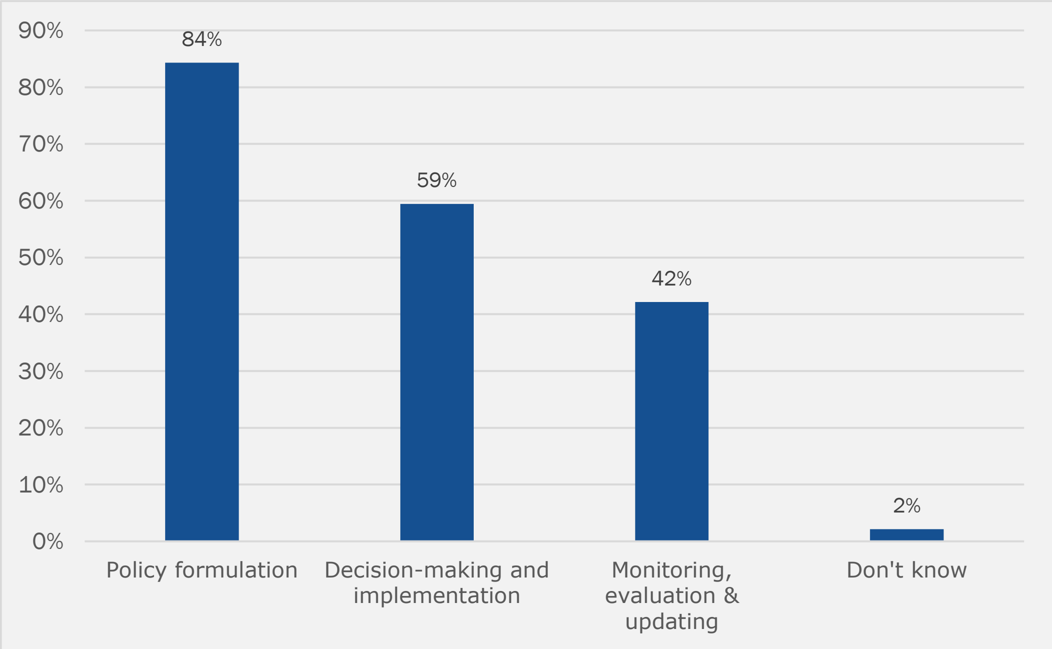
- **Strategy development:** The stakeholder process is considered to determine the priority areas by paying attention to their needs and opinions.

- **Decision-making and implementation:** The stakeholders of the EDP are engaged in the implementation and further decision making, for instance in the decision on and around implementation instruments (calls, projects, etc.).

- **Monitoring, evaluation & updating:** Stakeholders are participating in the review and the refinement of the priority areas.

As Figure 3-1 shows, a majority of the 185 S3 strategies have used an EDP for strategy development (84%) and to a lesser extent for decision-making and implementation (59%) or monitoring and evaluation (42%).

Figure 3-1: Share of S3 strategies that have used their EDP for different stages of the policy cycle



Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: n=185 for each column, respectively.

While the shares of the S3 strategies where the EDP is also used for implementation and monitoring are mediocre, they still indicate that a good number of S3 strategies are based on a continuous EDP, meaning that the EDP is not only used for policy formulation but also actual implementation and monitoring. **A certain continuity of the EDP has also been mentioned in the interviews with managing authority as a success factor**, as it would help to consolidate the idea of the S3 in the governance of the region and foster continuous communication between stakeholders. The case of the so-called Strategic Research and Innovation Partnerships in Slovenia can be seen as a good practice in this regard (see the following box).

Box 3-1: Evidence from the case studies

i

Establishment of partnerships to ensure EDP continuity

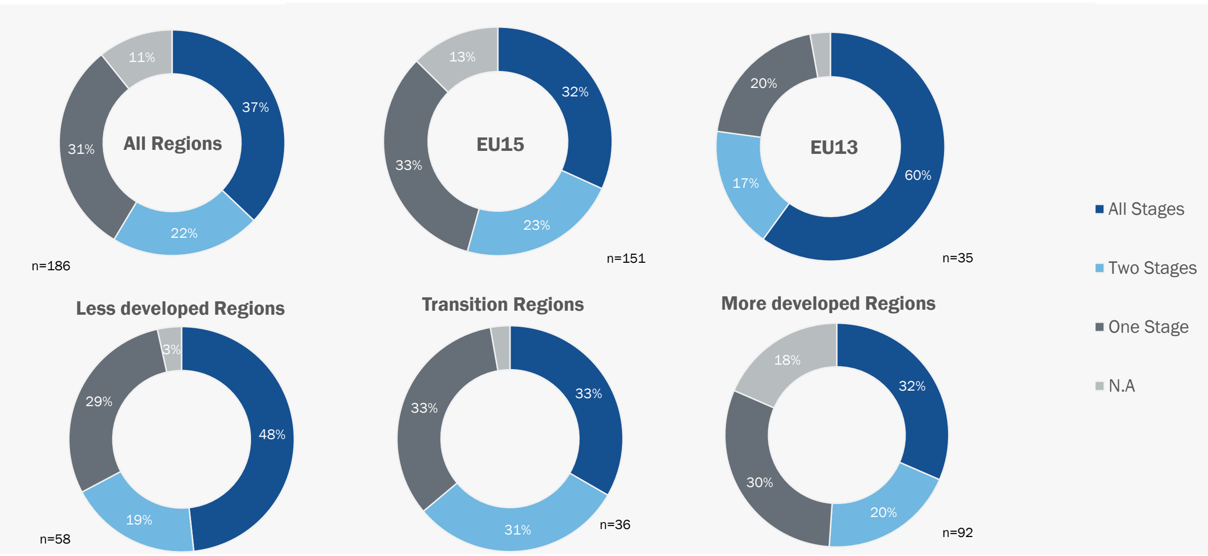
Slovenia – Strategic Research and Innovation Partnerships (SRIPs)

The Slovenian S3 priority areas are implemented through Strategic Research and Innovation Partnerships (SRIPs) (one for each priority area). These were established in 2016 and represent long-term partnerships between the business community, research organisations, the state and municipalities, and facilitators, innovation users and NGOs (i.e., the so-called quadruple helix). SRIPs define the focus areas and areas of development for each priority area in their action plans. Action plans are being regularly updated; as such, they constitute the ongoing EDP of the Slovenian S3. One of the key tasks of the SRIPs is to further refine priority areas to get to more granular definitions of priority areas. Because of this, in the case of Slovenia priority areas are defined by the stakeholders, and not only by the Government. SRIPs are also aimed at strengthening the Slovenian position in other EU initiatives such as the Vanguard Initiative.

Source: Prognos / CSIL (2021).

Figure 3-2 takes this into account and shows the **degree of continuity of the EDP** in the S3 strategies. For this purpose, it displays the shares for all regions, for EU15 and EU13 respectively and less developed, transition and Cohesion Regions. Looking at the 185 S3 strategies overall, the picture is mixed. 37% of the regions/countries use the EDP for all stages of the policy cycle, while 22% for two stages and 31% for one stage. A slightly more differentiated picture evolves when distinguishing between EU15 and EU13 Member States. Here, the findings illustrate that the degree of continuity is higher in EU13 countries (EDP used for all stages 60%, whereas 32% in EU15 countries). As the share of less developed countries is higher in EU13 countries, this finding is also reflected to an extent in the classification by Cohesion Region (48% use the EDP for all stages, in contrast to 33% in transition regions and 32% in more developed regions). This illustrates that Member States/regions with relatively younger institutions are capable of organizing and maintaining sound and lasting EDPs.[35]

Figure 3-2: Share of S3 strategies that make use of the EDP for (1) all stages of the policy cycle; (2) Two stages; (3) One Stage; (4) N/A



Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: The "n" varies from pie chart to pie chart as it only takes into account the S3 strategies from the respective category.

For the S3 strategies that are not based on a continued EDP, some explanations can be derived from the interviews. Primarily, it has been stated that managing authorities simply did not have the budgetary and human resources to maintain the EDP. This relates particularly to the monitoring and evaluation phase, which some interviewees found also unclear and difficult as the links with the respective OPs have not been very pronounced at times. In other cases, it was indicated that the main difficulty with regards to the policy stages implementation and monitoring was to continuously mobilise different stakeholders, especially from the private sector (also see next section).

3.1.2 *Stakeholder involvement in S3 development and implementation*

RQ: Has the prioritisation been developed through an Entrepreneurial Discovery Process? On which level and with what methodologies?

As an interactive bottom-up process, the EDP ideally involves stakeholders from different areas. In this context, this study essentially differentiates between four types of stakeholders each consisting of multiple types of subcategories:

- **Public Sector:** Regional/local/national governments, European institutions;

[35] See also Esparza-Masana, R., 2019: Towards Smart Specialisation 2.0. Main Challenges When Updating Strategies. Journal of the Knowledge Economy, 2021. https://doi.org/10.1007/s13132-021-00766-1

- **Private Sector:** SMEs, large enterprises, business associations, chambers of commerce, cluster organisations, incubators, accelerators, financial entities, investors;

- **Research Sector:** Higher education institutions, research organisations;

- **Civil Society:** Civil society organisations, labour unions, political parties, public centres for social welfare.

Generally, **most of the EDPs involve stakeholders from the research sector** (90% of all identified S3 strategies), the **private sector** (90%) and the **public sector** (89%). 53% include stakeholders from a civil society organisation. While for the public sector it is mostly regional and local governments that are involved (81% and 51% respectively), the stakeholders that are involved most frequently come from SMEs (74%), large enterprises (65%), business associations (78%) and cluster organisations (62%).

With regards to the different types of stakeholders, interviews showed that it has been particularly challenging in instances to effectively mobilise the **private sector**, as there has been a lack of interest in some cases. This has also been reflected in the relevant literature, for instance, Marinelli and Perianez-Forte (2017). While the relatively high share of participants from the private sector does not directly reflect this, it can be assumed that the difficulty rather lies in involving the private sector in a continuous dialogue. The case studies however indicate that the involvement of cluster organisations has in instances been essential to maintain and strengthen private sector involvement. This is exemplified in Box 3-2.

Box 3-2: Evidence from the case studies

i

Continuous involvement of cluster organisations to maintain private sector involvement

Berlin/Brandenburg - Cluster 'Master Plans'

The individual priorities encompassed in the strategy were further developed and refined by distinct clusters. Each cluster developed a 'master plan' for one priority area, which defined and specified their objectives. These contained measurable development goals for the cluster as well as concrete fields of action for implementation. The master plans are essentially a participatory process. Using dedicated conferences, each stakeholder of the cluster can express an opinion on the cluster development and communicate their priorities. This consultative process is essential to assure that all stakeholders co-develop the strategy and are actively engaged.

Lombardy - Technology clusters and biannual work programmes

While priority areas are defined in a rather generic manner in the strategy, Lombardy has foreseen biannual Work Programmes that structure priorities into macro-themes and macro-themes into development themes. Three work programmes have been issued during the 2014-2020 programming period, in 2014, 2016 and 2019, respectively. Having rather generic priority areas in the strategy, to be further refined and detailed through biannual Work Programmes, implies that more specific domains of specialisation are identified during the continuous EDP process up to the implementation phase. A key role is especially played by technology clusters, which include enterprises, universities, and research centres.

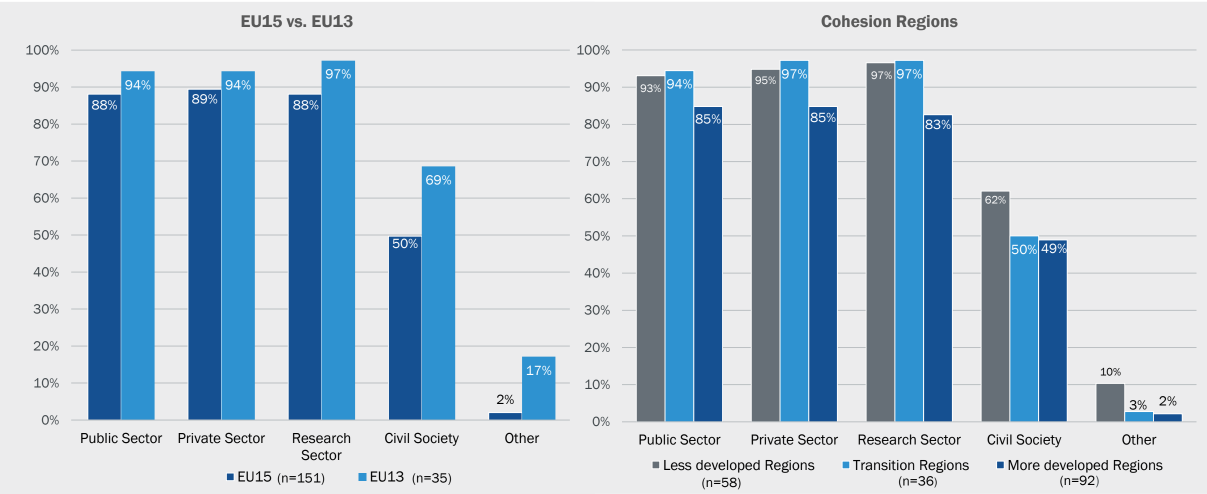
Source: Prognos / CSIL (2021).

Concerning the **public sector**, the involvement of different levels of governance that was not well coordinated and lacked internal coherence led to confusion and inefficient outcomes, sometimes changes in staff and/or regulation have been named as contributing elements. Alternatively, a dedicated governance structure and management system have been seen as particularly important on behalf of the public sector involvement (see also Pinna, 2019) that helped with the decision-making (see the German state of Thuringia as a positive example in this regard), especially in processes where a multitude of different stakeholders was involved or when the certain types of stakeholders do not have the knowledge and the capabilities to actively participate in the EDP.[36]

The overall shares of the **types of stakeholders** involved are shown in Figure 3-3. The shares of the different types of stakeholders that have been involved is overall slightly higher in EU13 and transition regions, respectively. Additionally, it stands out that a higher share of EDP in the EU13 countries involves civil society.

Figure 3-3. The shares of the different types of stakeholders that have been involved is overall slightly higher in EU13 and transition regions, respectively.[37] Additionally, it stands out that a higher share of EDP in the EU13 countries involves civil society.

Figure 3-3: Share of the types of stakeholder involved



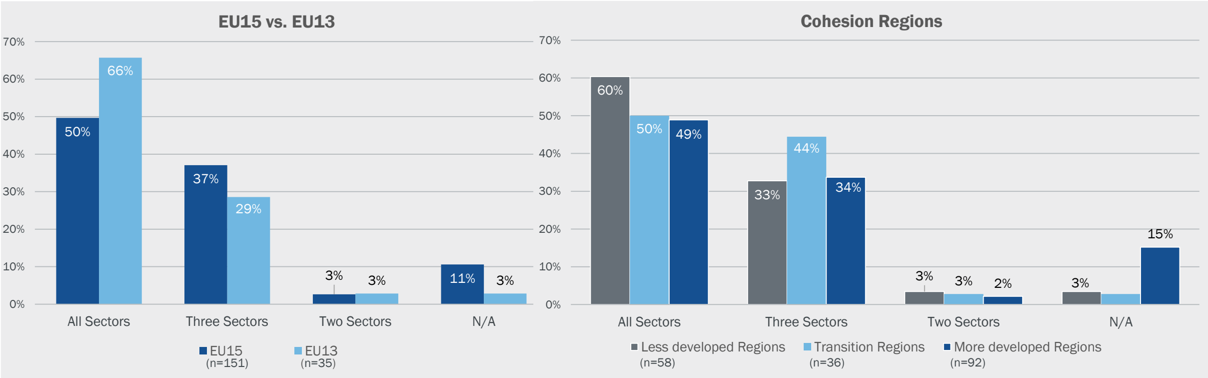
Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: The "n" varies between both charts as it only takes into account the S3 strategies from the respective category.

Qualitative evidence from the interviews further shows that a **broad EDP involving multiple different types of stakeholders is seen as a key success factor** for enriching the prioritization process. The quantitative evidence shows that 53% of the S3 strategies are based on an EDP that is made up of stakeholders from all four different backgrounds, while 36% stem from EDPs with at least three different types of stakeholders and only 3% with two. A broad stakeholder process that includes all four different types is observed in EU13 countries and less developed regions more frequently, in contrast to EU15 and more developed regions, respectively.

Whereas a **broad stakeholder process** is mostly seen as beneficial and stimulating for the priority selection, it tends to come along with **certain difficulties**. Some interviewees mentioned that it has been challenging to diffuse a common understanding of the concept of S3 and to mediate between stakeholders of different backgrounds. Others stated that it has been advantageous in this regard to build upon pre-existing networks that were created for previous strategy concepts or to put an emphasis on the involvement of cluster/business association. This underlines the importance of a continuous EDP, in line with Section 3.1.1.

[36] See also Arancegui et al. 2011; Crescenzi and Rodriguez-Pose, 2011.
[37] One must keep in mind the relatively smaller "n" in both transition and EU13 regions.

Figure 3-4:Sectoral Background of stakeholders by number of sectors (by region)



Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: The n varies between both charts as it only considers the S3 strategies from the respective category.

3.2 Main methods and tools used for determining S3 priority areas

3.2.1 *Data used for analysing the innovation ecosystem and potential priority areas*

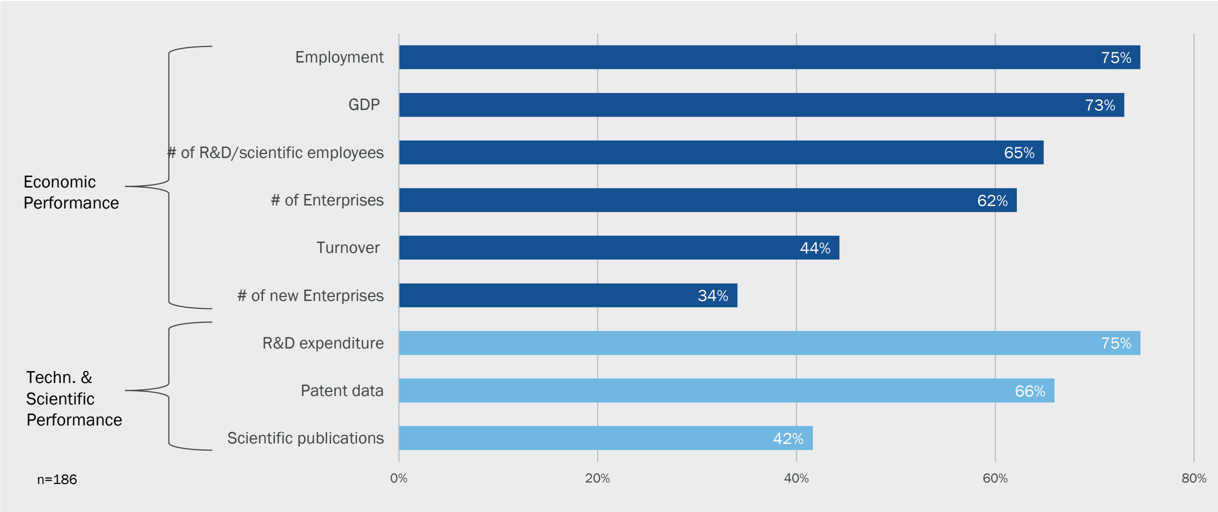
RQ: How have economic/technological/scientific strengths been assessed?

The data used for analysing the innovation ecosystem and potential priority areas can be differentiated between data analysis that aims at measuring the economic performance (GDP, employment, number of enterprises, turnover, number of new enterprises) and those aiming at the technological and scientific performance, namely R&D expenditure, patent data and scientific publications.

As Figure 3-5 illustrates, the **indicators that are most commonly used for measuring economic performance are employment (77%) and GDP (73%)[38]**. Concerning the technological and scientific performance, the S3 strategies show an overall emphasis on displaying relevant data regarding R&D expenditure. Other relevant statistical approaches that were identified are benchmarking (58% of the S3 strategies), specialisation indices (46% - mostly based on economic data and not on scientific or technological) and related variety analysis in 6% of the S3 strategies.

[38] Indicators that fall under 'GDP' are for instance the share of value added by sector or the change of value added by sector, even though that analysis over time (comparing two or more points in time) are only used in around 2/3 of the relevant S3 strategies.

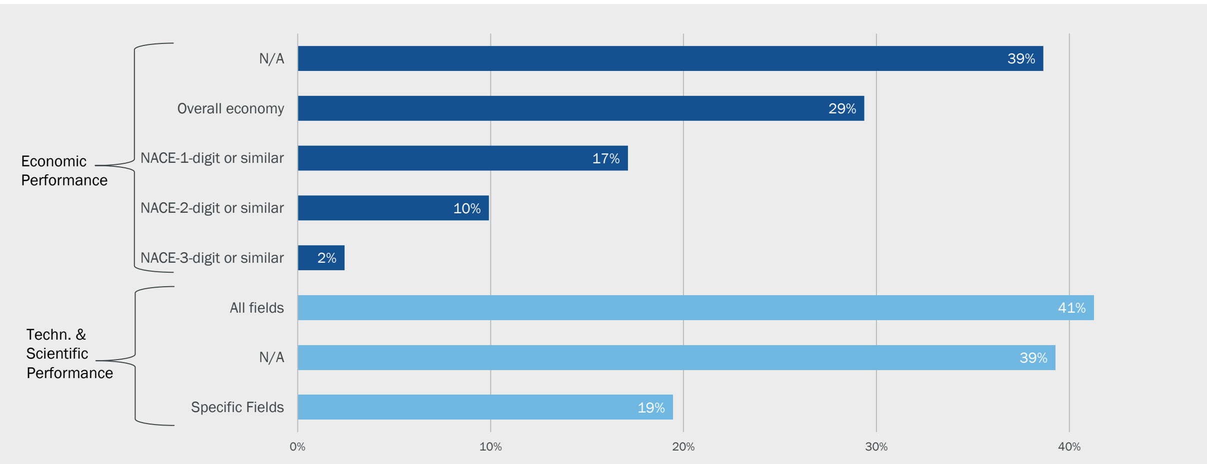
Figure 3-5: Data used for analysing the innovation ecosystem and potential priority areas



Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: The "n" varies between both charts as it only considers the S3 strategies from the respective category.

A topic of key relevance with regards to S3 strategies is the **granularity of the chosen priorities**. While this issue is discussed in later sections in more detail (Chapter 4 in particular), the granularity of the data that was used to contribute to the selection of priority areas gives a first indication. Figure 3-6 displays the granularity of data used in the S3 preparation process. While there is overall a high share of N/A in the responses from the Member States/regions in the dataset (39%), it can be seen that most data are analysed on a more abstract level, e.g., the overall economy (GDP on a country/regional level: 29% of all data categories of all S3 strategies; NACE-1-digit sectors[39]:17%). More granular data on a NACE-2/3-digit level is only used in 10% or 2% of all data categories of all S3 strategies, respectively.

Figure 3-6: Granularity of the used data / n=1116



Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities. Note: The "n" varies between both charts as it only considers the S3 strategies from the respective category.

The **qualitative evidence on the topic of data granularity is mixed**. While around 1/3 of the interviewees, i.e., S3 Managers, believe that the prioritization accurately reflects the existing economic and research orientation of the country/region, indicating their satisfaction with the level of granularity of the data analysis. However, there is a good

[39] Or similar, depending on the respective national context.

number of interviewees that regard their priorities as too broad, which has led to problems in the implementation phase (organisations of calls, selection of projects[40]). This can be linked back to the share of S3 strategies that are based on data analysis on the overall level of the economy. Some interviewees also indicated that their S3 strategies were **not thoroughly based on a data-driven process** and mentioned that improvement in this regard could potentially also lead to a more accurate prioritization.

3.2.2 *Additional approaches used in the S3 preparation process*

RQ: How have economic/technological/scientific strengths been assessed?

Next or related to the stakeholder involvement (Section 3.1.2) and the data used for the economic/scientific/technological performance (Section 3.2.1) many S3 strategies are based on other forms of approaches. The following table provides an overview of the approaches utilised most frequently.

Table 3-1: Additional approaches & analytical tools used in the S3 preparation process (2014-2020 period)

Approaches	Related to	Share of strategies using this approach
EDP focus groups/workshops	Stakeholder involvement	85% of all S3 strategies
Stakeholder interviews	Stakeholder involvement	52% of all S3 strategies
Mapping of research centres universities	Infrastructure mapping	70% of all S3 strategies
Mapping of clusters	Infrastructure mapping	58% of all S3 strategies
Mapping of technology incubators	Infrastructure mapping	38% of all S3 strategies
SWOT analysis	other	83% of all S3 strategies

Other stakeholder involvement approaches that have been used:	**Other stakeholder involvement approaches that have been used in instances:**
• Inter-ministerial working groups • Stakeholder conferences/roundtables • Online consultations/surveys • Expert panels/peer review	• Mapping of planned infrastructure • Mapping of relevant companies • Mapping of involvement in international R&D projects (Interreg, Horizon) • Technological foresight analysis • Mapping of financial institutions

Source: Prognos / CSIL (2021), based on an analysis of S3 strategy documents and accompanying interviews with managing authorities.

As already indicated in the literature and confirmed by the interviews with the managing authorities and the data collection in the course of this study, methodologies and tools used for developing S3 strategies vary significantly and are manifold. Elements such as workshops and focus groups are rather common features (of the EDP), others, such as foresight analysis, mapping of involvement in international projects or analysis around newly created enterprises are less commonly used. While there appears to be no clear "right or wrong" with regards to the selection of individual instruments or even a mix of instruments to determine priority areas, this study does shed some light on some **common**

[40] See Chapter 6 for more information in this regard.

success factors of more horizontal nature. In line with the literature, it can be said that a clear and dedicated governance structure is a core element and the basis of all tools and methodologies used for S3 development. This usually helps to establish some sense of continuity, clear communication structures and good decision-making in the context of a multitude of different interests and stakeholders. Furthermore, a continuous EDP that is not a one-off project but rather a sustained dialogue with a broad range of stakeholders has shown to be a catalyst to enhance overall dialogue in the respective region and to make the concept of S3 better understood. Furthermore, a broad data analysis that is based on both general economic but also scientific and technological indicators has been illustrated as key and has shown to be more accurate when conducted on a relatively granular level.

4 PRIORITISATION APPROACHES IN THE S3 STRATEGIES ACROSS THE EU

Overview of key findings

1. **The most prevalent topics addressed in the S3 priority areas are linked to engineering and ICT-related fields.** This confirms the finding from the literature review that many strategies seem to have an emphasis on R&D and technology-driven themes, while non-R&D-related topics are addressed to a lesser extent. At the same time, the fact that ICT topics were addressed so frequently by the priority areas is a sign that ICTs were often relevant as cross-cutting themes due to the ongoing digitalisation in each area of society, underlining its role as a GPT (i.e., applications of ICT in the field of energy, health, or mobility). At the same time, analysis of the thematic orientation of the S3 strategies reveals that the priority areas often tackle the societal challenges for a green and sustainable transition.

2. **Priority areas are most commonly based on a combined priority-setting approach and are generally not framed in terms of single scientific, economic, or technological fields.** Rather, they are defined at the intersection of these domains. Furthermore, they aim at solving specific societal and environmental challenges or at making use of the Member States'/regions' specific cultural or natural endowments. The analysis shows that 95% of the S3 strategies use such a joint priority-setting approach, taking into account at least four of these different elements (i.e., science, technology, economy, societal challenges, as well as cultural and natural resources). Despite their frequent combination, some elements are more pronounced in the priority-setting process than others. In this regard, economic sector-driven priority-setting appears to be more relevant and widespread.

3. **There are only very minor regional differences regarding the degree of complexity of S3 strategies and their priority areas.** The share of highly complex technology fields and high-tech economic sectors addressed by the priority areas targeted in S3 strategies is relatively similar for less developed (18% for technology fields and 24% for economic sectors), transition (17%/23%) and more developed regions (20%/25%). This may explain the desire of lagging-behind regions to use their S3 strategies to leapfrog into R&D-driven sectors and thereby support commercial innovation, as previously mentioned by Radosevic (2017), or help explain the potential mismatch between endogenous innovation capacities and selected priority areas (compare findings on "correspondence" below).

4. **Referring to the absolute number of priority areas is misleading, especially for Member States/regions that use a multi-level (tree-shaped) structure with a few broadly defined main priority areas and several sub-priorities.** The finding emphasises the importance to look beyond the main priorities to identify the real level of prioritisation. At the same time, Member States/regions using such multi-level priorities must ensure that the topics addressed in their S3 strategy do not become too wide (thematic bandwidth), as it currently is the case in some Member States/regions. Member States/regions with particularly broad S3 strategies are Portugal (bandwidth index of 76%; EU-average: 38%), Poland (66%), and Austria (63%; all national S3 strategies) as well as several French regions such as Bretagne (80%), Limousin (74%) or Pays de la Loire (70%). As Gianelle et al. (2019a, p.8) point out: "For a policy intervention to be selective, the priority tree needs to be sparse."

5. **Larger and economically stronger Member States/regions seem to prioritise less compared to smaller regions.** The data shows that Member States/regions with higher total ERDF TO1 funding, higher total R&D expenditures (GERD) and larger population sizes tend to define more priority areas (in absolute terms) and tend to cover a broader, less focused thematic spectrum in their S3 strategies as compared to smaller Member States/regions with lower financial resources. This can be related to the fact that larger and financially stronger Member States/regions find prioritising and concentrating resources less suited to their productive, scientific, and technological profile (Foray, 2019; Hassink and Gong, 2019). At the same time, larger and economically more diversified Member States/regions can face specific political challenges. A very focused approach on a few sectors potentially leaves out a larger number of actors, who may then engage in lobbying activities to be included in the strategy.

The S3 approach advocates the concentration of public resources in a **set of clearly defined priority areas** to be selected in a bottom-up approach. These priorities are supposed to reflect a regions' specific capacities and opportunities and should enable the region to benefit from new technological- and economic growth opportunities (Balland et al., 2019; Foray et al., 2018).

Against this background, this section seeks **to identify the extent to which prioritisation has been achieved in the various S3 strategies** of the Member States/regions. For this purpose, Chapter 4 addresses the following research questions:

- Is the prioritisation based on sectors or scientific and technology fields or was it an interdisciplinary/cross-sectoral approach?
- How and with what outcome has prioritisation been achieved?
- At what level of granularity has prioritisation been achieved?

The entire section is grounded on a methodological approach in which the different priorities were matched with economic sectors, scientific fields (FOR classification) and fields (classification by Schmoch 2008). The assignment of these standardised classifications makes the priorities comparable in terms of their respective thematic orientation (see the analysis in Section 4.3), their respective complexity (see the analysis in Section 4.4) as well as their granularity and selectivity (see analysis in Section 4.5). As a groundwork for this section, Section 4.1 illustrates the database and provides short explanations on the relevant classifications of the priorities.

4.1 The "S3 prioritisation database"

For this study, a comprehensive prioritisation database covering all Member States/regions and the S3 strategies was established. In total, 185 S3 strategies are included in the database.

As has been explained in Section 2.1, the matching of the S3 strategies' priority areas led to the creation of three prioritisation databases, which link the priority areas to economic sectors, technology fields and scientific fields.

Table 4-1 below provides a snapshot of the prioritisation data base for the economic profile of the S3 strategies and an overview of its basic structure. The structure is the same for the scientific and technological prioritisation databases.

For each priority area, basic information is provided on the corresponding region, priority area name, and priority area description. The latter consist of keywords extracted from the strategy document. The last two columns provide information on the economic sectors that based on the priority area description could be matched with the respective priority area. The column labelled "share" gives weight to each of the matched sectors and indicates their relevance. The higher this value, the higher the correspondence between the priority area description and the matched sector. If the value for one sector is 100%, this means that only this sector is relevant for the priority area. The field "non-NACE description" indicates how much of the description cannot be assigned to any economic sector. A share of 100% for "non-NACE Description" indicates that the priority area is not framed in terms of economic sectors. For each priority area, the weights add up to 100%.

Table 4-1: Snapshot of the prioritisation database for the economic profile (NACE)

Region	Country	Priority Area	Description	Share	NACE Code	NACE Description
Extremadura	Spain	Tourism	Tourism; electronics; automation; ICT; natural heritage; cultural heritage; new tourism products; nature tourism; agro-tourism; new materials; 3D modelling; digitalisation of historical-artistic heritage; virtual reality applications; applications for tourism management; health tourism; wellness tourism	19%	79	Travel agency, tour operator and other reservation service and related activities
				19%	55	Accommodation
				13%	18	Printing and reproduction of recorded media
				11%	62	Computer programming, consultancy, and related activities
				7%	26	Manufacture of computer, electronic and optical products
				31%	/	non-NACE Description
Rhineland Palatinate	Germany	Microsystems technology, sensor technology, automation	Microsystems technology; sensor technology; automation; chemistry; mechanical engineering; vehicle construction; measurement technology; control engineering; control technology; magnetic microsystems; smart factory; photonics; sensor systems; process automation; optical communication; special glass; glass ceramics; magnetic sensor technology; automation for robot systems; testing systems; cooling technology	33%	72	Scientific research and development
				24%	26	Manufacture of computer, electronic and optical products
				15%	71	Architectural and engineering activities; technical testing and analysis
				10%	23	Manufacture of other non-metallic mineral products
				9%	62	Computer programming, consultancy, and related activities
				5%	32	Other manufacturing
				5%	99	non-NACE Description

Source: Prognos / CSIL (2021).

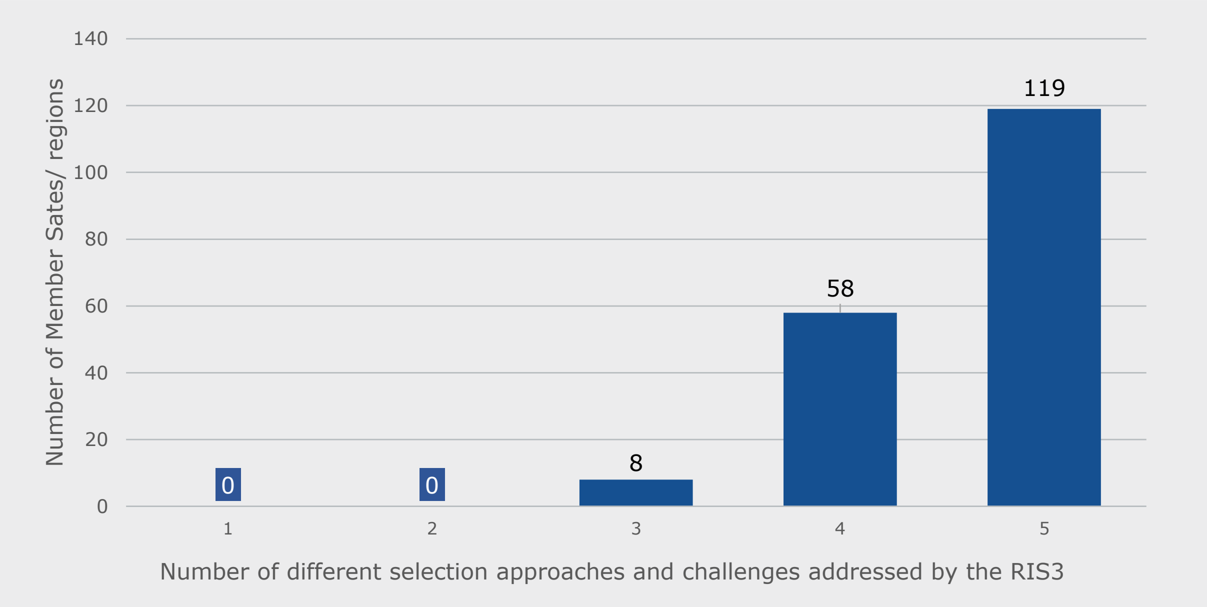
4.2 Prioritisation approach used in S3 (scientific, technological, sectoral)

RQ: Is the prioritisation based on sectors or scientific and technology fields or was it an interdisciplinary/cross-sectoral approach?

This section of the analysis has the objective to identify if the Member States/regions followed the proposed approach by the European Commission for smart specialisation which should lead to the identification of "[…] candidate activities for policy interventions at the intersection of different dimensions. Priorities shall result from the application of technologies or innovative processes to certain industries characterised, possibly, by the utilisation of specific natural or cultural assets, to pursue specific societal goals" (Gianelle et al., 2018, p.5). For this purpose, the following analysis displays the extent to which the different priority areas in the Member States/regions are economically, scientifically, or technologically driven and illustrated which elements of these were considered for defining priority areas.

Figure 4-1 takes the classifications into account and additionally includes the information if the priorities are linked to societal challenges[41] or cultural assets[42]. It illustrates the extent to which the Member States/regions have based their priorities on all approaches for selection (scientific, technological, economic) and multiple forms of challenges (societal challenges, cultural assets). It is shown that a large share of the Member States/regions has based their priority areas on either four (31%, 58 S3 strategies) or all five (64%, 119 S3 strategies), as shown also by Member State/region in Figure 4-1 below.

Figure 4-1: Number of different selection approaches and forms of challenges (scientific, technological, economic, societal challenges, cultural & natural resources) addressed by EU Member States/regions (initial strategy)



Source: Prognos / CSIL (2021). Note: n= 185 Member States/regions.

[41] This study's understanding of societal challenges is based on the Horizon 2020 challenges and is enriched by the SDGs themselves as well as combined with the European Innovation Partnership (EIP) areas. This was done to allow to connect the prioritisation areas of the regions more precisely to specific societal challenges and to investigate which societal challenges are focused on most. The societal challenges (main categories and sub-categories are illustrated in Section 9.2, Table 9-6.

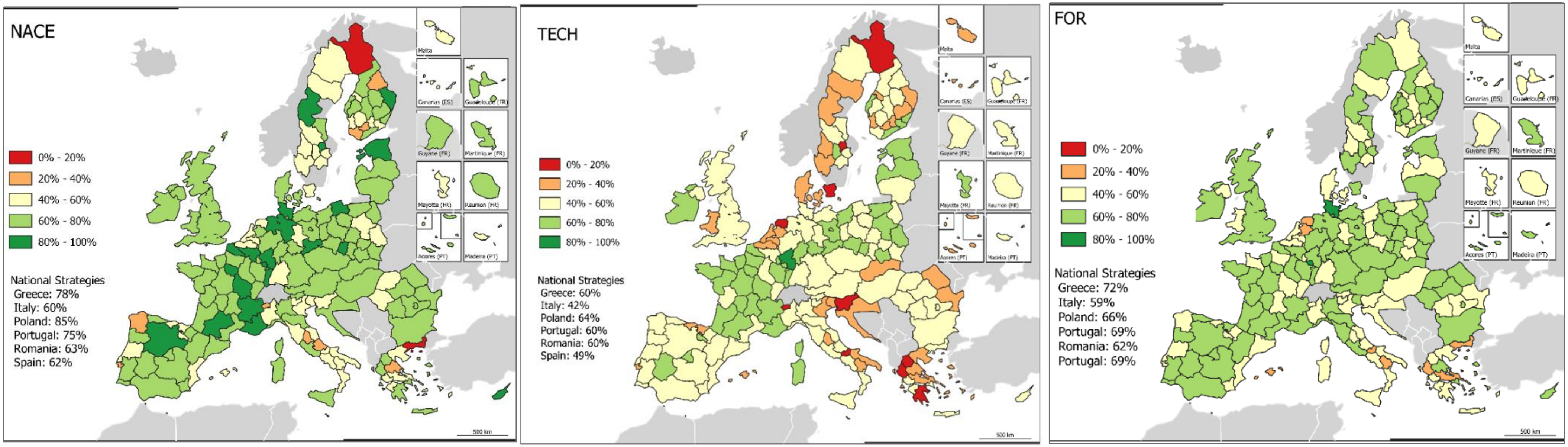
[42] The integration of the regions' cultural and natural resources in its priority areas can take multiple forms. For instance, the Italian region of South Tyrol focusses on "alpine technologies" due to its geographical location in the Alps (e.g., new materials for cableways, environmentally friendly snow-making systems or ski sportswear). Similarly, other regions might base their prioritisation on the richness of historical sites in their region to support their tourism sector in a smart way (e.g., usage of ICT for cultural heritage valorisation).

When comparing the three main selection approaches, it can be stated that the S3 strategies are strongly linked to all three areas, especially to economic sectors (64%) and scientific fields (60%) and slightly less to technology fields (48%).[43] These shares are further displayed on a regional/Member State level in Map 4-1. Here, it is shown that many Member States'/regions' priorities are not solely economically, scientifically, or technologically driven but rather reflect a combined approach. However, the comparatively lower shares of Member States/regions in which their S3 strategies are mostly technologically driven is obvious and shows the influence of the service sector (see the following section in this regard). The number of S3 strategies that are linked to science or are to some extent research-driven is relatively balanced out throughout the Member States/regions.

[43] The shares of the extent to which S3 strategies are linked to the three classifications is to an extent influenced by unspecific terms in the descriptions and are thus rather to be seen as an indication.

Map 4-1: Utilisation of economic, scientific and technological approaches in the Member States/regions (illustrated in explained shares)

Panel a: Utilisation of economic approaches | Panel b: Utilisation of technological approaches | Panel c: Utilisation of scientific approaches



Source: Prognos / CSIL (2021). n = 185 Member States/regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These Member States are Italy, Greece, Spain, Poland, Portugal, and Romania.

4.3 Thematic orientation of the prioritisation approach of S3 strategies

RQ: Is the prioritisation based on sectors or scientific and technology fields or was it an interdisciplinary/cross-sectoral approach?

Defining specific thematic areas of expertise as part of the prioritisation approach of S3 strategies is a key feature of smart specialisation.

This section provides a comprehensive overview of the thematic orientation of S3 strategies across the EU. Linked to the previous Section 4.2, this part illustrates which topics/themes within these approaches were important. These are illustrated in the following Figure 4-2 with regards to the addressed economic sectors (NACE classification), the addressed scientific fields (FOR classification) and the addressed technology fields (classification by Schmoch 2008). Next to these, it is displayed if priority areas are linked to societal challenges and cultural and natural resources.

4.3.1 *Addressed NACE / TECH / FOR fields by S3 strategies*

Figure 4-2 shows the **15 most matched priority areas** with each of the scientific fields (a.), the economic sectors (b.) and the technology fields (c.). While each of the illustrations highlights a different perspective (FOR: science-based; TECH: technology-based; NACE: overall economic sectors), certain similarities can be identified. **ICT-related topics appear to be of significant importance** concerning the thematic orientation of priority areas. Further analysis has also shown that ICT is an important cross-sectoral topic with an important influence on numerous other priority areas.[44] This is reflected in 465 matches in the FOR field 'Information & Computing Science', 374 matches with the economic sector 'Computer programming, consultancy & related activities' and 432 matches with the technology field 'Computer technology' and is supported by other relatively high shares of similar priorities, such as the scientific field 'Technology' or the technology field 'Digital Communication'. In contrast to this stand the relatively low shares in creative-related fields and sectors such as the economic sector 'Creative arts and entertainment activities. This finding supports a key observation from the literature that policy-makers tend to emphasise high-tech priorities due to their overall popularity but also because of their character as GPTs which can essentially be applied to any industry.[45] While Figure 4-2 displays this on an aggregate level for all Member States/regions, the tables in Annex 9.2[46] illustrate this by categorising countries in EU15/EU13, by Cohesion Region and by Regional Innovation Scoreboard region. Here, the centrality of ICT as a GPT is underlined, as it is one of the two most popular priorities no matter the regional classification, with slightly higher shares in the groups EU15, innovation leader and more developed regions. Other "popular" priorities appear to be engineering-related[47], as shown in the economic sector 'Architectural and engineering activities' and the scientific field 'Engineering' or medical- and health-related. The latter is shown by the high number of matches in the scientific field 'Medical and Health Sciences' and the technology field 'Medical technology', however not reflected in any specific regional settings.

Overall, the differences among the various Member States/regions are relatively small. However, some findings are worthwhile to highlight. The group of modest innovators has higher shares in the scientific field 'Agricultural and Veterinary Sciences (10%) compared to the innovation leaders (7%). This gap is also reflected in the economic sector 'Crop and

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[45] Other sources that have identified particularly R&D driven processes and high-tech related priorities as popular: Radosevic, 2017; Foray et al., 2018. For the central role of GPTs see among others Bresnahan, T. (2010). General purpose technologies. In Handbook of the Economics of Innovation (Vol. 2, pp. 761-791). North-Holland.

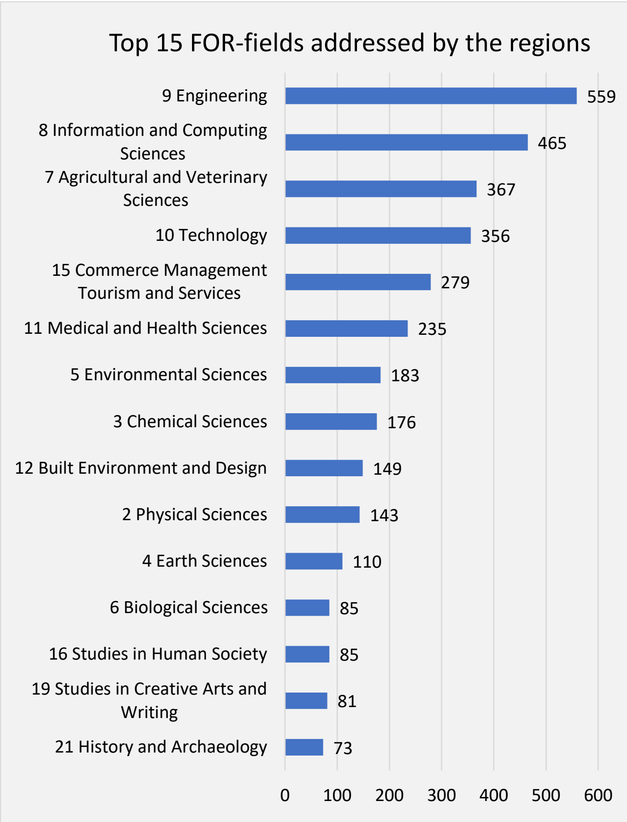
[46] see Annex 9.2: Table 9-7, Table 9-8, Table 9-9

[47] The rather broad field engineering includes multiple sub-fields. For the FOR, 16 sub-fields exist, ranging from automotive engineering to aerospace engineering or environmental engineering.

animal production’ (4% for the modest innovators; 2% for the innovation leaders) and the technology field ‘food chemistry’, where there is a 2% gap between the group of modest innovators and innovation leaders, pointing to a slightly more pronounced focus towards agricultural and food-related priorities in the group of modest innovators.

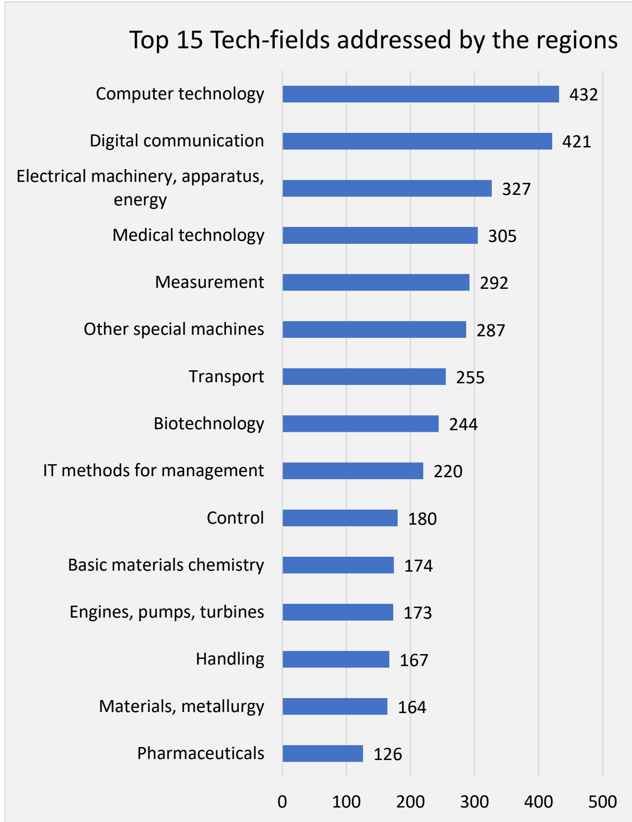
Figure 4-2: Top 15 Scientific/Technology/Economic fields and sectors addressed by the Member States/regions

Panel a: Top 15 Scientific fields



Panel b: Top 15 Economic sectors

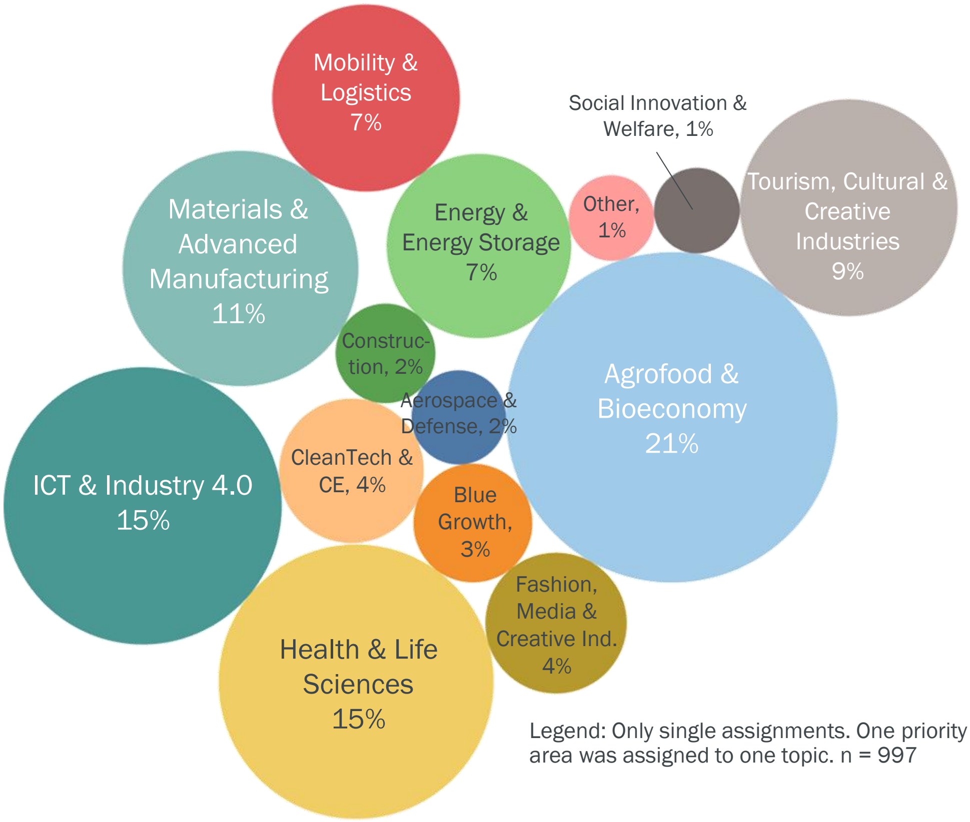
Panel c: Top 15 Technology fields



Source: Prognos / CSIL (2021).

Based on an overarching LDA-analysis, it can be said that the topics Agrofood & Bioeconomy (21%), Health & Life Sciences (15%) and ICT & Industry 4.0 are topics that are addressed most (see Figure 4-3). This also indicates that ICT is not only important as a priority area but also as a topic within other priority areas due to its GPT character.

Figure 4-3: Share of overarching topics addressed by priority areas



Source: Prognos / CSIL (2021). Note: n= 185 regions. This is based on a LDA through which overarching topics were defined based on priority descriptions.

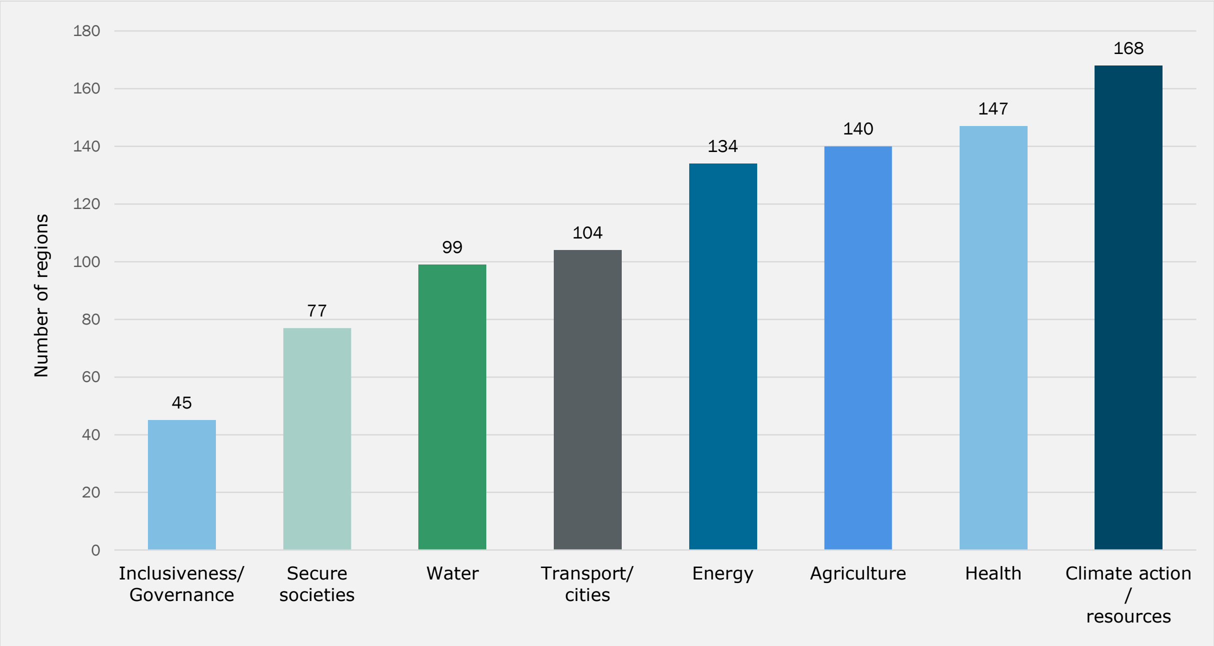
4.3.2 *Addressed societal challenges and natural/cultural resources in S3 strategies*

An important field of interest, both in policy terms and chosen priorities, is related to "green" or "sustainable" growth (Sörvik and Kleibrink, 2015). A first indication from the data comes with the scientific field "environmental science" which is a commonly addressed field in the priorities of the S3 strategies (see Figure 4-2). Simultaneously, scientific fields such as "engineering" and technology fields such as "biotechnology" indirectly entail interest in these topics.[48] Moreover, the interview survey of S3 managers across the EU shows that **more than 90% of all S3 strategies** (168 out of 185; 91%) **contain an explicit reference to the societal challenge 'Climate action/resources'** (see Figure 4-4). Similarly, the same figure points to a high rate of S3 linkages with the societal challenges subgroups 'Health' (79%), 'Agriculture' (76%), and 'Energy' (72%).[49] On a more granular level, the subgroups that are most often addressed are to ensure 'Sustainable consumption & production patterns', 'Good health and well-being' and 'Ensure access to affordable, reliable, sustainable & modern energy for all'.[50] As shown, the S3

[48] While the scientific fields "Environmental Science" and "Engineering" are linked to 559 and 183 priority areas respectively, the technological field "Biotechnology" is connected to 244 priority areas.
[49] According to Gianelle et al. (2016), priorities could be framed in terms of knowledge fields or sectors that are particularly relevant to societal and environmental challenges.
[50] An illustration of the share of the subcategories such as 'Sustainable consumption & production patterns' can be found in see Annex 9.2: Table 9-6.

strategies contain a strong linkage with societal challenges overall. The **real commitment to these challenges** in terms of implementation will be further addressed in Section 6.3.

Figure 4-4: Absolute number of S3 strategies that contain a link to a societal challenge

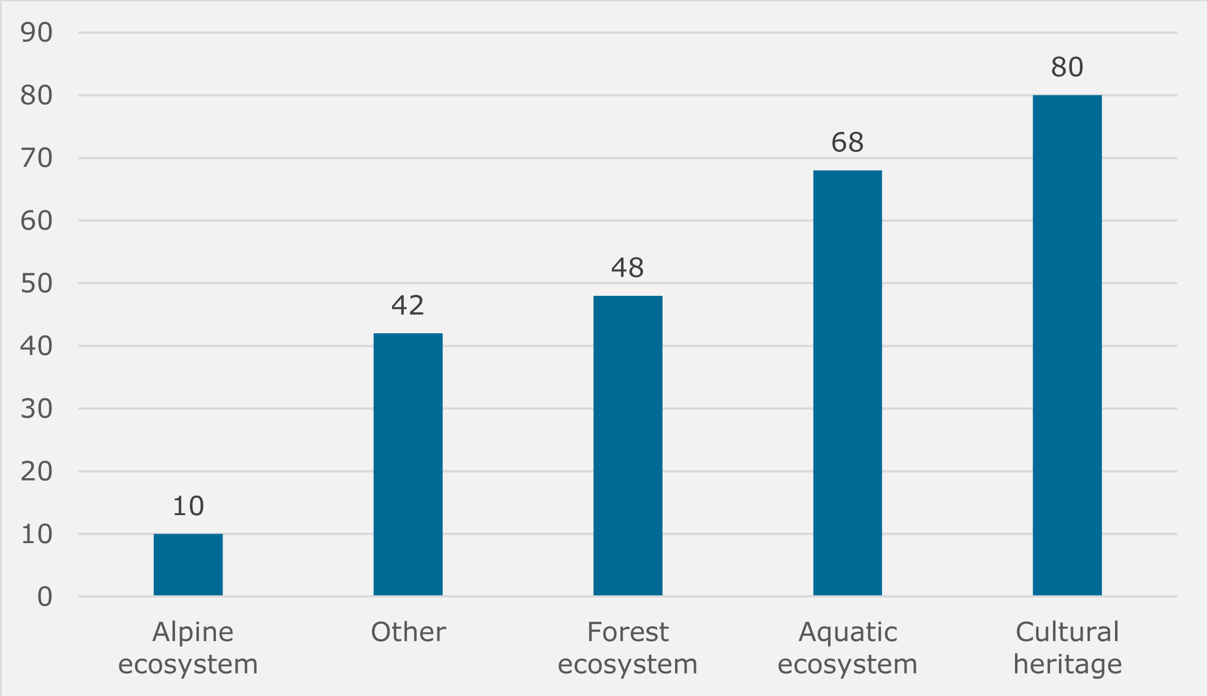


Source: Prognos / CSIL (2021). Note: The illustrated topics that are linked to societal challenges are based on the challenges defined in the context of Horizon 2020, are however refined by the SDGs themselves as well as combined with the European Innovation Partnership (EIP) areas. This was done to allow to connect the prioritisation areas of the Member States/regions more precisely to specific societal challenges and to investigate which societal challenges are focused on most. The main categories and sub-categories are explained in Table 9-6 see Annex 9.2 the shares in the subcategories are outlined in Figure 9-3 in Annex 9.2.

The process of defining priority areas within the S3 strategies may also be affected by specific **cultural or natural resources** that are available in a region. The integration of such resources within the respective priority areas can take multiple forms. For instance, the Italian region of South Tyrol focuses on "Alpine Technologies" due to its geographical location in the Alps (e.g., new materials for cableways, environmentally friendly snow-making systems, or ski sportswear). Similarly, other Member States/regions might base their priorities on the richness of historical sites in their region, to effectively support their tourism sector (e.g., usage of ICT for cultural heritage valorisation). The priority areas across the EU Member States/regions have been assessed for the integration of the following four cultural or natural resources, cultural heritage, aquatic ecosystems, alpine ecosystems, forest ecosystems.

When assessing which cultural or natural resources the priority areas have been based upon most frequently, Figure 4-5 shows that **a region's cultural heritage is most prevalently identified** – by 80 Member States/regions (43%). This is followed by the aquatic ecosystem (68 regions; 37%), the forest ecosystem (48; 26%) and the alpine ecosystem (10; 5%). A further 42 Member States/regions based their priority areas on other cultural or natural resources, such as agricultural ecosystems, geothermal resources, or resources for renewable energy creation.

Figure 4-5: Absolute number of S3 strategies that contain a link to cultural and natural resources



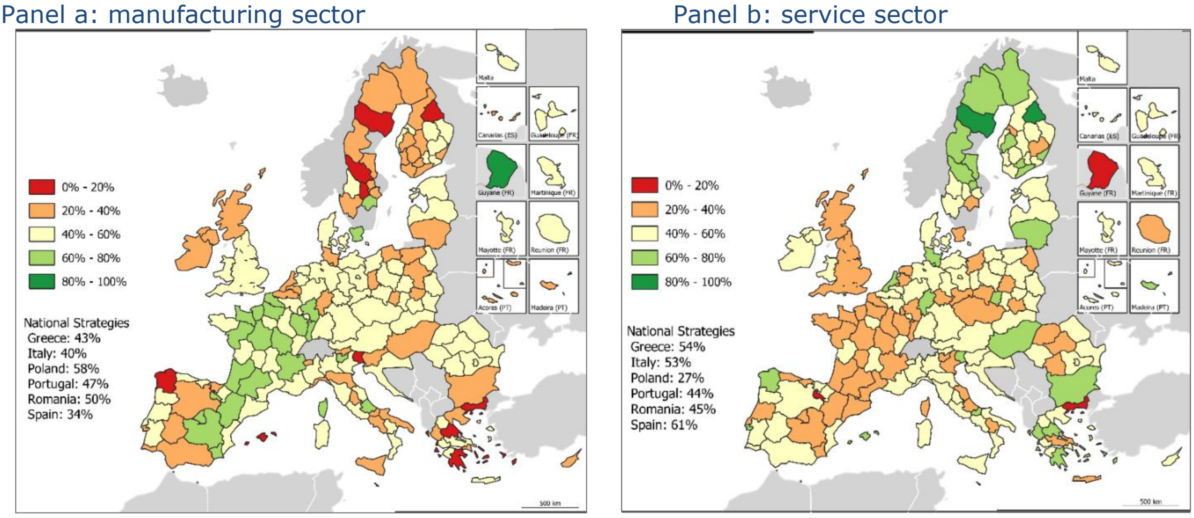
Source: Prognos / CSIL (2021).

Further analysis with regards to the thematic orientation of the priorities shows that **a large part of the priority areas (49%) are linked to the manufacturing sector** and the service sector (43%) while 8% can be connected to the primary sector. The map below shows that Swedish and Finnish regions have a relatively high share of their S3 priorities linked to the service sector.

Map 4-2: Share of priority areas that are linked to the manufacturing sector (left) and to the service sector (right)

Panel a: manufacturing sector

Panel b: service sector



Source: Prognos / CSIL (2021). n = 185 regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These Member States are Italy, Greece, Spain, Poland, Portugal, and Romania.

4.4 Complexity in prioritisation across S3 strategies in the EU

RQ: Has a prioritisation been achieved in the S3 strategies? How and with what outcome?

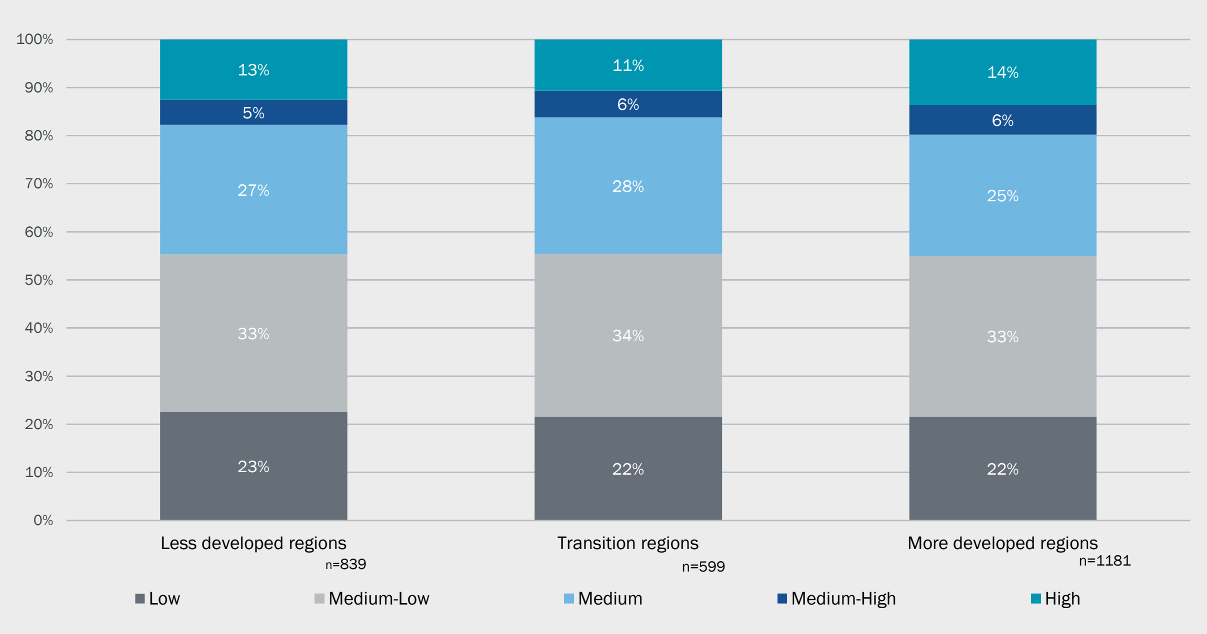
The concept of complexity of prioritisation areas in S3 strategies has received a lot of attention in recent policy and scientific debates. To see to which extent the S3 strategies are rather "ambitious" and might differ in their prioritisation approach, the following analysis will look at the degree of complexity of the technology fields and economic sectors addressed by the different regions' S3 strategies.

4.4.1 *Complexity in S3 strategies on technological level*

The concept of complexity of prioritisation areas in S3 strategies has received a lot of attention in recent policy and scientific debates. Since (at least) two different concepts of (technological) complexity exist in the literature, the approach used in this study will shortly be presented. The first explores the countries' or regional opportunities for structural economic transformation and diversification. This literature uses highly disaggregated export (e.g., Hausmann et al., 2007; Hausmann and Klinger, 2006) or employment data (e.g., Boschma and Balland, 2019) to identify activities that require new capabilities to be developed but might allow for upgrading and generate economic returns. The second stream in the literature constructs a "knowledge space", using patent (e.g., Leten et al., 2007; Kogler et al., 2013; Boschma et al., 2015; Rigby, 2015) and publication data (e.g., Heimeriks and Balland, 2016). Thereby, complexity refers to the notion that some technological fields are inherently more advanced (i.e., skill- and knowledge-intensive) than others. This study follows the latter stream of studies found in the literature. The complexity of technological fields is therefore based on the methodology of Balland and Rigby (2017) and at the same time uses a "region-invariant" approach, where the complexity index of technology fields is computed at the EU-level. The focus of this section lies entirely on the strategy content and its general level of complexity. Table 9-10 in Annex 9.2 provides an overview of the 35 technology fields and their classification according to their degree of technological complexity.

Figure 4-6 displays the share of technology fields addressed by the S3 strategies of the Cohesion Regions that can be described as highly complex. Overall, the **differences across the different types of Member States/regions are rather small**, although the share of more developed regions (20%) addressing highly complex technologies is slightly higher. This generally illustrated that S3 strategies are rather similar in terms of technological complexity.

Figure 4-6: Distribution of the complexity levels of technology fields in the strategies (Cohesion Regions)



Source: Prognos / CSIL (2021).

A more detailed regional overview for the shares of technology fields in the S3 strategies that address highly complex technology fields is given in Table 4-2 below and Map 9-3 in the Annex 9.2. It becomes evident that in most of the Member States/regions (166/185), the share of technology fields in the strategies that are highly complex amounts to less than 50%. Apart from some (data-driven) outliers, where regions do address almost exclusively highly complex technological fields (e.g., the North Aegean and Peloponnese) or do not address any highly complex technologies at all (e.g., Västmanlands län or Guyane), **the analysis intuitively cannot (as expected) identify any strong regional patterns.**

Table 4-2: Technological complexity of the S3 strategies in the Member States/regions

		Share of technology fields in the S3 strategies that are highly complex			
		0%- 25%	25% - 50%	50% - 75%	75% - 100%
Number of regions	**All regions**	80	86	18	2
	Less developed regions	26	27	5	0
	Transition regions	15	18	1	2
	More developed regions	39	41	12	0

Source: Prognos / CSIL (2021). Note : n = 186 regions.

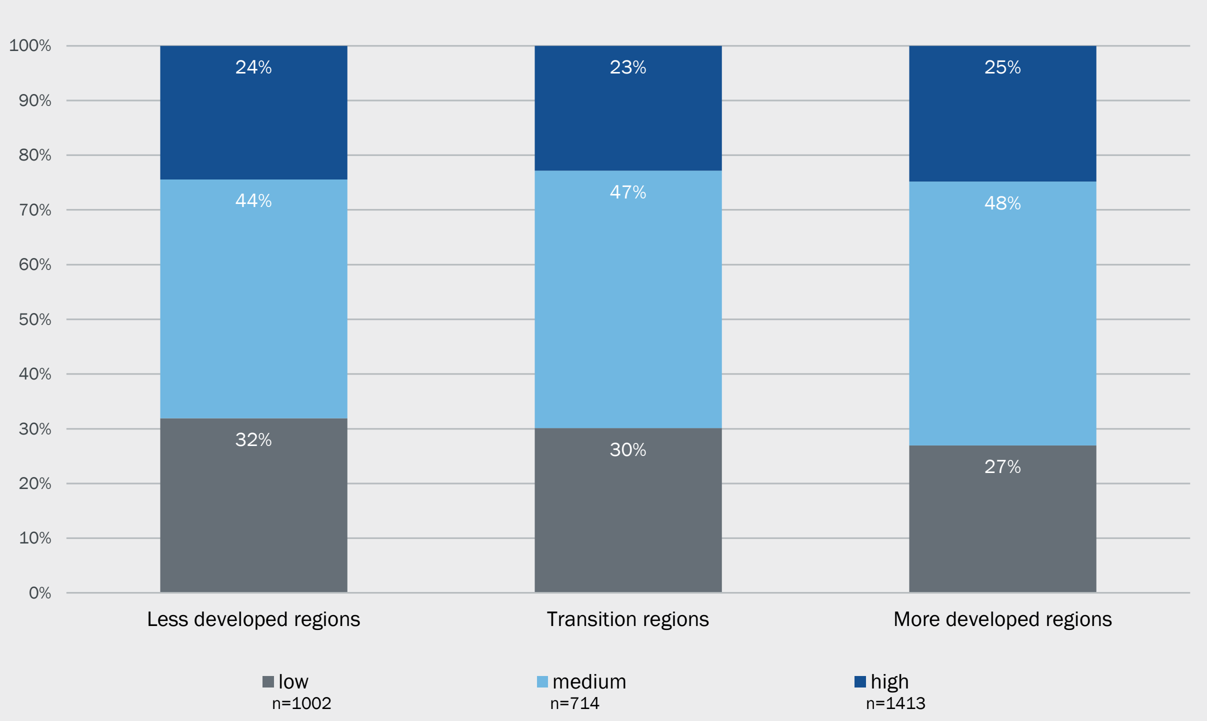
4.4.2 *Complexity in S3 strategies on sectoral level*

Figure 4-7 presents the share in the strategies of the Cohesion Regions that address high-tech manufacturing sectors and knowledge-intensive services. This analysis is based on the matching of the priority areas in the strategies with the different economic classifications. Thereby, the different economic sectors **were aggregated according to**

their technological intensity following the definitions of Eurostat[51] (see also Table 9-11 in Annex 9.2). In the analysis complexity is defined by sectors that are described as high-technology sectors and high-tech knowledge-intensive services since these categories constitute technology-intensive sectors.

This analysis brings to light similar results as presented in Figure 4-6. The share of sectors in the strategies that address high-technology sectors and high-tech knowledge-intensive services follows a similar pattern as the share of technology fields in the strategies that address highly complex technology fields. In other words, this share is the highest in more developed regions and the lowest in transition regions.

Figure 4-7: Distribution of the complexity levels of sectors in the strategies (Cohesion Regions)



Source: Prognos / CSIL (2021).

More nuanced results are yielded by the analysis of the share of sectors in the strategies of Innovation Scoreboard Regions that address high-technology sectors and high-tech knowledge-intensive services that are presented in Figure 9-4 in the Annex.

Table 4-3 provides a somewhat more detailed picture of the **degree of economic complexity** of the Member States/regions' S3 strategies. It can be seen that in most of the Member States/regions (160/185) high-technology manufacturing or high-tech service sectors on average represent less than 50% of all addressed economic sectors. Again, there exist some outliers with shares of 100% (e.g., Guyane) or 0% (e.g., some Swedish and Greek regions), where no high-technology manufacturing or service sectors are addressed by the respective S3 strategy. Overall, however, the results are similar to the analysis on technological complexity and no strong regional patterns can be identified.

[51] https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

Table 4-3: Economic complexity of the S3 strategies in the Member States/regions

		Share of economic sectors in the S3 strategies that address high-technology manufacturing and high-tech knowledge-intensive services			
		0%- 25%	**25% - 50%**	**50% - 75%**	**75% - 100%**
Number of regions	**All regions**	63	97	24	2
	Less developed regions	21	28	9	1
	Transition regions	12	19	3	0
	More developed regions	30	50	12	1

Source: Prognos / CSIL (2021). Note : n = 186 regions

Overall, the analysis of both economic and technological complexity has shed light on two findings. First, almost all Member States/regions address highly complex technology fields and sectors (albeit with varying prioritisation). Second, regional patterns can hardly be found. According to this analysis less developed regions do not overly emphasize high-technological domains and the share of strategies that address such high-technological domains is on average comparable among the Cohesion Region categories. The similar preference for R&D- and high-tech intensive activities of less developed regions compared to more developed regions can be seen as evidence for the desire of **economically weaker regions to use S3 to leapfrog into science-based sectors** and thereby to support commercial R&D as previously mentioned by Radosevic (2017).

However, at this point, the question of whether the regional strengths are reflected in the addressed complexity cannot be answered. This will be discussed in detail in Chapter 5.

4.5 Granularity & selectivity in prioritisation in S3 strategies across the EU

RQ: At what level of granularity has prioritisation taken place?

The overall debate around granularity and selectivity centres around the CPR European Union Common Provision Regulation 1303/2013 for Cohesion Policy (p. 438), which stipulates that resources should be concentrated on a limited set of research and innovation priorities. The underlying rationale for this is that the concentration of resources is seen as necessary to allow for a greater impact by achieving critical mass and avoiding the spread of innovation funding too thinly across too many priority areas.

However, as the literature shows, there have been issues with the degree of definition of priorities and the fact that the granularity of priorities is difficult to assess as it depends on the specificities of the concerned economy. Similarly, the assessment of the selectivity of the prioritisation process (whether it allows the concentration of resources) has proven to be difficult, as the optimal number of priorities depends to a large extent on the structure of the economy, but also on the level of priorities and the timing of the prioritisation process. The following analyses therefore will have a closer look at the actual selectivity and granularity of the 185 S3 strategies under consideration and how it is linked to regional specificities. To this end, the analysis not only considers the number of priority areas but also looks at the actual thematic bandwidth of the strategies (i.e., number of economic, technological, and scientific topics addressed).

4.5.1 *Number of thematic priorities in S3 strategies*

To begin with, it might be useful to define in more detail the type of S3 priority areas that are at the centre of the subsequent analysis.

Under **thematic priorities** fall all priority areas that, as defined by the European Commission, "are framed in terms of knowledge fields or activities (not only science-based, but also social, cultural and creative ones), sub-systems within a sector or cutting across sectors and corresponding to specific market niches, clusters, technologies, or ranges of application of technologies to specific societal and environmental challenges or health and security of citizens (…)."[52] This means that horizontal measures and priorities such as support measures for entrepreneurship or education are not taken into account.

Moreover, it needs to be considered that some Member States/regions use a **multi-level (tree-shaped) structure of priorities**. In these Member States/regions there exist some additional thematic focus topics below the (few) main priorities. In these cases, the count of the number of thematic priorities is based on the first-level, main priority areas. This issue is addressed in some more detail in Section 4.5.2.

Most studies that analysed the number of priority areas indicate that S3 strategies on average have around five thematic priorities. Overall, the number of priority areas across the analysed S3 strategies ranges from 3 to 17. The current analysis finds similar figures. Across the 185 S3 strategies analysed in this report (referring to the most current version), a total of 1,014 thematic main priority areas can be identified. **The number of priorities varies across regions**, ranging from as few as two (several strategies in Finland, France, Greece, Spain, and Sweden) to a maximum of 14 or 15 (Portuguese and Irish national strategy) (see Map 9-5 in the Annex). The average number of priorities per region is 5.5 and the median is five.

Table 4-4: Number of priority areas of the S3 strategies in Member States/regions (latest S3 strategy year)

	All regions	Less developed	Transition	More developed
Total	1014	325	189	500
Average per region	5.5	5.6	5.4	5.4
Median	5.0	6	5	5
Range: MIN – MAX	2 -15	2 – 15	2 – 8	2 – 15

Source: Prognos / CSIL (2021). Note: n=185 regions.

As discussed before, the number of priority areas can depend also on the **regions' economic structure or the financial size of its innovation funding budget**. Larger and economically stronger Member States/regions or more populous regions, for instance, might opt for more priorities as they possess a more critical mass in each of the addressed thematic fields. Also, Member States/regions receiving relatively high amounts of R&D funding, for instance, TO1 funding under Cohesion Policy, might be inclined to address a higher number of priority areas so that as many different stakeholders as possible can profit from public funding.

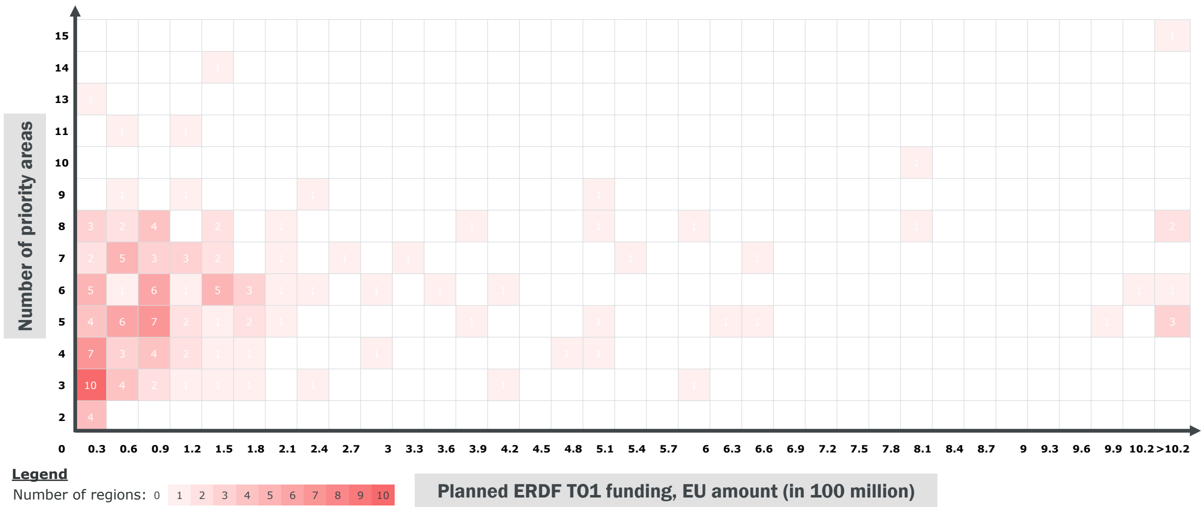
Table 4-4 above showed that the average and the median number of the priority areas is somewhat higher in the less developed regions (5.6 and 6) as compared to the transition and more developed regions (5.4 and 5). As these Member States/regions, in general, receive relatively higher amounts of (TO1) ERDF funding, this could be a sign that the number of priority areas could be driven by the size of the policy programme.

When looking at the correlation between the number of priority areas and the planned TO1 ERDF funding (EU amount) per capita, only a negligible and insignificant correlation could

[52] European Commission (2012): Frequently Asked Questions on S3: https://s3platform.jrc.ec.europa.eu/faqs-on-S3

be identified (see Table 9-13 in Annex 9.2). When considering the absolute EU amount of TO1 ERDF funding, the situation is somewhat different. As can be seen in Figure 4-8, there seems to be a positive relationship between the size of the TO1 funding and the number of priority areas. A more detailed analysis shows that there exists a significant but only very weak positive linear correlation (Pearson correlation = 0.14) (Table 9-14 in the Annex). However, given the fact that the TO1 funding data is quite skewed to the right and there exist some significant outliers as regards total TO1 funds received (e.g., Member States such as Poland, Spain, or Czechia), the Spearman rank correlation coefficient was computed as well[53]. This coefficient shows a somewhat more important and again significant, positive correlation of about 0.32. Since many S3 strategies, especially in more developed regions, are not entirely funded by the ERDF but rely also on other public national or regional funds as well as private R&D funding, the comparison with the overall R&D expenditures of a region is necessary as well. To this end, the regional GERD indicator[54] is taken as an absolute value and per capita. For both indicators, there exists again a significant but weakly positive correlation with the number of priority areas (see Table 9-17 and Table 9-18 in the Annex).

Figure 4-8: Relation between the number of the priority areas in the S3 strategies (latest strategy year) and the planned ERDF TO1 funding (EU amount)



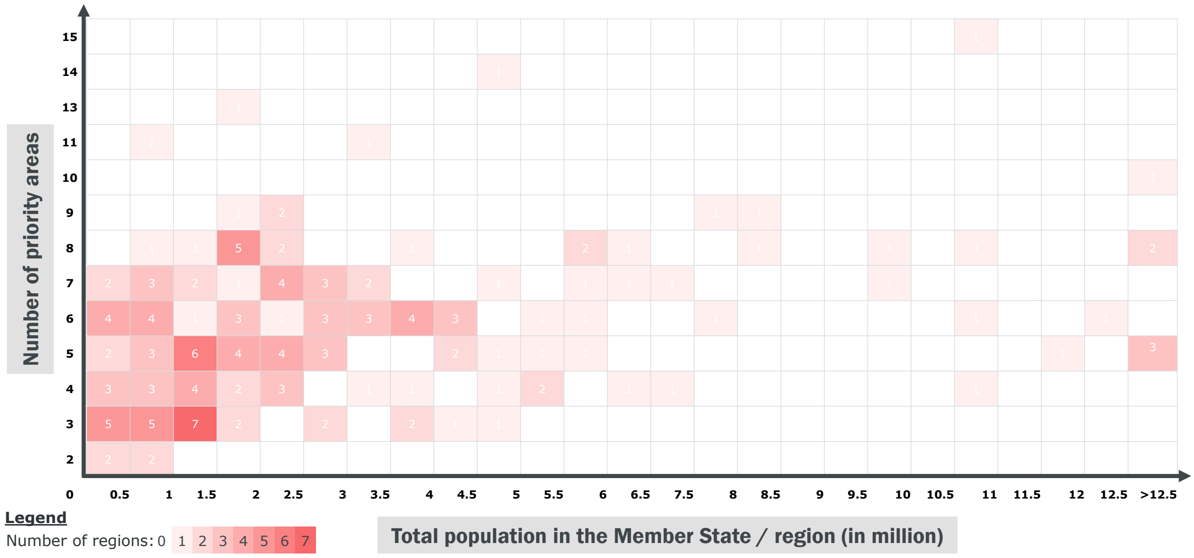
Source: Prognos / CSIL (2021). Note: n = 154 regions. Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions no ERDF TO1 funding data was available at the relevant NUTS level.

When observing the relationship between the economic strengths of the Member States/regions (measured by the average GDP per capita in PPP in the three years preceding the strategy) and the number of priority areas, no significant correlation could be identified (see Table 9-15 in Annex 9.2). However, as Figure 4-9 shows, there seems to be a positive interconnection between the size of the region (measured by average population size in the three years preceding the strategy) and the number of thematic priorities. The analysis on the correlation coefficients shows a significant, though again weak, positive correlation. Given the specific data properties, both correlation coefficients - Pearson and Spearman - were calculated, with the latter being higher (0.20 vs 0.35) (see Table 9-16 in Annex 9.2).

[53] "The Spearman's rank correlation coefficient is a nonparametric (distribution-free) rank statistic proposed by Charles Spearman as a measure of the strength of an association between two variables. It is a measure of a monotone association that is used when the distribution of data makes Pearson's correlation coefficient undesirable or misleading […]. It assesses how well an arbitrary monotonic function can describe a relationship between two variables, without making any assumptions about the frequency distribution of the variables. Unlike Pearson's product-moment correlation coefficient, it does not require the assumption that the relationship between the variables is linear, nor does it require the variables to be measured on interval scales; it can be used for variables measured at the ordinal level." (Hauke and Kossowski, 2011, p.87).

[54] Gross domestic expenditure on R&D, average of the three years preceding the strategy.

Figure 4-9: Relation between the number of the priority areas in the S3 strategies (latest strategy year) and population size of the region



Source: Prognos / CSIL (2021). Note: n = 165 Member States/regions. Data for Swedish and Finish regions aggregated at the NUTS2 level.

These positive (albeit weak) links between the number of priorities and the absolute amount of TO1 ERDF funding received, the total GERD and the population size of a region could be an indication that the granularity and selectivity of S3 strategies might potentially be influenced by the size of the ERDF policy programmes and the size of the region. However, no clear linkage can be found in this regard, as many other effects can potentially have an impact.

At the same time, reasoning in terms of the absolute number of priorities might not be very accurate. For instance, three very broadly defined priority areas might address more topics and thematic fields as compared to five more precisely and narrowly defined priority areas. In this case, the strategy with the lower number of priority areas might even be less concentrated than the first one. This issue will be addressed in the following Section 4.5.2.

4.5.2 *Granularity & selectivity of the prioritisation approach of S3 strategies*

To go beyond the simple count of the number of priorities and to analyse the thematic granularity and selectivity of the different S3 strategies, the following analysis relies on two different indexes, an index of thematic concentration and an index of bandwidth that are constructed based on the scientific, technological, and economic prioritisation databases (see also Section 4.1).

The concentration and bandwidth index

The **index of thematic concentration** indicates the degree to which a strategy is concentrated in terms of scientific, technological, or economic fields. It is defined as HHI (Herfindahl) index. The computation relies on the "Shares" computed for each priority area and which were aggregated at the strategy level. The index varies from 0 to 1. A value of 0 indicates that there is no specific concentration on any of the addressed fields. Hence, there is an equal distribution of shares across the different matched sectors, divisions, fields. This would be the case if for a specific S3 each of the matched scientific, technological, and economic fields have the same share (see example below).

Table 4-5: Example for a strategy with a concentration of 0

Region	Scientific field	Share	Technological field	Share	Economic field	Share
Region A	Medical and Health Sciences	33.3%	Pharmaceuticals	33.3%	Basic pharmaceutical products and pharmaceutical preparations	33.3%
	Information and Computing Sciences	33.3%	IT methods for management	33.3%	Computer programming, consultancy, and related activities	33.3%
	Engineering	33.3%	Transport	33.3%	Manufacture of motor vehicles, trailers, and semi-trailers	33.3%

Source: Prognos / CSIL (2021).

A value of 1, on the other hand, indicates that there is a maximum degree of thematic concentration. This means that for each classification the focus is to 100% on one specific field (see example below).

Table 4-6: Example for a strategy with a concentration of 1

Region	Scientific field	Share	Technological field	Share	Economic field	Share
Region B	Medical and Health Sciences	100%	Pharmaceuticals	100%	Basic pharmaceutical products and pharmaceutical preparations	100%

Source: Prognos / CSIL (2021).

The **index of bandwidth** indicates the thematic broadness that a S3 strategy covers. It is measured by the degree to which the strategy targets all the possible economic sectors, scientific and technological fields. It is defined as a %-share, where the number of economic sectors, scientific and technological fields targeted by the strategy is divided by the total number of existing economic sectors, scientific or technological fields (respectively 88 economic sectors, 22 scientific fields, 35 technology fields). Hence the share ranges between 0% and 100%. In this way it can be seen if a strategy is:

- "narrowly" defined (lower index), meaning that it picked only a few economic sectors, scientific and technological fields.

- "broadly" defined (higher index), meaning that it focuses on many economic sectors, scientific and technological fields.

To better analyse and compare the indexes under the three profiles, the S3 strategies are classified using a five-scale classification:

- **Low**: concentration index between 0 and 0.2; bandwidth index between 0 and 20%
- **Medium-low**: concentration index between 0.2 and 0.4; bandwidth index between 20% and 40%
- **Medium**: concentration index between 0.4 and 0.6; bandwidth index between 40% and 60%
- **Medium-high:** concentration index between 0.6 and 0.8; bandwidth index between 60% and 80%
- **High:** concentration index between 0.8 and 1; bandwidth index between 80% and 100%

Thematic concentration and bandwidth of the S3 strategies

As described before, the number of priority areas is not necessarily a good indicator of the effective granularity of the strategy, as Member States/regions with the same number of priority areas might have quite different strategies as regards their thematic broadness. Table 4-7 indicates to which extent the number of priority areas is (positively) related to the thematic broadness of the strategies (measured by the bandwidth index). As Table 4-7 shows, S3 strategies with a higher number of priority areas, not surprisingly, have a larger thematic focus. However, the relation is not 1-to-1 and some strategies with three or four priority areas have a broader thematic focus than strategies with five or more thematic priorities. In some Member States/regions this is strongly related to the fact that they use a **multi-level (tree-shaped) structure of priorities**. As mentioned before, in these Member States/regions there exist some additional thematic focus topics below the (few) main priorities. From the six S3 strategies that have two or three priority areas and at the same time have a medium to medium-high bandwidth, five use a multi-level prioritisation approach. For instance, the regions Aragón or Corse have three thematic main priority areas but also respectively 14 sub-priority areas. In addition, from seven Member States/regions having between four and six priority areas and a medium-high bandwidth, five Member States/regions developed a strategy with a tree-shaped structure of priorities. One example is the region Pays de la Loire, which has six main priority areas that are sub-divided into 16 sub-priorities. Hence, Member States/regions using a multi-level prioritisation approach rather seem to broaden their S3 strategy's thematic focus instead of narrowing it down. This shows that it is indeed important to go beyond simply counting the number of main priority areas and additional indicators are needed to measure the actual thematic width of the S3 strategies.

Table 4-7: Comparison of the number of priority areas with the thematic bandwidth of the S3 strategies (latest S3 strategy year)

Number of priority areas	Low	Medium-low	Medium	Medium-high	High
>12	0	1	1	1	0
10 - 12	0	0	2	1	0
7 - 9	2	11	24	8	0
4 - 6	13	38	27	7	0
1 - 3	9	14	4	2	0

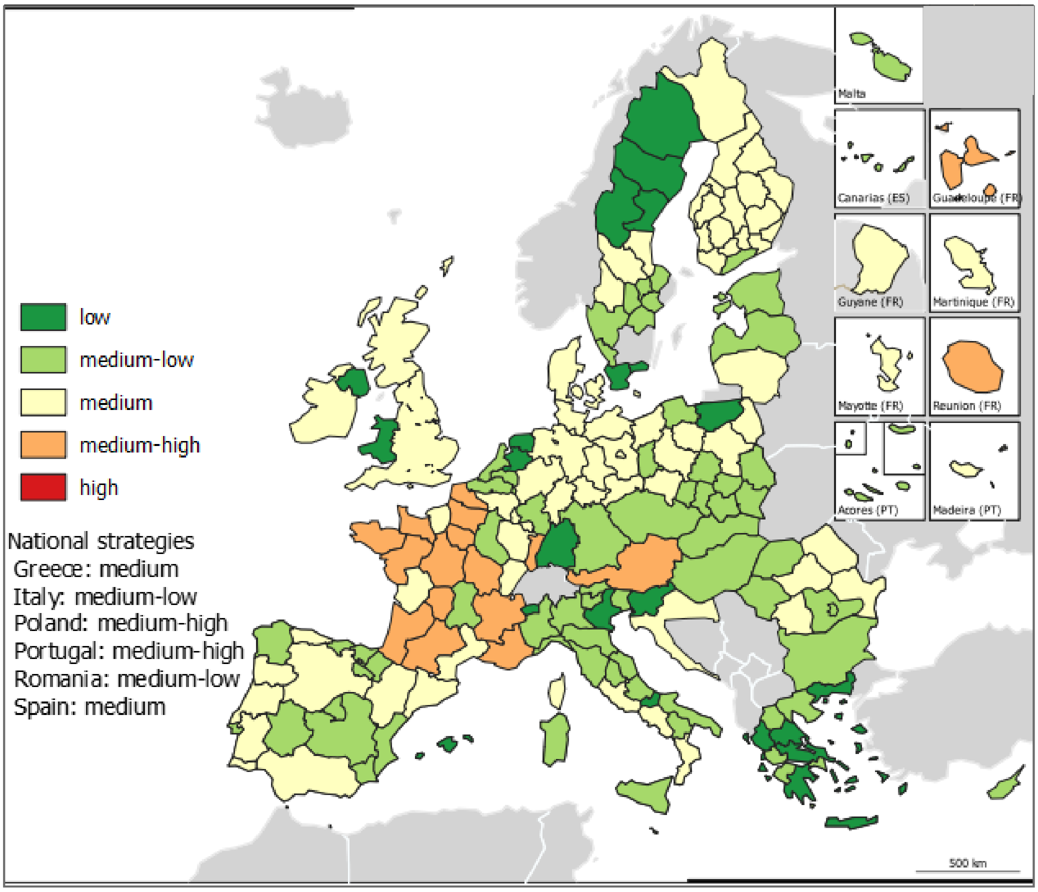
Thematic bandwidth index of RIS3 strategy

Legend
Number of regions: 0 … 38

Source: Prognos / CSIL (2021). Note: n = 165 Member States/regions. Data for Swedish and Finish regions aggregated at the NUTS2 level.

When looking more closely at the index for thematic bandwidth, about 75% of the S3 strategies fall into the medium-low to medium bandwidth category (i.e., bandwidth index between 20-60%, EU average = 37%). Outliers in this regard are the national strategies of Austria, Portugal, and Poland as well as most of the French regions. The RIS strategies of these Member States/regions have a rather broad thematic focus (medium-high) (see Map 4-3 below).

Map 4-3: Bandwidth index of the S3 strategies in the EU Member States/regions (latest S3 strategy year)



Source: Prognos / CSIL (2021). n = 165 Member States/regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania. Data for Swedish and Finish regions aggregated at the NUTS2 level. The concentration index, on the other hand, shows much less variation across the different S3 strategies. Overall, the concentration index is rather at the lower end (Map 4-3 in Annex). Hence, the topics that are addressed by the priority areas of a specific strategy, in general, have the same weight and there is, at least on a strategy level, no strong hierarchy between them (i.e., one scientific, technological, or economic topic more important than another one). Factors explaining the granularity and selectivity of S3 strategies.

The analysis across different types of variables characterising the Member States/regions again provides interesting insights into the S3 strategies' granularity and what might drive it. Even though there is not much difference between less developed, transition and more developed regions, we can again observe some expected and interesting **relationships regarding the Member States'/regions' population size, total TO1 ERDF funding and overall R&D expenditures (GERD)**.

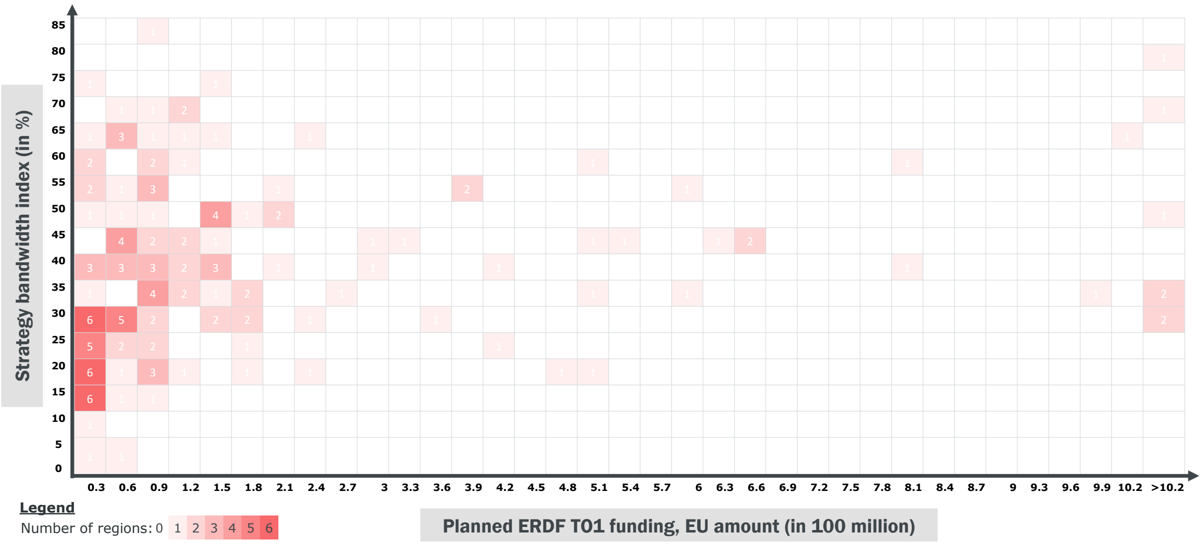
Similarly, to the correlation between the number of priority areas and total TO1 funding, there exists again a weak but positive and significant correlation with the thematic bandwidth (Pearson correlation = 0.17, Spearman correlation = 0.30) (see Figure 4-10 and Table 9-14 in Annex 9.2). Hence, strategies receiving higher amounts of TO1 funding strategies seem to cover (slightly) more scientific, technological, and economic topics. The same applies to the overall R&D expenditures in a region as the total GERD shows a weak and significant positive correlation with the strategies' bandwidth (Pearson correlation = 0.15; Spearman correlation = 0.32 see Table 9-17 in Annex 9.2). The correlation with GERD per capita, on the other hand, is not significant (see Table 9-18 in Annex 9.2).

Moreover, it is interesting that the relation between the S3 strategies' concentration and the total TO1 funding seems, as one would expect, to be negative (see Figure 4-10). The more detailed analysis of the correlation coefficients confirms this observation. The Pearson and Spearman correlation coefficients are weakly negative and significant (respectively -

0.14 and -0.28, see Table 9-14 in Annex 9.2). Regarding the total GERD, the picture is the same and a weak negative and significant correlation can be identified (Pearson correlation = -0.13, Spearman correlation = -0.27; see Table 9-17 in the Annex). However, as for the bandwidth index, the correlation with GERD per capita is not significant and negligible (see Table 9-18 in the Annex). This indicates that Member States/regions receiving higher amounts of TO1 funding or spending more on R&D overall might be inclined to concentrate less on specific sectors and instead try to spread it more equally across (a larger) number of topics.

Figure 4-10: Relationship (heatmap) between the ERDF TO1 funding (EU amount) and the S3 bandwidth index and concentration index (latest strategy year)

Panel a: Bandwidth index



Panel b: Concentration index

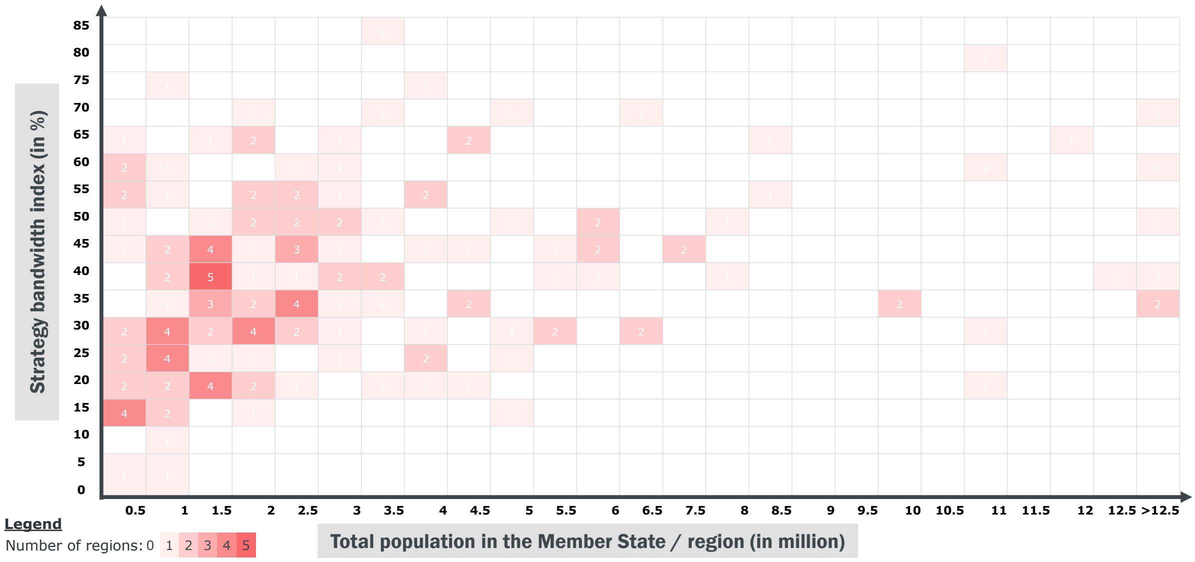
Source: Prognos / CSIL (2021). Note: n = 154 Member States/regions. Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions no ERDF TO1 funding data was available at the relevant NUTS level.

Given that both total TO1 funding and total GERD seem to positively correlate with the S3 strategies' thematic bandwidth index and negatively with the concentration index, and besides, TO1 per capita and GERD per capita only show an insignificant relationship, it might be that it is also the size of the region that drives the differences.

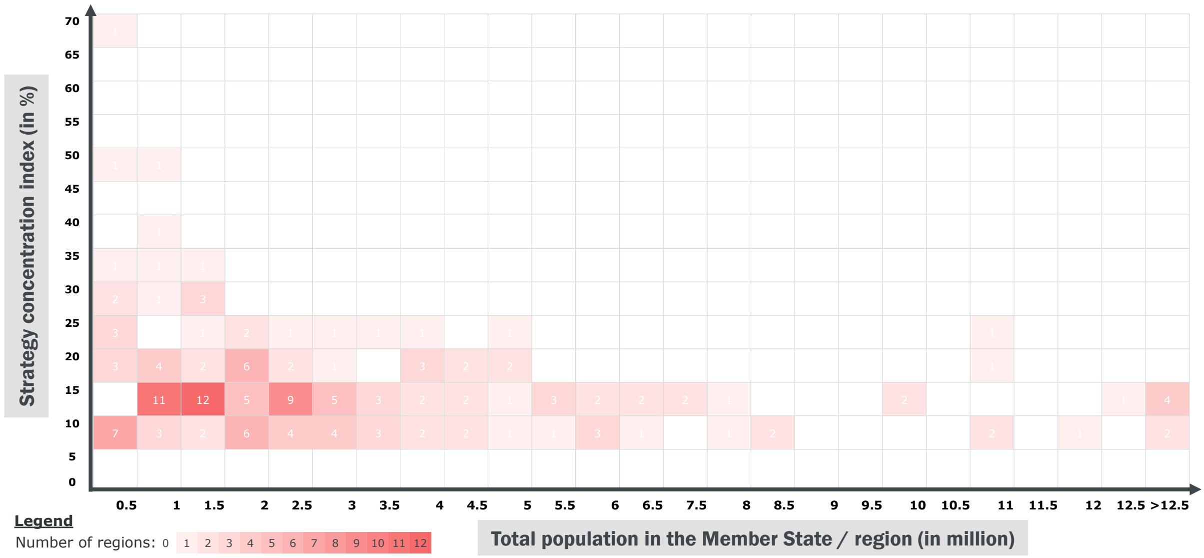
This observation is supported by the fact that there indeed seems to be some positive relation between the population size and the bandwidth index and a negative one with the concentration index (see Figure 9-8). Further analysis shows that a positive and significant (weak) correlation exists between the regions' size and the thematic broadness of the S3 strategies (Pearson correlation =0.14, Spearman correlation = 0.31) and a (weak) negative one for the regions' strategy concentration index (Pearson correlation = -0.16, Spearman correlation = -0.29) (see Table 9-16 in the Annex).

Figure 4-11: Relationship (heatmap) between population size and the S3 bandwidth index and the concentration index (latest strategy year)

Panel a: Bandwidth index



Panel b: Concentration index



Source: Prognos / CSIL (2021). Note: n=165 Member States/regions. Data for Swedish and Finish regions aggregated at the NUTS2 level. Total population is measured by the average population size in the three years preceding the strategy.

Overall, the results show that the number of absolute priorities, as often postulated in the literature, is not the most accurate indicator for measuring the selectivity of a strategy even though in many cases, it already provides a good first indication. However, as for almost all articles of current literature on S3, it is not possible to give a clear indication or benchmark for the optimum number of priority areas.

However, the **analysis on the correlation between the S3 strategies' number of priority areas, their thematic bandwidth and concentration with some regional characteristics** has shown that the granularity and selectivity of S3 strategies seem to be at least partially related to the Member States'/regions' size. Even though further econometric analysis would be needed to confirm a connection, several explanations exist that might explain this effect. On the one hand, prioritisation might be more challenging for larger Member States/regions as they tend to be economically more diversified, which makes it from a political point of view more difficult to focus on only a few sectors. For instance, a very focussed approach in a region with several strong economic sectors might lead to a situation where many stakeholders potentially feel left out and then engage in lobbying activities to nevertheless be included in the strategy. This effect has also been observed by several other researchers (Dziemianowicz and Peszat, 2014; Reimeris, 2016; Gianelle et al., 2019a). On the other hand, these Member States/regions might also possess more strengths and sufficient critical mass for the different topics they want to address. In this case, and in comparison, to smaller Member States/regions, thematically broader strategies do not necessarily show a lack of concentration or resources as recurrent findings in the literature indicate (Gianelle et al., 2019a, 2018; Iacobucci, 2014; Kroll, 2015; Pellegrini and Stefano, 2017). The extent to which the chosen thematic priorities effectively match the Member States'/regions' strengths is therefore analysed in the subsequent Chapter 5.

5 REGIONAL INNOVATION CAPABILITIES & THEIR CORRESPONDENCE WITH S3 PRIORITY AREAS

Overview of key findings

1. **S3 priority areas generally do not match the economic profiles of the Member States/regions** (according to any employment-based indicator used). Where some correspondence is found, Member States/regions seem to have prioritised based on their degree of specialisation relative to the EU28 average, rather than their intra-regional profiles. Some S3 strategies seem to have taken into account ongoing processes of structural fragmentation, by picking priorities in economic sectors characterised by higher employment growth rates. S3

2. **Priority areas of S3 strategies often match the scientific profiles of EU Member States/regions** (regardless of the indicator used to proxy the scientific profiles, based on publication and citation data). However, Member States/regions generally target fields of scientific production, i.e., those characterised by higher shares of publications within the Member States/regions, more than areas of true scientific excellence at the international level.

3. **S3 priorities generally match the technological profiles of Member States/regions** (using regional patent shares as a proxy). Correlations between priorities and technological specialisations relative to the EU average are much lower, indicating that it is easier for Member States/regions to target areas of technological strength in their territory, which do not necessarily correspond to areas of strong specialisation when compared to other EU regions.

4. **Both public and private-sector scientific and technological strengths seem to be reflected quite well in the S3 strategies**. More specifically, correspondence with scientific and technological profiles assessed against publications and patents owned by private companies match S3 priorities slightly better than profiles assessed based on public ones (e.g., universities or governmental authorities), although the difference is small. S3

5. **Several S3 strategies selected priority areas closer to their knowledge space** (as indicated by a positive correlation between S3 priorities and the technological relatedness index). However, there are also Member States/regions that pursued more ambitious strategies, targeting complex technologies, more distant from their current capabilities and aiming at unrelated diversification.

6. **Four groups of S3 strategies emerge when considering the overall correspondence of S3 priorities with the national/regional profiles**[55]:

    a. **61 S3 strategies** *match particularly well* with their **scientific profile** (29%);

    b. **62 S3 strategies** *match particularly well* with their **technological profile** (30%);

    c. **33 S3 strategies** have a *good level* of correspondence with the **economic profile** (16%);

    d. **53 S3 strategies** *do not match well* with **any profile** (scientific, economic, technological), but reveal higher ambition in terms of technological innovation and diversification goals (25%).

7. In addition to the above key findings, it was found that **S3 strategies that achieved a good match with their scientific, technological, and economic profiles generally have more broadly and vaguely defined priority areas, as reflected by the index of S3 concentration and bandwidth**. In contrast, the strategies that show a comparatively lower correspondence with the regional profiles tend to have more narrowly defined strategies and to be more concentrated in terms of priority areas. As further analysis shows, these strategies are generally more ambitious than others: by concentrating focus and resources on less priorities, the correspondence with the existing regional profiles is weaker, because they are probably pursuing goals of diversification and structural transformation.

[55] The total number of S3 strategies considered here is 209, which includes initial and updated strategies. The number of regions for which S3 strategies fulfilling ex-ante conditionality 1.1 have been identified was 185.

Chapter 4 has assessed the prioritisation approach adopted by Member States/regions in their S3 strategies, by examining the degree of granularity and selectivity of the priority areas identified, and the thematic orientation of each strategy. An inherent requirement of the smart specialisation approach is the alignment of the priority areas to the profile and areas of strength of the Member States and regions, with the aim of ensuring concentration on endogenous capacities and fostering innovation, to create new areas of strength and favour upgrading towards higher value-added activities. Striking the right balance between mirroring existing profiles and finding opportunities for diversification is a non-trivial exercise and different Member States/regions may have followed different approaches.

Existing literature in this field does not provide a conclusive assessment as to whether the S3 priorities truly reflect areas of strength at the local level. Empirical studies remind that **the prioritisation exercise should simultaneously account for the economic, scientific, and technological dimensions, but these might not be always aligned** (Schulz, 2019; Krammer, 2017; Smolinski et al., 2015). For example, while some regions might be specialised in the production of certain medium-tech sectors, the activities that they might be performing are not necessarily of high technological content. This creates a mismatch between the productive structure of the economy and its scientific and technological profile. According to an EU-level study by Sörvik and Kleibrink (2015), the chosen S3 priorities somewhat reflect growth in employment, the relative growth of the number of local units, and the absolute number of patent applications. However, the overall relationship between priorities and the economic and innovation structure is weak.

Foray, David, and Hall (2011) show how the economic, technological, and scientific profiles could be reflected and interpreted in a different way by the S3 prioritisation exercise. For instance, some Member States/regions may choose to focus their S3 priorities on traditional sectors (characterised by limited scientific and technological strengths) and on present locomotives (i.e., sectors with high employment level). This approach may testify to a limited search for areas of diversification, but it could also underly a strategy of modernisation, strengthening of the knowledge-driven growth potential and, perhaps, technological upgrade. Conversely, some priorities may strongly reflect areas of scientific and technological strengths, which however do not find large utilisation in the existing economic structure. The imperfect correspondence between the S3 priorities and the economic structure may be linked to a strategy of promoting radical innovation and search for new markets niches and emerging sectors.

The **objective of this section** is to determine whether and to what extent the priorities selected in the S3 strategies mirror the profiles of the regions, in terms of their economic, scientific, and the technological structures and areas of strength. This section aims at answering the following set of **research questions**:

- How does the prioritisation reflect the current economic structure of the region? How does it reflect ongoing changes and future developments of the economic structure?
- How does the prioritisation reflect the scientific strengths of the region? How have scientific strengths been assessed (based on public institutions only or including private organisations/research capacity of business)?
- How does the prioritisation reflect the technological strengths of the region? How have technological strengths been assessed (based on business capacities only or including public institutions)?
- To what extent does the prioritisation address issues such as diversification, specialisation and related variety?
- How was the information on the economic structure, scientific strengths and technological strengths combined in the overall strategy? Which rationale (economic, scientific, or technological) prevailed, i.e., better explains the chosen set of priorities? Are there common traits among Member States/regions that allow categorising their heterogeneous experiences?

To answer these questions, correlation, and econometric analyses (linear regression models) were performed on a rich database that gathers indicators on the economic, scientific, and technological profiles and specialisations of Member States/regions. Through these analytical tools, Member States/regions' profiles and specialisations were compared to the lists of economic sectors, scientific and technological fields of the S3 strategies to assess their degree of correspondence with existing endogenous capacities (for more details on the methodology underpinning this analysis, see Section 2.1.4 and Annex 9 – Section 9.3). The data used to proxy the three profiles are: employment data for the economic profiles, publication data for the scientific profiles, and patent data for the technological profiles (see Annex 9.3.1 on data sources and definitions of all indicators used in the analysis).

This Chapter is structured along the research questions above, as follows: first, Section 5.1 provides a general answer on the prevailing rationale behind the S3 prioritisation approach; the subsequent Sections 5.2-5.4 provide more details on how the prioritisation reflects the economic, scientific, and technological strengths of the Member States and regions. Section 5.5 investigates the level of technological relatedness and complexity in the S3. Finally, Section 5.6 combines information on the economic, scientific, and technological strengths and identifies groups of strategies that show similar results of correspondence. The specific research questions answered in each of the following sections are spelled out.

5.1 Rationales behind S3 prioritisation approaches

RQ: Which rationale (economic, scientific, or technological) prevailed, i.e., better explains the chosen set of priorities?

Overall, priorities reflect scientific and technological profiles better than they do with economic profiles (see Figure 5-1 and Table 5-1). This is an interesting finding, especially because strategies are mostly defined in economic terms, i.e., linked to economic sectors as shown in Section 4.2. These two findings indicate that, although in defining strategies Member States/regions had economic sectors in mind, the economic sectors chosen do not seem to match their profiles and specialisations. This might be due to a plethora of reasons, related for example to copycat behaviours that did not consider endogenous capacities or rather to ambitions to develop new sectors. A stronger correspondence between the S3 priorities and the scientific and technological capabilities of the Member States/regions may indicate that the strategy aims at affecting the most knowledge or technology intensive sectors of the economy, or to trigger a knowledge or technological upgrade process which could eventually lead to the emergence of new market niches or fuel a process of economic structural transformation.

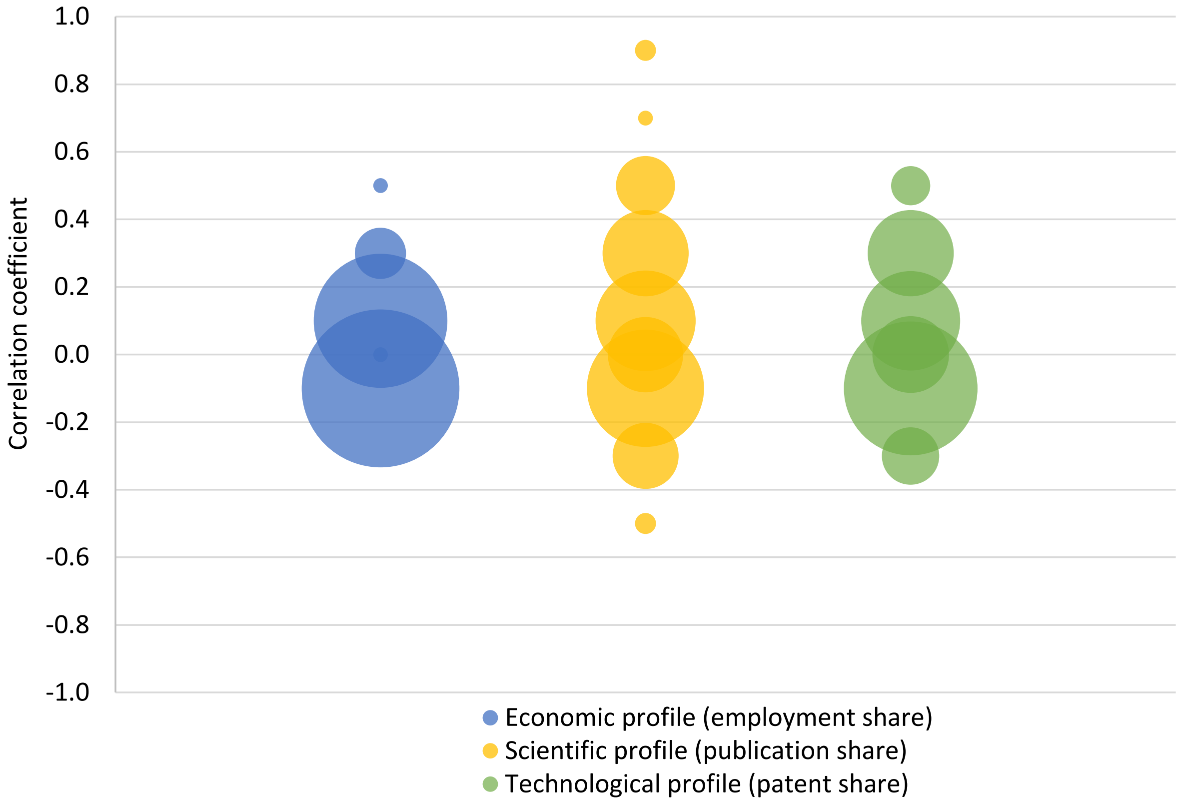
These results should also be interpreted in the light of the data and indicators used in our correlation analysis, which may not be the same as those analysed in the phase of design of the strategy. Case studies have evidenced that often Member States/regions have used different or more granular data and indicators to identify their areas of strengths, compared to those deployed in this study (see Box 5-1).[56]

Figure 5-1 shows the distributions of the correlation coefficients for economic, scientific, and technological profiles where economic profiles are captured by employment shares, scientific profiles by publication shares, and technological profiles by patent shares. The size of the bubble represents the number of strategies having a certain correlation coefficient on the three profiles. As the figure shows, the correlation coefficients for economic profiles are much closer to zero than the coefficients for scientific and technological profiles. For the latter two profiles, the maximum values of the correlation

[56] As explained in Section 2.1.4, the comparative nature of this study, and the necessity to tap into widely available data which are disaggregated at 2-digit NACE levels and up to NUTS 2 levels has limited our choice of data and indicators.

coefficients are also much higher, albeit fewer strategies achieve such high levels of correlation.

Figure 5-1: Economic, scientific, and technological correspondences at a glance



Source: Prognos / CSIL (2021). Note: The bubble's size is proportional to the number of S3 strategies with a given level of correlation coefficient (identified on the vertical axis). A correlation coefficient higher than 0 indicates a positive correspondence between the S3 priority areas and the Member State/regional profile. Conversely, a correlation coefficient lower than 0 indicates a negative correspondence between the S3 priority areas and the Member State/regional profile. The higher the coefficient in absolute terms (i.e., the closer it is to 1 or -1), the stronger the positive or negative correspondence.

The correlation coefficients computed on the lists of priorities and the economic, scientific, and technological profiles of the EU Member States/ regions are presented in Table 5-1. As detailed in Section 2.1.4 and Annex 9.3.1, a variety of indicators were deployed to proxy the profiles and specialisations of EU Member States/regions. The two most important of them are **shares and location quotients**. The difference between these two indicators is straightforward: shares (i.e., sectoral employment shares, publication shares in the different FOR, and patent shares in each technology class) look at the internal structure of a Member States/region, while location quotients (LQ) are measures of specialisations and therefore are relative measures that be used to compare Member States/regions. [57] As the Table shows, the correlation coefficients obtained for all the variables capturing economic profiles are consistently lower than those obtained on the technological and scientific profile. The latter presents the largest correlation coefficients, indicating a higher correspondence between priorities and scientific profiles.

[57] For example, the employment LQ is computed as the level of employment in a Member State/region and in a sector over the total employment in the same sector in the EU28. A LQ equal to 1 means that the Member State/region is not specialised in that sector. A LQ equal to 2 means that the share of employment in the given region and sector is 100% bigger than the share of employment in that NACE sector in the EU28, hence the Member State/region is specialised in that sector.

Table 5-1: Descriptive statistics of the correlation coefficients for economic, scientific, and technological profiles

Variable	Mean	Median	Min	Max	Standard Deviation
Economic profile					
Employment share	0.01	-0.01	-0.14	0.48	0.10
Pre-S3 employment growth	0.02	0.03	-0.52	0.26	0.11
Post-S3 employment growth	0.02	0.03	-0.42	0.29	0.12
Employment LQ vs EU	0.06	0.03	-0.20	0.62	0.13
Scientific profile					
Publication share	0.30	0.32	-0.23	0.82	0.21
Publication LQ vs EU	0.16	0.18	-0.50	0.96	0.27
Excellence Top 10	0.15	0.12	-0.32	0.94	0.24
Excellence Top 25	0.18	0.16	-0.32	0.97	0.24
Relative excellence 10%	0.19	0.19	-0.52	0.94	0.28
Relative excellence 25%	0.18	0.18	-0.51	0.98	0.29
Technological profile					
Patent share	0.25	0.21	-0.18	0.86	0.23
Patent LQ vs EU	0.04	0.00	-0.35	0.57	0.19
Technological relatedness	0.10	0.11	-0.37	0.62	0.21
Technological complexity	0.20	0.24	-0.26	0.57	0.20
Technological ambition	0.08	0.07	-0.54	0.55	0.22

Source: Prognos / CSIL (2021).

5.2 Correspondence of S3 priorities with economic profiles

RQ: How does the prioritisation reflect the current economic structure of the region?

In our analysis, S3 strategies generally do not match the economic profiles of the Member States/regions (regardless of the indicator used). The average correlation coefficient between priorities and sectoral employment shares[58] is close to zero, while a slightly higher correlation coefficient (0.06) is found when looking at sectoral specialisations as measured by location quotients (see Map 5-1).[59] In other words, a slightly better correspondence is found when looking at sectoral specialisations, compared to sectoral employment shares. Several factors could justify this finding. Labour intensities might be one of them: by looking at relative employment structures, the location quotient wipes away the effect of labour intensities. Another important factor could explain our results and should be born in mind. The correspondence with the economic performance can be assessed only with employment data since this is the only available at the desired level of granularity (NUTS 2 and economic sectors at 2-digit disaggregation). However, regional, and national authorities may have also used other variables to assess their economic performance, such as value-added, exports, or business turnover data. In principle, it is possible that some strategies, which display a limited correspondence with employment data, would reveal a better correspondence with the regional economic profile if measured with different variables (see Box 5-1).

Regression results shown in Annex 9.3.2 confirm that S3 priorities classified according to the economic classification do not match the economic profiles as captured by sectoral employment shares and LQs (Table 9-20 in Annex 9). Unobserved fixed effects, which could be related to the strategic value of an economic activity, play a more important role in this regard.

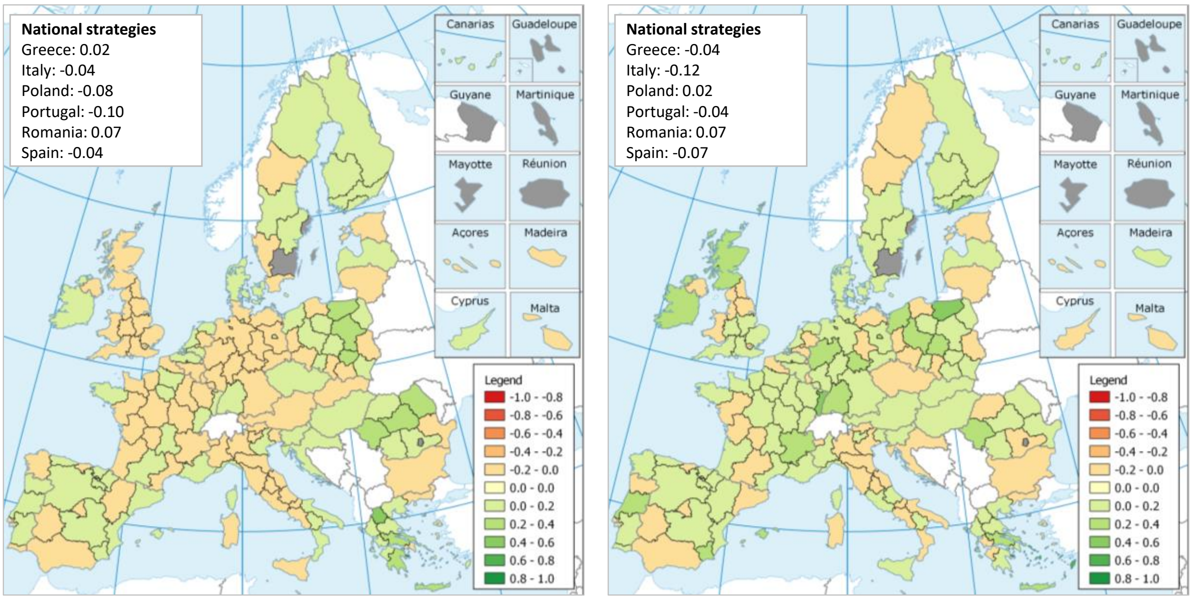
Map 5-1 gives a snapshot of the correlation coefficients of S3 strategies across EU Member States/regions. Among the regions with a better correspondence with the sectoral employment shares (Panel a), we find various Greek regions that prioritised agro-food and

[58] I.e., shares of employment across different NACE sectors in each Member State or region.
[59] As previously explained, location quotients are an indicator of economic specialisation of an area against the EU28 average.

tourism, sectors that employ large shares of their populations. For example, the Greek region of Western Macedonia (see Annex 9.6 on the case studies) selected four priority areas, three of which are established sectors that constitute the backbone of its economy. Various Romanian S3 strategies, including the national one, also mirror particularly well the economic profile as captured by sectoral employment shares. Similarly, regions in Poland show a relatively good match in Map 5-1 below, suggesting that economic profiles might have guided the process of prioritisation. As a matter of fact, **the regions that best match economic profiles are mostly transition and less developed regions.**

Map 5-1: Correlation coefficients between S3 priorities and economic profiles and areas of relative strength

Panel a: Employment share | Panel b: Employment Location Quotient vs. EU



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data. Correlation indexes were computed for both initial and revised strategies, at their corresponding geographical level (NUTS 0, NUTS 1 or NUTS 2). 30 strategies in Sweden and Finland cover NUTS 3 level regions. Priorities defined at NUTS 3 level have been aggregated at the NUTS 2 level because of missing data at 3-digit level.

Despite the prevalence of less developed regions, among the regions that best matched their economic profile we also find the German region of Baden Wurttemberg, a wealthy advanced region with a clear specialisation in sectors such as automotive, machinery and equipment, ICTs, and software in particular. The strategy of Baden Wurttemberg not only conforms with its economic profile, but also with its international specialisation as measured by the location quotient (LQ) computed with respect to the EU. This means that the priorities chosen by this region target the sectors where the region has (already) an advantage at the EU level. Indeed, various German regions (including Berlin, Hamburg, and North Rhine-Westphalia) do not match too well their economic profile in terms of sectoral employment shares, while they match their economic specialisations as measured by location quotients (Map 5-1). This might have to do with the fact that German regions are likely to have much higher LQs compared to other EU Member States/regions. Confirming this intuition, we find that other advanced countries such as France, the UK, Ireland, and Denmark match much better their relative specialisation in the EU than their economic profiles as measured by sectoral employment shares. Some transition and less developed regions, which have highly concentrated economic structures, also show a good correspondence between priorities and economic specialisations. These include the touristic regions of Greece (e.g., South Aegean and Crete), the Illes Balears (Spain), and some Polish regions (e.g., Warmińsko-Mazurskie and Zachodniopomorskie).

Box 5-1: Data and methodologies to account for endogenous capacities: evidence from the case studies

i

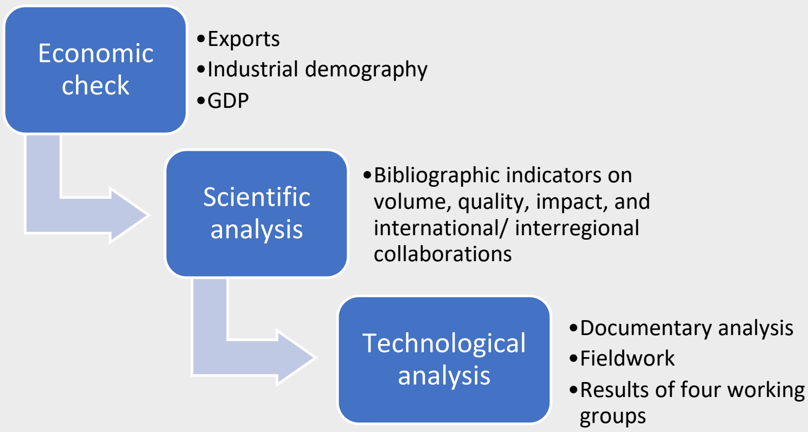
Slovenia – A rich and fine-grained analysis up to the company level

The key objectives of the Slovenian S3 strategy are fostering productivity growth, spur exports, and attract foreign investments. The strategy of Slovenia does not show a high correspondence with its economic profile in our analysis, but a great deal of analytical work went into the process of selection of priority areas. This process involved an analysis of a huge variety of data including highly disaggregated indicators on firms' turnover and exports, value-added and new entrepreneurial activities. Additionally, R&D intensities by branches, shares of employed researchers in enterprises of a certain branch and other firm-level indicators on R&D expenditures were also included in this analysis.

Castilla y León - Multi-dimensional and multi-step analysis

The strategy of Castilla y León was developed with the aim of offering reliable strategic patterns of development for the local community. To do so, Castilla y León took into great consideration economic, scientific, and technological indicators following a "cascade" approach as outlined in Figure 5-2. The analytical work that led to the adoption of the S3 strategy also included a correlation analysis (for each priority) between the economic, scientific, and technological dimensions. The selected S3 priorities, although quite broadly defined, were found to be highly or moderately correlated with the economic, scientific, and technological specialization.

Figure 5-2. The approach of Castilla y León to design its S3 in accordance with its endogenous capacities



Source: Prognos/CSIL (2021) based on findings from case study.

Source: Prognos / CSIL (2021).

RQ: How does the prioritisation reflect ongoing changes and future developments of the economic structure?

This research question looks at whether Members States/regions took into account the structural transformation processes that their economies are undergoing. To account for these ongoing changes and future developments, growth rates of the sectoral employment are computed and used in the correlation and econometric analyses (presented in Annex 9.3.2). This analysis, therefore, allows investigating to what extent growing sectors were included in the lists of S3 priority areas.

Results of the correlation analysis indicate that while few regions stand out for prioritising current economic structures, slightly more chose priorities in line with sectors in transformation, as measured by growth rates of employment in the three years before or after the publication of the S3 strategy (Map 5-2). This indicates that, at least to some extent, **S3 strategies considered the processes of structural transformation** (Table 5-1 and Map 5-2). The degree of correspondence, however, does not come close to the levels that we observe for scientific and technological profiles.

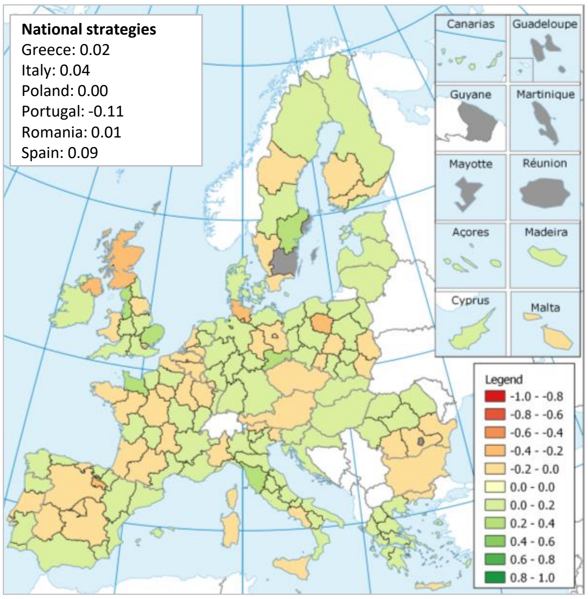
Regression analysis (see Annex 9.3.2) indicates that employment developments taking place *after* the S3 publication are better reflected in the priorities, compared to employment changes occurring in the years *before* the S3 publication. These results, however, are not statistically significant when unobserved Member States/regional-sectoral fixed effects are controlled for. This ultimately suggests that other (unobserved) drivers and considerations were more important than employment dynamics to select priority areas.

When we move away from the aggregate picture, Comunidad de Madrid (Spain), North-West England (UK), Saxony (Germany), and Tuscany (Italy) are the regions with the highest correlation coefficient between priorities and employment growth rates in the three years *before* the S3 publication. It means that these strategies reflected exceptional well the transformation processes in course during the phases of preparation of the S3 strategy. When we look at how S3 strategies reflected *future* economic developments, some French regions (Corse, Basse-Normandie, and Franche-Comté), but also Sicily and Friuli-Venezia Giulia (Italy), Cyprus, País Vasco (Spain), and Austria understood and captured well future economic developments as proxied by employment growth in the three years *after* the S3 publication.

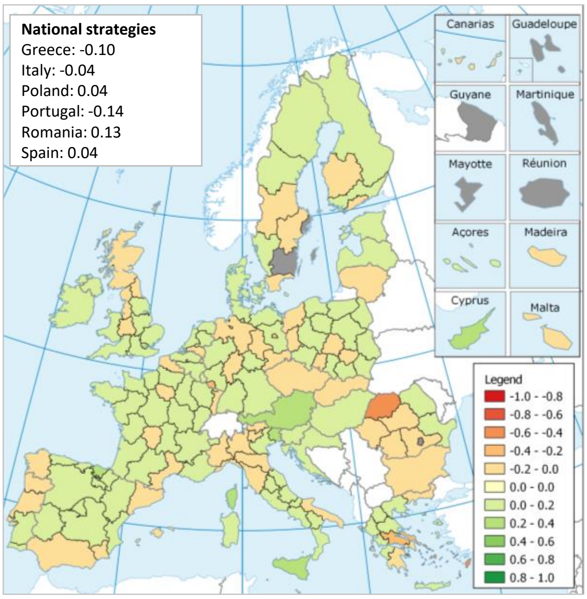
Interestingly, some of the strategies that better reflect ongoing and future changes of their economic structures negatively match the (static) economic profiles proxied by the sectoral employment shares analysed before in this section. This suggests that these regions and Member States might be experiencing important transformative processes of their economic structures which were deemed relevant in the prioritisation exercise. The strategies that followed this approach include those from the region Basse-Normandie (France); Mecklenburg-West Pomerania and North Rhine-Westphalia in Germany; Abruzzo, Marche, and Lombardy in Italy; and Małopolskie and Dolnośląskie in Poland. On the opposite side of the spectrum, we find strategies that seem anchored to their economic structures and less prone to reflect processes of structural transformation. Regions in Romania (Sud-Vest Oltenia and Sud Muntenia/South Muntenia), as well as Łódzkie and Opolskie in Poland, and Liguria in Italy followed this approach.

Map 5-2: Correlation coefficients between S3 priorities and changes in economic structures

Panel a: Pre-S3 employment growth



Panel b: Post-S3 employment growth



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

5.3 Correspondence of S3 priorities with scientific profiles

RQ: How does the prioritisation reflect the scientific strengths of the region?

Based on our analysis, S3 priorities match well the scientific profiles of EU Member States/regions (see Table 5-1 and Map 5-3Map 5-3).[60] The correlation coefficients between S3 priority areas and the share of publications in the different fields of research is the highest among all correlation coefficients, meaning that on average this is the best match that we observe in our data.

With correlation coefficients of 0.82, the initial strategies of the Italian region Marche and Luxembourg match almost perfectly their scientific profiles. This means that these strategies are especially focused on areas of scientific specialisation, i.e., on fields where the Member State/region has the largest share of publications. Other regions whose strategies match extraordinarily well the scientific profiles include several French regions (e.g., Lorraine, Picardie, Alsace, and Poitou-Charentes)[61], but also Swedish, Polish, Romanian, and Portuguese regions. In the case of Picardie, for example, since the 1980s RDI policies have traditionally put great emphasis on science and higher education, benefiting from a trans-partisan political support towards science and a permanent dialogue with regional universities. The region's intervention logic, therefore, was that R&D support would eventually lead to innovation and indirectly to economic impacts. Romania’s national S3 strategy is another case in point: with a private sector characterised by limited innovation capacities, large presence of multinational companies, and limited trust and

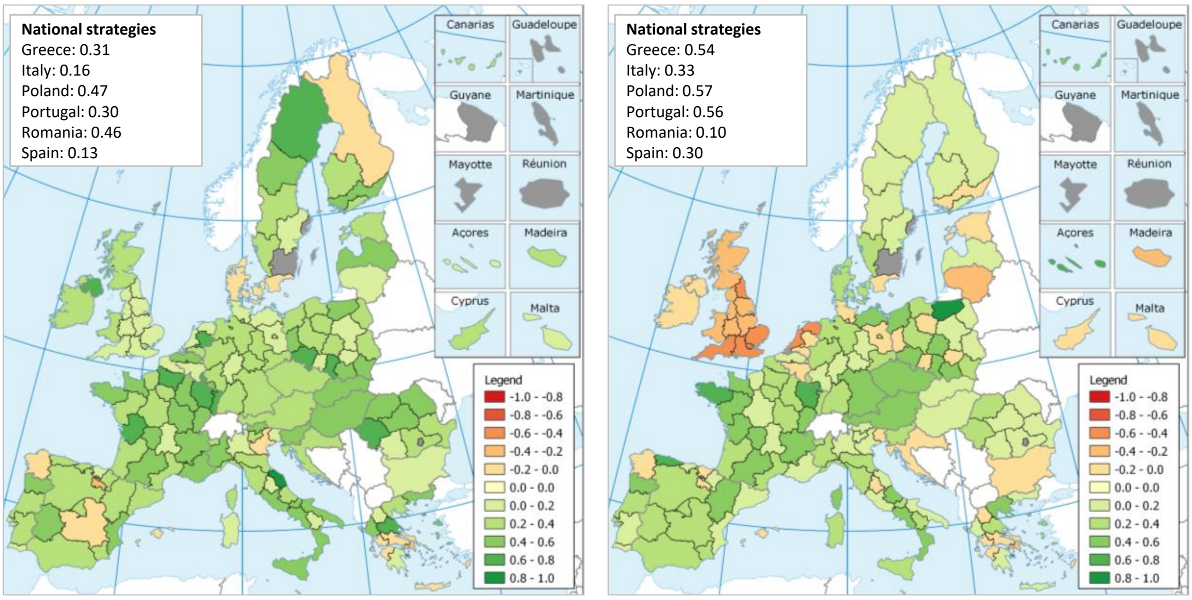
[60] The range of indicators that this task explored to shed light on this aspect is much larger than those provided for the other profiles. This is due to the richness of the data available and allows to look at this issue under multiple points of view.
[61] In these regions, universities are quite influential.

participation in the design and implementation of public policies, the S3 strategy of Romania became focussed on scientific research.[62]

As these examples and Map 5-3 shows, regions with the best match between priorities and scientific profiles include more as well as less developed regions, old and new Member States, and Member States/regions classified as Innovation leaders as well as strong, moderate, and modest innovators (according to the European Regional Innovation Scoreboard, 2017).

Map 5-3: Correlation coefficients between S3 priorities and scientific profiles as proxied by publication shares and publication location quotients vs EU

Panel a: Publication share   Panel b : Publication Location Quotient vs. EU



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

S3 strategies could match profiles or areas of relative specialisation as measured by **location quotients of publications** computed with respect to the EU. When we match priority shares with location quotients obtained from publication data, we see that the correlations remain good, albeit on average much smaller than the correlation coefficients observed with publication shares.[63] These results indicate that **not all the regions that match scientific regional profiles match equally well scientific specialisations**. Clear examples in this regard are the UK and Ireland. The latter, for instance, has several publications in fields such as Creative Arts and Writing, Education, and Philosophy and Religious Studies which (perhaps for obvious reasons) are not targeted by their S3 strategy. Many French strategies (e.g., those of Bretagne, Lorraine, and Rhône-Alpes), as well as Polish ones (the national strategies as well as the regional strategies of Dolnośląskie, Małopolskie, and Śląskie) stand out for matching well both publication shares

[62] While some measures were adopted to counterbalance this, these were largely ineffective in properly involving the private sector both at the national and regional levels. For more information, see the case study.
[63] This result might be due to a variety of factors. While regions might have publications in certain areas, achieving specialisation at the EU level is more difficult, thereby making correspondence more difficult to achieve. Small numbers of publications might also drive results: a region that has few publications overall, might seem specialised in terms of publication shares, but those number will probably be not high enough to make a difference at the EU level. Finally, being relative measures, location quotients could also wipe out the effect of different publication propensities across fields of research.

(i.e., the regions' areas of strengths) and location quotients (i.e., the areas of scientific specialisation as compared to the EU average).

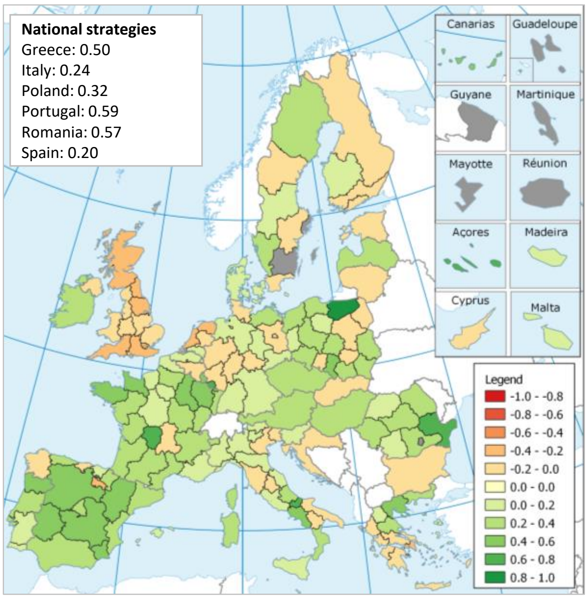
Producing many scientific publications is not necessarily a sign of scientific strength. The quality of these publications is also an important factor. When we look at the 10% and 25% of most-cited publications worldwide, we notice that strategies reflect areas of scientific excellence, at least to some extent (Table 5-1 and Map 5-4). Correlation coefficients between priority areas and fields of research with a high number of citations are on average much lower compared to correlation coefficients between priority areas and publication shares (Table 5-1). This suggests that it was **easier for the Member States/regions to identify and target areas of scientific production than areas of scientific excellence**.

In several cases, this mismatch is created by scientific fields related to humanities and social sciences (as evidenced also before), or fields of basic/fundamental research such as Physical sciences, Mathematical Sciences, and Earth sciences. As with humanities, these fields might be less suitable candidates for a S3 strategy. Member States/regions that boast excellent scientific performance in these fields include Croatia, Slovakia, the French region of Centre and the German region of North Rhine-Westphalia. All their strategies are characterised by a positive and relatively high correlation coefficient between priorities and publication shares, and a negative correlation coefficient between priorities and excellence indicators.

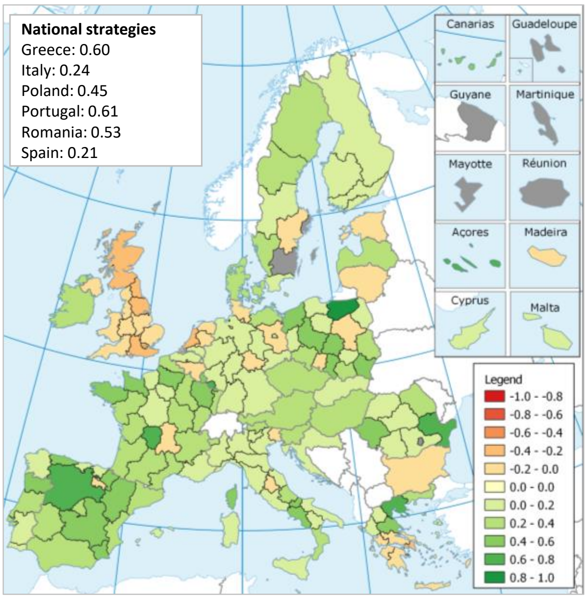
Other strategies that reflect well publication shares but do not mirror their areas of scientific excellence include those of East Netherlands (the Netherlands), Hamburg (Germany), Lubuskie (Poland), Comunidad Foral de Navarra (Spain), and Apulia (Italy).

Map 5-4: Correlation coefficients between S3 priorities and scientific excellence

Panel a: Scientific excellence top 10%



Panel b: Scientific excellence top 25%



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

The concept of scientific excellence can also be looked at in relative terms. By comparing the areas of excellence of a certain Member State/region to that of the EU, we can take into account if a certain Member State/region produced higher-quality publications than others in a certain field. We can compute this new indicator of scientific excellence using either the 10% or 25% thresholds as before. Results by and large confirm the findings from the previous indicators.[64]

As we did with employment indicators, we verified the robustness of our findings from the correlation analysis by means of regression analysis. Results from this econometric exercise are reported in Annex 9.3.2). They show that prioritisation in S3 strategies has considered scientific profiles at least to some extent, but other variables (related to unobserved characteristics of the scientific system in a certain field and member State/region) played a more important role. These characteristics might relate, for example, to the number of researchers or university professors in a certain field of research, to the specialisation of local universities and research centres in certain scientific fields, or to different propensities to publish in different fields of research (see Annex 9.3.2 for the econometric results).

RQ: How have scientific strengths been assessed (based on public institutions only or including private organisations/research capacity of business)?

The smart specialisation approach promotes a bottom-up approach to policymaking and the involvement of a wide variety of stakeholders, including firms and other private organisations. The research question that we tackle here aims at understanding the degree to which the prioritisation processes accounted for strengths gained within public as well as private institutions. To shed light on this aspect, two additional indicators are computed: the share of publications produced by firms (referred to as "publication share – private") and the share of publications produced within public institutions ("publication share – public").

Table 5-2 reports the correlation coefficients between these two indicators and the lists of priority areas and compares them with the overall correlation coefficient computed on the total number of publications as shown in the analysis before. As the table shows, the distributions of the three indicators (i.e., publication share, publication share – public, and publication share – private) are very similar, albeit publications by private organisations match S3 priorities in a slightly better way. This is a rather interesting finding: according to the dataset of publications used in this study, the vast majority of the publications across all EU Member States/regions and fields of research are produced by the public sector.[65] **Despite being less in number, publications by private institutions (i.e., firms) show a slightly better correspondence with the list of S3 priorities**. This provides an indication of the relevance of both the public sector and firms' scientific capacities in the context of S3 strategies.

This result is confirmed when we look at the indicators of scientific excellence (excellence top 10% and excellence top 25%). S3 strategies match areas of scientific excellence in the private sector slightly better than they do for areas of public scientific excellence.

Table 5-2: Descriptive statistics on the correlation coefficients between S3 priorities and the scientific public and private profiles, specialisations, and areas of excellence

Variables	Mean	Median	Min	Max	Standard Deviation
Scientific production					
Publication share	0.30	0.32	-0.23	0.82	0.21
Publication share – public	0.30	0.31	-0.23	0.82	0.21
Publication share – private	0.34	0.34	-0.22	0.92	0.29
Publication LQ vs EU	0.16	0.18	-0.50	0.96	0.27
Publication LQ vs EU – public	0.17	0.19	-0.49	0.96	0.27
Publication LQ vs EU – private	0.09	0.01	-0.38	0.75	0.21

[64] Detailed results of this analysis are not presented here, but available upon request.
[65] This explains why the distributions of the correlation coefficients computed with total publications and public publications are identical (see Table 5-2).

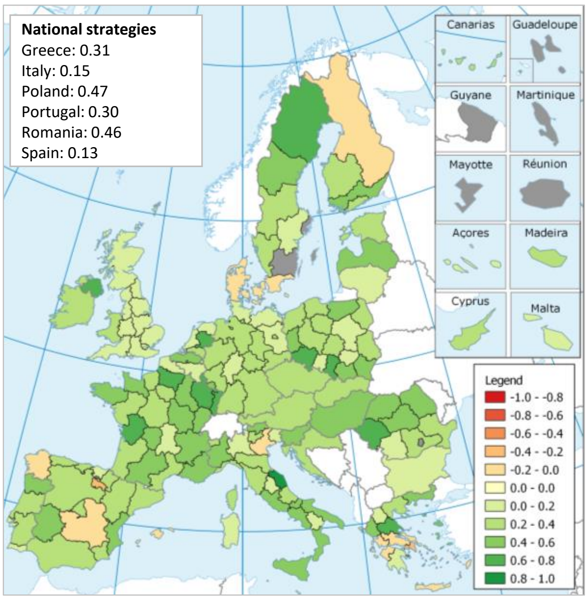
Scientific excellence					
Excellence Top 10%	0.15	0.12	-0.32	0.94	0.24
Excellence Top 10% - public	0.15	0.11	-0.32	0.94	0.24
Excellence Top 10% - private	0.22	0.13	-0.24	0.90	0.26
Excellence Top 25%	0.18	0.16	-0.32	0.97	0.24
Excellence Top 25% - public	0.18	0.15	-0.31	0.97	0.24
Excellence Top 25% - private	0.25	0.22	-0.33	0.91	0.28
Relative excellence Top 10%	0.19	0.19	-0.52	0.94	0.28
Relative excellence Top 10% - public	0.19	0.19	-0.52	0.94	0.29
Relative excellence Top 10% - private	0.11	0.00	-0.24	0.88	0.22
Relative excellence Top 25%	0.18	0.18	-0.51	0.98	0.29
Relative excellence Top 25% - public	0.19	0.18	-0.51	0.98	0.29
Relative excellence Top 25% - private	0.10	0.01	-0.31	0.87	0.22

Source: Prognos / CSIL (2021).

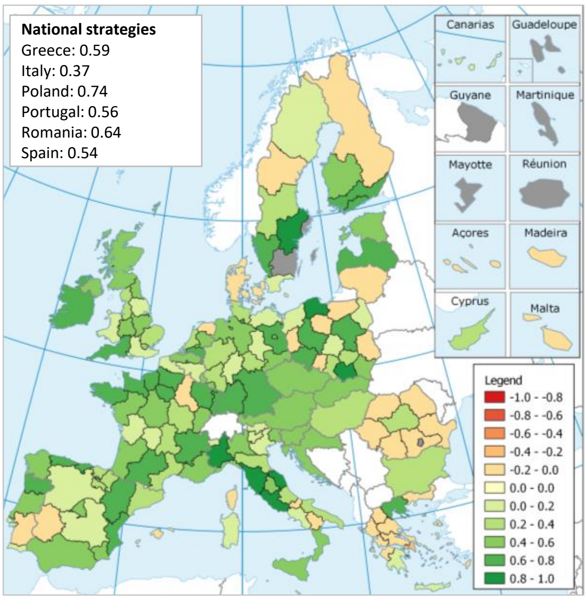
When we move away from averages and distributions to analyse single S3 strategies, interesting stories emerge. While on average strategies match better the publication profile of the private compared to the public sector, 61 strategies match better their public scientific profile, i.e., profiles as emerging from publications authored by public institutions. These strategies are mostly from less developed and transition regions and Member States, also classified as moderate or modest innovators in the European Regional Innovation Scoreboard (2017). These include, for example, various regions in Greece (e.g., Thessaly, Epirus, and Eastern Macedonia and Thrace), Romania (Nord-Vest and Nord -Est), and Spain (Comunidad Foral de Navarra and Extremadura). Among the regions that best mirrored their private scientific profiles, instead, we find extremely high matches, such as those of Małopolskie in Poland (0.92) and Tuscany in Italy (0.9), together with other Italian regions including Lazio, Marche, and Piedmont and also Lorraine and Haute-Normandie in France and Bavaria in Germany.

Map 5-5: Correlation coefficients between S3 priorities and the scientific profiles (publication shares) of public and private organisations

Panel a: Publication share – Public



Panel b: Publication share – Private



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

5.4 Correspondence of S3 priorities with technological profiles

RQ: How does the prioritisation reflect the technological strengths of the region?

S3 priorities match relatively well technological profiles of Member States/regions as proxied by patent shares across the different technological fields.

Most of the regions that better reflected their technological profile in the S3 are more developed Member States/regions, also classified as innovation leaders or strong innovators according to the Regional Innovation Scoreboard (2017). Provence-Alpes-Côte d'Azur (France), Berlin, London, Pohjois-ja Itä-Suomi (Finland), and Ireland achieved the best matches between their priorities and their technological profiles, with correlation coefficients above 0.7. These are also the regions that better match their areas of technological specialisation, as proxied by the location quotients computed between patent shares of the Member States/regions relative to the patent shares of the EU.

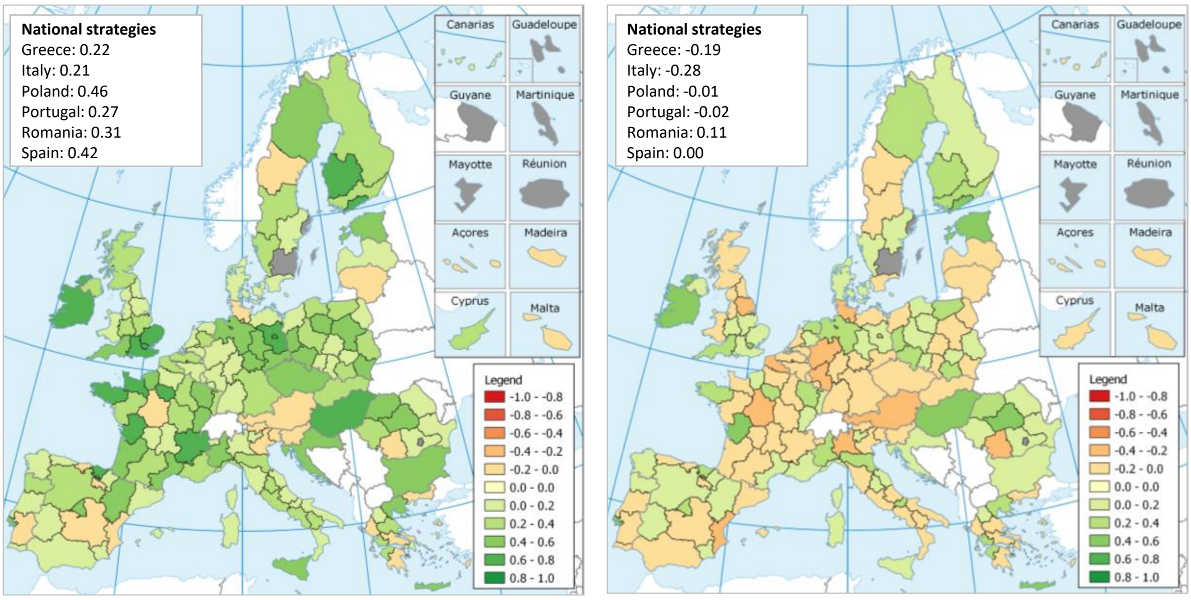
A few less developed and transition regions also stand out for a particularly high correlation coefficient between priorities and technological profiles. Hungary and the Romanian region of Centre are two of the most prominent examples. Estonia is another case in point: with three priorities centred around the fields of resources, health, and ICTs, the strategy achieves a correlation coefficient of 0.6 with patent shares and 0.5 with location quotients.

As Map 5-6 shows, Member States/regions with a particularly low match between priorities and technological profiles and specialisations (as accounted for by patent shares and LQs, respectively) are found among more and less developed Member States/regions, as well as strong, moderate, and modest innovators. Examples include the Lithuanian, Slovenian, Austrian, and Maltese strategies, as well as a bunch of regional strategies such as those of Mellersta Norrland (Sweden), Cantabria (Spain), and Schleswig Holstein (Germany).

Map 5-6: Correlation coefficients between S3 priorities and technological profiles as proxied by patent shares and location quotients with respect to the EU

Panel a: Patent share

Panel b : Patent Location Quotient vs. EU



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

As we did for the economic and scientific profiles, we performed an econometric analysis to verify the solidity of our findings from the correlation analysis. Econometric evidence is particularly suited for this objective because it allows to control for possible confounding factors that correlation analysis disregards. The specific model estimated, and the results of this econometric analysis are detailed in Annex 9.3.2. Overall, results indicate that technological profiles are not significant predictors of priority areas in S3 strategies. Member States/regional – technology fixed effects, which might relate for example to the different propensities to patent in different technological fields, play a much greater role. These findings are consistent with that we found for the economic and scientific profiles, thereby pointing to a more comprehensive (and perhaps strategic) analysis of potential priority areas which goes beyond the analysis of endogenous capacities.

RQ: How have technological strengths been assessed (based on business capacities only or including public institutions)?

As argued for scientific strengths, a key question of this study concerns the degree to which both public *and* private technological capacities were reflected in the prioritisation exercise. The involvement of the private sector is a key element of the S3 approach and its EDP. To tackle this question, we distinguish between patents applications filed by public institutions and patent applications filed by private institutions and compute the shares for each of these categories. Using these additional indicators, we computed new correlation coefficients, reported in Table 5-3 under "Patent share – public" and "Patent share – private", respectively.

In line with what observed for scientific profiles, strategies seem to reflect better private technological profiles and strengths than public ones, even if the difference is not particularly high (Table 5-3). Therefore, because most of the patents are owned by private organisations, the overall correspondence of S3 strategies with the technological profiles of the Member States/regions is relatively good.

Table 5-3: Descriptive statistics on the correspondence with the technological public and private profiles and areas of specialisations

Variables	Mean	Median	Min	Max	Standard Deviation
Patent share	0.25	0.21	-0.18	0.86	0.23
Patent share – public	0.14	0.13	-0.23	0.62	0.20
Patent share – private	0.23	0.20	-0.22	0.84	0.23
Location quotient	0.04	0.00	-0.35	0.57	0.19
Location quotient – public	0.03	0.00	-0.30	0.59	0.16
Location quotient – private	0.04	0.01	-0.37	0.58	0.19

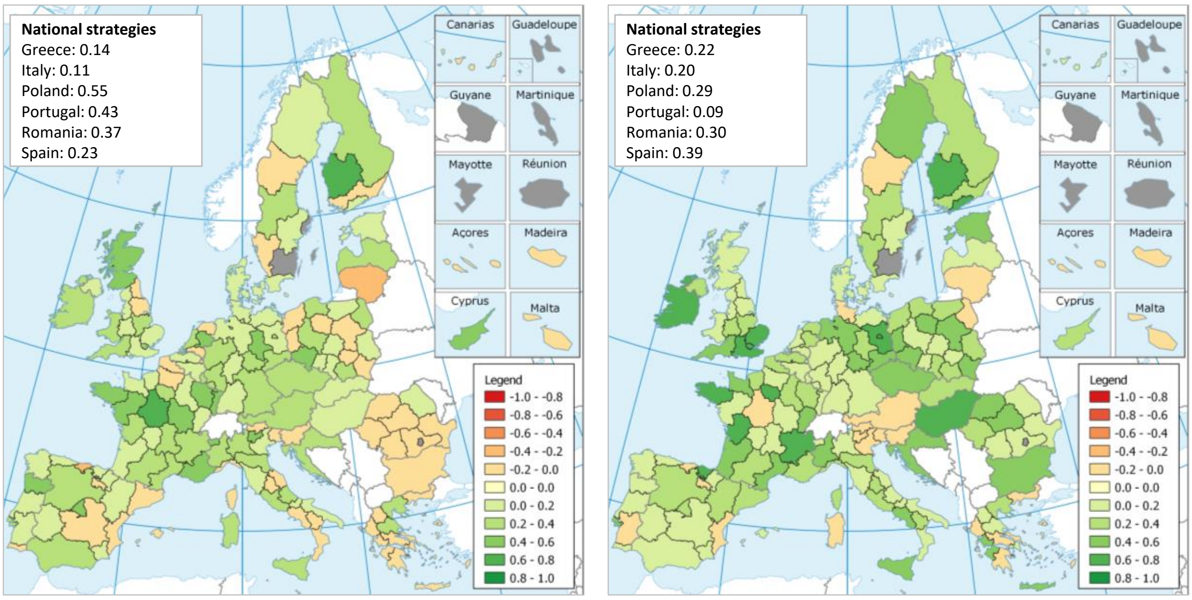
Source: Prognos / CSIL (2021).

Map 5-7 shows the regions that better reflected the technological profiles of private institutions compared to those that reflected public technological profiles. As expected, few regions matched better the public compared to private technological competencies. The Italian region of Sardinia is one of these: with limited private capacities and a weak private sector overall, this result can be considered unsurprising. Other cases include Austria, which was highlighted above as a case of a poor match between priorities and technological profiles, and thus providing a tentative explanation for this result. A similar story can be told for other strong innovators or innovation Leaders, such as the French region Centre or West Netherlands.

Map 5-7: Correlation coefficients between S3 priorities and technological profiles (patent shares) of public and private organisations

Panel a: Patent share – Public

Panel b: Patent share – Private



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

5.5 Strategies' orientations: diversification, complexity, and ambition

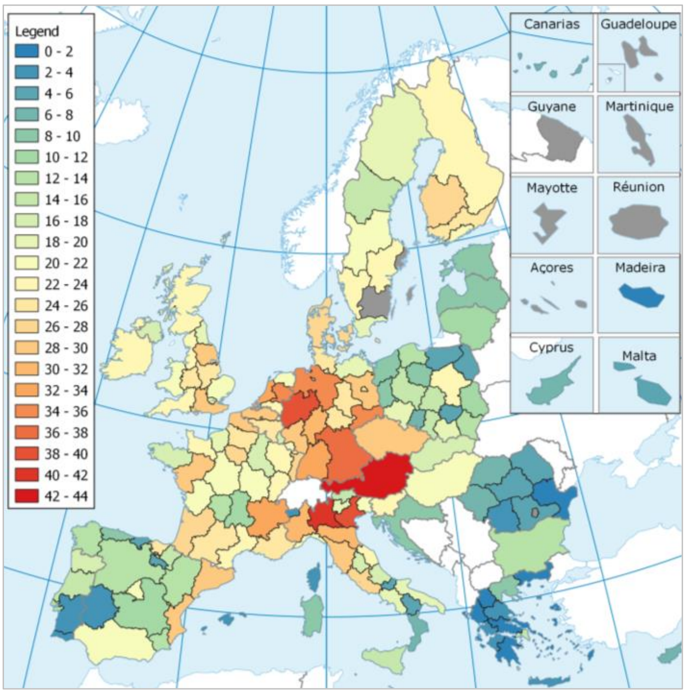
RQ: To what extent does the prioritisation address issues such as diversification, specialisation, and related variety?

To explore this issue, this study computed and used the indexes of technological relatedness density and technological complexity developed in the literature of knowledge space (Leten et al., 2007; Kogler et al., 2013; Boschma et al., 2015; Rigby, 2015; Heimeriks and Balland, 2016). In this literature, the notion of technological or knowledge relatedness is used to capture the idea that certain technological fields are related to (and similar to) other technological fields. In contrast, complexity refers to the notion that some technological fields are inherently more complicated to master because they require a combination of diverse skills and knowledge sets. In other words, technological complexity refers to the capacity of the Member State/region to produce complex technologies because it masters all the knowledge and capabilities necessary to produce and fully utilise them (Balland et al., 2019; see also Box 5-2).

Following the relevant literature, we measured technological relatedness with the technological relatedness density index, computed based on patent data and the co-occurrence of technological classes within the same patents. The index, ranging from 0 to 100, measures the extent to which a technological domain is linked to other domains in the technological portfolio of the region. Map 5-8 presents the average **regional relatedness density** between existing technologies in regions and all potential new technologies in the year when the latest S3 strategy in each region/country was published. The higher the score on this measure (i.e., the more the colour of the region goes towards the red colour), the denser the existing knowledge space of the region, i.e., the easier it is for these regions to diversify into new technological fields. Following the same reasoning, lower scores (i.e., the more the colour of the region goes to blue) indicate that the knowledge space of the region is not very populated and therefore new technologies are relatively more difficult to master, making diversification through related variety more difficult to achieve.

Confirming results from Balland et al. (2019), the figure shows the highest values of relatedness density in Austria, as well as in regions in Northern Italy (Lombardy and Veneto), and in Germany (North Rhine-Westphalia and Bavaria). By contrast, regions in Southern and Eastern Europe (including, for example, some Greek and Romanian regions) are characterised by low relatedness density scores, and hence a more difficult road towards diversification through related variety.

Map 5-8: Average regional relatedness density by NUTS region (latest S3 strategy year)



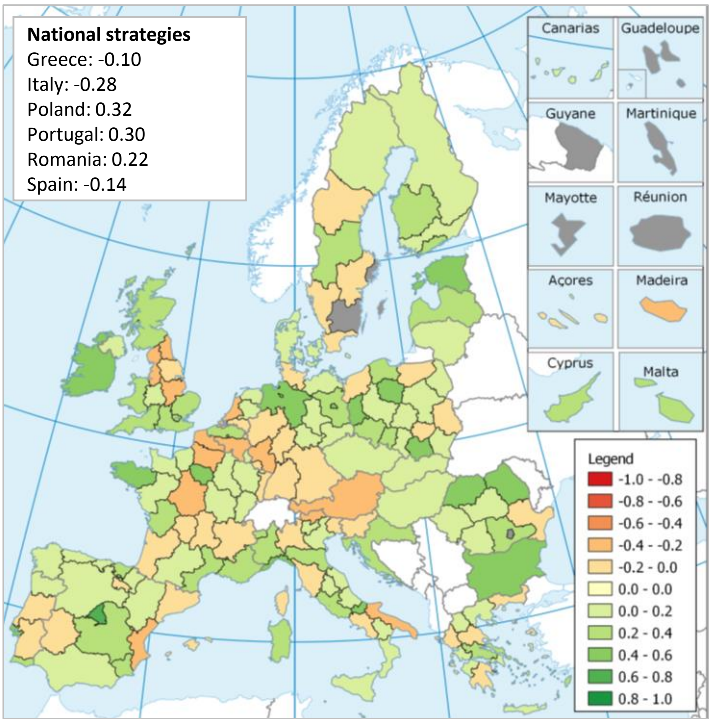
Source: Prognos / CSIL (2021).

We can use this index of technological relatedness to verify if regions and Member States chose priority areas closer (or more distant) to their knowledge space, i.e., to the bundles of technologies that they master. Results of the correspondence of S3 priorities with the level of technological relatedness in a Member State/region indicate that **several regions and countries chose fields closer to their knowledge space** (Map 5-9). This approach was followed by more and less developed regions alike, and no clear-cut categorisation can be found in terms of innovation profiles as characterised by the Regional Innovation Scoreboard. As a matter of fact, among the strategies with the highest correlation between priorities and technology relatedness density indexes we find Bulgaria (a less developed Member State, and a modest innovator), but also the French region of Ile-de-France (a more developed region, and an innovation leader). Other examples of relatively conservative strategies include Molise (Italy), Małopolskie (Poland), and Centru (Romania) among less technologically advanced and R&D intensive regions and Madrid and Berlin among more advanced and innovative Member States/regions.

The national S3 of Italy and Austria, or the strategies of Lombardy (Italy) and Picardie (France), are examples of the opposite scenario, i.e., cases where an aim to diversifying through unrelated variety might have played a larger role. Some of these strategies (e.g., Austria) seem to reflect public better than private technological profiles. Therefore, rather than being strategies aimed at unrelated diversification, these might also be strategies with a poor fit with private (and overall) technological profiles.

The results of our analysis are in line with those obtained in the study by Marrocu et al. (2020) which investigates the degree of relatedness of priority areas of S3 strategies. For example, in the analysis by Marrocu et al. (2020), the strategy of Lombardy (Italy) is classified as a "out of the beaten path" strategy. This confirms our results in Map 5-9 which point to a low degree of relatedness of the strategy, as well as the findings emerging from the case studies (see Annex 9.6 on case studies). Another illustrative case is provided by the Spanish region Castilla y León: in Marrocu et al. (2020), it is profiled as a "conservative path", confirming our positive correlation coefficients in Map 5-9 and the findings from our case study (see Annex 9.6).

Map 5-9: Correlation coefficients between S3 priorities and technological relatedness density



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

To be able to better characterize strategies in terms of the degree to which they aimed at related or unrelated diversification, we resort to the concept of technological complexity introduced in Section 4.4.1. The notion of technological complexity, combined with the notion of technological relatedness, are key to the understanding of whether certain goals and targets were part of a fairly or overly ambitious S3 strategy. In other words, if a strategy tackles very complex technologies, but its overall degree of relatedness is high, this can be considered a safer strategy compared to one that targets complex technologies with a low degree of relatedness. Before we move to the analysis of the level of ambition of S3 strategies, it is interesting to identify the strategies that more prominently targeted the most complex technologies.

Box 5-2: Understanding the complexity index

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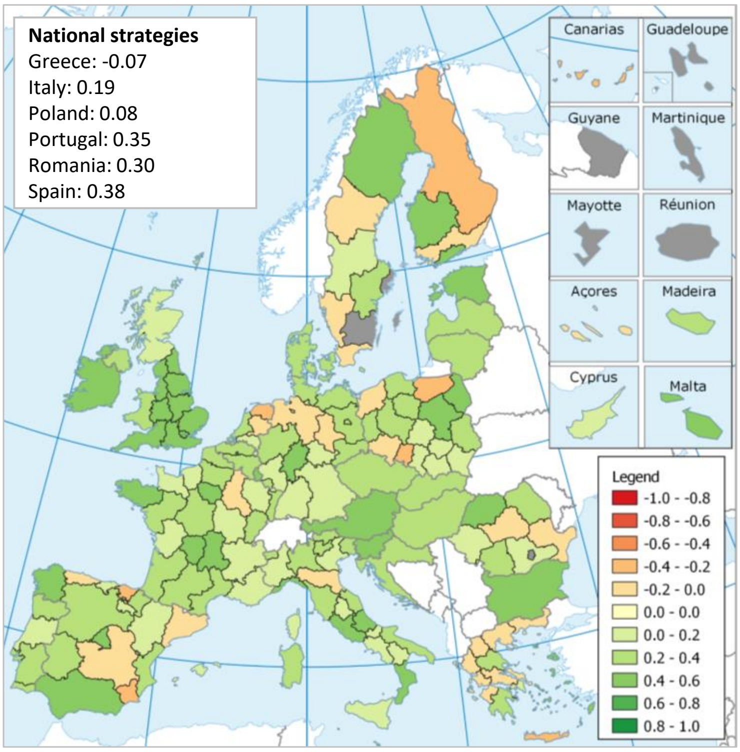
While some technologies might be characterised by a high level of technological, scientific, or R&D intensity, this is not what makes them "complex" according to the definition of the technological complexity index (Balland and Rigby, 2017). Rather, complexity is determined by how difficult it is to be innovative in a certain field, and how rarely countries manage to achieve this goal. As found by both Balland et al. (2019) and this study, the most complex technologies in the period and sample analysed (all EU regions and Member States) are related to digital communication and computer technology. These are more complex technologies because, by nature, they are more horizontal than others and applicable to several fields. Thus, their production and application require a very diverse mix of competences. The least complex technologies, requiring more specific and less diversified competences, are related to transport and machineries. At medium levels of complexity, we find fields such as medical or environmental technologies.

Source: Prognos / CSIL (2021).

The index of technological complexity can be used to assess whether strategies have targeted more complex technologies that are relatively difficult to master and therefore are considered as more strategic, or value-adding.

A high complexity index indicates that a technological field requires a higher and more diverse set of capabilities compared to others in the EU and is therefore less ubiquitous. The index varies from 0 to 100. As Map 5-10 shows, the strategies that have given more emphasis to complex technologies include the Bulgarian, Irish, and Austrian strategies, as well as regional strategies from Länsi-Suomi and Helsinki-Uusimaa (Finland), Liguria (Italy), Brussels, and the French regions of Ile-de-France and Provence-Alpes-Côte d'Azur. By contrast, several strategies in Greece, Spain, but also Finland, Sweden, and the Netherlands have a less complex profile. Consistently with the analysis presented in Section 4.4, **complex technologies are a target of both more and less developed Member States/regions, and Member States/regions at all levels of innovative capabilities** as captured by the European Innovation Scoreboard and the European Regional Innovation Scoreboard (2017). This is an interesting finding. On the one hand, we would expect Member States/regions at different levels of technological prowess to opt for different types of strategies, with more advanced Member States/regions choosing more complex technological fields. On the other hand, S3 strategies are meant to reflect endogenous capacities and aim at diversification, but also tackle societal and environmental challenges such as ageing population or climate change. While the mix of technologies used to address these challenges might contain complex technological elements (such as the application of ICTs), it might also involve less sophisticated technological fields. This ultimately reminds us that there are no normative judgements to be derived from this analysis, as a strategy tackling more complex technologies is not better than a strategy tackling less sophisticated technologies.

Map 5-10: Correlation coefficients between S3 priorities and technological complexity index



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

To better characterise the S3 strategies adopted by EU Member States/regions, we compute a **metric of the degree of ambition of the strategy**, by combining the indicators of technological relatedness density and technological complexity. The indicator of ambition reflects the degree to which a strategy has selected priority areas that can be regarded as overly or underly complex as compared to the mix of technologies already mastered by the Member State/region.[66] Figure 5-3 offers an illustration of how this metric of ambition relates to the notions of technological relatedness and complexity. It shows on the horizontal axis the correlation coefficients between the S3 priorities and the technological relatedness density indexes, and on the vertical axis the correlation coefficients between the S3 priorities and the technological complexity indexes. Therefore, a strategy that has chosen priorities which are related to its technological capabilities and at the same time complex, would feature on the upper-right quadrant of the figure. The colour of the dot indicates whether a strategy can be considered ambitious (green dot) or not (red dot), based on the correlation coefficient between the priorities and the ambition index. Hence, a strategy with a positive (negative) correlation between priorities and the ambition index is marked in green (red). Finally, the size of the nodes represents the magnitude of this ambition, with a larger green (red) node indicating a comparatively more ambition (more unambitious) strategy. Based on this new metrics:

i. a strategy that aimed at unrelated diversification (negative or relatively low correlation coefficient with technological relatedness density) and targeted

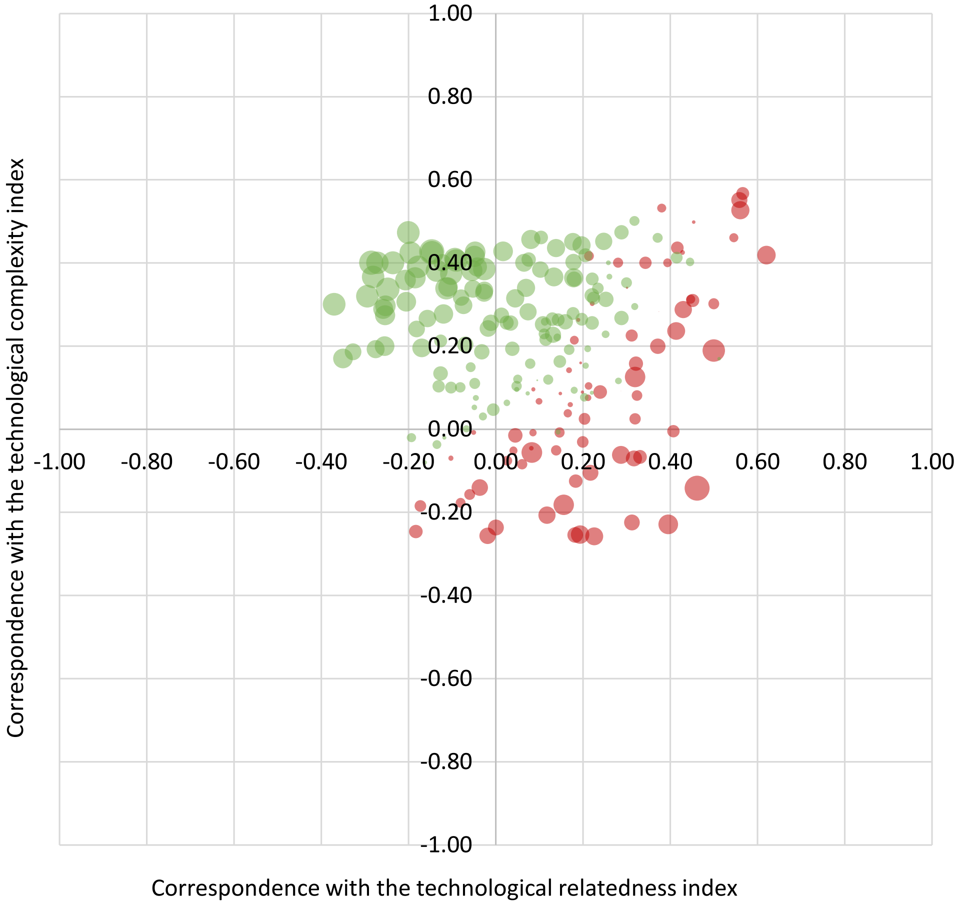
[66] In more technical terms, this index is constructed in two steps. First, the relatedness density index is rescaled from 0 to 100, so that, for each region and year, technologies are ranked from the closest (with a value of 100) to the most distant (with a value of 0). Second, an unrelatedness index is calculated as the opposite of the rescaled relatedness density index (100 - rescaled relatedness density index). Finally, the ambition index is constructed as the product between the unrelatedness index and the technological complexity index. This ambition index ranges from 100 (highly ambitious technology with respect to regional knowledge space) to 0 (low ambitious technology with respect to regional knowledge space).

complex (or even relatively complex) technologies is marked as an ambitious strategy (green dots in Figure 5-3);

ii. a strategy that prioritised technological fields very much related to the current capabilities of the Member States/region (high correlation with relatedness density index) is considered an unambitious strategy, regardless of its degree of complexity; and

iii. a strategy that prioritises unsophisticated technologies is marked as unambitious, no matter its degree of relatedness with the capabilities already in place in the Member State/region.

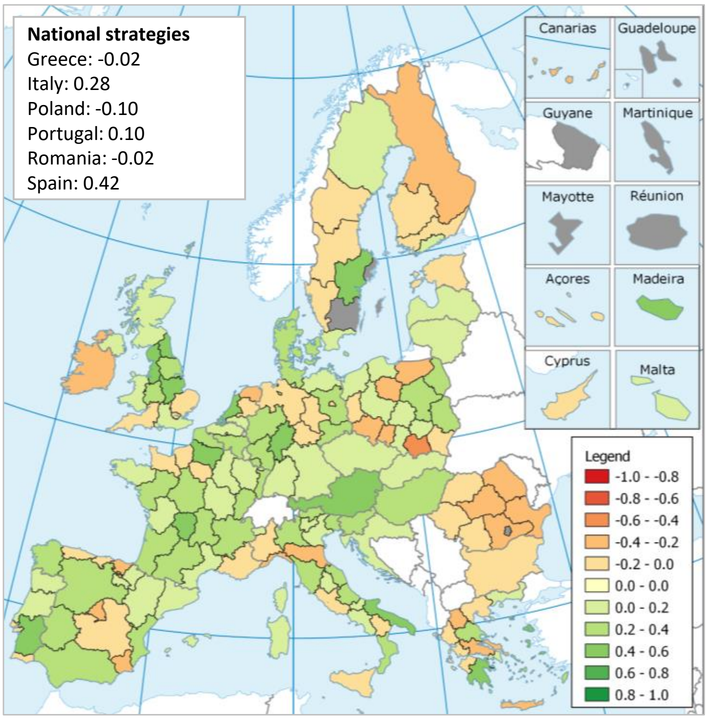
Figure 5-3: Correspondence between S3 priorities and technological relatedness density, technological complexity, and regional ambition



Source: Prognos / CSIL (2021). Note: Each node in the graph is a S3 strategy. The size of the nodes is given by the correlation coefficient between priorities and the ambition index. The colours of the nodes reflect the sign of the correspondence: a green node stands for a positive correspondence and a red node for a negative one.

Map 5-11 puts the new metric into use to illustrate which Member States/regions have adopted a more ambitious (positive correlation coefficients) or less ambitious (negative correlation coefficients) approach. Stark differences can be identified from a first glance: large parts of Central and Eastern Europe, Southern Europe, and Scandinavian Member States/regions seem to have adopted a more cautious approach compared to Western Europe. Based on this metric, the most audacious strategies seem to come from some French regions (e.g., Limousin and Picardie), Apulia (Italy), North West England (UK), Austria, Hesse (Germany), and West Netherlands. The least ambitious include the strategies of Centre and South Muntenia in Romania, Małopolskie and Dolnośląskie in Poland, Región de Murcia and Comunidad de Madrid in Spain, and Western Macedonia and Crete in Greece.

Map 5-11: Correlation coefficients between S3 priorities and technological ambition index



Source: Prognos / CSIL (2021). Note: The maps show the correlation coefficients computed for the latest strategy implemented in each Member State/region. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence with the sub-national strategy, while correspondence with the national strategy is provided in the box. Grey coloured regions are excluded from the analysis because of missing data.

Box 5-3: Path dependence and disruption goals in S3 strategies: evidence from case studies

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S3Berlin and Brandenburg – "Strengthening strengths" approach

The innoBB emerges as a S3 strategy that seeks regional diversification and upgrading through the application of complex technologies to existing activities or competences in the region. The incremental diversification approach builds on regional endogenous capabilities, while proactively identifying new topics that could be of importance in the future ("Zukunftsthemen") and would serve to diversify their strategy. As put by local stakeholders, the strategy crucially aims at strengthening existing strengths.

Denmark – Upgrading along the value chain

When looking at the Research and Innovation (R&I) expenditure pattern of Denmark, it is evident that it generates excellent outcomes in only two areas of the S3, notably health and welfare solutions and sustainable energy. Because of that, it was (and it is) deemed important for Denmark to expand R&I activities in other sectors where there are already strong competences and an established industrial base. The approach outlined in the S3 strategy, therefore, consisted in promoting a process of diversification and upgrading along traditional value chains by integrating digital and green contents in products, services, and processes and by moving into new niche and export-oriented segments.

Source: Prognos / CSIL (2021).

Box 5-4: Path dependence and disruption goals in S3 strategies: evidence from case studies (continued)

S3Western Macedonia – The challenge of decarbonisation

Western Macedonia is faced with a pressing need to diversify its economy away from lignite extraction and energy production from traditional (highly polluting) energy sources. The S3 strategy of the region tries to contribute to this important goal by promoting upgrading and value-addition in traditional sectors (such as agri-food) and by spurring the transition towards a more environmentally sound energy industry, leveraging also new research activities in this field.

Dolnośląskie – A mix of more and less related and complex technologies

The S3 strategy of the Polish region of Dolnośląskie aims at building new capabilities, both horizontal and more specific ones. The approach was the result of cooperation with representatives from the scientific world and discussions with representatives from those areas that are changing most rapidly.

The final choice of specialization areas resulted, therefore, in a mix of what was already present and what was emerging. This mix included traditional industries (e.g., pharmaceutical, or chemical), but also areas where new scientific capacities with great development potential require nurturing (e.g., space technologies). In addition to these, and based on an analysis of the historical data on how companies use funds for development, efforts were made to redirect support to those industries that had potential and which in the future may constitute a competitive advantage for the region. An example is the priority area "Natural and secondary raw materials", where efforts were made to redirect support towards projects involving modern technologies and the circular economy.

Source: Prognos / CSIL (2021).

5.6 Similarities across prioritisation approaches

RQ: How was the information on the economic structure, scientific strengths and technological strengths combined in the overall strategy? Are there common traits among regions that allow categorising their heterogeneous experiences?

The final step of our quantitative analysis aims at identifying groups of Member States/regions that adopted a similar prioritisation approach in their formulation of the S3 strategies. In this part of the study, the correlation coefficients computed on different sets of variables and presented in the previous sections were used to perform a cluster analysis (see Annex 9.3.3 on the details on this analysis).

Map 5-12 presents the results of this cluster analysis, mapping all S3 strategies of EU Member States/regions analysed in this study according to the cluster to which their latest strategy belongs. This means that if a region has updated its strategy during the period 2010-2019[67], only the updated strategy is shown on the map. Still, it is important to keep in mind that the analysis is performed on all the strategies under scrutiny in this study.

[67] As explained in Section 2.1.4, strategies published in 2020 could not be analysed due to the lack of sufficiently recent patent and employment data.

The analysis found **four groups of strategies**:

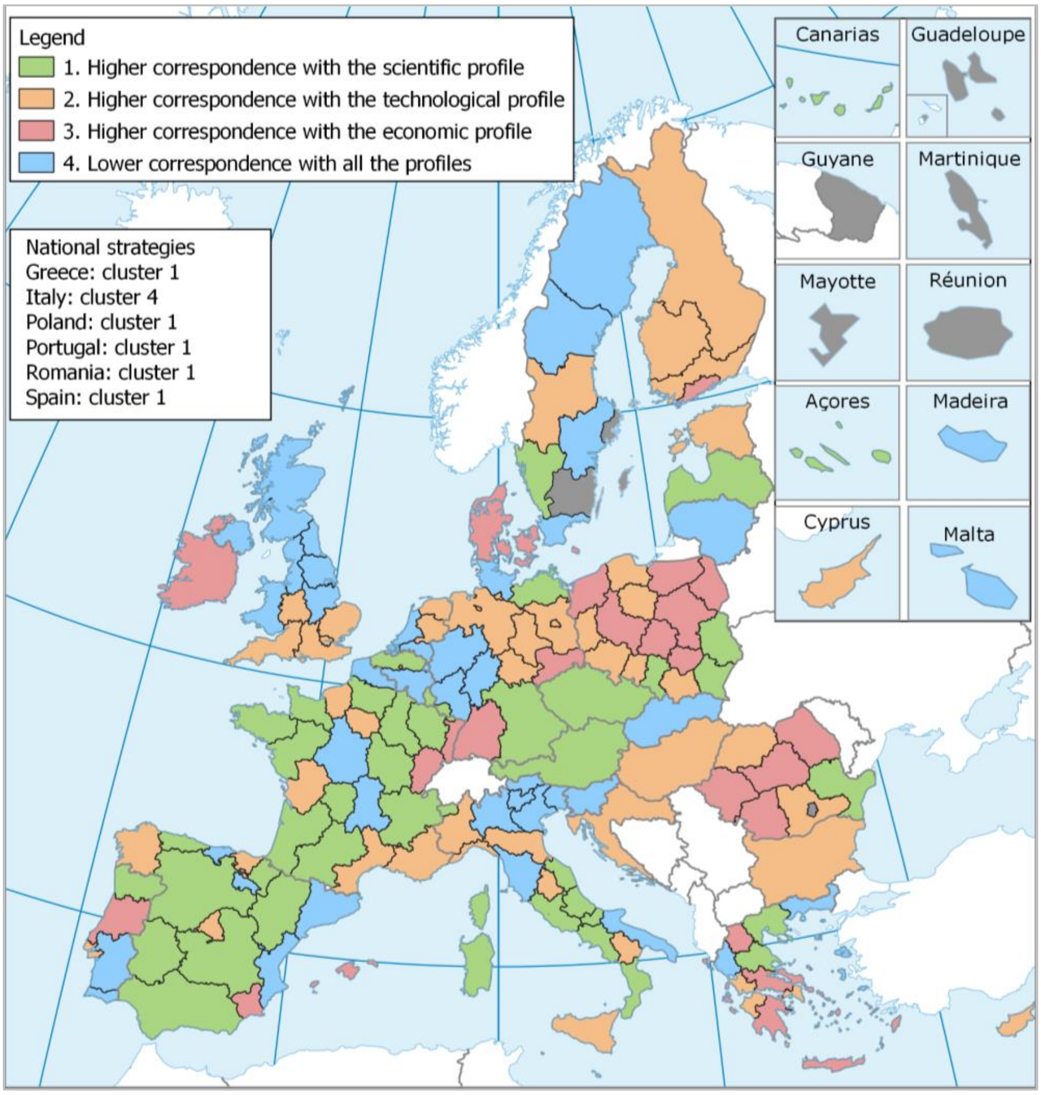
5. **61 S3 strategies (29%) have a higher correspondence with the scientific profile** (proxied by the share of publications, the publication LQ computed with respect to the EU28 average, the share of top 10% most cited publications, and the relative scientific excellence, i.e., the ratio of most cited publications against the EU average);

6. **62 S3 strategies (30%) have a higher correspondence with the technological profile** (proxied by the patent shares, the patent LQ computed with respect to the EU, and the regional technological relatedness index);

7. **33 S3 strategies (16%) have a higher correspondence with the economic profile** (proxied by the employment share and employment LQ vs the EU); and

8. **53 S3 strategies (25%) exhibit a relatively low correspondence with any profile** (scientific, technological, and economic), but the level of ambition of the priorities selected is quite high.

Map 5-12: Groups of S3 strategies according to the correspondence of their S3 priority areas with the regional/national profiles (method: hierarchical clustering)



Source: Prognos / CSIL (2021). Note: The map shows the specific cluster to which the latest S3 strategies belong. When a Member State/region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the cluster of the sub-national strategy, while the cluster of the national strategy is specified in the box. Grey coloured regions are excluded from the analysis because of missing data.

The table below (Table 5-4) synthesises the main characteristics of each cluster. The table has been filled in based on an analysis of how, for each cluster, the strategies are distributed across a number of socio-economic, institutional, geographical criteria, as well as their innovation profile and various characteristics of their EDP. We applied **logistic models to statistically test the probability that a S3 strategy belongs to a given cluster as a function of a set of variables characterising the Member States /regions that produced that strategy**. In other words, we ask ourselves whether certain Member States/regions' characteristics (for example having a higher share of the population employed in science and technology) are important predictors of the prioritisation approach adopted in the Member States/region (e.g., an approach that achieved for example a higher correspondence with the scientific and technological profile). Other questions that can be answered with this analysis are related to the role of institutions: for example, are Member States/regions with higher quality governments or higher innovation capabilities more likely to adopt an ambitious approach?

The prioritisation approaches can also be analysed in relation to specific features of the S3 strategy. To this end, in Table 5-5, we investigate how prioritisation approaches are related to the concentration and bandwidth of the S3 strategy (see Section 4.5 for a definition of these two indicators). In this regard, we investigate if less concentrated and more broadly defined strategies achieve a higher degree of correspondence with certain profiles (e.g., the scientific profile) or are associated with a lower degree of ambition.[68] Using the insights of Table 5-4 and Table 5-5, we can provide a characterisation of the four clusters, highlighting their most salient and robust features.

The *first cluster* is made of **strategies with a positive and relatively higher degree of correspondence between S3 priorities and scientific profiles**. With 61 strategies falling within this group (equal to 29% of all strategies analysed), this cluster is the second-largest cluster in our analysis. As expected, this group includes some of the Member States and regions mentioned in Section 5.3, including Luxembourg, Marche in Italy, as well as Lorraine and Picardie in France. Indeed, 14 of the strategies that compose this cluster are from France and 12 from Italy. A high number of Spanish strategies (11) also feature in this cluster.[69] As Table 5-4 indicates, this group seems to be characterised by a (statistically significant) prevalence of old Member States, classified as transition regions, and moderate or modest innovators, with a low share of the population engaged in Science and Technology, and a quality of government index below the EU average. One interpretation of these results could lead us to presume that this group of Member States and regions has some scientific competencies which are not necessarily translated into technological competencies and innovative behaviours within the productive sector. Interestingly, **broader strategies, i.e., strategies that cover a wide variety of sectors and scientific and technological fields, and strategies that are not particularly focused in any of these sectors and fields are also more likely to fall into this cluster** (Table 5-5). This hints to a certain association between adopting a science-driven approach *and* a broadly defined strategy.

The *second cluster* is composed of **strategies that matched particularly well their technological profile**. This is the largest cluster in our analysis, with 62 strategies, equal to 30% of all strategies analysed. The typical Member State/region of this cluster is a highly diversified Member State/region with a good innovation profile (classified as an innovation leader, strong or moderate innovator) and a high share of its population employed in Science and Technology. Member States and Regions that adopted this prioritisation approach can be found in various parts of the EU, with a significant share of them from Central Eastern, Northern, and Western Europe. Indeed, in this cluster we find seven German strategies, three Finnish ones, but also Bulgaria, Hungary, and seven Polish

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[68] The table summarises the results obtained when all the indicators of concentration and bandwidth, as well as all control variables in Table 5-9, are introduced in the regressions. For this reason, these results are to be considered as quite robust.

[69] In some of the Member States and regions belonging to this cluster, the political weight of public research institutes and universities is not negligible. Their generalist profile and limited activities in terms of technology transfer might also contribute to explain the prioritisation approach.

strategies. An interesting characteristic of this group is also the (statistically significant) prevalence of strategies where the results of an already existing or previous EDP were used. This pattern may hint to a more consolidated experience of stakeholder consultation and the existence of a previous innovation strategy which the S3 builds on. Finally, and similarly to the previous cluster, the strategies that compose this cluster are characterised by a prevalently low concentration in terms of technological fields, meaning that the weight of each technological field within the strategy is evenly distributed. This means that the **regions that achieved a good match with their technological profiles might have also been less specific in their definitions of leading technologies to be applied or developed to achieve the goals of the strategy** (Table 5.5).

The *third cluster* comprises the **strategies that achieved a relatively higher correspondence with the economic profiles**. As discussed in Section 3.2, few strategies match the economic profiles of the Member States/regions. This cluster analysis confirms this result: only 33 regions stand out for having achieved a comparatively good match with their economic profile (they represent 16% of the strategies considered in the cluster analysis). As it could be expected based on our correlation analyses, this group includes several Greek, Polish, and Romanian strategies that together account for 60% of the strategies within this cluster. Indeed, being a Central Eastern Member State or region increases the probability of falling into this group. With a similar profile to the Greek regions, the Balearic Islands (Spain) also fall within this cluster. As Table 5-4 shows, the typical Member State/region that opted for this prioritisation approach is a transition region and modest innovator, with a low degree of economic diversification. Notable exceptions include, for example, the strategy of the German region of Baden Wurttemberg, probably due to its strong specialisation in a handful of economic sectors in which it is a leader in Europe. Finally, and confirming also the results obtained on the former two clusters, a region that has **opted for a less focused approach (low concentration of priorities at the economic level)** is also more likely to have achieved a relatively better correspondence with its economic profile (Table 5-5).

In the *fourth cluster*, we find **the strategies that achieved a lower level of correspondence with their economic, scientific, as well as technological profiles while showing high levels of ambition**. A total of 53 strategies falls into this group (equal to 25% of strategies analysed). As Map 5-12 clearly shows, this approach was followed in different categories of regions and Member States of the EU, with 13 strategies from Italy, seven from the UK, five from Spain, and four each from Germany and Sweden. As these examples suggest, the probability of following this prioritisation approach is higher for old Member States. Still, some strategies from new Member States also belong here: these include the updated strategy of Lithuania, as well as the Slovenian and Slovakian strategies. Other salient characteristics of the Member States and regions that chose this approach are a high economic diversification, a strong innovation profile, and high-quality government. The strategies that belong to this group also seem to rank high in terms of their ambition. This is an extremely interesting finding from the perspective of this study. It means that these strategies might aim at elevating the ambitions of the regions through unrelated diversification and a focus on relatively complex technologies.

As Table 5-5 indicates, **the strategies that achieved a comparatively lower correspondence with their economic, scientific, and technological profile also tend to be more concentrated in terms of priority areas**, with some priorities emerging as more frequently mentioned and therefore key elements to achieve the goals of strategy. While Table 5-5 indicates that a significant and positive role for concentrations at the FOR and technological levels, results from regressions that look at one indicator at a time (with no control variables) suggest that this finding can be generalised to all concentration indexes, including the economic one. These regressions also identify a significant role for the indicators of bandwidth, suggesting that a more narrowly defined strategy is more likely to achieve a less precise correspondence with economic, scientific, and technological profiles. *Vice versa*, a more broadly defined strategy is generally associated with higher correspondence with the regional strengths and profile. This finding depends on the way how correlation coefficients are computed: the more sectors/fields a

S3 strategy is associated with, the more likely it is for the strategy to match with the regional profile.

Taken together, all these elements indicate that **low and high correspondences are not necessarily signs of good and badly designed S3 strategies**. A comprehensive analysis of each strategy and its policy process is paramount to assess whether a relatively low match is counterbalanced by high and reasonable ambitions, or a sign of sheep-like behaviours, which lead regions into selecting overly ambitious and too complex areas of specialisation, which are too far away from their set of actual capabilities. While this analysis goes well beyond the objectives of this study, the insights from the qualitative case studies presented in Annex 9.6 shed light on some of these issues.

Table 5-4: Characteristics of the clusters of S3 strategies according to their correspondence with the regional profiles: results of the regression analysis (Logit models)

		Higher correspondence with the scientific profile	Higher correspondence with the technological profile	Higher correspondence with the economic profile	Lower correspondence but high ambition
N. S3 strategies analysed		61	62	33	53
Geographi-cal factors	Old/New Member States	Old Member State (***)	No pattern	No pattern	Old Member State (**)
	Location	No pattern	Central Eastern, North, Western EU (***)	Central Eastern (**); North (***)	No pattern
	Regional population density	Low population density (***)	No pattern	Low population density (***)	No pattern
Human capital endowment [70]	Share of population employed in science and technology	Low share of population in S&T (***)	High share of population in S&T (***)	No pattern	No pattern
Economic conditions	Level of development	Transition (***)	No pattern	Transition (*)	No pattern
	Economic diversification	No pattern	High economic diversification (***)	Low economic diversification (***)	High economic diversification (***)
Innovation performance	Regional Innovation Scoreboard 2017[71]	Moderate and modest innovator (***)	Innovation leaders (***) strong innovator (***) and moderate innovator (*)	Modest innovators (***)	Innovation leaders and strong innovator (***)
Institutional quality	Quality of government indicator	Quality of government index below EU average (***)	No pattern	No pattern	Quality of government index above EU average (***)
	Use of Old or New EDP[72]	No pattern	Old EDP (***)	No pattern	No pattern

Source: Prognos / CSIL (2021). Legend: * p<0.10 (statistically significant at 90% level), ** p<0.05 (statistically significant at 95% level), *** p<0.01 (statistically significant at 99% level).
Notes: When no statistically significant associations emerged, this is indicated in the respective cell of the table.

[70] The ratio of young people over the total population has also been included in the analysis but has not given significant results and therefore has been dropped from this table.
[71] Government expenditures in R&D as a share of GDP (GERD) and Business expenditures in R&D as a share of GDP (BERD) were also tested as alternative indicators of the innovation performance of the Member States/region. Because results are statistically significant only in a few cases and because the Innovation Scoreboard already takes into account these variables, the results on GERD and BERD are omitted from this table.
[72] The method of the EDP (i.e., SWOT, focus groups, interviews) was also tested but for the same reasons outlined above it was decided to omit this variable from the analysis.

Table 5-5: The concentration and bandwidth of the strategies in each cluster: results of the regression analysis (Logit models)

	Higher correspondence with the scientific profile	**Higher correspondence with the technological profile**	**Higher correspondence with the economic profile**	**Lower correspondence but high ambition** **no controls**	**Lower correspondence but high ambition** **with controls**
N. S3 strategies analysed	61	62	33	53	53
S3 concentration	Low S3 concentration at FOR level (*)	Low S3 concentration at technology level (*)	Low S3 concentration at NACE level (***)	High S3 concentration at FOR level (***), at technology level (**) and at NACE level (***)	High S3 concentration at FOR level (*) and at technology level (***)
S3 bandwidth	High S3 bandwidth at FOR level (*)	No pattern	No pattern	Low S3 bandwidth at FOR level (**), at technology level (**) and at NACE level (***)	No pattern
With control variables (see indicators in Table 5-4)	Yes	Yes	Yes	No	Yes

Source: Prognos / CSIL (2021). Legend: * p<0.10 (statistically significant at 90% level), ** p<0.05 (statistically significant at 95% level), *** p<0.01 (statistically significant at 99% level).

6 IMPLEMENTATION OF S3 STRATEGIES 2014-2020 ACROSS THE EU

Overview of key findings

1. **ERDF funded calls/programmes predominantly require an alignment to the S3 strategies.** 84% of ERDF TO1 calls in the Member States/regions have a S3 alignment criteria in place. In this regard, some differences exist, especially less developed regions which use TO1 calls more often when projects need to align with the S3 priority areas (91% of all calls) as compared to transition (85%) and more developed regions (78%). Looking more closely at the way that priority areas are addressed by the calls, most cover all priority areas together (i.e., the call is open for projects addressing any of the existing priorities) instead of focusing on single priorities. Here too, there exist some noticeable regional differences as less developed regions have a higher percentage of calls that address all priority areas compared to transition and more developed regions. The latter indicates that transition/more developed regions use more targeted calls to support their priority areas.

2. **Linkages between ERDF-funded projects and S3 priorities were found for 57% the projects but there are substantial differences among MS/regions.** Overall, 49.749 out of 86,487 ERDF-funded projects analysed display a link to the corresponding S3 priority areas. This is also true for the share of the respective project budgets. Nevertheless, the findings also illustrate substantial differences regarding this link. While the average for less developed regions is the highest (69%), transition regions show the lowest average value (46%). More importantly, however, the variance between individual Member States/regions is more striking: while regions such as Bolzano (99%) in Italy, Wielkopolskie (95%) in Poland or Cataluña (89%) in Spain show particularly high shares of projects linked to their S3 priority areas, regions such as Haute Normandie (6%), Extremadura (9%) or Apulia (10%) stand on the other side of the spectrum.

3. **Strict S3 eligibility criteria seem overall to be well applied in the project selection processes and support the selection of projects linked to priority areas.** Regions that more often make use of stricter S3 eligibility criteria (i.e., substantial, or formal) have a larger share of ERDF funded R&D projects that are related to their respective S3 priority areas. This becomes especially clear in EU-13 Member States/regions as well as in less developed regions, which have a significantly higher share of TO1 calls with strict S3 eligibility and a higher share of S3 related projects when compared to the EU15, transition and more developed regions: This is strongly driven by the national and regional S3 strategies in Poland and the national S3 in Greece. In Poland, 94% of the projects on the national level and 93% in the region of Dolnośląskie are related to S3 priorities, while simultaneously having strict alignment criteria in the calls. In Greece, 96% of the priorities contain S3 linkage, with having similarly strict alignment criteria in the calls.

4. **The most frequently addressed priority areas of S3 strategies are also reflected in the implemented projects.** Across all 49,749 projects, the topics of Agrofood/Bioeconomy, Health/Life Science, and ICT/Industry 4.0 are most prevalent. These overarching topics are also most often reflected in the priorities of the 185 S3 strategies, for instance through priority areas related to computer programming or priorities related to health and agriculture.

One of the key rationales for the European Commission to integrate smart specialisation into Cohesion Policy was the desire to achieve better **correspondence between funding, projects, and regional economic structures and strength**.[73] Against this background and the objectives outlined in the terms of reference, this section provides insights on the implementation of the selected priority areas by analysing the S3 alignment criteria of the calls for proposals and by investigating the matching between selected projects and priority areas defined in the S3 strategies. Thereby, it will provide answers to the following research questions:

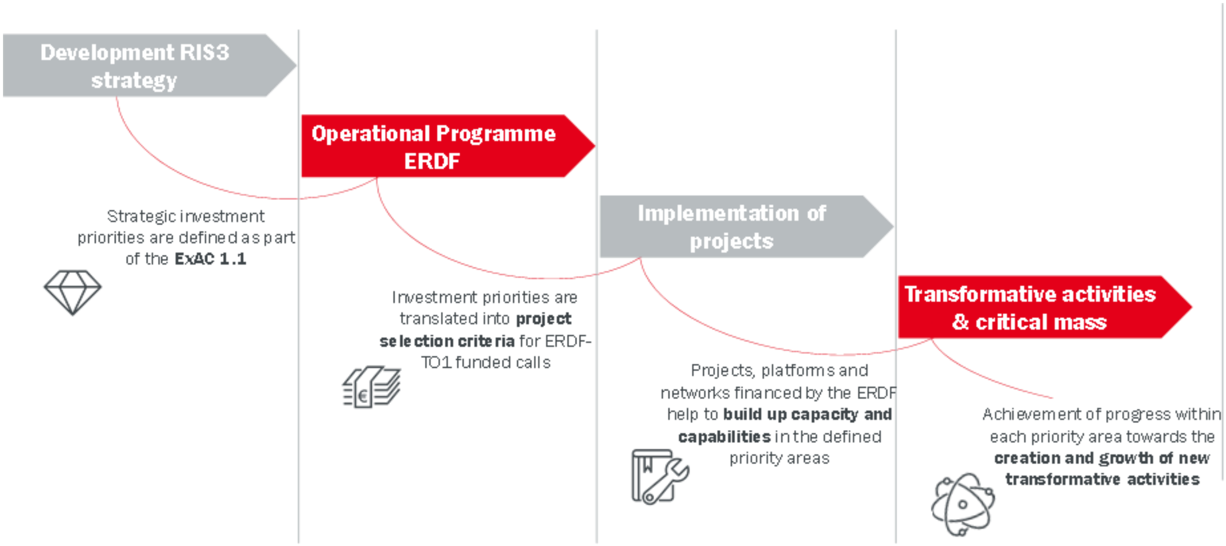
- How was the prioritisation reflected in the preparation and implementation of calls?

[73] See, for instance, Berkowitz (2017) for more on the rationale behind this.

- How did the project selection process reflect the prioritisation? Has the selection process led to the projects' implementation in the priority areas?
- Has the selection process led to a focus on specific smart specialisation areas?
- Have the experiences accumulated with the calls led to a revision or proposals for a revision of the prioritisation areas?

This Chapter applies a 'follow the money' approach (as illustrated in Figure 6-1) and is based on the linkage that exists between most of the identified S3 strategies and the respective ERDF Operational Programmes. This allows for connecting and comparing the topics addressed in the ERDF funded R&I projects to the priority areas defined in the S3 strategies and to assess the relative importance of these projects.

Figure 6-1: Linkage between S3 strategies, OPs and the implementation of projects



Source: Prognos / CSIL (2021).

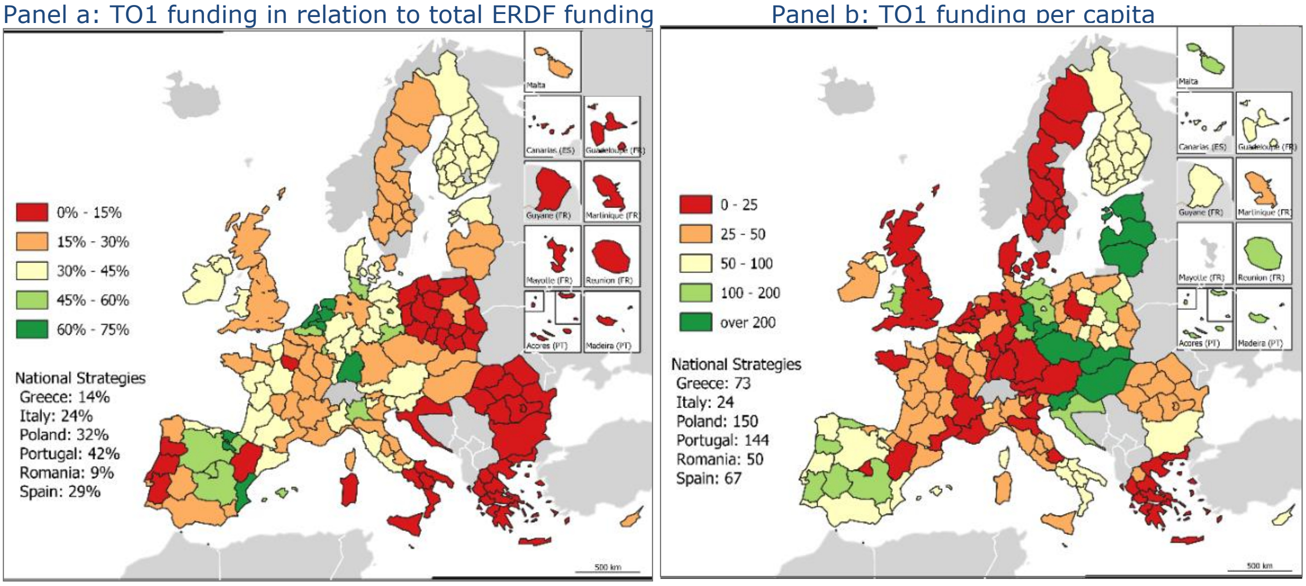
This Chapter follows a four-part structure. First, Section 6.1 illustrates the importance of ERDF funding for RDI in the EU Member States/regions. Second, Section 6.2 provides an analysis of the collected calls for proposals with a particular focus on the respective selection criteria and to the degree to which they are aligned with the S3 strategies. Section 6.3 links the identified ERDF projects to the priority areas of S3 strategies and illustrates the extent to which the projects reflect these. Finally, Section 6.3 connects the alignment criteria of the calls for proposals to the degree with which the projects address priority areas.

6.1 Importance of ERDF funding for research, technological development and innovation in the EU Member States and regions

In an initial step, it is insightful to highlight the **share of funding (EU contribution) for TO1** concerning overall ERDF funding (EU contribution) for a Member State or region. Across all regions, the average share of TO1 planned spending relative to total ERDF planned spending is 19%. Thus, across all Member States/regions in the EU, the average amount of planned TO1 spending is roughly a fifth of the total ERDF budget. Naturally, there is strong variation across the EU in this regard, as illustrated by Map 6-1 (a) below. For instance, while in the Northern Netherlands the share is 76% and in Pais Vasco (Spain) the share is 72%, in several regions in Greece (e.g., North Aegean, Peloponnese) the share is merely 2%. As such, there is strong variation in the relative importance (measured in financial terms) that Member States/regions associate to research and innovation in their budgets. Assessing this indicator along a region's level of development provides further insight. For instance, the relative share of TO1 funding is 14% among less developed regions, 26% among transition regions and 24% among more developed regions.

Map 6-1: ERDF TO1 funding in the Member States/regions

Panel a: TO1 funding in relation to total ERDF funding | Panel b: TO1 funding per capita



Source: Prognos / CSIL (2021), based on ESIF Open Data (https://cohesiondata.ec.europa.eu/2014-2020-Finances/). n = 185 regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These Member States are Italy, Greece, Spain, Poland, Portugal, and Romania.

Next, it is informative to assess the relationship between **TO1 spending concerning population**, to identify the amount of Euro spent (EU contribution) per capita for research and innovation. Across the EU, the Euro spent per capita on TO1 measures (for the whole programming period) is an average of EUR 53, while the Euro spent per capita for all ERDF measures is EUR 284. Yet again, there is strong variation across the EU, which is illustrated in Map 6-1 (b). At one end of the spectrum, such as in Estonia, Latvia or in Saxony (Germany), the TO1 Euro per capita was EUR 441, EUR 256, and EUR 250, respectively, while in Flanders (Belgium), in Hesse (Germany) or in Denmark, the amounts were EUR 13, EUR 14, and EUR 15, respectively. Moreover, trends are observable for more developed, less developed and transition regions. While less developed regions have a TO1 Euro per capita of EUR 86, transition regions record EUR 60 and more developed regions EUR 42.

The regional importance of the ERDF funding more generally and the TO1 funding more specifically can be assessed by relating the financing volume to the Member State or region's GDP. For instance, in Estonia the TO1 financing volume of the whole programming period is equal to 2.24% of national GDP in 2018 and the ERDF volume equates to more than 7% of GDP (2018). In Hungary, the TO1 (ERDF) financing volume (2014-2020) is equal to 1.6% (8%) of the GDP in 2018. In total, there are eight EU countries[74] where the TO1 financing volume for the whole programming period is equal to more than 1% of the national GDP in 2018. The variation in significance across the EU can be observed from Map 6-2 (a). Among all less developed regions, the share of TO1 funding to their GDP is 0.74% and the share of total ERDF funding to GDP is 5.5%. Among transition regions the shares are 0.13% (TO1) and 0.5% (ERDF) and for more developed regions they are 0.09% (TO1) and 0.26% (ERDF).

These relations provide insight into the relative significance of ERDF funding as a whole and research and innovation funding specifically across Member States/regions in the EU. The latter relationship can be further assessed by determining to what degree total R&D spending relates to TO1 financing. As can be observed from Map 6-2 (b), yet again there

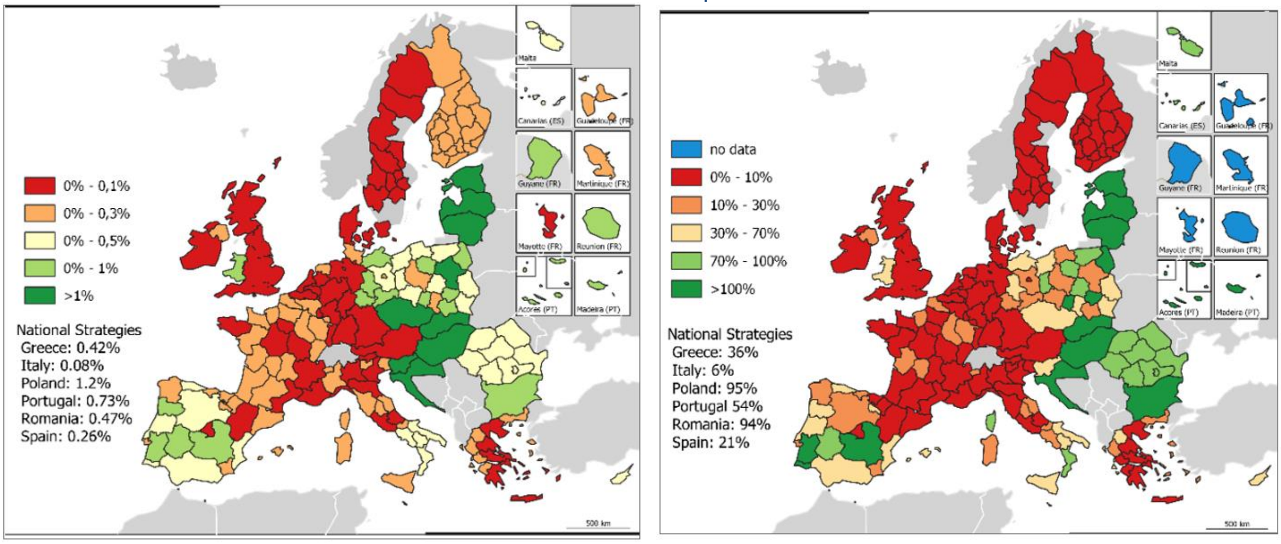
[74] Estonia, Latvia, Hungary, Lithuania, Slovakia, Croatia, Czechia, Slovenia.

are strong disparities in this regard across the EU. For more than half of the regions under review, TO1 funding over the whole programming period (2014-2020) is equal to less than 10% of R&D expenditure in the region in 2018.[75] For another 25% of regions, it is equal to less than half of the R&D spending. For 15% of the regions, it equals 50-100% of the regional R&D funding and for around 8% of the regions, TO1 funding is greater than regional R&D funding. From another perspective, the TO1 funding for all less developed regions equates to close to 70% of their R&D spending. For transition regions, this share is 7% and for more developed regions the share is 4%. As such, it is evident that this share decreases significantly as regions transition from less developed to more developed regions. Yet again, this shows the large spectrum when it comes to the relative significance of the ERDF funds in the context of investment for research and innovation.

Map 6-2: ERDF TO1 funding in the Member States/regions

Panel a:TO1 funding in relation to GDP

Panel b: TO1 funding in relation to own R&D expenditure



Source: Prognos / CSIL (2021) based on ESIF Open Data (https://cohesiondata.ec.europa.eu/2014-2020-Finances/). n = 185 regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These Member States are Italy, Greece, Spain, Poland, Portugal, and Romania.

The importance of ERDF funding described above can be complemented by the qualitative evidence garnered from interviews with officials in the respective Member States and regions, as displayed in Table 6-1 below. When asked to evaluate the importance of **ERDF funding** (including co-financing) for S3, 83% of the respondents associated **high importance to this source of funding**, with 6.8% claiming medium importance and 10.2% determining low or no importance. For more developed and transition regions, ERDF funding was deemed of high importance by 78% of the respondents, while for less developed regions regions 94% responded in that manner. These responses demonstrate the significance that ERDF financing currently has for the pursuit of S3 strategies across the whole EU and underscores the even greater importance it has for less developed regions. These insights are further substantiated by the assessment of the importance of regional and national funding sources in this context. Only 31.4% of the respondents deemed regional funding to have high importance and merely 21.1% considered national funding to have high importance for S3 financing. Indeed, 21.3% of the interviewees judged regional funding to have medium importance and 47.4% believed it to have low or no importance, while 30.4% of the respondents thought national funding had medium importance with 48.5% considering it to have low or no importance. In sum, these qualitative insights from the interviews further underscore the significance of ERDF funds concerning the financing of S3 strategies across the EU.

[75] R&D expenditure is measured by intramural R&D expenditure (GERD), Eurostat code: *rd_e_gerdreg*

Table 6-1: Relative importance of S3 funding sources

	Importance of S3 financing from the different funding sources:		
Level of Importance	**ERDF (including co-financing)**	**Regional Funding**	**National Funding**
High	83.0%	31.4%	21.1%
Medium	6.8%	21.3%	30.4%
Low	4.5%	16.0%	26.9%
No	5.7%	31.4%	21.6%

Source: Prognos / CSIL (2021) based on 181 interviews with Member State or regional officials. Note: For ERDF, N=176; for Regional, N=169; for National, N=171 (for the rest this question was not answered).

6.2 Analysis of selection mechanisms for calls for proposals and their impact on projects' implementation in the priority areas

RQ : How was the prioritisation reflected in the preparation and implementation of calls?

For the effective implementation of S3 strategies, selection criteria play a crucial role (Nieth et al., 2018). To analyse how Member States/regions implemented their S3 strategies through calls for proposals, comprehensive data from the collected calls was extracted and analysed concerning the calls' selection criteria, in particular, concerning their S3 alignment.[76] To effectively analyse these, the information was classified into four categories, which are briefly explained below:

- **S3 alignment as an eligibility condition – formal:** This classification covers calls for which only S3-related proposals are eligible and their evaluation is based on the characteristics of the applicants, i.e., whether or not applicants belong to the categories or sectors explicitly identified in the S3 strategies.

- **S3 alignment as an eligibility condition – substantial:** For these types of calls only S3-related proposals are eligible and their evaluation is based on the characteristics of the projects, i.e., whether they are consistent with the S3 priority areas and the associated objectives.

- **S3 alignment as a preferential criterion in the selection process:** This classification covers calls for which non-S3 proposals are also eligible, but S3-related proposals are preferred in the selection process. Preference is given to S3-related projects, in the form of additional points or ad-hoc rankings. Their evaluation is based on the characteristics of the projects. This is an actual evaluation which is typically carried out by a selection committee.

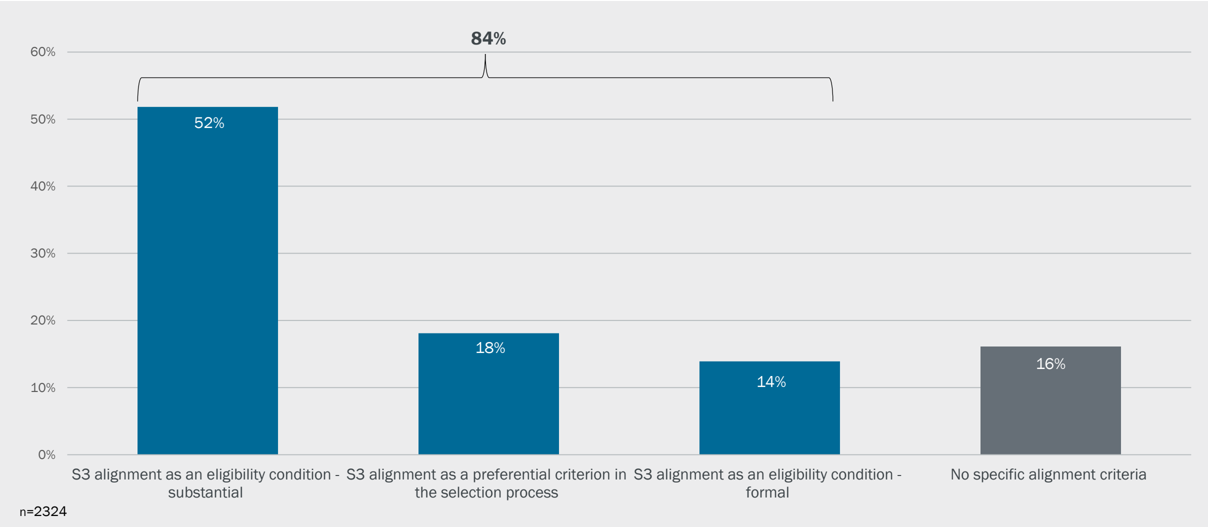
- **No specific alignment criteria:** This classification covers calls for which no specific criterion concerning the S3 is mentioned.

As Figure 6-2 shows, **almost all calls (84%) foresee an alignment to the S3 strategies**, whereas 16% of the calls do not require such an alignment. With respect to the classifications mentioned before, the analysis reveals that with 52% most of the calls require a substantial alignment to the S3. Calls that prefer S3-related proposals in the

[76] The databases for this is illustrated in Table 2-1 in Section 2.1.2, including an overview of the collected calls.

selection process ("S3 alignment as a preferential criterion in the selection process") account for 18% of the collected calls. Moreover, 14% of the calls are characterised by a formal S3 alignment condition. No specific alignment criteria were found in 16% of the collected calls.

Figure 6-2: S3 alignment criteria (all regions)



Source: Prognos / CSIL (2021). Note: To account for large variations in the number of calls between the Member States/regions the share in each region was computed and then averaged out. N=2324

The finding that most of the calls require an alignment to the S3 is further substantiated by the interviews that were held with the respective S3 managing authorities. From among 176 interviewees[77], 95% indicated that the priorities as outlined in the S3 strategies were reflected in the preparation and implementation of the programmes and/or calls for proposals. Moreover, these findings are in line with other findings in the literature. For instance, an analysis of the first calls for proposals launched in Italy, Poland, Portugal, Czechia, Hungary, Lithuania, and Slovenia, regarding the TO1 of national and regional Operational Programmes for the European Regional Development Fund finds a high level of alignment. Around 80% of these calls only accepted projects that are consistent with the priority areas identified in the S3 (Gianelle et al., 2019a).

To detect potential patterns between regions, the data concerning the calls for proposals is displayed on a more aggregate level. For this purpose, the **calls for proposals were categorised** as follows:[78]

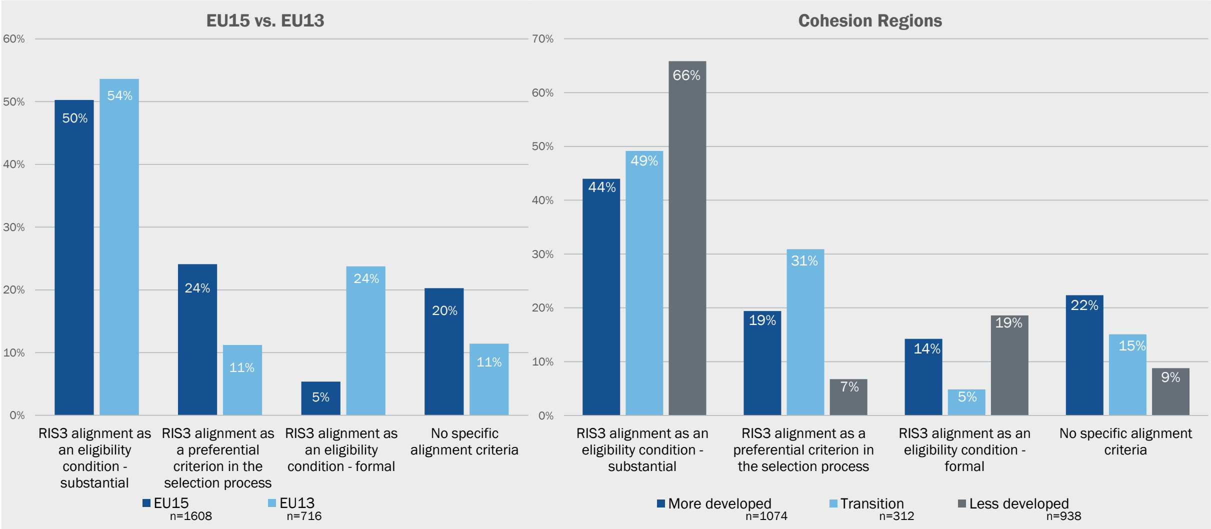
- EU15 and EU13 regions[79]
- Cohesion Region [80] (less developed regions, transition regions and more developed regions)
- Regional Innovation Scoreboard.

The analysis of the S3 alignment criteria of the calls and their regional classification yields the following results (see Figure 6-3). Calls that require a substantial alignment to the S3 strategy are more prevalent in Member States/regions that are classified as less developed in contrast to transition and more developed regions. No specific alignment criteria are found more often among calls in the EU15, transition and more developed regions.

[77] 176 interviewees out of a total of 181 interviewees gave an answer to this question.
[78] More information on the classification and the different categories can be found in Section 2.1.2.
[79] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:EU_enlargements
[80] https://ec.europa.eu/eurostat/documents/3217155/4387547/EU28-eligibility-1420.pdf

Figure 6-3: S3 alignment criteria (by regions)

Panel a: EU15 and EU13 Panel b: Cohesion Regions



Source: Prognos / CSIL (2021). Note: To account for large variations in the number of calls between the regions the share in each region was computed and then averaged out.

Calls that require a **formal alignment to the S3 are more dominant in EU13 and less-developed regions.** Moreover, less developed regions and EU13 Member States/regions less often issue calls for proposals with no specific alignment criteria. Based on these results it can be indicated that the older and more developed regions of the EU are less strict in their requirement regarding the S3 alignment of proposals. The same pattern applies to the regional classification according to the Regional Innovation Scoreboard (see Figure 9-6). Thereby, innovation leaders show similar patterns to the more developed regions. Simultaneously, the analysis of the S3 alignment criteria among the regions labelled as modest innovators yields similar results as the one of less developed regions.

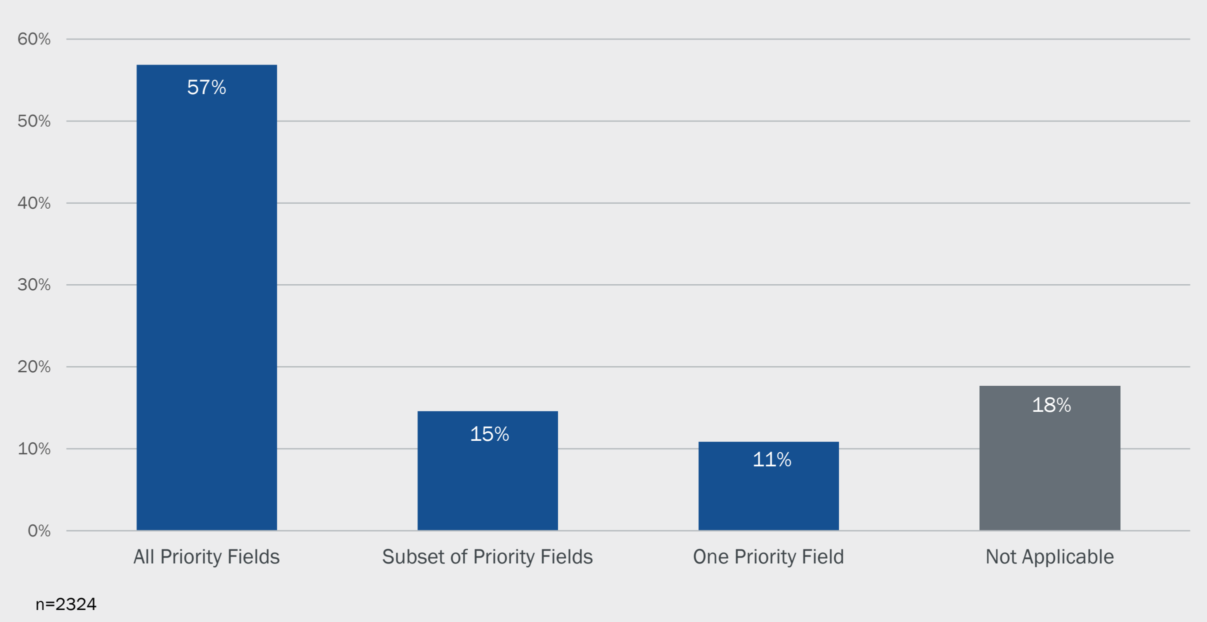
Furthermore, an analysis of the relationship between the strictness of calls for proposals (measured by the degree to which the priority areas had to be addressed) and the absorption of the budget for the first thematic objective revealed that no association can be observed between the degree of strictness in a region and its absorption capacity, as evidenced by Figure 9-12 in the annex. The analysis of the calls for proposals is taken up again in Section 6.3, in which the selection criteria are linked with the degree of correspondence of the priorities and the implemented projects.

Moreover, the collected calls were also analysed with regards to the priority areas they address. Based on this it was determined whether a call requires an alignment to all, a subset or only one priority area of a respective region. Thereby, a subset of priority areas refers to calls that address more than one S3 priority area but not all of them. Calls that do not require an alignment to the S3 strategy are included in the category "not applicable".[81]

As Figure 6-4Figure 6-5 shows, **the majority of the S3 related calls for proposal address <u>all</u> priority areas at the same time**. A subset of priority areas is addressed in 15% and only one priority area in 11% of all collected calls which fall under TO1.

[8181] It is worthwhile to mention that for a small number of calls that do require a S3 strategy alignment no information about the addressed priority areas was available. Hence, the share of "not applicable" is higher than the one of "not applicable" in Figure 6 2.

Figure 6-4: Priority areas addressed by calls for proposal (all regions)



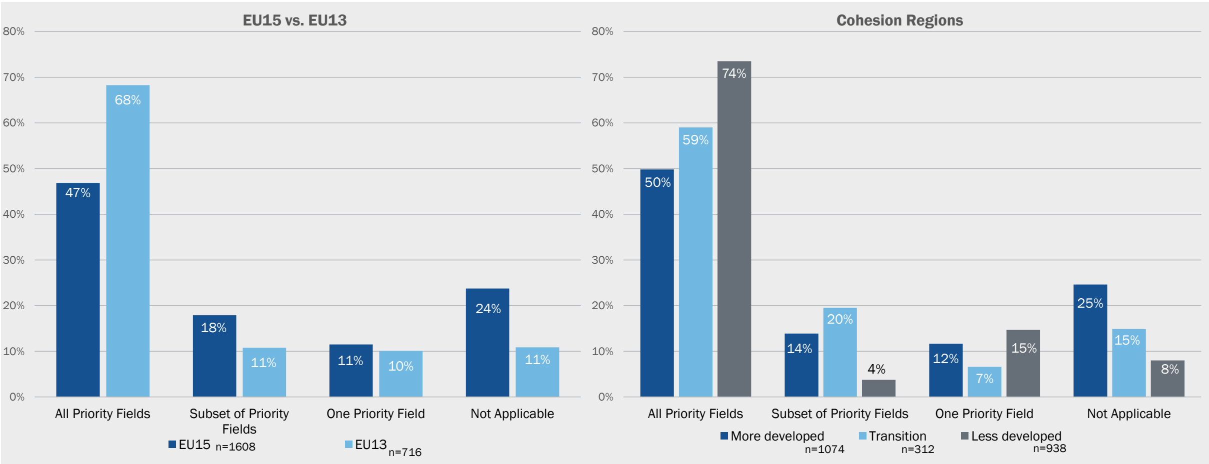
Source: Prognos / CSIL (2021). Note: To account for large variations in the number of calls between the Member States/regions the share in each region was computed and then averaged out.

Considering the analysis of the addressed priority areas and their regional structure (see Figure 6-5) a **difference mainly between the EU15 and EU13 as well as between the less and more developed regions becomes evident**. Calls in EU13 and less developed regions do more often address all priority areas compared to calls in EU15 and more developed regions. A subset of priority areas on the other hand is more often addressed by calls in EU15 and transition regions in contrast to calls in EU13 and less developed regions.

Figure 6-5: Priority areas addressed by calls for proposal (by regions)

Panel a: EU15 and EU13

Panel b: Cohesion Regions



Source: Prognos / CSIL (2021). Note: To account for large variations in the number of calls between the Member States/regions the share in each region was computed and then averaged out.

EU15 and EU13 Member States/regions are rather homogenous in terms of calls that address one priority area while the Cohesion Regions show rather mixed results for this classification. Since similar patterns emerged in the analysis of the addressed priority areas in the regional classification that follows the Regional Innovation Scoreboard these results are presented in the Annex (Figure 9-11). Thereby, the calls for proposals in less innovative Member States/regions tend to address all priority areas more often than the calls in more innovative regions.

These results provide EU-wide confirmation of previous indications in the literature. For instance, a study by Gianelle et al. (2019a) that analysed calls for proposals under TO1 in seven Member States (Italy, Poland, Portugal, Czechia, Hungary, Lithuania, and Slovenia) found that the majority of these calls addressed all priorities jointly. Broad (all-encompassing) priorities make coherence between calls and priority areas easier to achieve. However, by addressing all priorities at the same time, calls do not consider sectoral and technological specificities, as the very logic of smart specialisation would advocate (Gianelle et al., 2019a). The results from this study show that this is especially relevant for EU13 and less developed regions. Moreover, insights from the case studies that are illustrated in Box 6-1 provide additional information regarding good practices and lessons learned from some exemplary regions. Thereby, Romania exemplifies a less developed region in which the calls for proposal address all priority fields due to unclear levels of demand.

Box 6-1: Evidence from the case studies

i

From priorities to implementation

Denmark – Many specialization areas leading to a lack of critical mass

The project selection reflected well the prioritisation approach in each region and the project calls were generally aligned with the regional specialisation profiles. However, some regions experienced a lack of critical mass of actors in certain specialisation fields. This was because regions had identified too many specialisation areas, often unrelated with the regional technical and scientific profile, including within domains where there were lacks of innovative SMEs and critical mass of entrepreneurial resources.

Lithuania – Too specific priorities complicating project selection

After an interim evaluation of the initial S3 strategy priority areas were no longer strictly defined by a fixed list of 20 technologies (initially defined by the EDP process) but rather by a thematically oriented description. It was amongst others concluded that the too detailed description of specific technologies had become a limiting factor for participants in the R&D funding system. This approach led to situations where ideas/projects were excluded, which de facto fell within the priority areas' topics but did not de jure address one of the listed technologies. After the evaluation, the project selection is now based on the potential to address the themes and challenges of the Lithuanian priority areas. This should allow receiving more applications, and also encourage further cross-sectoral approaches.

Romania – Generic eligibility criteria to avoid non-absorption

The ERDF funded OP was based on calls for proposals, with an external evaluation of the correspondence with the S3 priorities and the RD&I component. The financial allocation was not based on priorities; the connection with the smart specialization priorities was an eligibility criterion, with the requirement to address at least one of the S3 priorities. This was considered the best approach, as there was not a clear view of the level of demand by priority and a risk of not spending all the money allocated was perceived. For the last ERDF funded calls for proposals, it was also compulsory to have activities leading to product/process innovation.

Source: Prognos / CSIL (2021).

6.3 Correspondence between implemented projects and the regions' priority areas

RQ: How did the project selection process reflect the prioritisation? Has the selection process led to focus on specific smart specialisation areas?

Based on a matching of the S3 priority areas of each Member State/region with the respective ERDF R&I projects (see Section 2.1.3 for a description of the underlying methodology), this section aims at displaying the share of projects for each Member State or region that is linked to the priority areas. It also illustrates the share of the budget that has been spent on projects (Section 6.1). Finally, the linkage between projects and priorities is illustrated at a more aggregate level and overarching topics that were addressed by the projects are discussed.

Linkage of projects with S3 priorities in the Member States and regions

Overall, the analysis highlights that **on average 57% of the projects are connected to the priority areas** (49,749 out of 86,487) as outlined in the initial S3 strategies for 167 Member States/regions[82]. This is further outlined for all Member States/regions on the following Map 6-3 (a). Here, major differences between Member States/regions in the degree to which projects correspond with priorities are illustrated. While some display an extremely high share of corresponding projects (e.g., Andalucía, Bourgogne, or Latvia), the share in other Member States/regions is rather low (e.g., Haute Normandie, Región de Murcia, etc.).

On a more aggregate level, **54% of the projects from EU15 Member States/regions are corresponding to the S3 priorities**, **the share is on average at 65% in EU13 Member States/regions**. Concerning the classification of regions into Cohesion Regions, the picture is relatively balanced. However, it appears in line with the findings for the EU13/15 regions, that Member States/regions that fall into the less developed regions have on average more projects connected to their priorities (60%), compared to transition and more developed regions (58% and 54% respectively).

The differences between shares are in some cases exaggerated by the **varying number of implemented projects**. For instance, only two relevant projects were identified for Western Macedonia, exacerbating the likelihood of either very high or very low share of projects with priority linkage. The number of projects in the respective regions depends on the specific circumstances in the Member State/region. For Western Macedonia, the case studies show that the specific OP architecture created an imbalance in terms of available resources between national and regional OPs. Such an imbalance had also an impact on the behaviour and interest of local stakeholders which perceived calls from the national OPs as richer and more "appealing" than calls originating from regional OPs. This has somewhat undermined the role and reach of the regional strategy and is also reflected in a low number of relevant projects.

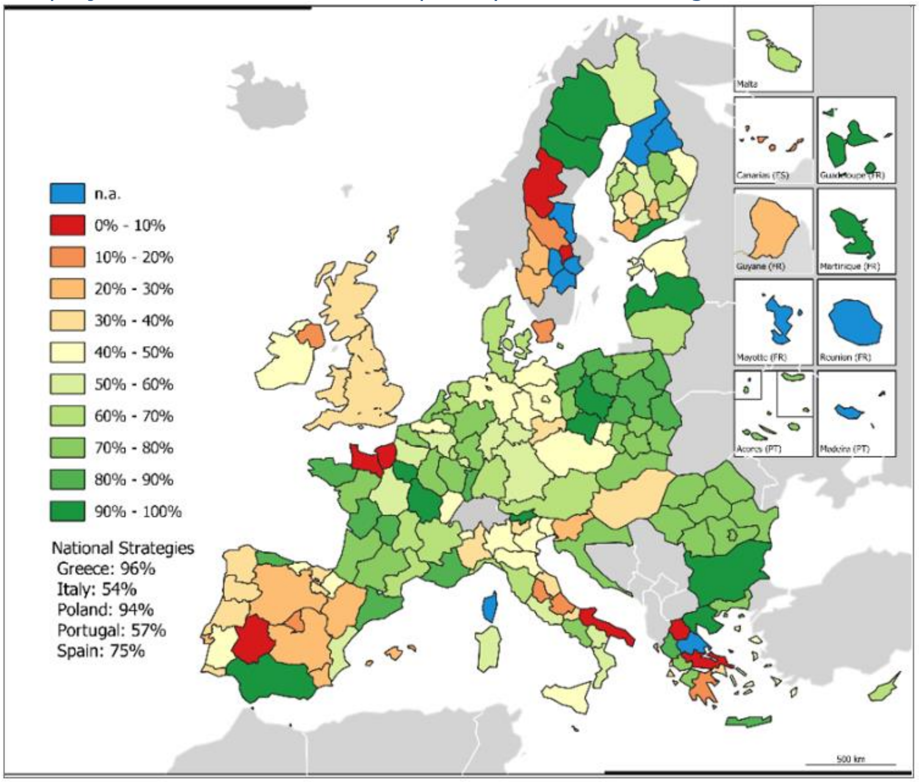
Overall EUR 19,6 billion have been spent on projects linked to priority areas (62% of the budget that has been identified overall[83]). The distribution of this is mostly a reflection of the share of the projects with a linkage to priority areas (see Map 6-3 (b)). The differences can either be explained through the non-availability of data on the budgets for certain Member States/regions or the varying sizes of the budgets attached to the projects. The amounts that have been spent per Member State/region on projects linked to priorities vary significantly. Unsurprisingly, they are the highest in Member States such as Poland, Spain, Czechia, and Hungary, where also a good share of TO1 funding is going.

[82] The difference between the number of S3 strategies (185) and the total number of Member States/regions that are used for this section exists because some regions did not record any projects (Thessaly, several Finnish and Swedish regions, Mayotte, Martinique) or there were no projects on the NUTS level of the S3 strategy (regions in Romania, OP only on a national level).

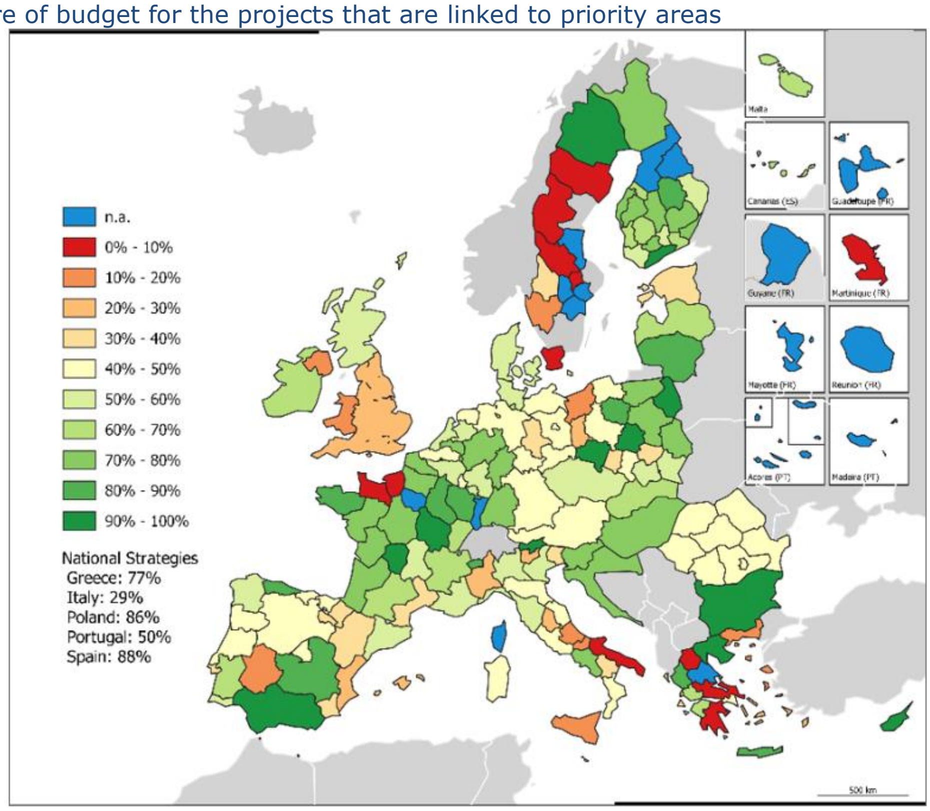
[83] 100% equal to EUR 31,3 billion (list of the JRC plus budgets of regions that were added – see methodology.

Map 6-3: Share of projects and budget that are linked to priority areas

Panel a: Share of projects that are linked to the priority areas in the region



Panel b: Share of budget for the projects that are linked to priority areas



Source: Prognos / CSIL (2021). n = 167 regions. Note: The figure is based on the projects that were successfully connected with the priority areas. Data for Romanian regions is aggregated at the NUTS0 level. The overall budget that has been linked to these and which is the bases for this figure is EUR 19.6 billion. When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are given by the figures next to the respective regions. These Member States are Italy, Greece, Spain, Poland, and Portugal. The projects/budgets for the Member States marked in blue were not available.

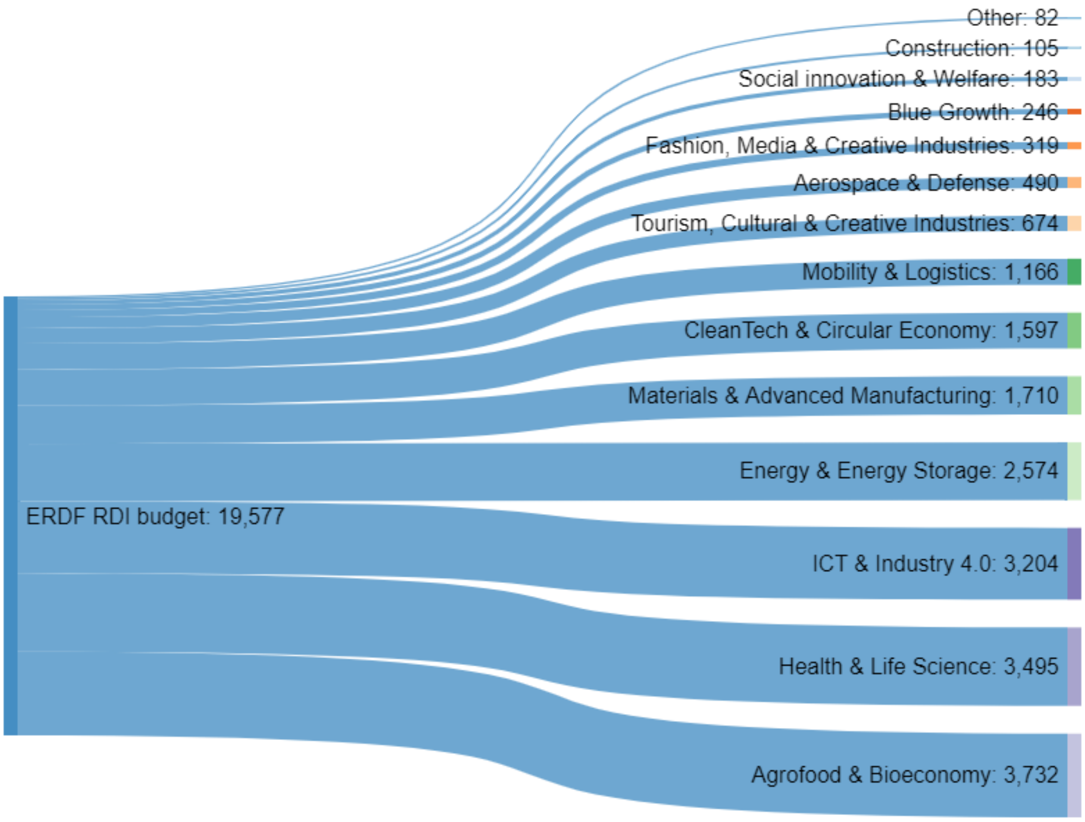
Thematic focus of ERDF projects in the Member States/regions

As a further step, the S3 priority areas identified in Chapter 4 were grouped into overarching thematic domains such as 'ICT & Industry 4.0', 'CleanTech & Circular Economy', or 'Aerospace & Defence' to allow for better comparability. This was done through a LDA algorithm which was set up to calculate ten topics based on the descriptions of the priority areas. Subsequently, the topics with the highest shares were assigned to the priority areas by computing the document-topic distribution for each priority area.[84]

Based on the matching of the prioritisation and the project database these topics were then assigned to the projects that are linked to the priority areas.

The following figure shows the volume of ERDF funding that has been spent on projects with S3 linkage in the different thematic domains of S3 strategies across the EU Member States/regions.[85] As outlined above, altogether almost EUR 19.6 billion have been channelled into projects in the S3 priority areas. Around 50% of these project budgets have been directed towards three thematic domains, namely **'Agrofood & Bioeconomy' (EUR 3.7 billion; 19%), 'Health and Life Sciences' (EUR 3.5 billion; 17.9%) and 'ICT & Industry 4.0' (EUR 3.2 billion; 16.3%)**, as can also be seen in Figure 6-6.

Figure 6-6: Overarching thematic domains and budget that was spent on these in the course of ERDF projects



Source: Prognos / CSIL (2021). Note: The numbers are based on the projects that were successfully connected with the priority areas of 167 regions, meaning that projects that potentially fell into a certain overarching thematic area, were however not connected with a priority field, are not included here. The overall budget that has been linked to these and which is the basis for this figure is EUR 19.6 billion.

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[84] After the automated allocation, a quality check was carried out, which led to manual adjustments. Here, some topics were split, for instance transport into mobility and aerospace, which led to a final number of 14 themes.

[85] Therefore, this means that this is not an overview thematic distribution of ERDF R&I funding overall but rather an overview of the thematic distribution of ERDF R&I funding that is linked to the S3 priorities.

All in all, these findings show an overall good correspondence between implemented projects and S3 priority areas, both in terms of a number of projects and the amount of funding. Considering the focus of funding on three key thematic domains that are also the most relevant priority areas across the EU, we can state that prioritisation in implementation has worked out relatively well.

6.4 Analysis of selection mechanisms for calls for proposals addressing the priority areas

RQ: Has the selection process led to the projects' implementation in the priority areas?

Whereas the current literature on S3 implementation so far only focused on the analysis of project selection processes (see e.g., Gianelle et al., 2019a; Polverari, 2016), the following analysis will go a step further and combine the previous EU-wide insights on the S3 selection criteria for TO1 projects (Section 6.2) with the information on the number of ERDF funded R&D projects that effectively were implemented in the Member States/regions (Section 6.3).

The following Table 6-2 provides a first overview on the relationship between the S3 alignment criteria that were used by the Member States/regions' TO1 related calls for proposals and the number of ERDF projects implemented. As it can be seen, many **Member States/regions tend to both have a large share of TO1 calls with specific S3 alignment criteria and a high correspondence of R&D projects with the respective priority areas**.

Table 6-2: Correspondence between the share of TO1 calls with a S3 alignment criteria and the share of ERDF funded R&I projects in the Member States/regions

		Share of ERDF R&D projects with a link to at least one priority area					
		0-20%	21-40%	41-60%	61-80%	81-100%	Total
Share of ERDF O1 calls with S3 alignment criteria	0-20%	1	1	4	0	0	6
	21-40%	1	1	2	1	0	5
	41-60%	2	1	1	3	3	10
	61-80%	2	2	6	4	3	17
	81-100%	5	13	29	34	21	102
		11	18	42	42	27	

Source: Prognos / CSIL (2021). n = 140 Member States and regions. Due to missing information on calls for proposals and ERDF project data in some Member States/regions as well as incompatibilities on the NUTS levels, the analysis focuses on a subset of the initial 185 regions.

This effect might be strongly driven by the fact that, as mentioned before in Section 6.2, the overarching number of TO1 calls had quite broadly defined alignment criteria, where a project can address any S3 priority areas of the respective Member State/region. Besides, around 2/3 of the TO1 calls had "substantial" or "formal" eligibility conditions, which made it generally impossible for a project to be accepted when it did not focus in any way on the S3 priority areas of the region.

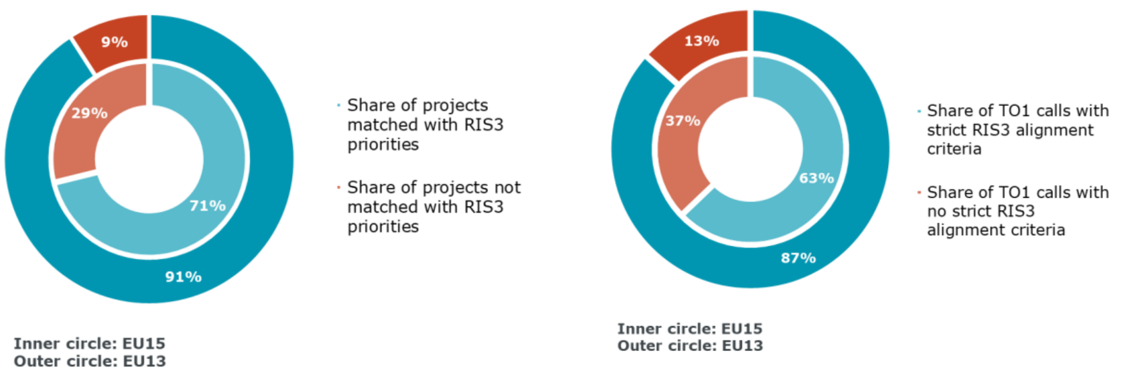
The analysis in Section 6.2 and Section 6.3 for the different regional categories (EU15 vs EU13 and Cohesion Policy categories) seem to confirm this finding. Those regions, that more often made use of stricter S3 eligibility criteria, seem to also have a larger share of ERDF funded R&I-projects that are related to their respective S3 priority areas.

Regarding the comparison of the EU15 Member States/regions as compared to the EU13 regions, the findings indicate that the latter made much more use of stricter S3 alignment criteria (i.e., substantial, or formal) (see Figure 6-7). Whereas about 63% of the TO1 calls in the EU15 Member States/regions use such strict conditions, the share in the EU13 Member States/regions (87%) is significantly higher for the 140 Member States/regions subject to this analysis. At the same time, the analysis on the correspondence between ERDF funded R&I projects and the S3 priority areas indicates that the EU15 countries seem to have a lower share in this regard (54%) as compared to the EU13 Member States/regions (65%).

Figure 6-7: Correspondence between the share of R&I projects matching the S3 priorities and stricter S3 alignment criteria, E15 vs EU13

Panel a: Share of projects matched

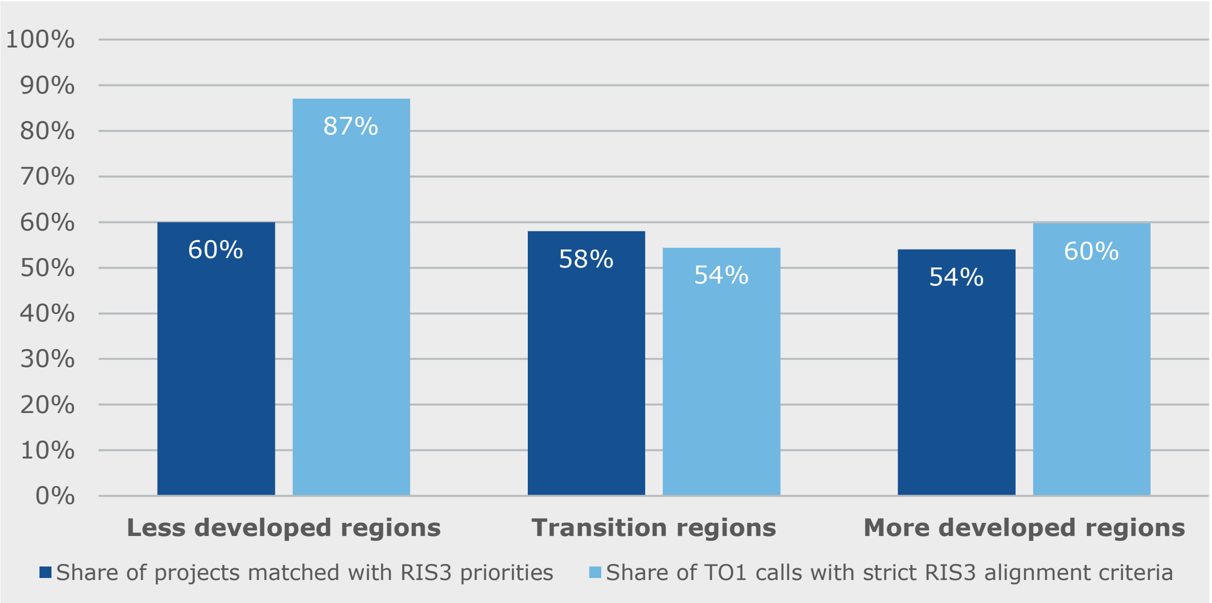
Panel b: Share of TO1 calls with strict alignment criteria



Source: Prognos / CSIL (2021). n = 140 Member States and regions. Due to missing information on calls for proposals and ERDF project data in some regions as well as incompatibilities on the NUTS levels, the analysis focuses on a subset of the initial 185 regions. Therefore, the figures are slightly different from those in Sections 6.2 and 6.3.

The same pattern, even though somewhat weaker, can be identified for the less developed, transition and more developed regions (see the figure below). Whereas the less developed regions have about 87% of TO1 calls with stricter S3 eligibility criteria, this share drops to 54% and 60% for the transition and more developed regions, respectively. Again, the share of ERDF funded R&I projects with a link to a S3 priority area is higher in the regional category with stricter eligibility conditions. In less developed regions around 83% of all R&D projects are linked to at least one priority area as compared to 54% and 60% for the transition and more developed regions, respectively.

Figure 6-8: Correspondence between the share of R&I projects matching the S3 priorities and stricter S3 alignment criteria across the different Cohesion policy region categories



Source: Prognos / CSIL (2020). n = 140 Member States and regions. Due to missing information on calls for proposals and ERDF project data in some regions as well as incompatibilities on the NUTS levels, the analysis focusses on a subset of the initial 185 regions.

7 CONCLUSION, LESSONS LEARNED ON THE FIRST CYCLE OF S3 STRATEGIES & RECOMMENDATIONS FOR S3 2.0

The main objective of this final section is to develop proposals for the future development of smart specialisation strategies based on the analysis performed in this study. A major focus is placed both on identifying strengths and weaknesses in the current approach to prioritisation in S3 as well as its implementation through calls and projects under ERDF programmes in the 2014-2020 period. Against this background, Section 7.1 introduces the new "S3 Scoreboard", which consolidates the comprehensive assessments into one overarching assessment of the processes and outcomes of S3 in the 2014-2020 period. This is followed by Section 7.2, which summarises the merits and demerits of current approaches to prioritisation and S3 implementation. Next, suggestions for the subsequent generation of S3 strategies are derived (Section 7.3) and, finally, an outlook is given in Section 7.4.

In addition to the key research questions outlined in the introductory parts of this report, the following sub-questions will be considered when **delineating recommendations** on future smart specialisation strategies/policy:

1. What factors support *better* prioritisation? Does any specific model of S3 design and/or implementation deliver *better* prioritisation?[86]

2. In terms of public spending, do S3 strategies that prioritise more (i.e., define a smaller number of priorities or select more specific priorities) spend resources *better* (i.e., in terms of absorption)?[87]

3. How can S3 strategies address the tension between path dependency of endogenous fields of expertise and disruptive innovation?

Based on this, we will provide suggestions on how future strategies could improve both in terms of **prioritisation** (i.e., how to find the *right* priority areas) and **implementation** of the defined set of priority areas. Considering current insights into S3 strategies and their priorities, emphasis is placed on good practices at the "level of granularity of priority domains", considering their competitive positioning and the socio-economic conditions of regions, economies of scale and scope.

7.1 The S3 Scoreboard 2021 – European S3 strategies compared

The "S3 Scoreboard" 2021 is a comparative assessment of all 185 smart specialisation strategies in EU Member States and regions based on a novel methodology, using six indicators grouped into outcome and process criteria (see Section 2.1.6 for the methodology behind the S3 Scoreboard). It provides a **detailed breakdown of performance groups** with contextual data, including the share of ERDF budget linked to S3 priority areas, the continuity of the EDP or the strictness of selection criteria for S3 related calls under ERDF 2014-2020, which can all be used to analyse and compare the sophistication of S3 strategies across the EU.

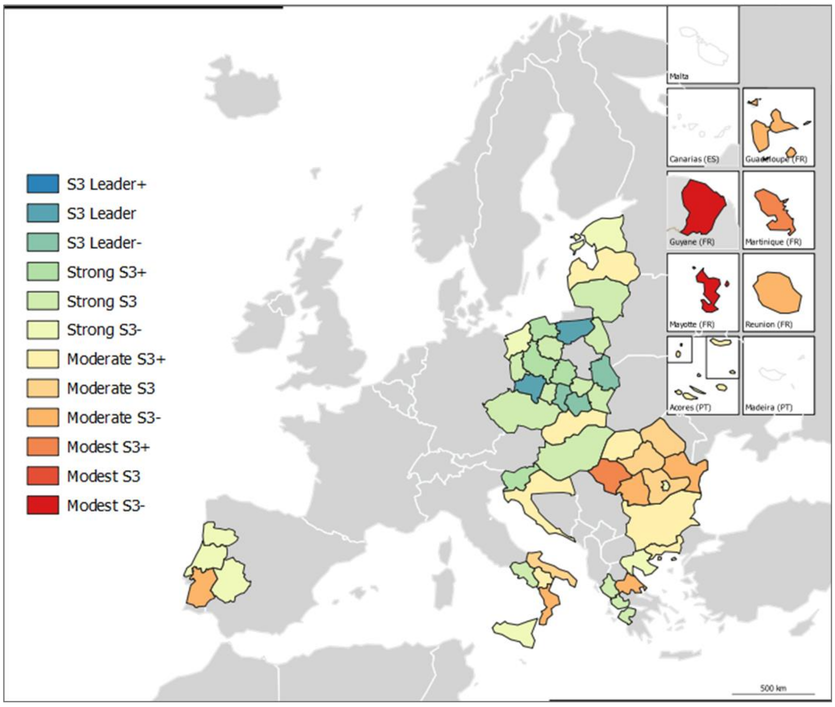
The S3 Scoreboard covers **163 regions across 28 European countries**. In addition, S3 strategies at the **country level,** like in Malta, Luxembourg, or Cyprus, are included.

[86] The term "better prioritisation" needs to be treated carefully. It should not be considered as an absolute term (e.g., a higher number of more specific priorities is better than a lower number of broader priorities, etc.) but rather it should be treated as a relative term (e.g., in which types of regions with their approach to prioritisation do we see a better match of selected priorities and endogenous innovation capacities, etc.).
[87] In line with the objectives of this study, the study is not about assessing the effectiveness of S3 strategies (i.e., it is not an impact evaluation). Therefore, "better spending" will be treated in relative terms and shall rely on qualitative judgements rather than on quantifiable metrics.

An overview of the **S3 Scoreboard by Cohesion Groups and National S3 strategies** can be found below and in more detail in Section 9.5 in the Annex.[88] The variation is particularly stark given the different starting points for smart specialisation in terms of the strength of the research and innovation system, the amount of resources available compared to national resources and levels of aid intensity.

In the figures below, a **comparison between regions at similar levels of development** (less developed, transition, and more developed regions) depicts the relative strength of S3 regions in each group of regions. Below the results for the S3 Scoreboard 2021 for the Less Developed Regions is shown.

Figure 7-1: S3 Scoreboard 2021 – Less Developed Regions



Among the 55 Less Developed Regions:

- 6 are S3 Leaders:
  - 2 S3 Leader
  - 4 S3 Leader-
- 25 are Strong S3:
  - 9 are Strong S3+
  - 12 are Strong S3
  - 9 are Strong S3-
- 20 are Moderate S3:
  - 9 Moderate S3+
  - 4 Moderate S3
  - 7 Moderate S3-
- 4 are Modest S3:
  - 2 Modest S3+
  - 2 Modest S3-

Source: Prognos / CSIL (2021)

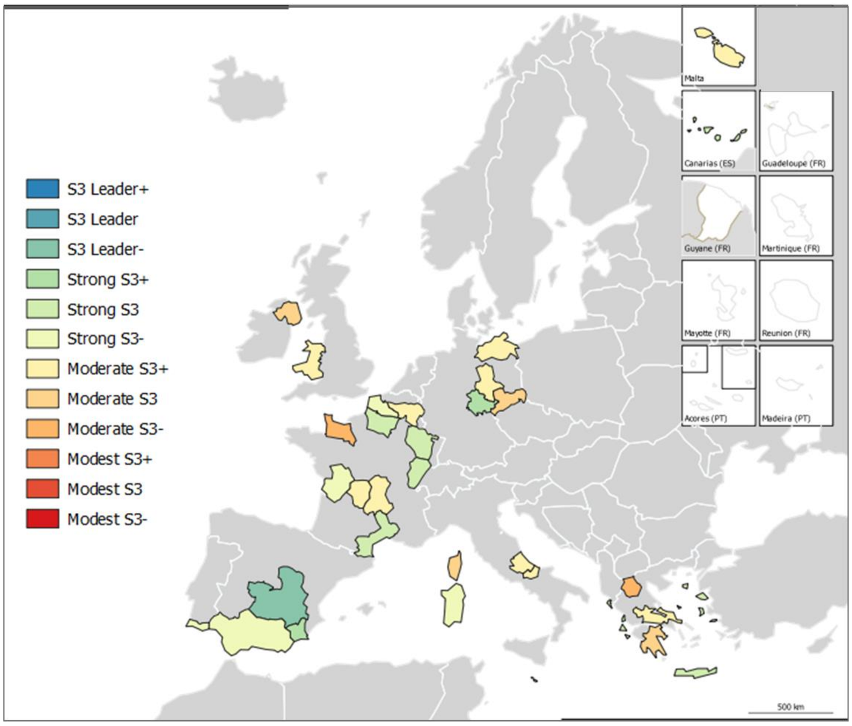
When comparing the S3 Scoreboard 2021 to the Regional Innovation Scoreboard (RIS) 2021 or the European Quality of Government Index (EQG) 2017, it stands out that several **regions/countries that have low innovation capacities and low institutional capacities perform relatively well in the S3 scoreboard**, as shown for the LDRs in the map above**.** This could be due to the fact that their financial envelope from EU funds (esp. ERDF) was relatively large (and larger than their own national R&I resources) and because these regions tried to follow the S3 approach in many parts (e.g., EDP, rules for selection of projects, etc.). In some cases, these regions might have even used S3 to experiment with less top-down (old style) policy approaches (e.g., Slovenia, Dolnośląskie/PL or Lithuania).

However, some Member States/regions that have low innovation and institutional capacities also perform relatively poorly in the S3 Scoreboard. A possible explanation for these cases could be that existing assets and capacities were too much of a limiting factor or that the S3 approach was not applied very systematically due to, for instance, the lack of political will, limited administrative capacity, limited interest from stakeholders or a weak private sector. Examples include Western Macedonia/EL and Calabria/IT.

[88] The underlying data for the "S3 Scoreboard" is presented in Table 9 32, Table 9 33, and Table 9 34 in Section 9.3.

The results for the **Transition Regions** are shown below, indicating a mixed picture of strong and moderate S3 strategies. While 16 out of 33 Transition Regions in the 2014-2020 period have been classified as Strong S3 or better, 17 regions have rather moderate S3 strategies.

Figure 7-2: S3 Scoreboard 2021 – Transition Regions



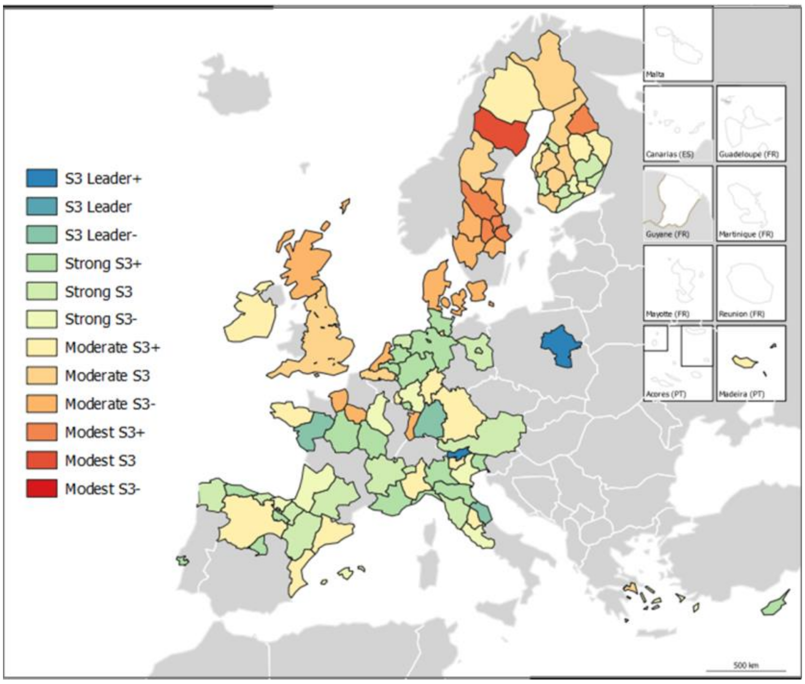
Among the 33 Transition Regions:

- 1 is a S3 Leader-
- 15 are Strong S3:
  - 2 are Strong S3+
  - 8 are Strong S3
  - 5 are Strong S3-
- 17 are Moderate S3:
  - 10 Moderate S3+
  - 4 Moderate S3
  - 3 Moderate S3-

Source: Prognos / CSIL (2021)

In more developed areas, **some Member States/regions that perform strongly in the RIS 2021 and EQG 2017 underperform in the S3 Scoreboard**, as depicted in Figure 7-3. Here, an explanation could be that the financial envelope of S3 was thin compared to national resources for R&I. Additionally, a strong tradition and experience with (regional) innovation policies could be another potential explanation for this observation. Interestingly, the MDRs of the 2014-2022 period show the biggest span, with all Scoreboard categories represented and five S3 leaders and six modest S3.

Figure 7-3: S3 Scoreboard 2021 – More Developed Regions



Among the 97 More Developed Regions:

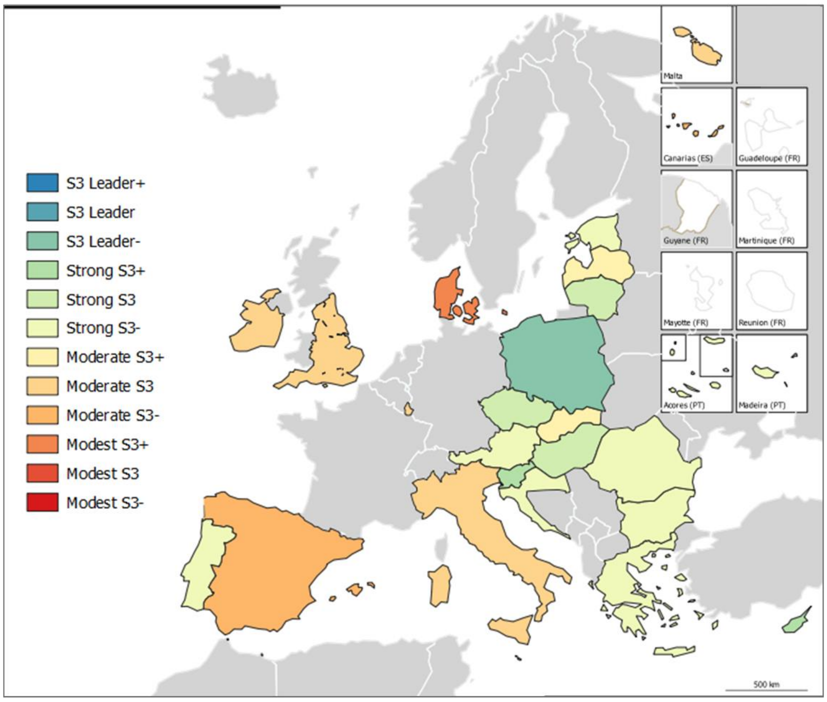
- 5 are S3 Leader
  - 2 S3 Leader+
  - 3 S3 Leader-
- 46 are Strong S3:
  - 19 are Strong S3+
  - 17 are Strong S3
  - 10 are Strong S3-
- 40 are Moderate S3:
  - 18 Moderate S3+
  - 11 Moderate S3
  - 11 Moderate S3-
- 6 are Modest S3:
  - 5 Modest S3+
  - 1 Modest S3

Source: Prognos / CSIL (2021)

These Member States/regions may have followed the S3 approach to some extent but did not fundamentally change their policies and policy approaches as a consequence of it. Relevant examples include the Nordic countries (Sweden, Finland, Denmark), the UK or some German, French, and more developed Spanish regions (e.g., Basque). This Nordic paradox and similar cases need to be assessed in more detail in the future to understand the mismatch between (current) innovation strengths (as depicted by the RIS 2021 and similar assessments) and future innovation opportunities stimulated by S3.

Finally, the **22 national S3 strategies** across the EU perform relatively well in the S3 Scoreboard 2021. Out of 22 national S3 strategies, 60% are classified as strong or even as S3 leaders, and only eight are considered moderate S3, and one as modest.

Figure 7-4: S3 Scoreboard 2021 – National Strategies



Among the 22 national strategies:

- 1 is S3 Leader-
- 12 are Strong S3:
  - 2 are Strong S3+
  - 3 are Strong S3
  - 7 are Strong S3-
- 8 are Moderate S3:
  - 2 Moderate S3+
  - 4 Moderate S3
  - 2 Moderate S3-
- 1 is Modest S3+

Source: Prognos / CSIL (2021)

Finally, in some cases, regions pursued S3 strategies based on **more disruptive forms of innovation** that build on regional capabilities yet encourage greater flexibility in outcomes. This is a higher risk approach of unrelated diversification that is presumably less appropriate to less developed regions (see Chapter 5 for details).

While the S3 Scoreboard sheds light on the relative performance of S3 strategies across Europe, i.e., the process and immediate outcomes of these strategies, it does not provide direct insights on the level of ambition of these strategies (e.g., in terms of technological innovation and diversification goals) nor their impact on regional innovation capabilities. The latter will require further evaluations in the next few years. Some further answers on the strengths and weaknesses of S3 strategies are outlined below.

7.2 Synthesis of key findings on strengths and weaknesses of prioritisation and implementation of S3 strategies in Europe

From the outset, S3 was intended to be more than just a case of re-naming existing strategies. Rather, it implied an ambitious strategy that sought to prevent "copycat" behaviour with regards to chosen priority combinations. Therefore, the ExAC 1.1 requested national and regional decision-makers to make choices and to "concentrate resources on a limited set of research and innovation priorities".[89]

The following sections summarise the **key findings** of the study regarding the overarching research questions, which focus on how and if prioritisation was achieved (RQ 1), how the selected priorities reflect the actual regional profiles (RQ 2) and how the selected priorities have been implemented (RQ3).[90]

[89] See the Common Provision Regulation 1303/2013 for Cohesion Policy.
[90] See Figure 1 1.

Key findings regarding the development of S3 strategies and the delineation of the priority areas

1. **A broad stakeholder process has been applied in the majority of Member States/regions.** This stakeholder process mostly consists of stakeholders from the private, public and research sectors and to a lesser extent those from civil society. While a broad stakeholder process is seen as a key success factor, some Member States/regions have encountered difficulties in this process, which are mostly attributed to different understanding/different interests when it comes to S3. A clear and, if possible, dedicated governance structure has proven to be important in this regard but difficult to implement in light of a lack of human, budgetary and time resources.

2. **Member States/regions have used a wide range of different instruments and processes when it comes to the EDP and data analysis.** Most S3 strategies include EDP-related information gathering activities such as focus groups, workshops and interviews or mapping activities of, for instance, research centres. Similarly, many S3 strategies make use of information processing tools such as SWOT analyses. Information gathering activities such as the mapping of involvement in international R&D projects or technological foresight analysis are far less common.

3. **A continuous EDP could not be established in many regions, although formal continuity was slightly higher in EU13/less developed regions.** The continuation of the EDP (involvement of stakeholders in the implementation and monitoring phases) is seen as important but difficult to achieve. While the share of Member States/regions that use some sort of sustained EDP is slightly higher in EU13/less developed regions, it has proved difficult to continuously mobilise stakeholders, especially from the private sector, to maintain dialogue. The involvement of network organisations such as cluster initiatives and business associations are mentioned as being supportive in this regard (European Expert Group on Clusters 2021). A continuous EDP has worked particularly well in Lombardy and Berlin/Brandenburg (confirmed in the case studies) and in other Member States/regions such as Poland (national level). On the other side of the spectrum, a limited/one-off EDP has been observed in Western Macedonia (see case studies, Annex 9.6) and other regions such as Malta, East Netherlands, and Wales.

4. **Data analysis to determine S3 priority areas has in many cases not been sufficiently granular.** Regarding the analysis of the economic performance, only 12% of the S3 strategies make use of NACE-2/3-digit data. For the analysis of technological/scientific performance, only 19% use more in-depth data. In contrast to that, 47% of the S3 strategies are based on economic analysis of NACE-1-digit or the overall economy level, and 41% of the S3 strategies are based on an analysis of the scientific/technological performance on a more general level. Qualitative evidence shows that very general data analysis or a sheer lack of data analysis are key obstacles when attempting to narrow down S3 priorities.

Key findings regarding the prioritisation approaches used in S3 strategies

5. **The most prevalent topics addressed in the S3 priority areas are linked to engineering and ICT-related fields.** This confirms the finding from the literature review that many strategies seem to have an emphasis on R&D and technology-driven themes, while non-R&D-related topics are addressed to a lesser extent. At the same time, the fact that ICT topics were addressed so frequently by the priority areas is a sign that ICTs were often relevant as cross-cutting themes due to the ongoing digitalisation in each area of society, underlining its role as a GPT (i.e., applications of ICT in the field of energy, health, or mobility). At the same time,

analysis of the thematic orientation of the S3 strategies reveals that the priority areas often tackle the societal challenges for a green and sustainable transition.

6. **Priority areas are mostly based on a combined priority-setting approach and are generally not framed in terms of single scientific, economic, or technological fields.** Rather, they are defined at the intersection of these domains and aim to solve specific societal and environmental challenges or seek to make use of the Member States'/regions' specific cultural or natural endowments. The analysis shows that 95% of the S3 strategies use this joint priority-setting approach, considering at least four of these different elements (i.e., science, technology, economy, societal challenges, as well as cultural and natural resources). Despite their frequent combination, some elements are more pronounced in the priority-setting process than others. In this regard, economic sector-driven priority-setting appears to be more relevant and widespread.

7. **There are only very minor regional differences regarding the degree of complexity of S3 strategies and their priority areas**. The share of highly complex technology fields and high-tech economic sectors addressed by the priority areas targeted in S3 strategies is relatively similar for less developed (18% for technology fields and 24% for economic sectors), transition (17%/23%) and more developed regions (20%/25%). This may explain the desire of lagging-behind regions to use their S3 strategies to leapfrog into R&D-driven sectors and thereby support commercial innovation, as previously mentioned by Radosevic (2017), and may also help explain the potential mismatch between endogenous innovation capacities and selected priority areas (compare findings on "correspondence" below).

8. **Referring to the absolute number of priority areas is misleading, especially for Member States/regions that use a multi-level (tree-shaped) structure with a few broadly defined main priority areas and several sub-priorities**. The finding emphasises the importance to look beyond the main priorities to identify the real level of prioritisation. At the same time, Member States/regions using such multi-level priorities must ensure that the topics addressed in their S3 strategy do not become too wide (thematic bandwidth), as is currently the case in some Member States/regions. Member States/regions with particularly broad S3 strategies are Portugal (bandwidth index of 76%; EU-average: 38%), Poland (66%), and Austria (63%; all national S3 strategies) as well as a number of French regions such as Bretagne (80%), Limousin (74%) or Pays de la Loire (70%). As Gianelle et al. (2019a, p.8) point out: "For a policy intervention to be selective, the priority tree needs to be sparse."

9. **Larger and economically stronger Member States/regions seem to prioritise less compared to smaller regions.** The data shows that Member States/regions with higher total ERDF TO1 funding, higher total R&D expenditures (GERD) and larger population sizes tend to define more priority areas (in absolute terms) and tend to cover a broader, less focused thematic spectrum in their S3 strategies as compared to smaller Member States/regions with lower financial resources. This can be related to the fact that larger and financially stronger Member States/regions find prioritising and concentrating resources less suited to their productive, scientific, and technological profile (Foray, 2019; Hassink and Gong, 2019). At the same time, larger and economically more diversified Member States/regions can face specific political challenges. A very focused approach on a few sectors potentially leaves out a larger number of actors, who may then engage in lobbying activities to be included in the strategy.

Key findings regarding the correspondence of the S3 strategies with the regional profile

10. Even if S3 priority areas may be defined in terms of economic sectors (point 6 above), **S3 priority areas generally do not match the economic profiles of the Member States/regions** (according to any employment-based indicator used). The Member States/regions that best match economic profiles are mostly transition and less developed regions, but there are also a few more advanced regions with strong sectoral specialisation. Some S3 strategies seem to have considered ongoing processes of structural transformation, by picking priorities in economic sectors characterised by higher employment growth rates.

11. Priority areas of S3 strategies more often match the scientific profiles of EU countries and regions (regardless of the indicator used to proxy the scientific profiles; based on publication and citation data). However, Member States/regions generally target fields of scientific production, i.e., those characterised by higher shares of publications within the Member States/regions, more than areas of true scientific excellence at the international level.

12. S3 priorities generally match the technological profiles of Member States/regions (using regional patent shares as a proxy). The correspondence is positive and strong especially for more developed and innovative Member States/regions. The analysis indicates that it is generally easier for Member States/regions to target areas of technological strength in their territory, which do not necessarily correspond to areas of strong specialisation when compared to other EU regions.

13. Both public and private-sector scientific and technological strengths seem to be reflected quite well in the S3 strategies. More specifically, correspondence with scientific and technological profiles assessed against publications and patents owned by private companies match S3 priorities slightly better than profiles assessed based on public ones (e.g., universities or governmental authorities), although the difference is small. This finding is in line with the fact that both public and private sectors have been involved in the EDP of the large majority of S3 strategies.

14. Several S3 strategies selected priority areas closer to their knowledge space (as indicated by a positive correlation between S3 priorities and the technological relatedness index). However, there are also Member States/regions that pursued more ambitious strategies, targeting complex technologies, more distant from their current capabilities and aiming at unrelated diversification. Distinguishing between ambitious but feasible and over-ambitious strategies, however, is not straightforward and will require additional research in the coming years.

15. In synthesis, four groups emerge when considering the overall correspondence of S3 priorities with the national/regional profiles[91]:

a. **61 S3 strategies** *match particularly well* with their **scientific profile** (29.2 %);
b. **62 S3 strategies** *match particularly well* with their **technological profile** (29.7 %);
c. **33 S3 strategies** have a *good level* of correspondence with the **economic profile** (15.8 %);

[91] The total number of S3 strategies considered here is 209, which includes initial and updated strategies. The number of regions for which S3 strategies fulfilling ex-ante conditionality 1.1. have been identified was 185.

d. **53 S3 strategies** *do not match well* with **any profile** (scientific, economic, technological), but reveal higher ambition in terms of technological innovation and diversification goals (25.4 %).

Key findings regarding the implementation of the selected S3 priorities

16. **ERDF funded calls/programmes predominantly require an alignment to the S3 strategies.** 84% of ERDF TO1 calls in the Member States/regions have a S3 alignment criteria in place. In this regard, some differences exist: especially less developed regions use TO1 calls aligned with the S3 priority areas more often (91% of all calls) compared to transition regions (85%) and more developed regions (78%). Looking more closely at the way that priority areas are addressed by the calls, most cover all priority areas together (i.e., the call is open for projects addressing any of the existing priorities) instead of focusing on single priorities. Here too, there exist some noticeable regional differences as less developed regions have a higher percentage of calls that address all priority areas compared to transition and more developed regions. The latter indicates that transition/more developed regions use more targeted calls to support their priority areas.

17. **Linkages between ERDF-funded projects and S3 priorities were found for 57% of the projects but there are substantial differences among MS/regions.** Overall, 49,749 out of 86,487 ERDF-funded projects analysed display a link to the corresponding S3 priority areas. This is also true for the share of the respective project budgets. Nevertheless, the findings also illustrate substantial differences regarding this link. While the average for less developed regions is the highest (69%), transition regions show the lowest average value (46%). More importantly, however, the variance between individual Member States/regions is more striking: while regions such as Bolzano (99%) in Italy, Wielkopolskie (95%) in Poland or Cataluña (89%) in Spain show particularly high shares of projects linked to their S3 priority areas, regions such as Haute Normandie (6%), Extremadura (9%) or Apulia (10%) stand on the other side of the spectrum.

18. **Overall, strict S3 eligibility criteria seem to be well applied in the project selection processes and support the selection of projects linked to priority areas.** Regions that more often make use of stricter S3 eligibility criteria (i.e., substantial, or formal) have a larger share of ERDF funded R&D projects that are related to their respective S3 priority areas. This becomes especially clear in EU-13 Member States/regions as well as in less developed regions, which have a significantly higher share of TO1 calls with strict S3 eligibility and a higher share of S3 related projects when compared to the EU15, transition and more developed regions: This is strongly driven by the national and regional S3 strategies in Poland and the national S3 in Greece. In Poland, 94% of the projects on the national level and 93% in the region of Dolnośląskie are related to S3 priorities, while simultaneously having strict alignment criteria in the calls. In Greece, 96% of the priorities contain S3 linkages, and similarly strict alignment criteria exist in the calls.

19. **The most frequently addressed priority areas of S3 strategies are also reflected in the implemented projects.** Across all 49,749 S3-related projects (out of 86,487 ERDF R&I projects; 57%), the topics of Agrofood/Bioeconomy, Health/Life Science, and ICT/Industry 4.0 are most prevalent. These overarching topics are also most often reflected in the priorities of the 185 S3 strategies, for instance through priority areas related to computer programming or priorities related to health and agriculture.

All in all, a **complex and multi-faceted picture regarding prioritisation and implementation of smart specialisation strategies** emerges in the EU: on the one hand, priority areas of S3 strategies in the EU are largely based on objective data-driven identification processes, including the EDP. This has led to prioritisation approaches across EU Member States/regions that define a limited, yet often broad, set of priority areas oriented towards R&D and more technology driven themes.

At the same time, our analysis shows that overall, there is a **relevant linkage between ERDF-funded projects in the field of R&I and associated S3 priority areas**. Almost 60% of all projects considered were linked to S3 priority areas, with an investment volume of approximately EUR 20 billion equalling 62% of the overall identified ERDF expenditure on R&I (approximately EUR 31 billion). However, we also observe a wide gap between Member States/regions that managed to prioritise with >80% of ERDF-funded projects associated to priority areas of their S3 and other regions in which shares are around 10% or even lower.

Finally, our analysis also shows that **more than 25% of the S3 strategies do not match their endogenous innovation potential**, while the remaining strategies only match a single element of the innovation ecosystem (e.g., scientific, technologic, or economic). Although this finding does not inherently allow for a normative conclusion, it highlights that a better, more holistic delineation and specification of S3 priority areas may still be necessary to improve the potential effectiveness of smart specialisation along the different elements of the intervention logic.

7.3 Recommendations for policy makers on prioritisation and implementation mechanisms of S3

This study has derived several conclusions which provide important messages for future smart specialisation approaches in the Member States/regions of the EU.

As has been discussed throughout this report, despite efforts to identify suitable priority areas, there is (a constant) need to improve identification approaches that allow for a "better" definition of priority areas. These need to be evidence-based and assessed in the context of an international benchmark and should not be too broad, as this would undermine the rationale of smart specialisation. At the same time, a too narrow approach would potentially result in "picking winners". A better understanding of multiple levels of priorities and sub-priorities is needed (network hierarchy) along with the point in time when priorities are refined (e.g., in masterplans for specific priority fields or calls for proposals rather than in the main [static] strategy document). Referring to an absolute number of priorities when searching for an optimum may be misleading, as much depends on the structure of the economy but also on the level of priorities and timing. From an overall EU perspective, it is also crucial to reduce duplication and fragmentation of the R&I capacities across Member States/regions and rather find ways to identify common but specific priorities that could be jointly facilitated in the future.

The objective of the following section is to **provide suggestions** for the next generation of S3 strategies in view of improving prioritisation and its implementation in practice. These recommendations are developed around three main requirements for effective S3 strategies in the future, namely (1) *better* identification of priority areas, (2) *better* utilisation of (emerging) regional innovation strengths in these priority areas and (3) *better* monitoring and evaluation of the strategic choices (assessing whether they turn out to be suitable and whether the strategy is effectively implemented).

7.3.1 *Recommendations for improving prioritisation approaches and processes in future S3 strategies (incl. EDP)*

The analysis in this study shows that while Member States/regions largely followed an evidence-based approach in determining priority areas, S3 strategies are still often static and too broad. This can potentially be explained by analytical and financial capacity constraints as well as other influencing factors (political will, leadership, lobbying) when performing the necessary analysis for the respective S3 strategy. At the same time, the very idea of smart specialisation is based on the rationale that a set of clearly defined priority areas are selected in a top-down & bottom-up process based on innovation analytics and entrepreneurial discovery.

Suggestions for improved identification of economic, scientific, and technological potential in EU regions/Member States.

To improve the identification of priority areas in future S3 strategies that correspond to endogenous strengths positioned in an international perspective, thereby allowing for comparative advantages, the following preliminary suggestions can be made:

1. **The identification of potential priority areas based on secondary data requires a more holistic and at the same time, fine-grained and dynamic perspective*.*** By holistic identification we refer to the complementary competencies required in the regional innovation ecosystem and the potential priority areas – derived from scientific, technological, cultural, and economic sources. To clearly understand the potential endogenous capacities in these fields, detailed data on sectors, fields of research, cultural assets and technological capabilities need to be utilised. Moreover, a dynamic perspective needs to be adopted: identifying potential priority areas that can drive the ongoing transformation of regional economies requires an evolutionary view on endogenous innovation capabilities – be it in sectors, fields of research, technologies or elsewhere. Our analysis shows that when employment dynamics (i.e., which regional industries are developing particularly well compared to others/the national or EU average) are included in the identification of potential priority areas, we observe a better match between selected priorities and endogenous capacities. Similarly, including data on start-up activities (including venture capital investments) and their respective thematic focus helps to identify dynamic fields of (emerging) economic strengths or potential niches. All in all, this data-based identification and mapping exercise (top-down perspective) needs to be closely coupled with an ongoing EDP (bottom-up perspective; see Section 7.2.2). It will be important to take different starting points (development levels of regions) and future needs (green and digital) into account in the analysis. Linkages with national and regional initiatives should also be considered.

2. **Potential priority areas of S3 strategies need to be positioned in a global perspective*.*** As outlined above, identifying potential priority areas purely from an intra-regional perspective is insufficient – yet it still often occurs. It prevents S3 strategies from addressing differentiating elements that, given the windows of opportunity in a global context, could constitute comparative advantages. The use of specialisation indices, such as location quotients for the indicators mentioned above (employment, publications, patents, etc.), is a simple tool to compare the relative importance of the potential priority field to the national or European average. Complementary to this, future S3 strategies should position their priority areas more explicitly in an interregional value chain perspective. Analytically, this would require mapping global value chains (GVC)[92] and identifying the unique positioning of the region's priority area within the GVC (e.g., following the M3DA-approach)[93] whilst looking for interregional coalitions with EU Member States/regions providing complementary capacities. The new DG REGIO initiative

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[92] Technically speaking, value chain analysis could be based on multi-regional input-output (MRIO) tables showing the added value by different sectors within and across national economies. Whereas classical bilateral trade statistics analysis such as the OECD's "product space" approach (OECD 2019) only shows the value of the "final" traded goods or services, the value chain analysis allows for the identification the origin of the value added contained in these traded goods and services. It indicates the comparative advantage of a sector/economy.

[93] The M3DA-approach by Brennan & Rakhmatullin (2015), comprises five steps: (1) **M**apping (plotting out the various stages of GVC across geographies and firms) (2) **D**igging (exploring each stage of the value chain in terms of activities, resources, assets, capabilities, relationships and financial and operating data), (3) **D**etermining (exploring the orchestration of the value chains in terms of actors, linkages and flows), (4) **D**ecomposing (exploring each stage of the value chain into occupations and associated tasks), (5) **A**scertaining the participation possibilities by considering not only the status quo of GVCs from one to four above but by also anticipating likely future chain trajectories.

on "Interregional Innovation Investments" (I3) provides helpful structures for moderating these coalitions.

Suggestions for the identification of cross-sectoral innovation domains, related variety, and transformative areas.

Beyond that, the potential of innovation mapping approaches needs to be utilised more effectively, in particular when trying to identify cross-innovation potentials that entail the transformative capacity in driving future innovation-based growth in a region. In the central innovation topics of the coming decades cross-industry innovation will become a strategic imperative, especially at the interfaces between traditional industries. The interdisciplinary linkage of actors from different industries holds the potential to set new impulses in the innovation activities of companies of different sizes (cross innovation approach).

To help Member States/regions of different development levels to identify emerging, cross-innovation potentials, the mapping of related variety in regional innovation ecosystems and mapping of scientific, technological, and economic potentials beyond existing taxonomies will be key. The following approaches can be helpful in that regard:

1. **Identifying emerging innovation strengths through the utilisation of data from competitive public funding programmes:** Competitive public funding programmes, such as the Framework Programme of the European Commission (FP7, Horizon 2020, SME Instrument) or similar national and intergovernmental programmes (e.g., EUREKA, COST) often provide suitable data at a very disaggregated level. This primary data allows for the detection thematic strengths of sectors and firms within the respective Member State/region by the number of (related) projects, absorbed funding and quite specific thematic profiling (including key-enabling technologies). It also allows for comparative assessments, (e.g., by calculating an R&I excellence index as a share of funding per employee in the region with the funding volume per employee in the corresponding Member State or the EU). Moreover, this data uncovers existing network structures to innovation agents in other regions. This can be used for identifying partner Member States/regions for interregional innovation partnerships (see recommendation above).

2. **Mapping and profiling S3 priority areas using unstructured data and semantic analysis:** There is high, and largely, untapped potential for smart specialisation analysis, for instance through the mapping and profiling of priority areas and constant observation of their development in unstructured datasets on websites, the big data platforms of single private firms (including start-ups), research organisations and potentially even labour markets. Using web-scraping techniques and deep learning text analysis models, unstructured data from websites and/or big data platforms[94] could be used to help identify priority areas beyond static public statistical classifications (incl. relevant indicators on industry & innovation) and to assist in determining their specific comparative advantage and specialisation profile (thematically using LDA). Besides, these techniques allow for complementary forms of network analyses in regional and international networks, e.g., by using the number of hyperlinks to other relevant firms in the same region or other regions.

3. **Analysing the *related variety* of potential specialisation domains:** The concept of related variety can be another complementary approach in determining and specifying priority areas in S3 strategies. The main argument of related variety

[94] The European Commission already reached first legal agreements with private big-data platforms with regard to the access to tourism accommodation data (https://ec.europa.eu/commission/presscorner/detail/en/IP_20_194). Projects are ongoing to determine and conclude further agreements with private platforms on unstructured data for territorial analysis (e.g., the ESPON Project "Territorial Indictors based on Big Data"; 2020-2021).

regarding prioritisation is that it is neither the regional diversity of innovation potential (risk of a too large cognitive distance) nor regional specialisation per se (risk of excessive cognitive proximity and lock-in) but rather a regional specialisation in related innovation activities that drives the economic prosperity of Member States/regions (Asheim et al., 2011; Boschma and Iammarino, 2009). To that end, S3 strategies should address those regional economic, scientific, technological, and cultural domains, which are linked to a Member States'/regions' existing assets and knowledge bases and provide options for future diversification ("related-variety"). Thereby, the concept can help to identify existing specialisations and knowledge bases in a region and at the same time highlight options for future diversification. Methodologically, related variety analysis requires granular data, ideally available at a cross-regional level. Existing measures of relatedness across industries include indicators based on the Standard-Industrial Classification (SIC-codes), co-occurrence of products within firms, input-output linkages (e.g., based on trade data), technological relatedness based on patent data or the intensity of labour reallocation between industries (Boschma and Gianelli, 2014; Balland et al. 2019, Balland & Boschma, 2019 a&b).[95] However, related variety is only one dimension for the analysis, and it should be seen as complementary to both the assessment of cross-innovation potentials (see above) and an approach based on unrelated diversification and potential leapfrogging (e.g., take the example of the Tesla plant in Brandenburg, which provides an enormous innovation opportunity for the region but is a rather unrelated field).

7.3.2 *Recommendations for a better utilisation of (emerging) regional innovation strength in S3 priority areas.*

As the funding period 2021-2027 is starting, many EU regions have been striving to further specify their priority areas and define transformation paths. While prioritisation is an essential foundation of smart specialisation (see recommendations above), *smart funding* is equally important. The main purpose of the suggestions below is to help improve **operationalise smart choices**, i.e., translating S3 strategies and priorities into effective projects. Based on the lessons learned from this study, suggestions on how to improve the implementation of S3 strategies are outlined below:

1. **Build up more effective and participatory governance structures for the implementation of S3 strategies:** The quality of regional governance systems (including capacities for strategy development/implementation) remains a key differentiating factor in terms of regional innovation capacity (Prognos AG et al., 2020). Irrespective of an exact determination of performance, it is important to regularly assess governance capacities and to further develop them in a targeted manner in close connection with the implementation of S3 strategies. Governance should also leave sufficient room for bottom-up processes and linkages with national and regional initiatives. Our findings show that a clear and dedicated S3 governance structure has proven to be important in this regard. However, implementation has been difficult due to a lack of human, budgetary and time resources. In the process towards the next generation of S3 strategies, each region needs to assess whether its governance model worked or if it needs to be reshaped to become more efficient. Pragmatic (not overly complex) collaboration mechanisms need to be established/maintained, which ensure smooth information flows and efficient decision making. The lessons learned from this study provide some suggestions in this regard, both at the level of the overall strategy and at the level of individual priority areas. The so-called "Strategic Research and Innovation Partnerships" (SRIPs) in Slovenia provide a good practice in this context: One SRIP is established for each priority area of the S3 and represents a long-term partnership between businesses, research organisations, facilitators, innovation users and NGOs. The

[95] A very helpful summary of the approach and its application can be found here: https://www.onlines3.eu/phase-4-priority-setting/4-3-related-variety-analysis/

governance structure of Thuringia can be seen as a further good practice when it comes to a dedicated governance structure. The Thuringian Cluster Management organisations are closely aligned to the priority areas and serve as a dedicated structure to maintain communication with stakeholders and to continuously monitor S3 implementation (Prognos, 2020; Kroll et. al, 2016).

2. **Enlarge and improve the outcomes of the EDP:** Our analysis confirms that the degree of continuity of the EDP is mixed across EU Member States/regions and sometimes only focuses on the early stages of the strategy process. However, most Member States/regions also agree that a continuous EDP is of great importance, particularly in the light of the requirements of the new enabling condition. In fact, the EDP should be established as a key mechanism leading to competitive advantages. Effective governance structures are vital in this respect, in particular having authorities in place that oversee the strategic and daily management of the strategy and that can orchestrate the various activities linked to the S3 (as "ecosystem moderators"; see also recommendation 1 above). To improve the outcomes of the EDP, Member States/regions should, from the beginning of S3 preparation/updating, have mechanisms in place that ensure active and wide participation from all relevant stakeholder groups (following the quadruple helix model). This should include clear views on the ideal stakeholder composition for an ongoing EDP (linked also to the priority areas), a clear plan on the topics on which the EDP shall work and reach conclusions on, and a clear idea on how to maintain the EDP beyond the strategy updating stage (e.g., by means of working groups/communities of practices linked to the priority domains). Our results also illustrate that the involvement of network organisations such as cluster initiatives and business associations can be supportive for an ongoing EDP. All in all, agile structures need to be established that are flexible, allow pro-active engagement and participation, reflexive, and support the balance between stability and transformation.

3. **Optimise the process from S3 strategy to implementation through "transformation roadmaps":** In the 2014-2020 funding period, it was observed that after the adoption of the S3 strategies, there were, at times, slowdowns in implementation – a challenge also well known in the business sector under the term "strategy gap" (Sull et al., 2015). This was due to both organisational (e.g., adaptation of governance structures) and funding-related reasons (e.g., preparation of the funding guidelines in accordance with the ERDF regulation). The interviews conducted in the course of this study revealed that such difficulties were experienced in several regions, for example, in Romania with the implementation of the national strategy, where administrative issues due to the split of responsibilities had to be faced. Likewise, many Greek regions (like North Aegean or Western Greece) experienced delays or other problems in the implementation of the S3 governance structure. For the longer-term commitment of the regional innovation stakeholders (especially from the private sector) and the implementation success of S3 strategies, strategy implementation should be pushed even more forcefully for the next generation of S3. For this purpose, overarching or priority area-specific master plans/action plans or roadmaps ("transformational roadmaps") have proven to be helpful, in which more concrete plans for financial planning, objectives and thematic (sub-)priorities are made (Foray, 2019). The continued development of new funding instruments must be closely linked to this. Good practices from the field in this regard are the so-called "Technology Clusters & Bi-Annual Work Programmes" in Lombardy or the annual "Cluster Masterplans" in the S3 of Berlin-Brandenburg.

4. **Reshape the policy mix & funding instruments for the support of S3 priority areas:** For the funding period 2014-2020, it is apparent that in many regions, technology, or theme-open funding, continues to be the main focus of the policy instruments under S3. As shown above, most calls for proposals linked to S3 strategies in the EU address all priority areas together (i.e., the call is open for

projects addressing any of the existing priorities), instead of focusing on single priorities – in particular in less developed regions. For the next generation of S3 strategies, the recommendation is to develop more focused funding models with the aim of promoting "portfolios of connected projects" that can jointly achieve the transformation and innovation goals in the priority areas. This does not involve the political definition of specific technologies (with the danger of "picking the winners"), but rather a combination of the advantages of smart specialisation (i.e. definition of specialisation fields as strategic focal points and a limited number of thematic focal points) with a deliberate openness to technology/solutions, which in turn allows funding recipients (from business, science, civil society) to make independent choices in which technological or non-technological R&D projects they want to invest. Jointly, this can generate a certain thematic directionality in the support schemes, while simultaneously not excluding a large number of potential projects and thus, promote transformational change. Good examples include R&D&I project funding through the NRW Lead Market Competitions (Prognos AG and DLR-PT, 2019; Guzzo and Gianelle, 2021), and the biannual work programmes in place in Lombardy (the latter inspired by Horizon 2020). The action plan to implement the priority field 'sustainable construction' in Andalusia[96] contains sub-priorities and outlines a coherent policy mix for implementation. In all these programmes there are regular calls for funding for the existing specialisation fields, based on expert opinions and sufficiently open to address the identified topics. In addition to the direct technical reference, criteria such as the level of innovation, social significance, or cross-innovation potential also play an important role in the assessment of applications.

5. **Enhance the promotion of supra-regional and international forms of cooperation and networking:** While regional networking of innovation actors often plays a central role in the S3 strategies and associated measures of many regions, national governments should support the European Commission in its emphasis on supra-regional and international forms of cooperation and networking with its R&D funding measures. This should be done in close coordination with the S3 priorities of the regions and consider other international funding initiatives at the European level (e.g., "Interregional Innovation Investments"[97] under ERDF or "European Strategic Cluster Partnerships for smart specialisation investments"[98] or or the newly introduced Joint Cluster Initiative[99]). This could enable researchers, innovators, and companies in application-oriented R&D processes (i.e., in lower and medium TRLs) to benefit from global knowledge flows and to tap international markets on the way to commercialisation (i.e., in higher TRLs to the threshold of the market). In this way, S3 projects can also help shape new developments in cutting-edge technologies across Europe.[100] In this context, it would be useful to assess whether there are transnational or macro-regional alignments regarding the S3 strategies and priorities chosen by Member States.

6. **Expand support for the holistic innovation models and the absorption of innovations via S3 strategies:** In the 2014-2020 funding period, social and non-technical innovations played a rather limited role in the funding activities of EU regions. While technological innovation remains a central pillar in regional innovation, non-technical and social innovations should also be supported more strongly in the next generation of S3 strategies. Moreover, to increase regional

[96] see https://s3platform.jrc.ec.europa.eu/-/energising-innovation-policy-through-dual-use-and-sustainable-construction?inheritRedirect=true
[97] see: https://ec.europa.eu/regional_policy/sources/newsroom/consultations_interregional_innovation_final_en.pdf
[98] see: https://clustercollaboration.eu/eu-cluster-partnerships/escp-s3
[99] see: https://clustercollaboration.eu/news/clusters-need-be-included-recovery-plans-eu-member-states
[100] see in addition: Broekel, T. et al. 2017. 'Joint R&D Subsidies, Related Variety, and Regional Innovation', in International Regional Science Review Vol. 40, Issue 3. The authors show that joint R&D subsidies promote the innovation growth of German regions in particular when they mobilise access to different partners for cross-innovation and help to embed actors from the region in international, cross-regional knowledge networks.

innovator rates, the market introduction of new ventures as well as the absorption of innovations should also be promoted more strongly, e.g., through innovation advisory services and innovation voucher schemes. This applies in particular to economically weaker regions in the EU and also to those regions with a higher proportion of SMEs without R&D departments (Expert Commission on Research & Innovation/EFI, 2020).

7.3.3 *Recommendations on better monitoring, evaluation, and communication approaches for S3*

Envisaging the future without having a clear picture of the past has never been an effective approach in policy making. Thus, *better* monitoring and evaluation of whether the strategic choices in S3 strategies across the EU regions turn out to be suitable and whether strategy implementation is effective are crucial. Monitoring encompasses the collection and processing of information on the achievement of expected results and the degree of implementation of policy measures (Gianelle and Kleibrink, 2015). It will also enable the maintenance of an open dialogue with stakeholders. Evaluation should give answers to the question whether the implementation of the S3 provides favourable results and whether the resources are being spent efficiently.

Clearly defined ownership, transparency and a general openness to changes are key success factors for the monitoring and evaluation of S3. Policymakers and instrument owners should, therefore, be involved in the design of the monitoring and evaluation system, in order to ensure continuous political support over time, a provision of required data and a high acceptability of the results. This requires a well-resourced and legitimate monitoring and evaluation body (e.g., a dedicated function within the Ministry/Managing Authority), ensuring coordination and cooperation across the system with an adequate budget secured over the long-term. Effective monitoring and evaluation needs stability over time as well as flexibility to adjust to changing circumstances.

As has been touched upon in this and other reports (Gianelle et al., 2019b), EU Member States/regions have had various experiences and showed different degrees of ambition when it comes to monitoring and evaluation of S3 strategies in the 2014-2020 period. Against this background, the following recommendations can be made.

1. **Upgrade and fine-tune S3 monitoring systems:** As per "enabling condition" for the 2021-2027 funding period, a monitoring and evaluation system shall be established to collect information on the implementation of the priority areas under the coordination of the competent institution and to collect information per specialisation area, including the timely and regular collection of data, the analysis and use of which shall serve as feedback on strategy implementation. Member States/regions should establish or fine-tune their S3 monitoring systems. Ideally, S3 monitoring systems should be composed of an indicator system comprising output indicators (based on ERDF-monitoring systems, other funding programme data, etc.), result indicators (same sources as above) as well as context indicators covering the overall innovation system (e.g., from the Regional Innovation Scoreboard). Moreover, defining key performance indicators for a constant assessment of priority areas is needed (for data sources, see recommendations under Section 7.2.1). Finally, preparing an annual S3 monitoring [101] report summarising the key results is strongly recommended. This report can be helpful in multiple ways, such as for strategic dialogue with key stakeholders in the region

[101] Annual monitoring reports for the S3 are in place for instance in Thuringia (see Prognos AG, 2020) or Wielkopolska (see https://s3platform.jrc.ec.europa.eu/documents/20182/250727/Policy+instruments+for+Smart+Specialisation+Strategies_Sewilla17+01+2018_Wielkopolska.pdf/d8bbda67-f262-4030-8acd-53b90b0a321d)

(see recommendations 1 & 2 in Section 7.2.2 on governance & EDP) and for broader communication purposes (see recommendation three below).

2. **Establish S3 evaluation plans:** The authorities in charge of S3 should determine the overall objective and key questions for the S3 evaluation at the start of the implementation phase. The body responsible for the management of the S3 needs to ensure that during the implementation period of the strategy, evaluations, including those to assess effectiveness, efficiency, and impact, are carried out based on the evaluation plan. The role of the evaluation plan is central to achieving this aim: it will support quality evaluations as well as their effective use; it will facilitate sharing of knowledge on what works in different policy fields. Ultimately, it will contribute to the design and implementation of evidence-based programmes and policies. Typically, an evaluation plan should define the rationale and objectives of the policy to be evaluated, its target recipients, delivery method and intended outcomes; the extent of the existing evidence base related to the policy; the evaluation objectives and research questions; the audience and intended use of the evaluation; the available information, for example monitoring data collection processes already set up; the possible evaluation approach, research design and methods; the required capabilities, skills and experience of the proposed evaluation and team; the required evaluation outputs (including datasets) and the milestones to be met; data archiving requirements; the indicative budget; and the evaluation timetable (Tolias, 2019).

3. **Aim for more holistic communication on S3 strategies:** According to our observations, the perception of the S3 strategies in the (professional) public seems to be very different across EU Member States/regions. At the same time, studies show that coherent visibility and systematic communicative connection of (funding) activities with the respective strategy promotes their implementation success. Clear commitment and ownership is also seen as the key success factor for strategies in the private sector (McKinsey & Company, 2014). Important reasons are, among others, the activation of "collaborative leadership" (especially after the strategy phase), and the regular visibility of the strategy (Beer and Clower, 2014). For the next generation of S3 strategies, communication measures should therefore definitely be aimed for.

7.4 Outlook on S3 2.0

The multi-annual framework (MFF), the 2021-27 programming period for major EU programmes – most notably Cohesion Policy – and the EU-wide impact of the Covid-19 pandemic provides a new and more challenging setting for upgrading, refreshing, and implementing S3 strategies in the Member States and regions.

S3 strategies within the framework of EU Cohesion Policy make an important contribution to the EU's competitiveness through their non-cyclical, structure-building intervention logic. This is also their unique selling point in the European funding landscape. If an innovation and investment policy is implemented with the help of the S3 strategies, these strategies can make important contributions to overcoming urgent challenges at European level, also in the context of economic recovery after the Covid-19 pandemic. S3 strategies, in conjunction with EU Cohesion Policy, can act as an important facilitator of European-level goals and priorities (including the Green Deal, digital EU, resilient EU) to European regions.

It will be important to strengthen the role of S3 strategies in the context of European R&D funding and the **EU Recovery Fund**: Regionalised innovation funding is essential for the sustainable development of European regions and the reduction of regional disparities. The consequence of a progressive centralisation of European research and innovation funding would be a spatial concentration of European funding, most likely in the more developed regions of the EU. Due to the expected spatial distribution of funds, this would be both positive and negative for the EU. It is therefore important, both in the context of the next multi-annual financial framework and in the context of the EU Recovery Fund and its specific programmes, to strengthen the role of the S3 strategies beyond the ERDF Operational Programmes. The planning of the EU Commission in the context of the Just Transition Fund, which in many cases include close strategic links with the respective S3 strategies, is exemplary in this respect.

At the time of reporting at the end of 2020/beginning of 2021, numerous Member States/regions across the EU were already engaged in revising and updating their S3 strategy. Based on data collected in mid-2020, 13 Member States/regions had already finalised their revision process, while another 149 Member States/regions were in the process of updating. Despite the challenges brought about by the Covid-19 pandemic, we may assume that the number of Member States/regions which have finalised their strategy revision process is now even higher. Furthermore, the European Commission has outlined several initiatives to help foster the next generation of S3 strategies, including support measures for promoting interregional value chain investments in smart specialisation domains.

The findings of this study include **several key lessons and recommendations** that policy makers can draw upon in the continuation of S3 implementation, the entrepreneurial discovery process, and in fostering innovation-based growth in their territory beyond the specific S3 strategy. While this study did not, or only partially, cover all challenges related to S3 design & implementation (e.g., with regards to the design of policy instruments, S3 governance, etc.), several important learnings at the core of the S3 concept are put forward that can help Member States/regions respond better to the challenges ahead and can effectively contribute to a sustainable, post-pandemic recovery.

However, as indicated throughout the study, there are still some **open questions requiring future research**. Rigorous impact evaluations on the effectiveness and value-added of the S3 strategies will be needed in the coming years, complemented by in-depth comparative assessments of the effectiveness of S3 intervention models and instruments.

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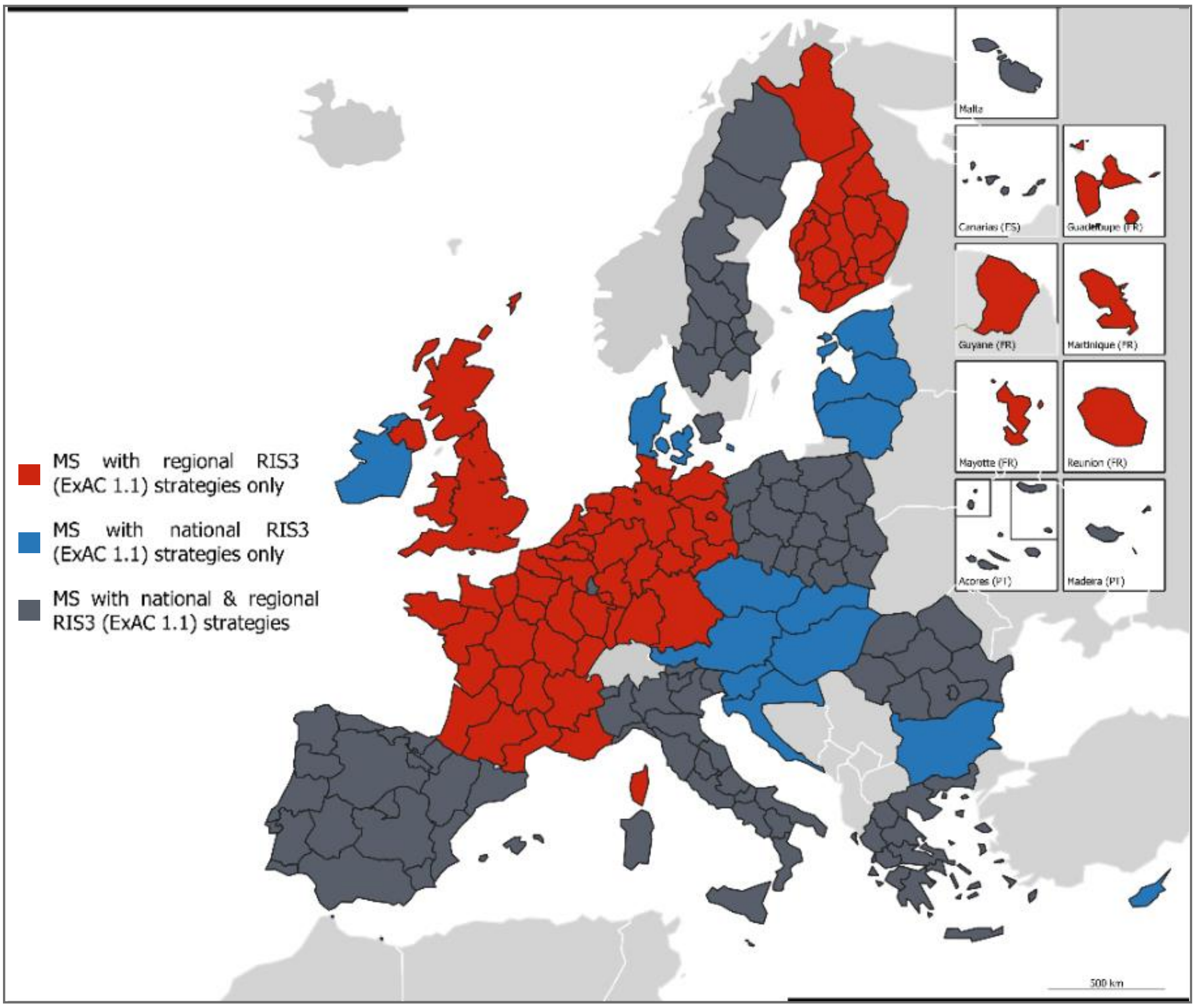
9 ANNEX

9.1 Chapter 2 – Further information regarding data collection/methodology

Map 9-1: Overview of the relevant Member States and regions and their level of governance



Source: Prognos / CSIL (2021). Note: the map refers to the latest available strategies

For the relevant Member States and regions by their level of governance please refer to the following tables.

Table 9-1: Member States and regions with regional S3 (ExAC 1.1) strategies only

NUTS	Region	NUTS	Region	NUTS	Region	NUTS	Region
BE1	Brussels	DEG	Thuringia	FI1D7	Lapland	FR71	Rhône-Alpes
BE2	Flanders	FI193	Central Finland	FR10	Ile-de-France	FR72	Auvergne
BE3	Wallonia	FI194	Southern Ostrobothnia	FR21	Champagne-Ardenne	FR81	Languedoc-Roussillon
DE1	Baden Wurttemberg	FI195	Ostrobothnia	FR22	Picardie	FR82	Provence-Alpes-Côte d'Azur
DE2	Bavaria	FI196	Satakunta	FR23	Haute-Normandie	FR83	Corse
DE3	Berlin	FI197	Pirkanmaa	FR24	Centre	FRA1	Guadeloupe
DE4	Brandenburg	FI1B1	Helsinki-Uusimaa	FR25	Basse-Normandie	FRA2	Martinique
DE5	Bremen	FI1C1	Southwest Finland	FR26	Bourgogne	FRA3	Guyane
DE6	Hamburg	FI1C2	Kanta-Häme	FR30	Nord-Pas-de-Calais	FRA4	Réunion
DE7	Hesse	FI1C3	Päijät-Häme	FR41	Lorraine	FRA5	Mayotte
DE8	Mecklenburg-West Pomerania	FI1C4	Kymenlaakso	FR42	Alsace	NL1	North Netherlands
DE9	Lower Saxony	FI1C5	South Karelia	FR43	Franche-Comté	NL2	East Netherlands
DEA	North Rhine-Westphalia	FI1D1	Etelä-Savo	FR51	Pays de la Loire	NL3	West Netherlands
DEB	Rhineland Palatinate	FI1D2	Pohjois-Savo	FR52	Bretagne	NL4	South Netherlands
DEC	Saarland	FI1D3	North Karelia	FR53	Poitou-Charentes	UKE	England
DED	Saxony	FI1D4	Kainuu	FR61	Aquitaine	UKL	Wales
DEE	Saxony-Anhalt	FI1D5	Central Ostrobothnia	FR62	Midi-Pyrénées	UKM	Scotland
DEF	Schleswig Holstein	FI1D6	Northern Ostrobothnia	FR63	Limousin	UKN	Northern Ireland

Source: Prognos / CSIL (2021).

Table 9-2: Member States and regions with national S3 (ExAC 1.1) strategies only

NUTS	Region
AT	Austria
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DK	Denmark
EE	Estonia
HR	Croatia
HU	Hungary
IE	Ireland
LT	Lithuania
LV	Latvia
SI	Slovenia
SK	Slovakia

Source: Prognos / CSIL (2021).

Table 9-3: Member States and regions with national & regional S3 (ExAC 1.1) strategies

NUTS	Region	NUTS	Region	NUTS	Region	NUTS	Region
EL	Greece	ES51	Cataluña	ITI3	Marche	PT17	Lisbon
EL30	Attica	ES52	Comunidad Valenciana	ITI4	Lazio	PT18	Alentejo
EL41	North Aegean	ES53	Illes Balears	LU	Luxembourg	PT20	Azores
EL42	South Aegean	ES61	Andalucía	MT	Malta	PT30	Madeira
EL43	Crete	ES62	Región de Murcia	PL	Poland	RO	Romania
EL51	Eastern Macedonia and Thrace	ES70	Canarias	PL11	Łódzkie	RO11	North-West/Nord-Vest
EL52	Central Macedonia	IT	Italy	PL12	Mazowieckie	RO12	Centre / Centru
EL53	Western Macedonia	ITC1	Piedmont	PL21	Małopolskie	RO21	North-East / Nord-Est
EL54	Epirus	ITC2	Valle d'Aosta	PL22	Ślaskie	RO22	Sud-Est/South-East
EL61	Thessaly	ITC3	Liguria	PL31	Lubelskie	RO31	Sud Muntenia/South Muntenia
EL62	Ionian Islands	ITC4	Lombardy	PL32	Podkarpackie	RO32	Bucuresti - Ilfov
EL63	Western Greece	ITF1	Abruzzo	PL33	Świętokrzyskie	RO41	Sud-Vest Oltenia
EL64	Central Greece	ITF2	Molise	PL34	Podlaskie	RO42	West/Vest
EL65	Peloponnese	ITF3	Campania	PL41	Wielkopolskie	SE122	Södermanlands län
ES	Spain	ITF4	Apulia	PL42	Zachodniopomorskie	SE123	Östergötlands län
ES11	Galicia	ITF5	Basilicata	PL43	Lubuskie	SE124	Örebro län
ES12	Principado de Asturias	ITF6	Calabria	PL51	Dolnośląskie	SE125	Västmanlands län
ES13	Cantabria	ITG1	Sicily	PL52	Opolskie	SE224	Skåne län
ES21	País Vasco	ITG2	Sardinia	PL61	Kujawsko-pomorskie	SE232	Västra Göalands län
ES22	Comunidad Foral de Navarra	ITH1	Autonomous Province of Bolzano	PL62	Warmińsko-Mazurskie	SE311	Värmlands län
ES23	La Rioja	ITH2	Autonomous Province of Trento	PL63	Pomorskie	SE312	Dalarnas län
ES24	Aragón	ITH3	Veneto	PT	Portugal	SE313	Gävleborgs län
ES30	Comunidad de Madrid	ITH4	Friuli-Venezia Giulia	PT11	Norte	SE322	Jämtlands län
ES41	Castilla y León	ITH5	Emilia-Romagna	PT15	Algarve	SE331	Västerbottens län
ES42	Castilla-La Mancha	ITI1	Tuscany	PT16	Centro	SE332	Norrbottens län
ES43	Extremadura	ITI2	Umbria				

Source: Prognos / CSIL (2021).

Table 9-4: New concept of technology classes by Schmoch/WIPO (2008)

Code	Area (main category, I-IV) Field (sub-category, 1-35)	Related IPC codes (4 digit)
I	**Electrical engineering**	
1	Electrical machinery, apparatus, energy	The field primarily covers the non-electronic part of electrical engineering, for instance, the generation, conversion and distribution of electric power, electric machines but also basic electric elements such as resistors, magnets, capacitors, lamps, or cables. This field is often associated with "traditional" electrical engineering, but the high patent activity shows that technological innovation is still very important.
2	Audio-visual technology	Audio-visual technology is largely equivalent to consumer electronics. The relevant IPC codes primarily refer to technologies and only sometimes products are directly addressed (H04R Loudspeakers …, H04S Stereophonic systems)
3	Telecommunications	Telecommunications is a very broad field covering a variety of techniques and products. The IPC codes are often quite technology-oriented, so that it is difficult to separate relevant product/applications areas such as mobile communication in a clear-cut field. With almost 6 percent of all applications in 2005, telecommunications is one of the largest fields of the suggested classification.
4	Digital communication	In the ISI-OST-INPI classification, this field was part of telecommunications. At present, it is a self-contained technology at the border between telecommunications and computer technology. A core application of this technology is the internet.
5	Basic communication processes	In the ISI-OST-INPI classification, this field was part of telecommunications. It covers very basic technologies such oscillation, modulation, resonant circuits, impulse technique, coding/decoding. These techniques are used in telecommunications, computer technology, measurement, control. However, the explicit link to these fields by multiple classification is moderate, in the case of telecommunications 2.4 percent. So, the definition as a separate field is justified. However, with 0.9 percent of all applications in 2005, it is the smallest fields of the present version of the classification.
6	Computer technology	This field is the largest of the proposed classification with 6.4 percent of all applications in 2005. Its size is already reduced by extracting field 7. The core area of C06F (Electrical digital processing) is defined in a very technical way (Arrangement for programme control, methods, and arrangements for data conversion …), so that a further break-down is difficult. It may be possible to separate specific application fields such as image data processing, recognition of data or speech analysis, but then these special fields may become too small.
7	IT methods for management	A major improvement of IPC8 is the introduction of the subclass G06Q "Data processing methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes". This field represents software for these special purposes. In most countries, business methods are not patentable, but if they are admitted, they are registered in this sub-class. In any case, the size of this field is relevant with 1.2 percent of all applications in 2005. A combination of the fields three to seven represents information technology in general. As the overlap is limited, this can be done by simple addition. The correct way is to combine the fields without double counting (unit)
8	Semiconductors	The field comprises semiconductors including methods for their production. Integrated circuits or photovoltaic elements belong to this field. The field includes microstructural technology (B81), as the number of applications in this sub-field is too small for a separate field
II	**Instruments**	
9	Optics	This field covers all parts of traditional optical elements and apparatus, but also laser beam sources. In recent years new optical technologies such as optical switching have become more relevant

10	Measurement	This field covers a broad variety of different techniques and applications. It would be possible to differentiate special sub-fields such as measuring of mechanical properties (length, oscillation, speed …), but these sub-fields are generally too small
11	Analysis of biological materials	This is the largest sub-field of "measurement" and was defined as a separate field. It primarily refers to the analysis of blood for medical purposes. In many cases, biotechnological methods are addressed.
12	Control	In the ISI-OST-INPI classification, this field was part of measuring & control. In recent years, the part of control has become quantitatively more important, so that an independent field is justified. The field covers elements for controlling and regulating electrical and nonelectrical systems and referring test arrangements, traffic control or signalling systems etc.
13	Medical technology	Medical technology is generally associated with high technology. However, a large part of the class A61 refers to less sophisticated products and technologies such as operating tables, massage devices, bandages etc. These less complex sub-fields represent a large number of patent applications, and the total field is the second largest of the suggested classification with 6.3 percent of all applications in 2005
III	**Chemistry**	
14	Organic fine chemistry	Without further limitations, the applications in organic chemistry primarily refer to pharmaceuticals. More than 40 percent of the applications have an additional code in pharmaceuticals. As such a large overlap of fields is less appropriate for a classification system, all documents with co-classification in A61K were excluded. The major exception is the group A61K-008, which refers to cosmetics
15	Biotechnology	Biotechnology is defined as a separate field, although it is linked to a variety of different applications. Like organic chemistry or computer technology, it is a crosscutting or generic technology. However, the overlap with pharmaceuticals is too large, with a share of nearly 30 percent. Therefore, as in organic chemistry, applications with explicit co-classification in A61K are excluded
16	Pharmaceuticals	This field refers to an area of application, not a technology. However, the key sub-class A61K is primarily organized by technologies (e.g., medicinal preparations containing inorganic active ingredients …). Cosmetics are explicitly excluded from the field; these represent about 10 percent of all applications classified in A61K
17	Macromolecular chemistry, polymers	This field contains the chemical aspects of polymers. Machines for producing articles from plastics are classified in B29 and not included.
18	Food chemistry	This field represents 1.3 percent of the applications in 2005 and is one of the smallest fields in this classification. However, the growth of this field is remarkable, so that a 14 higher weight can be assumed for the next years. Machines for food production are not included but classified as part of field 28 (other special machines).
19	Basic materials chemistry	Basic materials chemistry: This field primarily covers typical mass chemicals such as herbicides, fertilisers, paints, petroleum, gas, detergents etc.
20	Materials, metallurgy	This field covers all types of metals, ceramics, glass, or processes for the manufacture of steel.
21	Surface technology, coating	The coating of metals, generally with advanced methods represents the core of this field (C23). Furthermore, it covers electrolytic processes, crystal growth and apparatus for applying liquids to surfaces. This field may be qualified as the high-tech part of field 20.
22	Micro-structure and nanotechnology	This field covers micro-structural devices or systems, including at least one essential element or formation characterised by its very small size. It includes nanostructures having specialised features directly related to their size.
23	Chemical engineering	This field covers technologies at the borderline of chemistry and engineering. It refers to apparatus and processes for the

		industrial production of chemicals. Some of these processes may be classified as physical ones.
24	Environmental technology	This field covers a variety of different technologies and applications, in particular filters, waste disposal, water cleaning (a quite large area), gas-flow silencers and exhaust apparatus, waste combustion or noise absorption walls. However, it is not possible to define measuring of environmental pollution by IPC codes in a clear-cut way.
IV	**Mechanical engineering**	
25	Handling	This field comprises elevators, cranes, or robots, but also packaging devices. So, in terms of research intensity, the field is quite heterogeneous.
26	Machine tools	The field is dominated by patent applications referring to turning, boring, grinding, soldering, or cutting with a focus on metals.
27	Engines, pumps, turbines	This field covers non-electrical engines for all types of applications. In quantitative terms, applications for automobiles dominate.
28	Textile and paper machines	The fields 27 and 28 cover machines for specific production purposes. Textile and food machines represent the most relevant part of these machines and are classified separately.
29	Other special machines	See field 26.
30	Thermal processes and apparatus	The field covers applications such as steam generation, combustion, heating, refrigeration, cooling, or heat exchange.
31	Mechanical elements	The field covers fluid-circuit elements, joints, shafts, couplings, valves, pipe-line systems or mechanical control devices. The focus is on engineering elements of machines such as joints or couplings.
32	Transport	The field covers all types of transport technology and applications with dominance of automotive technology. In principle, a separation of rail traffic and air traffic would be feasible, but the associated fields would be too small. In both cases, this is due to a low propensity to patent. The samples are quite small and not representative of the total technological activities in these sub-fields.
V	**Other fields**	
33	Furniture, games	This field represents the main parts of consumer goods in terms of the number of patent applications. The other consumer goods are a mix of many different technologies, all of them with low quantitative weight. Therefore, a further differentiation is not useful. Even furniture and games combined comprise not more than 2.3 percent of all applications in 2005.
34	Other consumer goods	This field primarily represents less research-intensive sub-fields.
35	Civil engineering	The field covers construction of roads and buildings as well as elements of buildings such as locks, plumbing installations, or strong rooms for valuables. A special part refers to mining which may be important for some countries. In general, the importance of mining is so low that the definition of a separate field is not justified.

Source: WIPO / Schmoch (2008).

Table 9-5: Fields of Research (FOR) classification – divisions and groups

DIVISION 01 MATHEMATICAL SCIENCES
GROUP 0101 PURE MATHEMATICS
GROUP 0102 APPLIED MATHEMATICS
GROUP 0103 NUMERICAL AND COMPUTATIONAL MATHEMATICS
GROUP 0104 STATISTICS
GROUP 0105 MATHEMATICAL PHYSICS
GROUP 0199 OTHER MATHEMATICAL SCIENCES
DIVISION 02 PHYSICAL SCIENCES

GROUP 0201 ASTRONOMICAL AND SPACE SCIENCES
GROUP 0202 ATOMIC MOLECULAR NUCLEAR PARTICLE AND PLASMA PHYSICS
GROUP 0203 CLASSICAL PHYSICS
GROUP 0204 CONDENSED MATTER PHYSICS
GROUP 0205 OPTICAL PHYSICS
GROUP 0206 QUANTUM PHYSICS
GROUP 0299 OTHER PHYSICAL SCIENCES
DIVISION 03 CHEMICAL SCIENCES
GROUP 0301 ANALYTICAL CHEMISTRY
GROUP 0302 INORGANIC CHEMISTRY
GROUP 0303 MACROMOLECULAR AND MATERIALS CHEMISTRY
GROUP 0304 MEDICINAL AND BIOMOLECULAR CHEMISTRY
GROUP 0305 ORGANIC CHEMISTRY
GROUP 0306 PHYSICAL CHEMISTRY (INCL. STRUCTURAL)
GROUP 0307 THEORETICAL AND COMPUTATIONAL CHEMISTRY
GROUP 0399 OTHER CHEMICAL SCIENCES
DIVISION 04 EARTH SCIENCES
GROUP 0401 ATMOSPHERIC SCIENCES
GROUP 0402 GEOCHEMISTRY
GROUP 0403 GEOLOGY
GROUP 0404 GEOPHYSICS
GROUP 0405 OCEANOGRAPHY
GROUP 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
GROUP 0499 OTHER EARTH SCIENCES
DIVISION 05 ENVIRONMENTAL SCIENCES
GROUP 0501 ECOLOGICAL APPLICATIONS
GROUP 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT
GROUP 0503 SOIL SCIENCES
GROUP 0599 OTHER ENVIRONMENTAL SCIENCES
DIVISION 06 BIOLOGICAL SCIENCES
GROUP 0601 BIOCHEMISTRY AND CELL BIOLOGY
GROUP 0602 ECOLOGY
GROUP 0603 EVOLUTIONARY BIOLOGY
GROUP 0604 GENETICS
GROUP 0605 MICROBIOLOGY
GROUP 0606 PHYSIOLOGY
GROUP 0607 PLANT BIOLOGY
GROUP 0608 ZOOLOGY
GROUP 0699 OTHER BIOLOGICAL SCIENCES
DIVISION 07 AGRICULTURAL AND VETERINARY SCIENCES
GROUP 0701 AGRICULTURE LAND AND FARM MANAGEMENT
GROUP 0702 ANIMAL PRODUCTION
GROUP 0703 CROP AND PASTURE PRODUCTION
GROUP 0704 FISHERIES SCIENCES
GROUP 0705 FORESTRY SCIENCES
GROUP 0706 HORTICULTURAL PRODUCTION
GROUP 0707 VETERINARY SCIENCES
GROUP 0799 OTHER AGRICULTURAL AND VETERINARY SCIENCES
DIVISION 08 INFORMATION AND COMPUTING SCIENCES
GROUP 0801 ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING

	GROUP 0802 COMPUTATION THEORY AND MATHEMATICS
	GROUP 0803 COMPUTER SOFTWARE
	GROUP 0804 DATA FORMAT
	GROUP 0805 DISTRIBUTED COMPUTING
	GROUP 0806 INFORMATION SYSTEMS
	GROUP 0807 LIBRARY AND INFORMATION STUDIES
	GROUP 0899 OTHER INFORMATION AND COMPUTING SCIENCES
DIVISION 09 ENGINEERING	
	GROUP 0901 AEROSPACE ENGINEERING
	GROUP 0902 AUTOMOTIVE ENGINEERING
	GROUP 0903 BIOMEDICAL ENGINEERING
	GROUP 0904 CHEMICAL ENGINEERING
	GROUP 0905 CIVIL ENGINEERING
	GROUP 0906 ELECTRICAL AND ELECTRONIC ENGINEERING
	GROUP 0907 ENVIRONMENTAL ENGINEERING
	GROUP 0908 FOOD SCIENCES
	GROUP 0909 GEOMATIC ENGINEERING
	GROUP 0910 MANUFACTURING ENGINEERING
	GROUP 0911 MARITIME ENGINEERING
	GROUP 0912 MATERIALS ENGINEERING
	GROUP 0913 MECHANICAL ENGINEERING
	GROUP 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY
	GROUP 0915 INTERDISCIPLINARY ENGINEERING
	GROUP 0999 OTHER ENGINEERING
DIVISION 10 TECHNOLOGY	
	GROUP 1001 AGRICULTURAL BIOTECHNOLOGY
	GROUP 1002 ENVIRONMENTAL BIOTECHNOLOGY
	GROUP 1003 INDUSTRIAL BIOTECHNOLOGY
	GROUP 1004 MEDICAL BIOTECHNOLOGY
	GROUP 1005 COMMUNICATIONS TECHNOLOGIES
	GROUP 1006 COMPUTER HARDWARE
	GROUP 1007 NANOTECHNOLOGY
	GROUP 1099 OTHER TECHNOLOGY
DIVISION 11 MEDICAL AND HEALTH SCIENCES	
	GROUP 1101 MEDICAL BIOCHEMISTRY AND METABOLOMICS
	GROUP 1102 CARDIORESPIRATORY MEDICINE AND HAEMATOLOGY
	GROUP 1103 CLINICAL SCIENCES
	GROUP 1104 COMPLEMENTARY AND ALTERNATIVE MEDICINE
	GROUP 1105 DENTISTRY
	GROUP 1106 HUMAN MOVEMENT AND SPORTS SCIENCE
	GROUP 1107 IMMUNOLOGY
	GROUP 1108 MEDICAL MICROBIOLOGY
	GROUP 1109 NEUROSCIENCES
	GROUP 1110 NURSING
	GROUP 1111 NUTRITION AND DIETETICS
	GROUP 1112 ONCOLOGY AND CARCINOGENESIS
	GROUP 1113 OPHTHALMOLOGY AND OPTOMETRY
	GROUP 1114 PAEDIATRICS AND REPRODUCTIVE MEDICINE
	GROUP 1115 PHARMACOLOGY AND PHARMACEUTICAL SCIENCES
	GROUP 1116 MEDICAL PHYSIOLOGY

	GROUP 1117 PUBLIC HEALTH AND HEALTH SERVICES
	GROUP 1199 OTHER MEDICAL AND HEALTH SCIENCES
DIVISION 12 BUILT ENVIRONMENT AND DESIGN	
	GROUP 1201 ARCHITECTURE
	GROUP 1202 BUILDING
	GROUP 1203 DESIGN PRACTICE AND MANAGEMENT
	GROUP 1204 ENGINEERING DESIGN
	GROUP 1205 URBAN AND REGIONAL PLANNING
	GROUP 1299 OTHER BUILT ENVIRONMENT AND DESIGN
DIVISION 13 EDUCATION	
	GROUP 1301 EDUCATION SYSTEMS
	GROUP 1302 CURRICULUM AND PEDAGOGY
	GROUP 1303 SPECIALIST STUDIES IN EDUCATION
	GROUP 1399 OTHER EDUCATION
DIVISION 14 ECONOMICS	
	GROUP 1401 ECONOMIC THEORY
	GROUP 1402 APPLIED ECONOMICS
	GROUP 1403 ECONOMETRICS
	GROUP 1499 OTHER ECONOMICS
DIVISION 15 COMMERCE MANAGEMENT TOURISM AND SERVICES	
	GROUP 1501 ACCOUNTING AUDITING AND ACCOUNTABILITY
	GROUP 1502 BANKING FINANCE AND INVESTMENT
	GROUP 1503 BUSINESS AND MANAGEMENT
	GROUP 1504 COMMERCIAL SERVICES
	GROUP 1505 MARKETING
	GROUP 1506 TOURISM
	GROUP 1507 TRANSPORTATION AND FREIGHT SERVICES
	GROUP 1599 OTHER COMMERCE MANAGEMENT TOURISM AND SERVICES
DIVISION 16 STUDIES IN HUMAN SOCIETY	
	GROUP 1601 ANTHROPOLOGY
	GROUP 1602 CRIMINOLOGY
	GROUP 1603 DEMOGRAPHY
	GROUP 1604 HUMAN GEOGRAPHY
	GROUP 1605 POLICY AND ADMINISTRATION
	GROUP 1606 POLITICAL SCIENCE
	GROUP 1607 SOCIAL WORK
	GROUP 1608 SOCIOLOGY
	GROUP 1699 OTHER STUDIES IN HUMAN SOCIETY
DIVISION 17 PSYCHOLOGY AND COGNITIVE SCIENCES	
	GROUP 1701 PSYCHOLOGY
	GROUP 1702 COGNITIVE SCIENCES
	GROUP 1799 OTHER PSYCHOLOGY AND COGNITIVE SCIENCES
DIVISION 18 LAW AND LEGAL STUDIES	
	GROUP 1801 LAW
	GROUP 1802 MAORI LAW
	GROUP 1899 OTHER LAW AND LEGAL STUDIES
DIVISION 19 STUDIES IN CREATIVE ARTS AND WRITING	
	GROUP 1901 ART THEORY AND CRITICISM
	GROUP 1902 FILM TELEVISION AND DIGITAL MEDIA
	GROUP 1903 JOURNALISM AND PROFESSIONAL WRITING

	GROUP 1904 PERFORMING ARTS AND CREATIVE WRITING
	GROUP 1905 VISUAL ARTS AND CRAFTS
	GROUP 1999 OTHER STUDIES IN CREATIVE ARTS AND WRITING
DIVISION 20 LANGUAGE COMMUNICATION AND CULTURE	
	GROUP 2001 COMMUNICATION AND MEDIA STUDIES
	GROUP 2002 CULTURAL STUDIES
	GROUP 2003 LANGUAGE STUDIES
	GROUP 2004 LINGUISTICS
	GROUP 2005 LITERARY STUDIES
	GROUP 2099 OTHER LANGUAGE COMMUNICATION AND CULTURE
DIVISION 21 HISTORY AND ARCHAEOLOGY	
	GROUP 2101 ARCHAEOLOGY
	GROUP 2102 CURATORIAL AND RELATED STUDIES
	GROUP 2103 HISTORICAL STUDIES
	GROUP 2199 OTHER HISTORY AND ARCHAEOLOGY
DIVISION 22 PHILOSOPHY AND RELIGIOUS STUDIES	
	GROUP 2201 APPLIED ETHICS
	GROUP 2202 HISTORY AND PHILOSOPHY OF SPECIFIC FIELDS
	GROUP 2203 PHILOSOPHY
	GROUP 2204 RELIGION AND RELIGIOUS STUDIES
	GROUP 2299 OTHER PHILOSOPHY AND RELIGIOUS STUDIES

Source: Australian Bureau of Statistics.

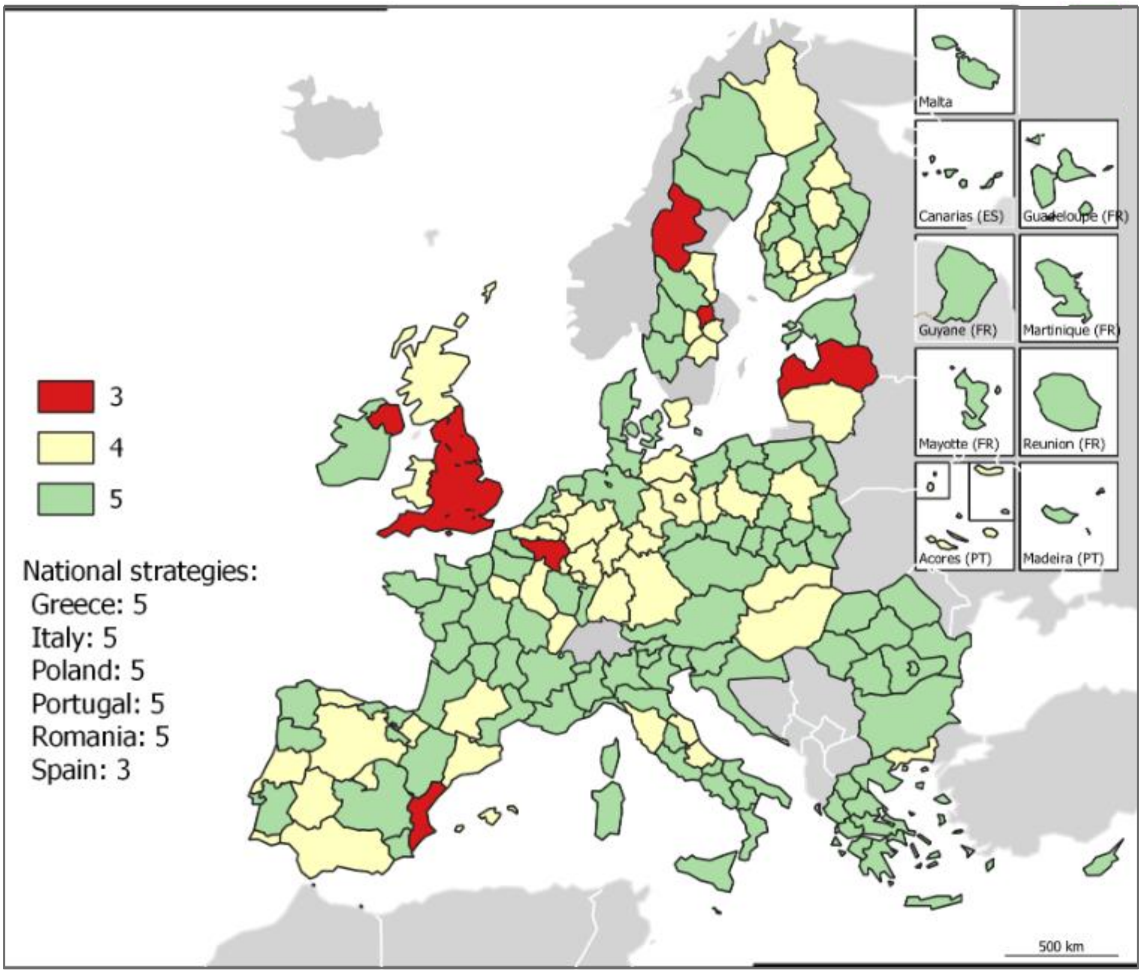
9.2 Chapter 4 – Background information regarding prioritisation approaches

Table 9-6: Categorisation for the Societal Challenges

Main Category	Sub-Category
Health	Active and healthy ageing
	Good health and well-being
Agriculture	Productivity and efficiency of the agricultural sector
	Sustainable use of ecosystems, sustainably manage forests, combat desertification, reverse land degradation and biodiversity loss
Water	Ensure availability and sustainable management of water and sanitation for all
	Conserve and sustainably use the oceans, seas, and marine resources
Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all
Transport / cities	Make cities inclusive, safe, resilient, and sustainable
	Sustainable and integrated transportation
Climate action / resources	Ensure sustainable consumption and production patterns
	Act to combat climate change and its impacts
Inclusiveness / Governance	Inclusive and equitable quality education and lifelong learning
	Gender equality and empowering women and girls
Secure societies	Digital security for citizens and enterprises
	Enhance border and external security

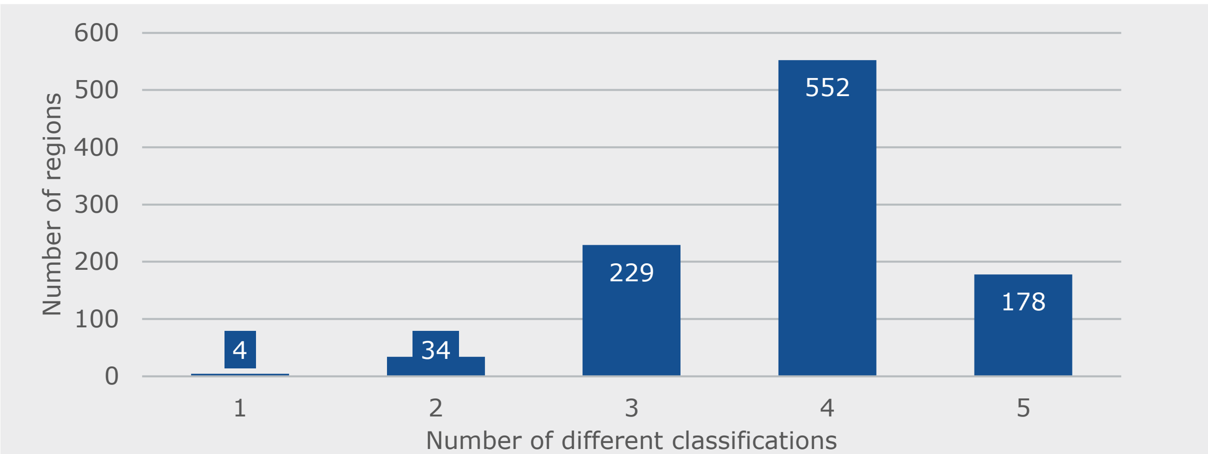
Source: Prognos / CSIL (2021).

Map 9-2: Number of different approaches (scientific, technological, economic, societal challenges, cultural & natural resources) used by EU Member States/regions (initial strategy)



Source: Prognos / CSIL (2021). n = 185 Member States/regions. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These Member States are Italy, Greece, Spain, Poland, Portugal, and Romania.

Figure 9-1: Number of different themes (scientific, technological, economic, societal challenges, cultural & natural resources) addressed by priority areas across EU regions (initial strategy)



Source: Prognos / CSIL (2021). n = 997 priority areas.

Table 9-7: Thematic orientation by regional group - NACE sectors

NACE-sectors	EU15	EU13	Less developed region	Transition region	More developed regions	Modest innovators	Moderate innovators	Strong innovators	Innovation leaders
Accommodation	1%	1%	2%	1%	1%	2%	2%	0%	1%
Activities auxiliary to financial services and insu	0%	0%	0%	0%	0%	0%	0%	0%	0%
Activities of head offices; management consulta	0%	0%	0%	0%	0%	0%	0%	0%	0%
Activities of households as employers of domes	0%	0%	0%	0%	0%	0%	0%	0%	0%
Activities of membership organisations	0%	0%	0%	0%	0%	0%	0%	0%	0%
Advertising and market research	0%	0%	0%	0%	0%	0%	0%	0%	1%
Air transport	1%	1%	1%	1%	1%	1%	1%	1%	1%
Architectural and engineering activities; technic	4%	4%	4%	4%	4%	4%	3%	4%	3%
Civil engineering	1%	1%	1%	1%	1%	1%	1%	1%	1%
Computer programming, consultancy and relate	5%	5%	5%	5%	6%	5%	5%	5%	7%
Construction of buildings	0%	1%	0%	0%	0%	0%	0%	0%	0%
Creative, arts and entertainment activities	0%	0%	0%	1%	0%	1%	0%	0%	1%
Crop and animal production, hunting and related	2%	3%	4%	3%	2%	4%	3%	2%	2%
Education	0%	0%	0%	0%	0%	0%	0%	0%	0%
Electricity, gas, steam and air conditioning suppl	3%	3%	2%	2%	3%	2%	3%	3%	3%
Employment activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Extraction of crude petroleum and natural gas	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fishing and aquaculture	1%	1%	1%	1%	1%	1%	1%	1%	1%
Food and beverage service activities	1%	2%	2%	1%	1%	2%	2%	1%	1%
Forestry and logging	1%	1%	1%	0%	1%	1%	1%	1%	0%
Human health activities	1%	1%	1%	0%	1%	1%	1%	1%	1%
Information service activities	1%	1%	0%	1%	1%	0%	0%	0%	1%
Insurance, reinsurance and pension funding, exc	0%	0%	0%	0%	0%	0%	0%	0%	0%
Land transport and transport via pipelines	1%	1%	1%	1%	1%	1%	1%	1%	1%
Legal and accounting activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Libraries, archives, museums and other cultural a	1%	1%	1%	1%	1%	1%	1%	0%	0%
Manufacture of basic metals	1%	1%	1%	2%	1%	1%	1%	2%	1%
Manufacture of basic pharmaceutical products ar	3%	3%	3%	3%	3%	3%	3%	3%	2%
Manufacture of beverages	0%	0%	0%	0%	0%	0%	1%	0%	0%
Manufacture of chemicals and chemical products	2%	1%	2%	2%	2%	1%	2%	2%	1%
Manufacture of coke and refined petroleum pro	2%	1%	1%	2%	1%	1%	1%	2%	2%
Manufacture of computer, electronic and optical	5%	4%	4%	5%	5%	4%	4%	5%	6%
Manufacture of electrical equipment	2%	2%	1%	3%	3%	1%	2%	3%	2%
Manufacture of fabricated metal products, excep	1%	0%	0%	1%	1%	0%	0%	1%	1%
Manufacture of food products	3%	4%	4%	3%	3%	4%	3%	3%	3%
Manufacture of furniture	0%	1%	1%	0%	0%	1%	0%	0%	0%
Manufacture of leather and related products	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manufacture of machinery and equipment n.e.c.	2%	1%	1%	2%	2%	1%	2%	2%	2%
Manufacture of motor vehicles, trailers and sem	2%	1%	1%	2%	2%	1%	1%	2%	1%
Manufacture of other non-metallic mineral prod	3%	3%	3%	3%	3%	2%	3%	3%	3%
Manufacture of other transport equipment	1%	1%	1%	1%	1%	0%	1%	1%	1%
Manufacture of paper and paper products	1%	1%	1%	1%	1%	1%	1%	1%	0%
Manufacture of rubber and plastic products	1%	0%	0%	1%	1%	0%	0%	2%	1%
Manufacture of textiles	0%	1%	0%	1%	0%	1%	0%	1%	1%
Manufacture of tobacco products	0%	0%	0%	1%	0%	0%	0%	0%	0%
Manufacture of wearing apparel	0%	0%	0%	0%	0%	1%	0%	0%	0%
Manufacture of wood and of products of wood a	1%	1%	1%	1%	1%	1%	1%	1%	0%
Mining of coal and lignite	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mining of metal ores	0%	1%	0%	0%	0%	0%	0%	0%	0%
Mining support service activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Motion picture, video and television programme	2%	1%	1%	2%	2%	0%	1%	2%	2%
non-NACE Description	13%	15%	14%	11%	15%	16%	16%	10%	17%
Office administrative, office support and other b	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other manufacturing	2%	2%	1%	2%	2%	1%	1%	2%	2%
Other mining and quarrying	1%	2%	2%	1%	1%	2%	1%	1%	0%
Other personal service activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other professional, scientific and technical activ	1%	1%	1%	1%	1%	0%	0%	1%	1%
Printing and reproduction of recorded media	3%	2%	2%	3%	3%	2%	2%	3%	3%
Programming and broadcasting activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Public administration and defence; compulsory s	0%	0%	1%	0%	0%	0%	1%	0%	0%
Publishing activities	1%	1%	1%	1%	1%	1%	1%	1%	2%
Remediation activities and other waste manage	1%	1%	1%	1%	1%	1%	1%	1%	0%
Repair and installation of machinery and equipm	0%	1%	0%	1%	1%	1%	0%	1%	0%
Repair of computers and personal and househol	0%	0%	0%	0%	0%	0%	0%	0%	0%
Residential care activities	2%	1%	1%	2%	2%	1%	2%	2%	2%
Scientific research and development	7%	8%	8%	6%	8%	8%	8%	7%	8%
Security and investigation activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Services to buildings and landscape activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Social work activities without accommodation	1%	1%	1%	1%	1%	0%	1%	1%	1%
Specialised construction activities	1%	1%	1%	1%	1%	1%	1%	1%	1%
Sports activities and amusement and recreation	0%	0%	0%	0%	0%	0%	0%	0%	0%
Telecommunications	2%	2%	1%	2%	2%	2%	1%	2%	3%
Travel agency, tour operator and other reservati	2%	2%	2%	1%	1%	2%	2%	1%	1%
Veterinary activities	0%	0%	0%	0%	0%	0%	0%	0%	0%
Warehousing and support activities for transport	1%	2%	2%	1%	1%	2%	2%	1%	1%
Waste collection, treatment and disposal activiti	1%	2%	2%	1%	1%	2%	1%	1%	1%
Water collection, treatment and supply	0%	0%	0%	1%	0%	1%	0%	0%	1%
Water transport	1%	2%	2%	1%	1%	2%	1%	1%	1%
Wholesale and retail trade and repair of motor v	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Prognos / CSIL (2021).

Table 9-8: Thematic orientation by regional group - FOR fields

FOR-fields	EU15	EU13	Less developed region	Transition region	More developed regions	Modest innovators	Moderate innovators	Strong innovators	Innovation leaders
1 Mathematical Sciences	0%	0%	0%	0%	0%	0%	0%	0%	0%
10 Technology	8%	7%	7%	8%	9%	7%	7%	9%	9%
11 Medical and Health Sciences	5%	5%	5%	5%	6%	4%	5%	6%	4%
12 Built Environment and Design	3%	3%	3%	3%	3%	3%	2%	4%	4%
13 Education	0%	1%	1%	0%	1%	2%	0%	0%	0%
14 Economics	0%	0%	0%	0%	0%	0%	0%	0%	0%
15 Commerce Management Tourism and Servic	7%	5%	6%	7%	7%	6%	7%	6%	6%
16 Studies in Human Society	2%	1%	2%	2%	2%	2%	3%	1%	2%
17 Psychology and Cognitive Sciences	1%	1%	0%	0%	1%	0%	1%	1%	0%
18 Law and Legal Studie	0%	0%	0%	0%	0%	0%	0%	0%	0%
19 Studies in Creative Arts and Writing	2%	1%	2%	2%	2%	2%	1%	2%	2%
2 Physical Sciences	3%	3%	3%	3%	3%	3%	3%	4%	3%
20 Language Communication and Culture	1%	0%	1%	2%	1%	1%	1%	1%	2%
21 History and Archaeology	2%	2%	2%	1%	1%	2%	2%	1%	1%
22 Philosophy and Religious Studies	0%	0%	0%	0%	0%	0%	0%	0%	0%
3 Chemical Sciences	4%	5%	4%	4%	4%	4%	4%	5%	4%
4 Earth Sciences	3%	2%	3%	3%	2%	3%	3%	3%	1%
5 Environmental Sciences	4%	3%	4%	5%	4%	3%	5%	4%	4%
6 Biological Sciences	2%	1%	2%	2%	2%	0%	2%	3%	2%
7 Agricultural and Veterinary Sciences	8%	9%	9%	8%	8%	10%	9%	8%	7%
8 Information and Computing Sciences	10%	11%	10%	10%	11%	10%	9%	11%	13%
9 Engineering	12%	14%	13%	13%	13%	13%	13%	12%	14%
non-FOR Description	21%	24%	22%	20%	22%	24%	23%	19%	24%

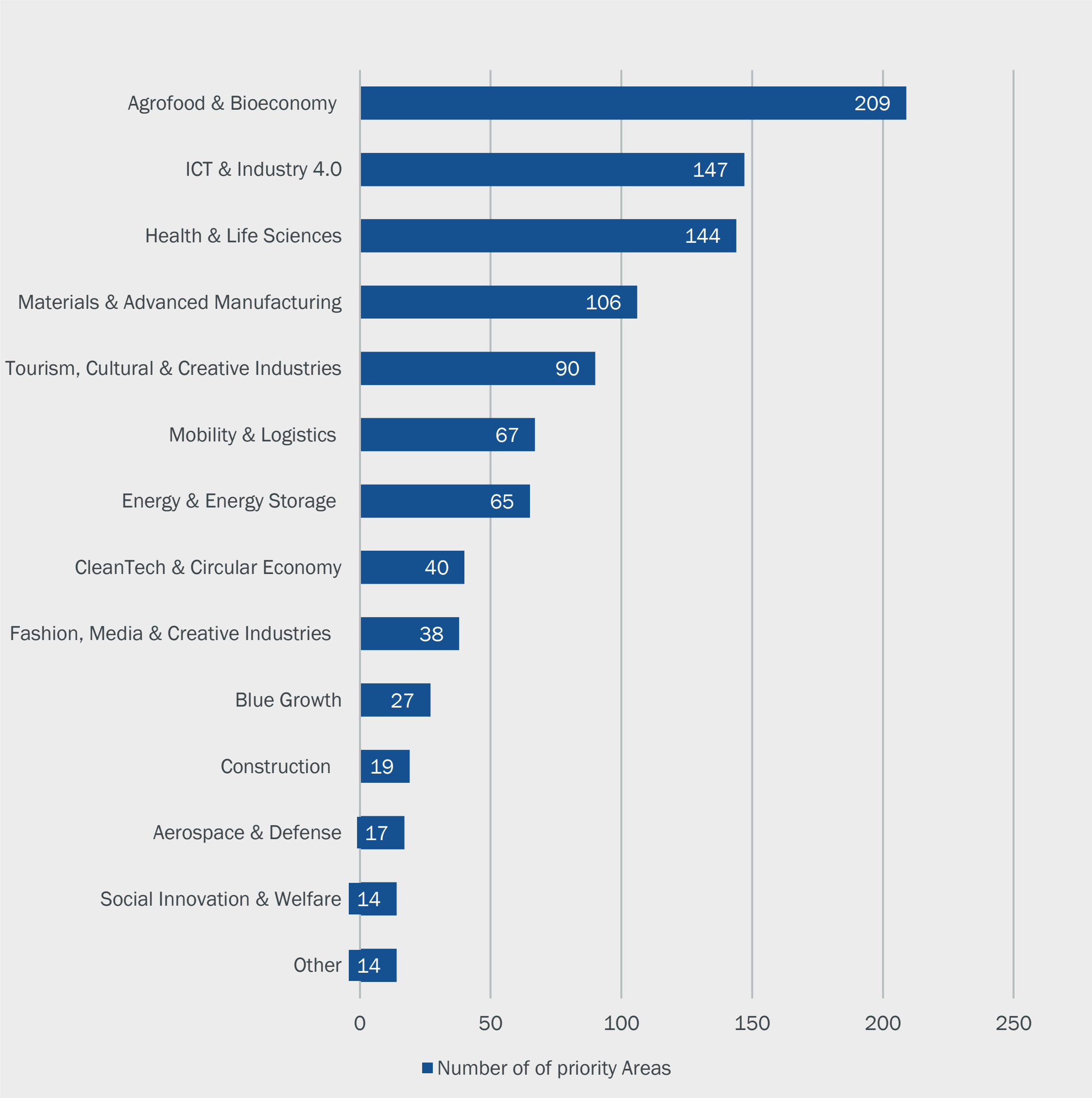
Source: Prognos / CSIL (2021).

Table 9-9: Thematic orientation by regional group - TECH fields

Tech-fields	EU15	EU13	Less developed region	Transition region	More developed regions	Modest innovators	Moderate innovators	Strong innovators	Innovation leaders
Analysis of biological materials	1%	1%	1%	1%	1%	1%	1%	1%	1%
Audio-visual technology	1%	0%	0%	1%	1%	0%	0%	1%	1%
Basic communication processes	0%	0%	0%	0%	0%	0%	0%	0%	0%
Basic materials chemistry	3%	3%	3%	3%	3%	2%	3%	3%	3%
Biotechnology	4%	4%	4%	5%	4%	4%	4%	4%	4%
Chemical engineering	2%	1%	1%	2%	1%	1%	1%	2%	1%
Civil engineering	2%	2%	2%	2%	2%	2%	2%	2%	2%
Computer technology	8%	6%	7%	7%	8%	7%	7%	7%	9%
Control	3%	3%	3%	3%	3%	2%	2%	3%	4%
Digital communication	7%	8%	7%	6%	7%	8%	7%	7%	7%
Electrical machinery, apparatus, er	6%	5%	5%	6%	6%	6%	5%	6%	6%
Engines, pumps, turbines	3%	3%	3%	3%	3%	3%	3%	3%	4%
Environmental technology	2%	1%	2%	1%	2%	1%	2%	2%	1%
Food chemistry	2%	2%	2%	2%	1%	3%	2%	1%	1%
Furniture, games	1%	1%	1%	1%	1%	1%	1%	1%	1%
Handling	3%	3%	3%	3%	3%	4%	3%	3%	3%
IT methods for management	4%	3%	3%	4%	4%	4%	3%	4%	3%
Machine tools	1%	1%	1%	1%	1%	1%	1%	1%	0%
Macromolecular chemistry, polym	1%	1%	1%	2%	1%	0%	1%	2%	1%
Materials, metallurgy	3%	3%	3%	4%	2%	3%	3%	3%	3%
Measurement	5%	4%	4%	5%	5%	4%	5%	6%	5%
Mechanical elements	0%	0%	0%	0%	1%	0%	0%	1%	1%
Medical technology	5%	6%	5%	5%	5%	6%	5%	6%	5%
non-technological Description	16%	20%	18%	14%	18%	22%	19%	12%	20%
Optics	1%	0%	0%	1%	1%	0%	0%	1%	0%
Organic fine chemistry	1%	1%	1%	1%	1%	1%	1%	2%	1%
Other consumer goods	1%	0%	1%	2%	1%	1%	1%	2%	0%
Other special machines	5%	6%	5%	5%	4%	6%	5%	5%	4%
Pharmaceuticals	2%	2%	2%	2%	2%	1%	2%	2%	1%
Semiconductors	1%	0%	0%	1%	0%	0%	0%	1%	0%
Surface technology, coating	1%	0%	1%	1%	1%	0%	1%	1%	1%
Telecommunications	1%	0%	0%	1%	1%	0%	0%	1%	1%
Textile and paper machines	0%	1%	1%	0%	0%	1%	1%	0%	0%
Thermal processes and apparatus	2%	2%	2%	2%	2%	1%	2%	2%	3%
Transport	4%	4%	4%	4%	5%	3%	4%	5%	4%

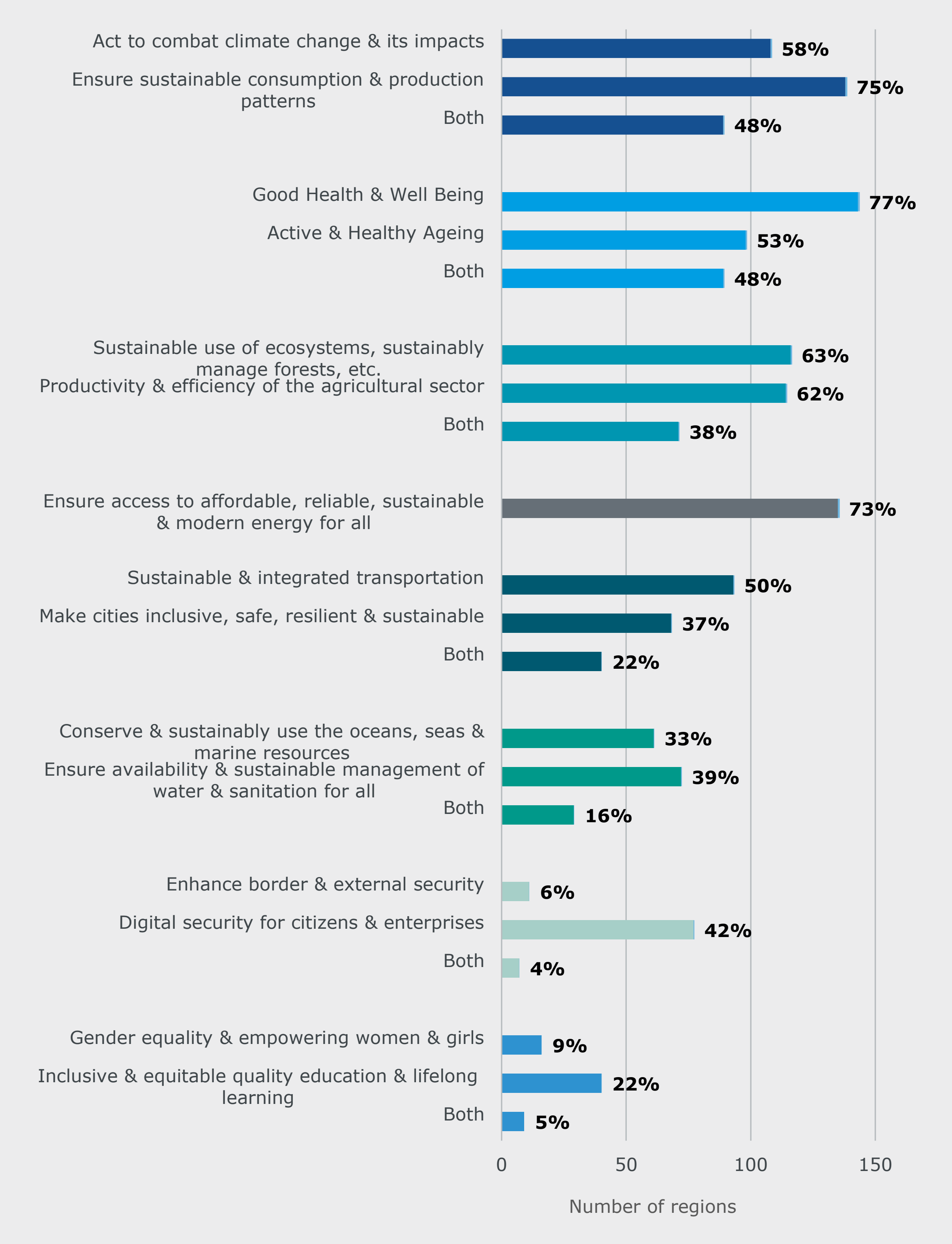
Source: Prognos / CSIL (2021).

Figure 9-2: Number of overarching topics as identified through LDA analysis



Source: Prognos / CSIL (2021). Note: As a further step, the S3 priority areas identified in Chapter 4 were grouped into overarching thematic domains such as 'ICT & Industry 4.0', 'CleanTech & Circular Economy', or 'Aerospace & Defence' to allow for better comparability. This was done through a LDA algorithm which was set up to calculate ten topics based on the descriptions of the priority areas. Subsequently the topics with the highest shares were assigned to the priority areas by computing the document-topic distribution for each priority area.

Figure 9-3: Individual sub-components of societal challenges



Source: Prognos AG / CSIL (2021). Own computations based on S3 strategies of 185 S3 strategies.

Table 9-10: Complexity index and categorisation of technology fields

Code	Technology field	Technology sector	Complexity index*	Category
1	Electrical machinery, apparatus, energy	Electrical engineering	22.7	Medium-Low
2	Audio-visual technology	Electrical engineering	71.1	Medium-High
3	Telecommunications	Electrical engineering	86.6	High
4	Digital communication	Electrical engineering	99.4	High
5	Basic communication processes	Electrical engineering	74.0	Medium-High
6	Computer technology	Electrical engineering	93.4	High
7	IT methods for management	Electrical engineering	76.6	Medium-High
8	Semiconductors	Electrical engineering	49.9	Medium
9	Optics	Instruments	57.8	Medium
10	Measurement	Instruments	50.9	Medium
11	Analysis of biological materials	Instruments	58.4	Medium
12	Control	Instruments	50.0	Medium
13	Medical technology	Instruments	49.2	Medium
14	Organic fine chemistry	Chemistry	43.9	Medium
15	Biotechnology	Chemistry	53.9	Medium
16	Pharmaceuticals	Chemistry	55.4	Medium
17	Macromolecular chemistry, polymers	Chemistry	25.3	Medium-Low
18	Food chemistry	Chemistry	35.5	Medium-Low
19	Basic materials chemistry	Chemistry	33.2	Medium-Low
20	Materials, metallurgy	Chemistry	24.0	Medium-Low
21	Surface technology, coating	Chemistry	18.3	Low
22	Micro-structural and nanotechnology	Chemistry	53.0	Medium
23	Chemical engineering	Chemistry	25.0	Medium-Low
24	Environmental technology	Chemistry	36.1	Medium-Low
25	Handling	Mechanical engineering	5.9	Low
26	Machine tools	Mechanical engineering	0.6	Low
27	Engines, pumps, turbines	Mechanical engineering	28.8	Medium-Low
28	Textile and paper machines	Mechanical engineering	17.1	Low
29	Other special machines	Mechanical engineering	8.9	Low
30	Thermal processes and apparatus	Mechanical engineering	17.3	Low
31	Mechanical elements	Mechanical engineering	8.2	Low
32	Transport	Mechanical engineering	20.3	Medium-Low
33	Furniture, games	Other fields	19.9	Low
34	Other consumer goods	Other fields	22.0	Medium-Low
35	Civil engineering	Other fields	17.4	Low

Source: Prognos / CSIL (2021). The column shows the average complexity index over the period 2011-2019. The categories are defined as follows: Low = 0 -20; Medium-Low = 20-40; Medium = 40-60; Medium-High = 60-80; High = 80-100.

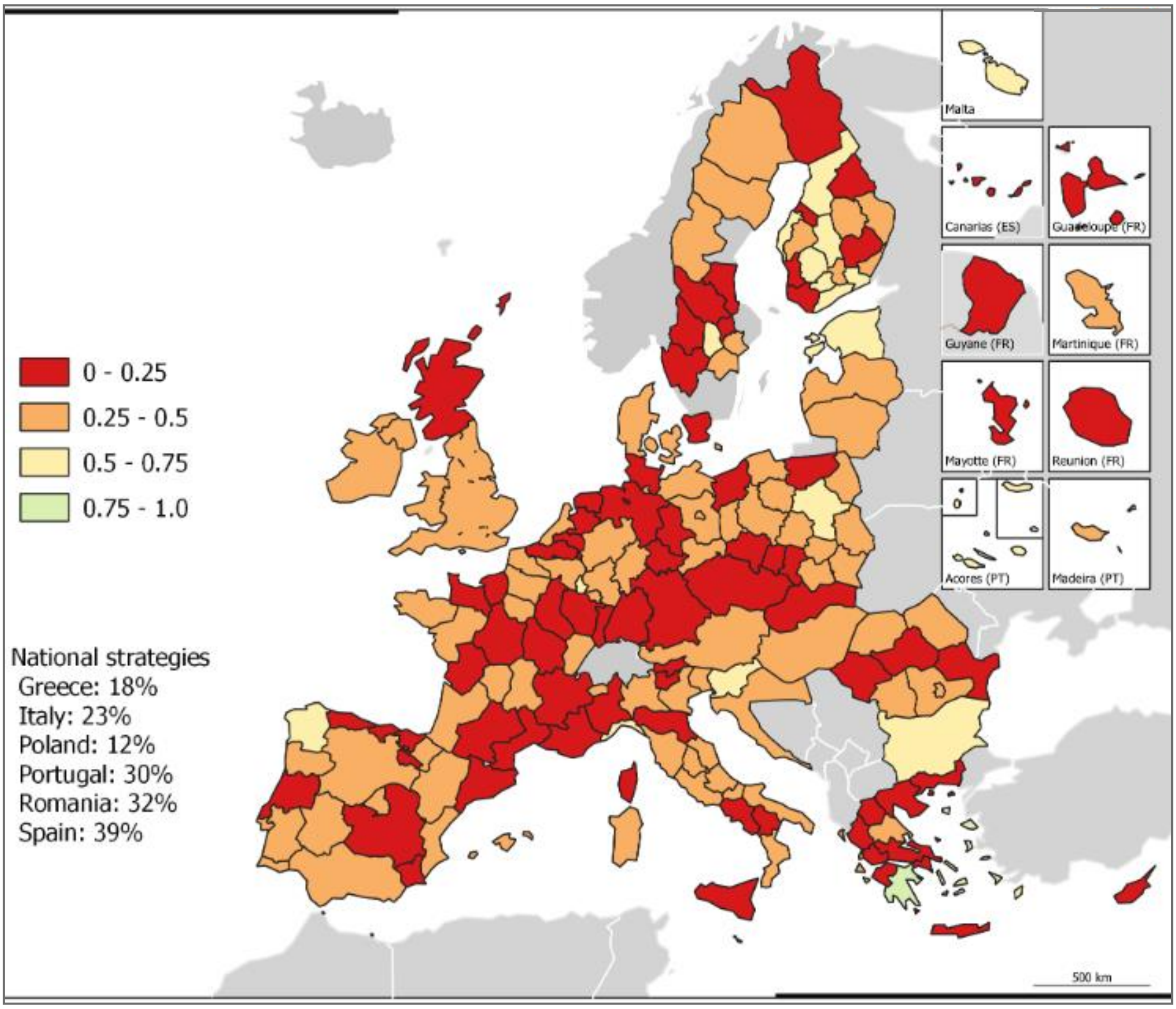
Table 9-11: High-tech aggregation by NACE Rev.2

Manufacturing Industries	NACE Rev. 2 codes – 2-digit level	
High-technology	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations;
	26	Manufacture of computer, electronic and optical products
Medium-high-technology	20	Manufacture of chemicals and chemical products;
	27 to 30	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c. ; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment
Medium-low-technology	19	Manufacture of coke and refined petroleum products;
	22 to 25	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment;
	33	Repair and installation of machinery and equipment
Low technology	10 to 18	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media;
	31 to 32	Manufacture of furniture; Other manufacturing

Knowledge based services	NACE Rev. 2 codes – 2-digit level	
Knowledge-intensive services (KIS)	50 to 51	Water transport; Air transport;
	58 to 63	Publishing activities; Motion picture, video and television programme production, sound recording and music publish activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities (section J);
	64 to 66	Financial and insurance activities (section K);
	69 to 75	Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis; Scientific research and development; Advertising and market research; Other professional, scientific and technical activities; Veterinary activities (section M);
	78	Employment activities;
	80	Security and investigation activities;
	84 to 93	Public administration and defence, compulsory social security (section O); Education (section P), Human health and social work activities (section Q); Arts, entertainment and recreation (section R).
Knowledge-intensive market services (excluding high-tech and financial services)	50 to 51	Water transport; Air transport;
	69 to 71	Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis;
	73 to 74	Advertising and market research; Other professional, scientific and technical activities;
	78	Employment activities;
	80	Security and investigation activities;
High-tech knowledge-intensive services	59 to 63	Motion picture, video and television programme production, sound recording and music publish activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities;
	72	Scientific research and development;
Knowledge-intensive financial services	64 to 66	Financial and insurance activities (section K).
Other knowledge-intensive services	58	Publishing activities;
	75	Veterinary activities;
	84 to 93	Public administration and defence, compulsory social security (section O); Education (section P), Human health and social work activities (section Q); Arts, entertainment and recreation (section R).

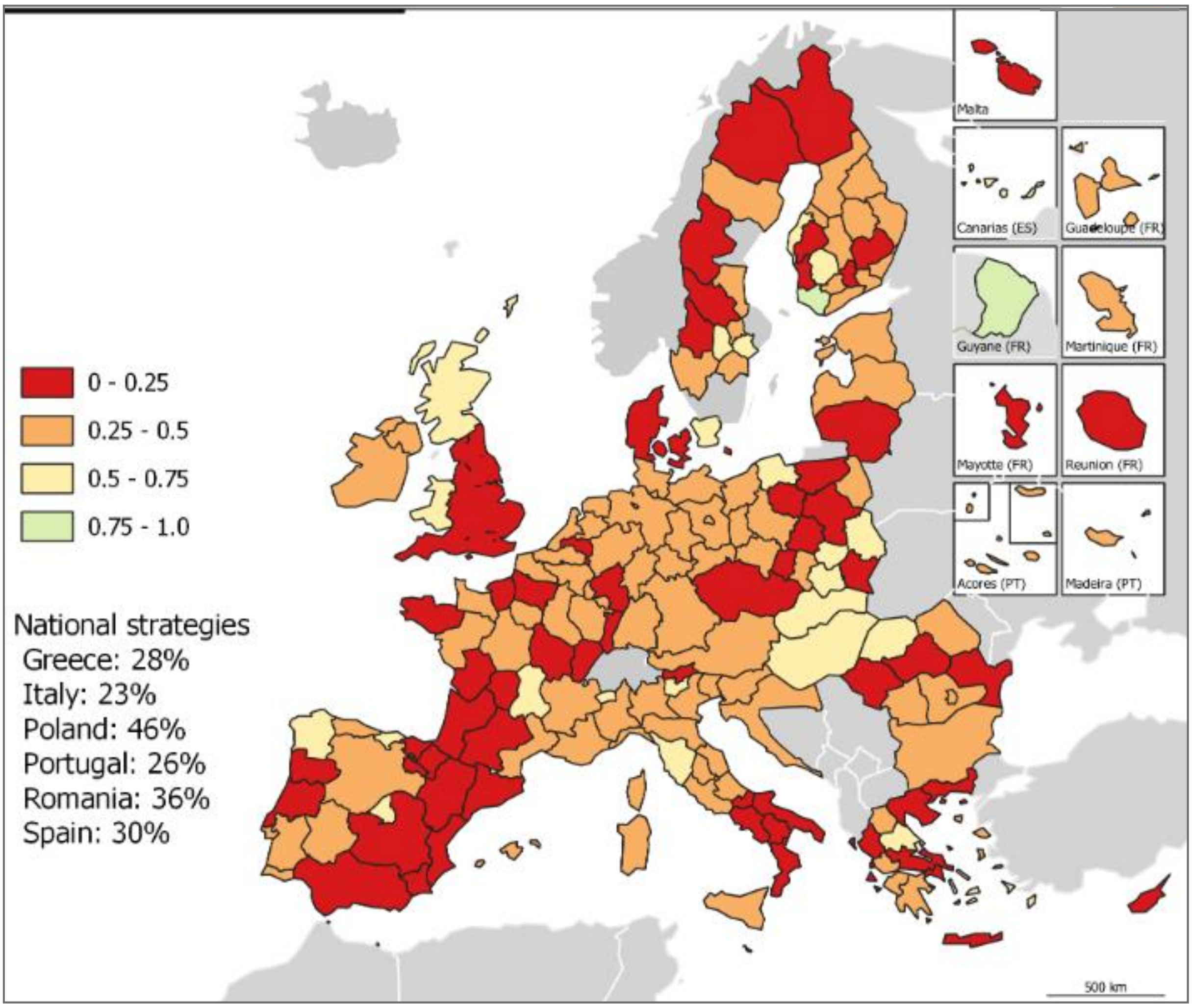
Source: Eurostat (n.d): Eurostat indicators on High-tech industry and Knowledge – intensive services. Annex 3 – High-tech aggregation by NACE Rev.2 Retrieved from : https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

Map 9-3: Share of technology fields in the strategies that address highly complex technology fields



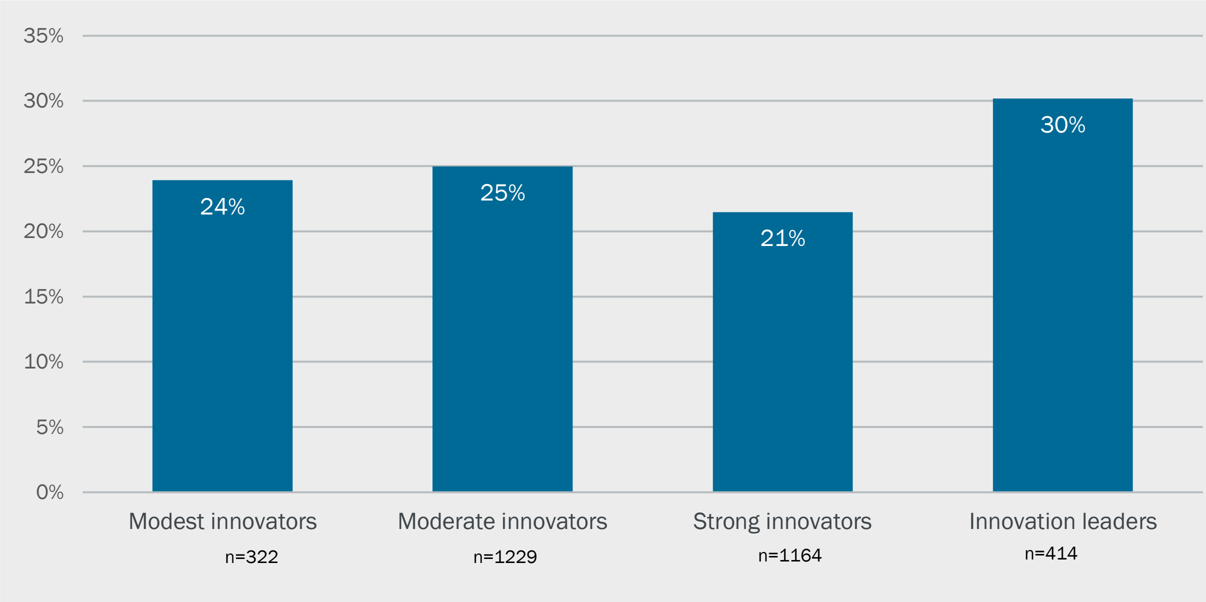
Source: Prognos / CSIL (2021). n = 185 S3 strategies. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania.

Map 9-4: Share of sectors in the strategies that address high-technology manufacturing sectors and high-tech knowledge-intensive services



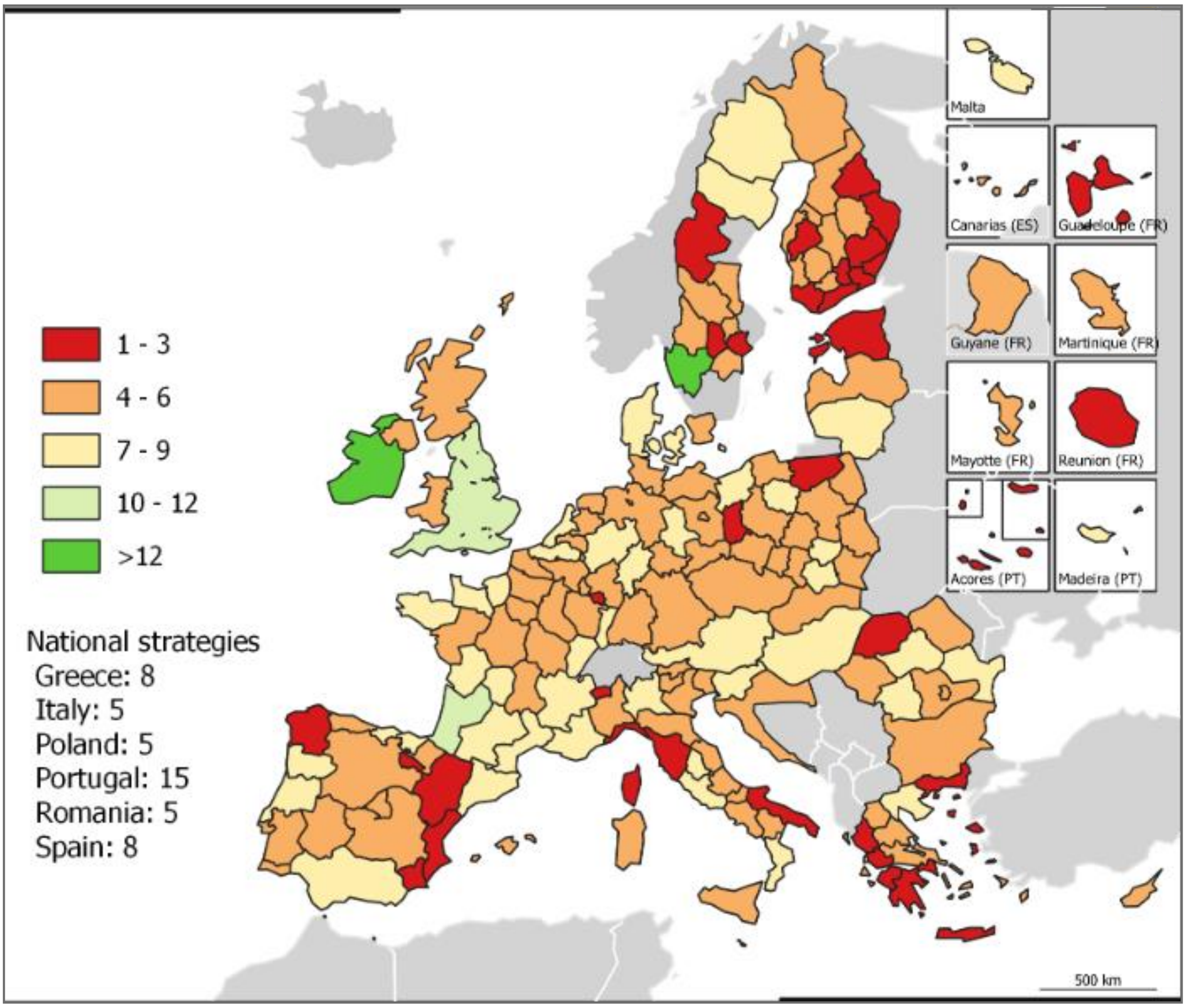
Source: Prognos / CSIL (2021). n = 185 S3 strategies. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania.

Figure 9-4: Share of sectors in the strategies that address high-technology sectors and High-tech knowledge-intensive services (Innovation Scoreboard Regions)



Source: Prognos AG / CSIL (2021).

Map 9-5: Number of priority areas of S3 strategies in the EU regions (latest S3 strategy year)



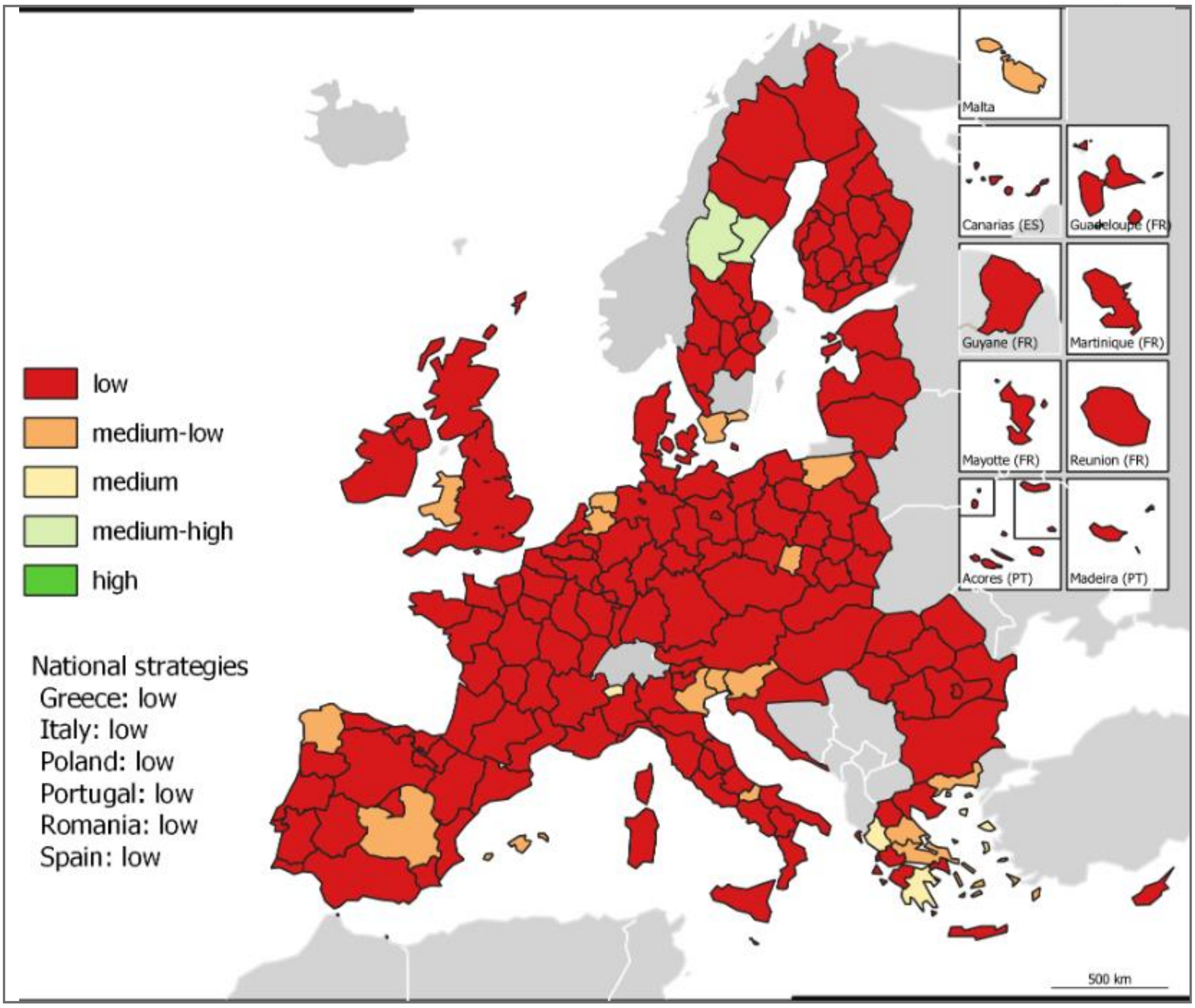
Source: Prognos / CSIL (2021). n = 185 S3 strategies. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania.

Table 9-12: Concentration and bandwidth of S3 strategies in the EU regions (latest S3 strategy year)

Number of all regions		Bandwidth index				
		LOW	MEDIUM-LOW	MEDIUM	MEDIUM-HIGH	HIGH
Concentration index	LOW	5	59	58	19	0
	MEDIUM-LOW	14	5	0	0	0
	MEDIUM	4	0	0	0	0
	MEDIUM-HIGH	1	0	0	0	0
	HIGH	0	0	0	0	0

Source: Prognos / CSIL (2021). n = 165 S3 strategies. Data for Swedish and Finish regions aggregated at the NUTS2 level

Map 9-6: Concentration index of the S3 strategies in the EU regions (latest S3 strategy year)



Source: Prognos / CSIL (2021). n = 165 S3 strategies. Note: When a region is covered by both a national strategy and a sub-national strategy, the coloured area of the sub-national region refers to the correspondence of the sub-national strategy. The values for the national strategies are provided in the legend. These regions are Italy, Greece, Spain, Poland, Portugal, and Romania. Data for Swedish and Finish regions aggregated at the NUTS2 level.

Table 9-13: Correlation between total ERDF TO1 funding per capita and the number of priority areas, concentration index and bandwidth index

ERDF TO1 funding per capita			
	Number of priority areas	**Concentration index**	**Bandwidth index**
Pearson correlation	0.03	-0.08	0.04
N:	154	154	154
t-statistic:	0.35	0.99	0.46
DF:	152	152	152
p-value:	0.727	0.324	0.647
Spearman correlation	0.04	-0.11	0.10
N:	154	154	154
t-statistic:	0.55	1.39	1.22
DF:	152	152	152
p-value:	0.582	0.168	0.224

Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions, no ERDF TO1 funding data was available at the relevant NUTS level.

Table 9-14: Correlation between total ERDF TO1 funding and the number of priority areas, concentration index and bandwidth index

ERDF TO1 funding			
	Number of priority areas	**Concentration index**	**Bandwidth index**
Pearson correlation	0.14	-0.14	0.17
N:	154	154	154
t-statistic:	1.78	1.76	2.18
DF:	152	152	152
p-value:	0.077*	0.080*	0.031**
Spearman correlation	0.32	-0.28	0.30
N:	154	154	154
t-statistic:	4.18	3.63	3.83
DF:	152	152	152
p-value:	0.000***	0.000***	0.000***

Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions, no ERDF TO1 funding data was available at the relevant NUTS level.

Table 9-15: Correlation between total GDP per capita and the number of priority areas, concentration index and bandwidth index

GDP per capita			
	Number of priority areas	**Concentration index**	**Bandwidth index**
Pearson correlation	0.10	-0.02	0.04
N:	165	165	165
t-statistic:	1.26	0.27	0.52
DF:	163	163	163
p-value:	0.211	0.787	0.607
Spearman correlation	0.10	-0.03	0.06
N:	165	165	165
t-statistic:	1.28	0.32	0.77
DF:	163	163	163
p-value:	0.203	0.748	0.444

Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Note: Data for Swedish and Finish regions aggregated at the NUTS2 level.

Table 9-16: Correlation between total population size and the number of priority areas, concentration index and bandwidth index

Population size			
	Number of priority areas	**Concentration index**	**Bandwidth index**
Pearson correlation	0.20	-0.16	0.14
N:	165	165	165
t-statistic:	2.58	2.01	1.86
DF:	163	163	163
p-value:	0.011**	0.046**	0.065*
Spearman correlation	0.35	-0.29	0.31
N:	165	165	165
t-statistic:	4.76	3.81	4.13
DF:	163	163	163
p-value:	0.000***	0.000***	0.000***

Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Data for Swedish and Finish regions aggregated at the NUTS2 level.

Table 9-17: Correlation between total GERD and the number of priority areas, concentration index and bandwidth index

GERD total			
	Number of priority areas	Concentration index	Bandwidth index
Pearson correlation	0.21	-0.13	0.15
N:	160	160	160
t-statistic:	2.74	1.67	1.85
DF:	158	158	158
p-value:	0.007***	0.097*	0.066*
Spearman correlation	0.30	-0.27	0.32
N:	165	165	165
t-statistic:	3.96	3.59	4.35
DF:	163	163	163
p-value:	0.000***	0.000***	0.000***

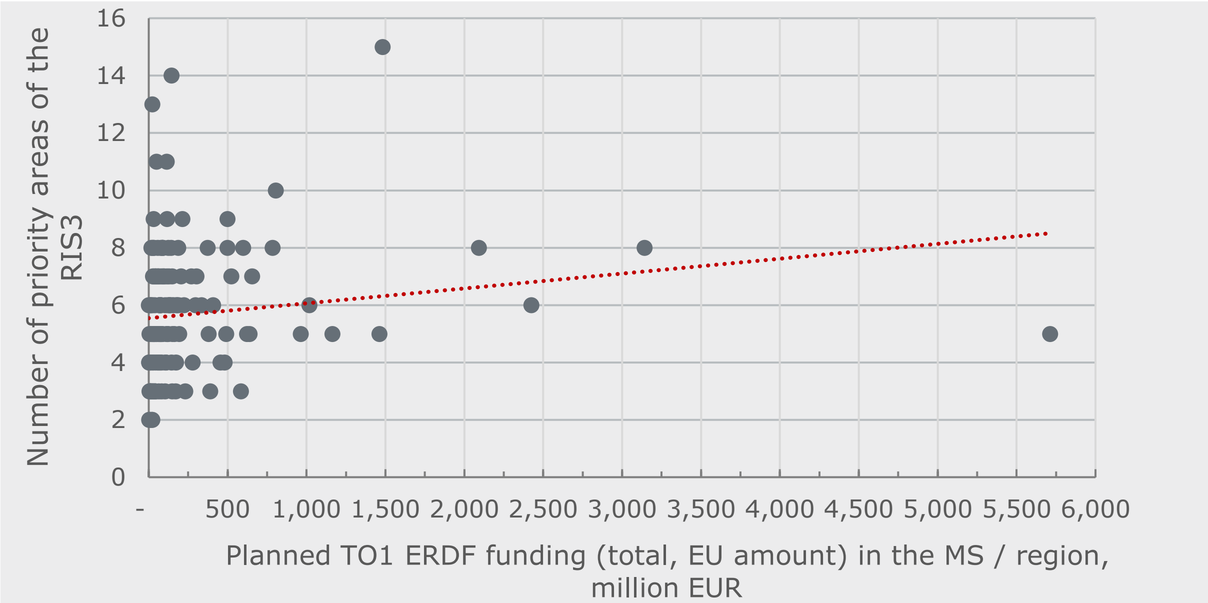
Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Data for Swedish and Finish regions aggregated at the NUTS2 level. No GERD data available for La Réunion, Guadeloupe, Guyane, Martinique, Mayotte.

Table 9-18: Correlation between GERD per capita and the number of priority areas, concentration index and bandwidth index

GERD per capita			
	Number of priority areas	Concentration index	Bandwidth index
Pearson correlation	0.18	-0.09	0.10
N:	160	160	160
t-statistic:	2.28	1.13	1.31
DF:	158	158	158
p-value:	0.024**	0.260	0.192
Spearman correlation	0.17	-0.11	0.18
N:	160	160	160
t-statistic:	2.18	1.45	2.32
DF:	158	158	158
p-value:	0.031**	0.148	0.022

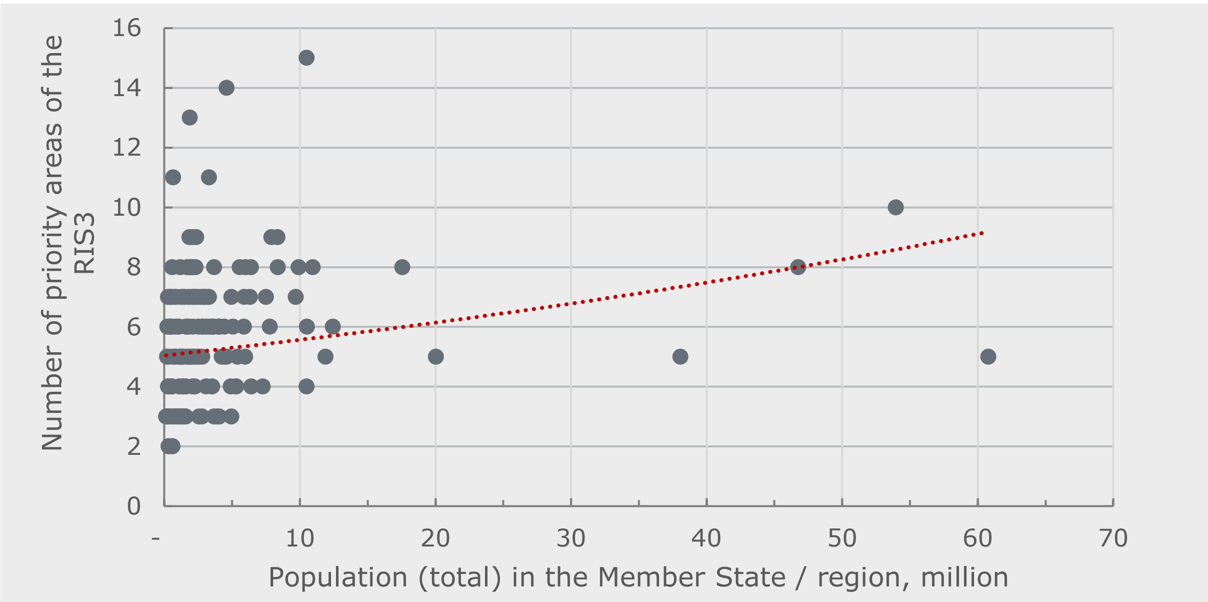
Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Note: Data for Swedish and Finish regions aggregated at the NUTS2 level. No GERD data available for La Réunion, Guadeloupe, Guyane, Martinique, Mayotte.

Figure 9-5: Correlation between the number of the priority areas in the S3 strategies (latest strategy year) and the ERDF TO1 funding (EU amount)



Source: Prognos / CSIL (2021). Note: n=154 S3 strategies. Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions, no ERDF TO1 funding data was available at the relevant NUTS level.

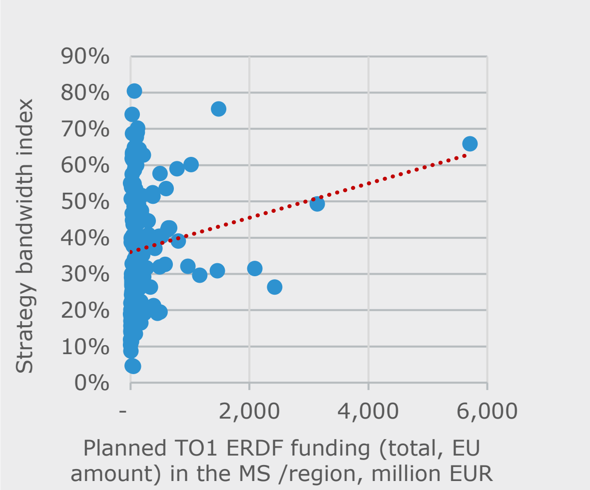
Figure 9-6: Correlation between the number of the priority areas in the S3 strategies (latest strategy year) and population size



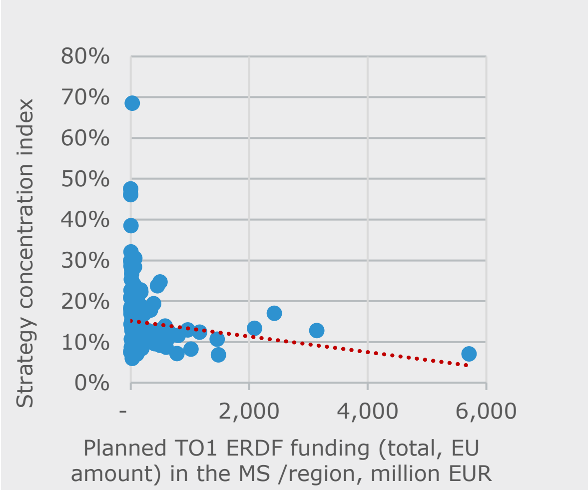
Source: Prognos / CSIL (2021). Note: n = 165 S3 strategies. Data for Swedish and Finish regions aggregated at the NUTS2 level.

Figure 9-7: Correlation between total ERDF TO1 funding (EU amount) and the bandwidth index (left) and concentration index (right) of the S3 strategies

Panel a: Bandwidth index



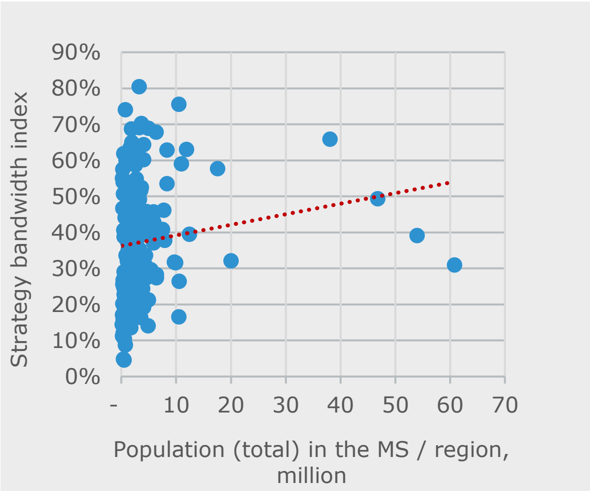
Panel b: Concentration index



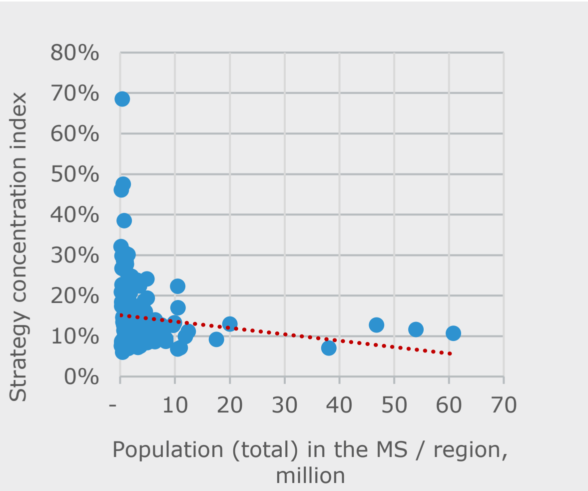
Source: Prognos / CSIL (2021). Note: n=154 S3 strategies. Data for Swedish regions aggregated at the NUTS2 level. For the Finish and Romanian regions, no ERDF TO1 funding data was available at the relevant NUTS level.

Figure 9-8: Correlation between population size and the bandwidth index (left) and concentration index (right) of the S3 strategies

Panel a: Bandwidth index



Panel b: Concentration index



Source : Prognos / CSIL (2021). Note : n=165 S3 strategies. Data for Swedish and Finish regions aggregated at the NUTS2 level.

9.3 Chapter 5 – More detailed information regarding the correspondence analysis

9.3.1 *Data used to assess the correspondence of the S3 strategies with the Member States/regional profiles*

We have put together extensive and complete databases to study the economic, scientific, and technological profiles of the EU regions and countries. The key features of these databases are listed here:

- They draw from **four main sources**: Eurostat for employment-related data, OECD-REGPAT and PATSTAT for patent data, and the proprietary GRID database owned by Dimensions for publication data.
- They include **six main indicators** (employment, scientific output, scientific excellence, patent counts, technology relatedness density, and technology complexity). They are defined according to different specifications (e.g., shares, growth rates, ratios, and location quotients; the scientific excellence indicator is defined at two threshold levels) and distinguishing by sectors of performance (public vs private institutions).
- Data on several additional indicators were collected to use as **control variables** in the econometric analyses, for the interpretation of clusters, and the selection of case studies. These indicators are also defined according to different specifications.
- The variables are available at **NUTS 0, NUTS 1 and NUTS 2** level, to allow the matching with the corresponding S3 level priorities.[102]
- The variables are defined at a **high degree of granularity**. Employment data are defined at the NACE 2-digit level. Patent data are classified according to 35 technological fields (Schmoch, 2008). Scientific publications are classified according to 22 Fields of Research (division level).
- Data cover the following **periods**: 2008-2019 for employment data, 2007-2019 for publication data, 2008-2016 for patent data and the related indicators of technological relatedness density and complexity. Control variables are available from 2008 to 2017. In very few cases, the team has estimated the missing data when possible, e.g., using interpolating techniques.
- The constructed databases are very rich and enable the **matching with the largest majority of S3 priorities** classified under Task 3. More specifically, the employment and patent databases can be matched with 215 out of a total of 219 S3 documents (including strategies' updates), while the publication database can be matched with all the S3 strategies. The strategies that are excluded from the Task 4 analysis are: "Strategia Innowacyjności i Efektywności Gospodarki (SIiEG) - Krajowa inteligentna specjalizacja" from Poland; "Regionalna Strategia Innowacyjności Województwa Warmińsko-Mazurskiego do roku 2020" from Warmińsko-Mazurskie (Poland); "Smart Specialisation Strategy in the Helsinki-Uusimaa Region" from Helsinki-Uusimaa (Finland), and "An International Innovation strategy for Skåne 2012-2020" from Skåne län (Sweden). These are all updates of already existing S3. The analysis instead covers the respective initial strategies.

The following table offers an overview of all the variables that we constructed for each dataset.

[102] As shown in Task 3, 30 strategies in Sweden and Finland cover NUTS 3 level regions. Given the nature of the Task 4 databases and the impossibility to carry out the analysis at the 3-digit level, priorities defined at NUTS 3 level have been aggregated at the NUTS 2 level.

Table 9-19. Variables entering the Task 4 analysis of correspondence between the S3 priorities and the Member States/regional profiles

Variable short name	Definition	Source
Database of S3 priorities		
Priority shares by NACE 2-digit sectors	See Section 2.1.3	Own elaboration based on Task 3 data
Priority shares by FOR 1-digit fields		
Priority shares by Schmoch (2008) technological fields		
Economic profile		
Employment share	Employment share by 2-digit NACE sectors in each region or country; average in the years t-1, t-2, t-3 (t=year of the S3 publication)	Own elaboration based on EU Labour Force Survey (LFS)
Pre-S3 empl. growth	Average employment growth in the years t-1, t-2, t-3 (t=year of the S3 publication)	
Post-S3 empl. growth	Average employment growth in the years t, t+1, t+2 (t=year of the S3 publication). Actual data up to 2018 were used, no forecasts were developed.	
Employment LQ vs NUTS0	Location quotient of employment in each region (NUTS 1 and NUTS 2) versus employment in its respective country (NUTS 0); average in the years t-1, t-2, t-3	
Employment LQ vs EU	Location quotient of employment in each region and country (NUTS 0, 1, 2) versus employment in the EU28; average in the years t-1, t-2, t-3	
Scientific profile		
Publication share	Scientific output: share of publications by FOR in each region or country, for all types of institutions; average in the years t-1, t-2, t-3	Own elaboration based on Dimensions' GRID data[103]
Publication share - public	Scientific output: share of publications by FOR in each region or country, published by the following types of institutions: archive, education facility, government, healthcare, non-profit, and others; average in the years t-1, t-2, t-3	
Publication share - private	Scientific output: share of publications by FOR in each region or country, published by the following types of institutions: company; average in the years t-1, t-2, t-3	
Publication LQ vs NUTS0	Location quotient of publications in each region (NUTS 1 and NUTS 2) versus publications in its respective country (NUTS 0); average in the years t-1, t-2, t-3	
Publication LQ vs NUTS0 – Public Publication LQ vs NUTS0 – Private	Location quotient as from the previous definition, but distinguishing between public and private institutions	
Publication LQ vs EU	Location quotient of publications in each region and country (NUTS 0, 1, 2) versus publications in the EU28; average in the years t-1, t-2, t-3	

[103] The GRID database distinguishes eight sectors of performance: archive, company, education, facility, government, healthcare, non-profit, and others. To classify publication data according to sector of performance, we assigned all publications that were performed by companies to the private sector, and the rest to the public sector. These indicators should be regarded as proxy of public and private publications.

Publication LQ vs EU – Public Publication LQ vs EU – Private	Location quotient as from the previous definition, but distinguishing between public and private institutions	
Excellence Top 10% Excellence Top 25%	Scientific excellence: share of the top 10% (or 25%) most cited publications worldwide, in each region or country, for all types of institutions;[104] average in the years t-1, t-2, t-3	
Excellence Top 10% (and 25%) - public Excellence Top 10% (and 25%) - private	Location quotient as from the previous definition, but distinguishing between public and private institutions	
Relative excellence Top 10% (and 25%) vs NUTS0 – Total, Public, Private	Ratio of regional share of top-cited publications over the NUTS0 share, for all types of institution, or distinguishing between public and private; average in the years t-1, t-2, t-3	
Relative excellence Top 10% (and 25%) vs EU – Total, Public, Private	Ratio of region/country share of top-cited publications over EU share, for all types of institution, or distinguishing between public and private; average in the years t-1, t-2, t-3	
Technological profile		
Patent share	Patents share by Schmoch (2008) technological fields, for all types of institutions; average in the years t-1, t-2, t-3	Own elaboration based on OECD REGPAT (January 2020 edition) and PATSTAT[105] [106]
Patent share - Public	Patents share by Schmoch (2008) technological fields, filed by the following types of applicants: government, non-profit, university, hospital; average in the years t-1, t-2, t-3	
Patent share - Private	Patents share by Schmoch (2008) technological fields, filed by the following types of applicants: individual, companies; average in the years t-1, t-2, t-3	
Patent LQ vs NUTS0 (Total, Public, Private)	Location quotient of patents in each region (NUTS 1 and NUTS 2) by technological field versus patents in its respective country (NUTS 0) in the same tech. fields; average in the years t-1, t-2, t-3; calculated for all types of applicants, or distinguishing between public and private ones	
Patent LQ vs EU (Total, Public, Private)	Location quotient of patents in each region and country (NUTS 0, 1, 2) by technological field versus patents in the EU28 in the same tech. fields; average in the years t-1, t-2, t-3; calculated for all types of applicants, or distinguishing between public and private ones	

[104] The indicator was developed by looking at the distribution of all number of citations, grouped by FOR and year of publication of the receiving publication. This means that the citation threshold for the top 10% (or top 25%) depends on both FOR and publication year (not citation year). Thus, the correlation coefficients between S3 priorities and the indicator of scientific excellence assesses the degree to which priorities match high-quality publications in a given field of research. The identification of high-quality publications is done by considering the number of citations received since the publication date.

[105] We used the OECD REGPAT database of patent applications to determine the regional origin of each patent starting from information on the addresses of the inventors. In this approach, patents are assigned to regions based on the address of the inventor. Our unit of analysis are patent families (DOCDB family in PATSTAT). Therefore, we combine patent application data in the OECD REGPAT database with related information available in PATSTAT in order to construct the database at the DOCDB family level instead of patent application level. This choice avoids double counting of patents belonging to the same invention.

[106] Information on the patent applicant's affiliation comes from PATSTAT and is used to distinguish between public and private sources of the invention. More specifically, the PATSTAT database distinguishes six sectors of the applicant: individual, company, government, non-profit, university, hospital. To classify patent data according to the sector of the applicant, we assigned all patents that were filed by companies and/or individuals to the private sector and the rest to the public sector. Patent counts have been computed after fractionalising patent applications by NUTS regions and IPC classes.

Technological relatedness density	Technological relatedness density index between a given technology (according to the Schmoch classification) and the overall technology portfolio of a region or country	Own elaboration based on PATSTAT, following Crespo et al. (2017) and Balland and Boschma (2019)
Technological complexity	Technology complexity index for a given technology field (according to the Schmoch classification) at EU level referring to the degree of sophistication and the number of capabilities required to develop such technology	
Technological ambition	Technology ambition index for a given technology field (according to the Schmoch classification) measuring the degree of technological complexity with respect to the regional knowledge space. It is calculated as $Technological\ ambition\ index_{irt} = \left(100 - \left(\frac{Technological\ relatedness\ density_{irt} - \min_{rt} Technological\ relatedness\ density_i}{\max_{rt} Technological\ relatedness\ density_i - \min_{rt} Technological\ relatedness\ density_i} * 100\right)\right) * Technological\ complexity\ index_{irt} \quad for\ each\ technology\ i, region\ r, year\ t$	
Control variables		
Strategy concentration index - NACE	Strategy concentration index by NACE defined as $\sum_{ir} s_{ir}^2$ for each NACE sector i where s_i equals the priority share in the NACE sector i for region r	Own elaboration based on Task 3 data
Strategy concentration index - FOR	Strategy concentration index by FOR defined as $\sum_{ir} s_{ir}^2$ for each FOR division i where s_i equals the priority share in the FOR division i for region r	
Strategy concentration index - TECH	Strategy concentration index by TECH defined as $\sum_{ir} s_{ir}^2$ for each TECH field i where s_i equals the priority share in the TECH field i for region r	
Strategy concentration index - Overall	Overall strategy concentration index defined as the average between strategy concentration index by NACE, FOR, and TECH	
Strategy bandwidth index - NACE	Strategy bandwidth index by NACE defined as the share of NACE sectors covered by each strategy out of the 88 existing NACE sectors	
Strategy bandwidth index - FOR	Strategy bandwidth index by FOR defined as the share of FOR divisions covered by each strategy out of the 22 existing FOR divisions	
Strategy bandwidth index - TECH	Strategy bandwidth index by TECH defined as the share of TECH fields covered by each strategy out of the 35 existing TECH fields	
Strategy bandwidth index - Overall	Overall strategy bandwidth index defined as the average between strategy bandwidth index by NACE, FOR, and TECH	
GDP per capita	GDP per capita (in PPP), in each region or country, average in the years t-1, t-2, t-3	Own elaboration based on Eurostat and INSEE
GDP per capita growth	GDP per capita (in PPP) growth rate, in each region or country, average in the years t-1, t-2, t-3	
GERD	Intramural R&D expenditure (GERD) as shares of GDP, in each region or country, average in the years t-1, t-2, t-3	Own elaboration based on Eurostat
BERD	Business R&D expenditure (BERD) as shares of GDP, in each region or country, average in the years t-1, t-2, t-3	
People in Science & Technology	Share of people employed in science and technology, in each region or country, average in the years t-1, t-2, t-3	
Population	Population, in each region or country, average in the years t-1, t-2, t-3	
Population growth	Population growth rate, in each region or country, average in the years t-1, t-2, t-3	
Young population share	Ratio of people aged between 15 and 29 years over the total population, in each region or country, average in the years t-1, t-2, t-3	
Regional population density	Population density per km squared, in each region or country, average in the years t-1, t-2, t-3	

Economic diversification	Economic diversification index defined as $1-\sum_i s_i^2$ for each NACE sector i where s_i equals the employment share in the NACE sector i for each region or country at time t	Own elaboration based on EU Labour Force Survey
Scientific diversification	Scientific diversification index defined as $1-\sum_i s_i^2$ for each FOR division i where s_i equals the publication share in the FOR division i for each region or country at time t	Own elaboration based on Dimensions' GRID data
Technological diversification	Technological diversification index defined as $1-\sum_i s_i^2$ for each technological field (according to the Schmoch classification) i where s_i equals the patent share in the technological field i for each region or country at time t	Own elaboration based on OECD REGPAT (January 2020 edition) and PATSTAT
EQGI	European Quality of Government Index	Charron et al. (2019)
ERDF Aid intensity	Total amounts of TO1 programmes per capita	Own elaboration based on REGIO data
Old/New Member States	Categorical variable indicating whether each region belongs to (each country is) a New or an Old EU Member State	Own elaboration
Location	Categorical variable indicating whether each region belongs to a country (each country is) located in Northern/Southern/ Western/Central and Eastern Europe	Own elaboration based on Eurostat
Level of development	Categorical variable indicating whether each region/each country is defined as Less developed / More developed / Outermost or Northern sparsely populated / Transition	Own elaboration based on the ERDF regulation
Level of innovation	Categorical variable indicating whether each region/each country is defined as Innovation leader / Strong innovator / Moderate innovator / Modest innovator	Own elaboration based on the EU Regional Innovation Scoreboard (2017)
Use of EDP	Categorical variable indicating whether an EDP process was used ("yes") or not ("no")	Own elaboration based on Task 2 data
Use of Old or New EDP	Categorical variable indicating whether a new EDP process was initiated ("new") or not ("old")	
EDP method	Categorical variable indicating whether the EDP process envisaged SWOT analysis / Stack interviews / Focus Group / SWOT analysis & Focus Group / Focus Group & Stack interviews / SWOT, Focus Group, & Stack interviews	
EDP_phase	Categorical variable indicating in which phase the EDP process was used, namely Policy formulation / Decision making / Monitoring & Evaluation / Policy formulation & Decision making / Policy formulation & Monitoring & Evaluation / Decision making & Monitoring & Evaluation / All	

Source: Prognos / CSIL (2021)

9.3.2 *Econometric analyses to verify the correspondence between priorities and profiles*

The models that we estimate are three-dimensional panel data models that take into account the complex structure of our dataset, where a territorial unit (whether a Member States or region) is repeated across the various sectors, scientific, and technological fields and might also be repeated over time when strategies were updated. In these models, the prioritisation variable (i.e., the share of a certain sector or field in the strategy) is explained by the economic, scientific, or technological variables that capture the profiles and areas of strength of the Member State and regions involved in the analysis. In these regressions, a set of control variables are added to account for other factors that could affect prioritisation approaches. Fixed effects at the regional-sectoral level are also added to the estimations. For these models, the prioritisation variable is expressed at time t (the year of publication of the S3, which varies from one strategy to another). The explicatory variables and the vector of control variables are instead expressed as the average of the three-years before t.[107]

Because the prioritisation variable can be either expressed in terms of economic sectors, fields of research or technological fields, we estimate three distinct panel models:

1. **A model of economic correspondence**:

$$Y_{e,r,t} = \beta_0 + \beta_1 Emp_{e,r,t} + \beta_2 \overline{EmpGr}_{e,r,t} + \beta_3 EmpLQ_{e,r,t} + \gamma_1 \bar{Z}_{r,t} + \gamma_2 \bar{d}_{e,r} + \ + \varepsilon_{e,r,t} \quad (1)$$

where:

- $Y_{e,r}$ is the prioritisation variable by region (*r*) and NACE sector (*e*), and year of the S3 (*t*);
- $Emp_{e,r,t}$ is the employment share in each region, sector, and year;
- $\beta_2 \overline{EmpGr}_{e,r,t}$ is the employment growth rate in the three years *before* the S3 publication (pre-S3 employment growth) and three years *after* the S3 publication (post-S3 employment growth) by region and sector, reflecting whether the prioritisation reflects or spurs a process of transformation in the region;
- $EmpLQ_{e,r,t}$ is the location quotient calculated with respect to Europe, which captures the regional specialisations within Europe;
- $\bar{Z}_r, t$ is the vector of control variables (for the list of controls, see Table 4-2);
- $\gamma_2 \bar{d}_{e,r}$ are region-sector fixed effects that capture non observable heterogeneity among regions and sectors; and
- $\varepsilon_{e,r,t}$ is a random error term with zero expected value.

The results of this model are presented in Table 9-20. Regression results confirm that S3 priorities classified according to the economic classification do not match the economic profiles as captured by sectoral employment shares. The coefficient on the employment share is negative and not significantly associated with the priority share. It is positive and significant only when we omit fixed effects at the Member State/region – sector level. This finding suggests that unobserved fixed effects at the sectoral level play a great role in shaping S3 strategies. Such unobserved effects might have to do with sectoral productivity level, modernisation levels, or strategic value, for example. Results hold when we add control variables that capture regional characteristics. The same is true when we include control variables that capture the characteristics of the EDP, or the type of region and country (New vs Old Member States, regional groups, Cohesion Policy groups, and innovation groups as classified by the European/Regional Innovation Scoreboard). When we replicate these results using LQ instead of employment shares, we find by and large the same results: areas of specialisations are generally not good predictors of priority

[107] The only exception is the post-S3 employment growth rate, which is the average of years *t*, *t+1* and *t+2*.

areas. Unobserved country/region – sector fixed effects play a greater role in explaining the correspondence between S3 priorities and economic sectors.[108]

Table 9-20: Regression results: Correspondence between S3 priorities and economic profiles

	No controls and no fixed effects	With controls and no fixed effects	No controls and no fixed effects	With controls and fixed effects
Employment share	0.034*** (0.01)	0.034*** (0.01)	-0.035 (0.12)	-0.107 (0.11)
GERD		-0.000 (0.00)		0.000 (0.01)
BERD		-0.000 (0.00)		-0.000 (0.01)
People in Science & Technology		0.000 (0.02)		-0.000 (0.101
GDP per capita		-0.000 (0.00)		0.000 (0.01)
GDP per capita growth		-0.000 (0.00)		-0.000 (0.00)
EQGI		0.000 (0.00)		0.000 (0.00)
Population		0.000 (0.00)		0.000 (0.00)
Population growth		-0.000 (0.03)		-0.000 (0.06)
ERDF aid intensity		0.000 (0.00)		-0.000 (0.03)
Constant	0.011*** (0.00)	0.011 (0.01)	0.012*** (0.00)	0.013 (0.24)
Region – sector fixed effects	No	No	Yes	Yes
Observations	18390	16806	18390	16806

Source: Prognos / CSIL (2021). Legend : * p<0.10, ** p<0.05, *** p<0.01. Standard errors in parentheses.

Table 9-21 presents the regression results of a model similar to the one shown above but where we account for structural transformation processes by using as regressors the growth rates of the sectoral employment shares three years before and after the publication of the S3 strategy. The coefficients of the econometric regressions show that employment developments taking place after the S3 publication are better reflected in the priorities, compared to ongoing employment changes occurring in the years before the S3 publication, even if results are not statistically significant when unobserved regional-sectoral fixed effects are controlled for. In these regressions, the coefficients on employment growth measured in the three years before the publication of the S3 strategy (pre-S3 employment growth) are always positive but not significant. The coefficients on employment growth measured in the three years after the publication of the strategy (post-S3 employment growth) is positive and significant, when no fixed effects are included in the regressions, but become not significant when country/region – sector fixed effects are controlled for. These results hold when we include control variables capturing regional and country characteristics in terms of R&D intensities, human capital in Science and Technology, GDP per capita and GDP per capita growth, quality of institutions, population trends, and aid intensity.

Table 9-21: Regression results: Correspondence between S3 priorities and ongoing changes and future developments of the economic structure

	No controls and no fixed effects	With controls and no fixed effects	No controls and no fixed effects	With controls and fixed effects
Pre-S3 employment growth	0.001 (0.00)	0.001 (0.00)	0.000 (0.00)	0.000 (0.00)
Post-S3 employment growth	0.003** (0.00)	0.004*** (0.00)	0.001 (0.00)	0.003 (0.00)
GERD		-0.000 (0.00)		-0.001 (0.01)
BERD		0.000		0.001

108 Results are not all shown here but are available on request.

		(0.00)		(0.01)
People in Science & Technology		0.000		0.003
		(0.02)		(0.10)
GDP per capita		0.000		-0.001
		(0.00)		(0.01)
GDP per capita growth		-0.000		0.000
		(0.00)		(0.00)
EQGI		-0.000		-0.000
		(0.00)		(0.00)
Population		-0.000		0.000
		(0.00)		(0.00)
Population growth		-0.001		0.002
		(0.03)		(0.06)
ERDF aid intensity		0.000		-0.000
		(0.00)		(0.03)
Constant	0.011***	0.011	0.011***	0.018
	(0.00)	(0.01)	(0.00)	(0.24)
Region – sector fixed effects	No	No	Yes	Yes
Observations	18390	16807	18390	16806

Source: Prognos / CSIL (2021). Legend : * p<0.10, ** p<0.05, *** p<0.01. Standard errors in parentheses.

2. A model of scientific correspondence:

$$Y_{s,r,t} = \beta_0 + \beta_1 Pub\_G_{s,r,t} + \beta_2 Pub\_B_{s,r,t} + \beta_3 TopPub\_G_{s,r,t} + \beta_4 TopPub\_B_{s,r,t} + \beta_5 PubLQ_{s,r,t} + \beta_6 TopPubR_{s,r,t} + \gamma_1 \bar{Z}_{r,t} + \gamma_2 \bar{d}_{s,r} + \varepsilon_{s,r,t} \quad (2)$$

where:

- $Y_{s,r}$ is the prioritisation variable by region (r), Field of Research (s) and year of the S3 (t);
- $Pub\_G_{s,r,t}$ and $Pub\_B_{s,r,t}$ are the shares of publications in each region, by FOR, produced by public institutions (Pub_G) or by private actors (Pub_B);
- $TopPub\_G_{s,r,t}$ and $TopPub\_B_{s,r,t}$ are the shares of the top 10% (and 25%) most cited publications in each region by FOR, produced by public institutions ($TopPub\_G$) or by private actors ($TopPub\_B$);
- $PubLQ_{s,r,t}$ is the location quotient of the share of publication by region and FOR and the $TopPubR_{s,r,t}$ is the ratio between the regional share of top-cited publications in a certain FOR over the EU28 share (relative excellence); because of multi-collinearity, different specifications of this model are estimated, by considering a smaller set of explicatory variables;
- $\bar{Z}_{r,t}$ is a vector of control variables, that do not vary by FOR, but only by region or country, and year of the strategy (for the list of controls, see Table 4-2);
- $\gamma_2 \bar{d}_{s,r}$ are region-FOR fixed effects that capture non-observable heterogeneity among regions and Field of Research; and
- $\varepsilon_{s,r,t}$ is a random error term with zero expected value.

The results of this estimation are presented in Table 9-22. The econometric analyses performed to verify the match of S3 strategies with the scientific profiles and areas of strength of the EU regions and countries uncovers interesting regularities. **Unobserved characteristics of the fields of research seem to have a great impact on the choices of priorities in S3 strategies**. When we estimate 3-dimensional panel models (with the three dimensions being NUTS level, FOR, and year), the variables that capture scientific profiles (being them publication shares, location quotients, and areas of excellence as measured by top-cited publications) are negatively and not significantly related to S3 priorities.[109] When we drop the fixed effects that capture region/country-FOR unobservable features, scientific profiles become positively and significantly associated with the priorities. This result suggests that prioritisation in S3 strategies has considered

[109] Results using other indicators of scientific profiles are not shown here and available on request.

scientific profiles at least to some extent, but other variables (related to unobserved characteristics of the scientific system in a certain field and region) also played a role. These characteristics might relate, for example, to the number of researchers or university professors in a certain field of research, to the specialisation of local universities and research centres in certain scientific fields, or to different propensities to publish in different fields of research. Interestingly, results hold when we include region/country-level control variables, confirming the role of unobserved characteristics, especially at the FOR level.[110]

Table 9-22: Regression results: Correspondence between S3 priorities and scientific profiles

	No controls and no fixed effects	With controls and no fixed effects	No controls and no fixed effects	With controls and fixed effects
Publication share	0.307***	0.307***	-0.022	-0.217
	(0.02)	(0.02)	(0.13)	(0.18)
GERD		0.000		-0.000
		(0.00)		(0.03)
BERD		-0.000		0.000
		(0.00)		(0.03)
People in Science & Technology		-0.001		0.000
		(0.07)		(0.39)
GDP per capita		-0.000		0.000
		(0.01)		(0.04)
GDP per capita growth		-0.000		-0.000
		(0.00)		(0.00)
EQGI		-0.000		-0.000
		(0.00)		(0.00)
Population		-0.000		-0.000
		(0.00)		(0.00)
Population growth		-0.003		-0.000
		(0.13)		(0.22)
ERDF aid intensity		-0.000		-0.000
		(0.00)		(0.12)
Constant	0.032***	0.036	0.046***	0.055
	(0.00)	(0.06)	(0.01)	(0.93)
Region – FOR fixed effects	No	No	Yes	Yes
Observations	4686	4224	4686	4224

Source: Prognos / CSIL (2021). Legend: * p<0.10, ** p<0.05, *** p<0.01. Standard errors in parentheses.

3. A model of technological correspondence:

$$Y_{d,r,t} = \beta_0 + \beta_1 Pat\_G_{d,r,t} + \beta_2 Pat\_B_{d,r,t} + \beta_3 PatLQ_{d,r,t} + \beta_5 Complex_{d,t} + \gamma_1 \bar{Z}_{d,t} + \gamma_2 \bar{d}_{d,r} + \varepsilon_{d,r,t} \quad (3)$$

where:

- $Y_{d,r,t}$ is the prioritisation variable by region (r), technological fields (d) and year of the S3 (t);
- $Pat\_G_{d,r,t}$ and $Pat\_B_{d,r,t}$ are the shares of patents in each region by technological field, produced by public institutions (Pat_G) or by business (Pat_B);
- $PatLQ_{d,r,t}$ is the location quotient calculated with patent data. In case of multi-collinearity, different specifications of this model are estimated, by considering a smaller set of explicatory variables at a time;
- $Complex_{d,t}$ is the index of technological complexity defined and computed by Crespo et al. (2017) and Balland and Boschma (2019b), which varies by technology, but not by region;
- $\bar{Z}_{r,t}$ is a vector of control variables, that do not vary by technological field, but only by region or country and year of the strategy (for the list of controls, see Table 4-2);

[110] This result is further corroborated by the fact that when we introduce in the regressions dummy variables that capture the different fields of research, most of these dummies are significant. These regressions are not shown in this report but could be provided upon request.

- $\gamma_2 \bar{d}_{d,r}$ are region-technological field fixed effects that capture non-observable heterogeneity among regions and technological fields; and
- $\varepsilon_{d,r,t}$ is a random error term with zero expected value.

Results of this econometric estimation are reported in Table 9-23. They indicate that technological profiles are significant predictors of priority areas in S3 strategies only if we disregard country/regional – technology fixed effects. The latter, which might relate to the different propensities to patent in different technological fields, play a much greater role compared to technological profiles as proxied by patent shares.

Indeed, patent shares are negatively and not significantly associated with priority areas when we account for country/region- technology fixed effects (columns three and four of Table 9-23) and become positive and significant only when these fixed are omitted (columns one and two of Table 9-23). Results hold when we introduce control variables that capture socio-economic and institutional variables, R&D intensity of the region/country, its human capital in Science and Technology, and aid intensity. The same results are found when location quotients are used instead of patent shares, or when we include variables that capture the nature of the EDP and dummy variables identifying the profile of the region/country in terms of Cohesion Policy group, Regional Innovation Scoreboard group, and New/Old Member State.[111]

Table 9-23: Regression results: Correspondence between S3 priorities and technological profiles in the private and public sector

	No controls and no fixed effects	With controls and no fixed effects	No controls and no fixed effects	With controls and fixed effects
Patent share	0.195***	0.223***	-0.005	-0.013
	(0.02)	(0.02)	(0.03)	(0.05)
GERD		-0.000		0.000
		(0.00)		(0.03)
BERD		-0.000		0.000
		(0.00)		(0.02)
People in Science & Technology		-0.001		-0.000
		(0.04)		(0.33)
GDP per capita		-0.000		0.000
		(0.00)		(0.04)
GDPpc_growth		-0.000		0.000
		(0.00)		(0.00)
EQGI		0.000		-0.000
		(0.00)		(0.00)
Population		-0.000		0.000
		(0.00)		(0.00)
Population growth		-0.005		-0.000
		(0.10)		(0.18)
ERDF aid intensity		-0.000		0.000
		(0.00)		(0.10)
Constant	0.023***	0.026	0.029***	0.029
	(0.00)	(0.04)	(0.00)	(0.79)
Region – technology fixed effects	No	No	Yes	Yes
Observations	7315	6720	7315	6720

Source: Prognos / CSIL (2021). Legend : * p<0.10, ** p<0.05, *** p<0.01. Standard errors in parentheses.

[111] Results are not shown here but are available upon request.

9.3.3 *Cluster analysis of S3 strategies*

This annex presents the methodology and the results of the cluster analysis carried out to classify the 209 S3 strategies published between 2011 and 2019. Strategies published in 2020 could not be included in the analysis due to lack of updated data on patents and employment.

Methodology

A cluster analysis is a non-parametric multivariate method which aims at grouping observations based on a set of common characteristics. In our case, the cluster analysis aims at classifying the S3 strategies according to the prioritisation approach that they adopted. This is proxied by the degree of correspondence between priorities and the regional/country economic, scientific, and technological profiles and strengths, as measured by Pearson's coefficients (see Section 2.1.4). The clusters, i.e., the groups of S3 strategies, that are produced by this analysis are characterised by high similarity within the cluster and low similarity between clusters.

The following steps were taken to carry out the cluster analysis:

- **Correlation matrix**: since many alternative variables can be considered to determine the regional profiles from either an economic, scientific, or technological perspective (e.g., when looking at the economic profiles, either the employment share across different NACE sectors or the employment growth rate can be used), the correlations between different sets of correlation coefficients were firstly examined (see Table 9-25).
- **Principal Component Analysis (PCA)**: given the high correlation found between certain sets of Pearson's coefficients, a PCA was used to reduce the number of variables to be considered for the cluster analysis. This allowed working with the most relevant components that capture the specialisation approaches of the regions, without losing any relevant information in the data. The PCA was performed on normalised Pearson's coefficients computed between priority areas and the following ten variables: publication shares, shares of the top 10% most cited publications, relative excellence computed on top 10% most cited publications and in comparison to the EU28 average, publications LQ computed with respect to the EU28 average, patent shares, patent LQ computed with respect to the EU28 average, the technological relatedness index, employment shares, employment LQ computed with respect to the EU28 average, and the employment growth rate in the three years before the publication of the S3 strategy. Out of the ten identified components, four components were retained. Together, these components explain 77.7% of the total variance. As shown in Table 9-26 each component is correlated with a specific set of variables:
    - The *first component* is correlated with the four variables that capture the strategies' correspondence with the scientific profile (i.e., the share of top 10% most cited publications, relative excellence of top 10% most cited publications, publication shares, publication LQ);
    - The *second component* is correlated with the three variables that capture the strategies' correspondence with the technological profile (i.e., patent shares, patent LQ, and the technological relatedness density index);
    - The *third and the fourth components* are both correlated with the variables capturing the strategies' correspondence with the economic profile. The third component captures the correspondence with the current economic profile (employment share and employment LQ), while the fourth captures the correspondence with ongoing economic transformations (proxied by the employment growth rate in the three years before the publication of the S3 strategy).

  A Kaiser-Meyer-Olkin (KMO) test was performed to measure sampling adequacy. The KMO equals 0.64, meaning that the variables included in the PCA are sufficiently correlated to perform a PCA.

- **Cluster analysis**: the S3 strategies were clustered according to five variables, namely the four components obtained through the PCA (see previous point) and the technological ambition index.[112] Against different existing clustering methods, the hierarchical algorithm was used as the preferred one for this study (on this matter, see also Box 9-1 below). Specifically, an agglomerative (bottom-up) hierarchical clustering approach was performed based on the Ward's minimum-variance distance measure.
- **Robustness checks**: different checks were performed to ensure the robustness of the results of the cluster analysis. First, the hierarchical cluster analysis was performed on individual variables instead than on principle components. This approach produces the same results as our preferred method in 78% of the strategies. Second, a k-means clustering method was also tested, overall confirming our original results.[113] In particular, the hierarchical and the k-means algorithms produce the same results in 68% of the strategies.

Box 9-1: Differences between hierarchical and k-means clustering

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Differences between hierarchical and k-means clustering

Agglomerative hierarchical algorithms start by assigning each observation (the RIS strategy in our application) to one single cluster. Then, according to selected distance measures (e.g., Ward), each pair of most similar clusters are grouped together. This step is repeated until all the observations are assigned to one cluster. This aggregation process is illustrated in a tree-like diagram, the so-called dendrogram.

The k-means algorithm, instead, partitions the observations in a number k of clusters, by minimising the intra-cluster distance (Hamerly and Elkan, 2002). This clustering algorithm starts with a k-number of centroids (initial values for the centroids are either randomly selected or might be derived from a priori information). Then, each observation is assigned to the closest cluster (i.e., closest centroid). Finally, the centroids are recalculated according to the associated observations. This process is repeated until convergence is achieved. Furthermore, k-means has a constant weight function, thus, all observations have equal importance (Hamerly and Elkan, 2002).

The main advantages and drawbacks of each method are presented in Table 9-24.

Table 9-24. Advantages and limitations of hierarchical and k-means clustering

	Hierarchical clustering	K-means clustering
Advantages	• It is not sensitive to the initial data points and less sensitive to noise in the dataset (Leung et al., 2000); • It constructs a hierarchy of clusters, not just a single partition of objects; • It generates clustering similar to that perceived by human eyes and conceptually simple and	• It considers every point in the dataset and uses that information to modify the clustering over a series of iterations. • It works well when the shape of the clusters is hyper spherical, meaning that cluster data points are centred around a centroid.

[112] This variable was not introduced in the PCA due to its strong negative correlation with the other technological correlation coefficients. If included, this variable would have been combined in one component together with the other technological related variable and this would not allow to distinguish between ambitious and purely technological profile driven approaches.

[113] As explained in the Box 9-1, the k-means method requires to select the number of clusters a priori. The Elbow method was used to select the most appropriate number of clusters among which the dataset could be partitioned. The results, which vary depending on the possible ranges of *K* that is set as a parameter, indicate that *K* equal to four or five is appropriate.

	easier to interpret (Leung et al., 2000); • The number of clusters does not need to be specified a priori (Frigui and Krishnapuram, 1999). • The identified clusters are independent of the initial conditions (Frigui and Krishnapuram, 1999): the only requirement (which k-means also shares) is that a distance can be calculated for each pair of data points	• When both the number of clusters, k, and the number of iterations, t, are small, it is considered a linear algorithm. • It is less computationally expensive, thus easy to implement and suitable for very large data sets (Turi, 2001).
Limitations	• It is computationally expensive (Turi, 2001); hence, it is not suitable for very large data sets. • It is static, i.e., patterns assigned to a cluster cannot move to another cluster when moving along the dendrogram. This means that clusters' merging/splitting is permanent. • It may fail to separate overlapping clusters due to a lack of information about the global shape or size of the clusters. • It puts together clusters that seem close, but no information about other points is considered.	• The algorithm is data-dependent (Davies, 1997) and sensitive to initial centroids and outliers. • It depends on the initial conditions, the most notable being that the data is 'spherical', which may cause the algorithm to converge to suboptimal solutions (Davies, 1997). • The user needs to specify the number of clusters in advance (Davies, 1997); results may be unintuitive if the chosen k is ill-suited to the shape of the data, i.e., the value picked is too high or too low.

Source: Prognos / CSIL (2021), based on quoted references.

Table 9-25. Correlation matrix of Pearson's coefficients

Variables	Top10_ share	Top10_ Ratio	Publ_ share	Publ_ LQ	Patent_ share	Patent_ LQ	Relatedness	Complexity	Ambition	Empl_ share	Empl_ past_ growth_ rate	Empl_ future_ growth_ rate	Empl_ LQ
Top10_share	1.000												
Top10_Ratio	0.900***	1.000											
Publ_share	0.404***	0.391***	1.000										
Publ_LQ	0.741***	0.873***	0.442***	1.000									
Patent_share	0.029	0.059	0.200***	0.096	1.000								
Patent_LQ	0.061	0.047	0.081	-0.003	0.698***	1.000							
Relatedness	0.010	0.049	0.004	0.001	0.564***	0.647***	1.000						
Complexity	-0.152**	-0.101	0.042	-0.113*	0.051	-0.050	0.078	1.000					
Ambition	-0.086	-0.057	0.034	0.004	-0.364***	-0.502***	-0.647***	0.588***	1.000				
Empl_share	0.059	0.020	-0.044	-0.030	-0.066	0.147**	0.043	-0.277***	-0.252***	1.000			
Empl_past_ growth_rate	0.041	0.104	0.067	0.120*	0.072	0.074	-0.005	-0.020	-0.004	0.156**	1.000		
Future_growth	0.107	0.093	0.189***	0.080	0.144**	0.033	-0.026	-0.089	-0.052	-0.056	0.019	1.000	
Empl_LQ	0.057	0.029	-0.047	0.049	0.054	0.097	0.049	-0.110	-0.118*	0.488***	0.088	-0.127*	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Table 9-26. Principal Component Analysis (PCA) results

Principal components/correlation			Number of obs.	=	209
			Number of comp.	=	4
			Trace	=	10
Rotation: orthogonal varimax (Kaiser off)			Rho	=	0. 7770

Component	Variance	Difference	Proportion	Cumulative
Comp1	2.938	0.649	0.294	0.294
Comp2	2.288	0.770	0.229	0.523
Comp3	1.518	0.493	0.152	0.674
Comp4	1.025		0.102	0.777

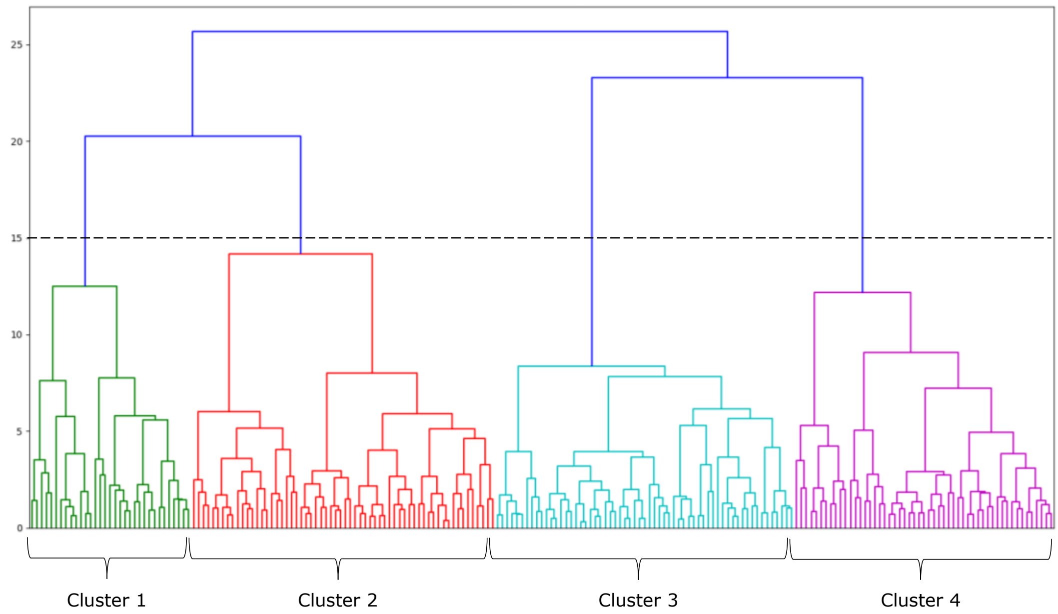
Rotated components (blanks are abs(loading)<.3)

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Top10_share	0.542				0.144
Top10_Ratio	0.560				0.082
Publ_share	0.327				0.589
Publ_LQ	0.533				0.159
Patent_share		0.577			0.222
Patent_LQ		0.591			0.181
Relatedness		0.558			0.284
Empl_share			0.690		0.253
Empl_past_growt_rate				0.969	0.036
Empl_LQ			0.690		0.279

Results

The cluster analysis was performed on the four components identified with the PCA (see section above) and the indicator of technological ambition. Using the agglomerative cluster method described in the previous section, a dendrogram was generated (Figure 9-9). In the dendrogram, four clusters were identified at the level indicated by the horizontal line.

Figure 9-9: Hierarchical clustering dendrogram



Source: Prognos / CSIL (2021). Notes: The dendrogram represents the individual S3 strategies and the remaining nodes represent the clusters to which the strategies belong, with the arrows representing the Ward's distance measure (dissimilarity). The distance between merged clusters is monotone, increasing with the level of the merger: the height of each node in the plot is proportional to the value of the intergroup dissimilarity between its two daughters (the nodes in the bottom, representing individual observations, all plotted at zero height).

The four identified clusters differ by the degree of correspondence with the regional profiles and the degree of ambition that characterise their prioritisation approach. The average value of the variables entering the clustering algorithm was compared across the four clusters to identify common prioritisation approaches within each cluster (Table 9-27). This comparative analysis shows that each cluster is characterised by a predominant correspondence with a (economic, scientific, or technological) profile, except for the fourth cluster which includes strategies that have a low correspondence with all profiles and a relatively high level of ambition.

Table 9-27: Average value of variables in each cluster

	Cluster 1: Higher correspondence with the economic structure	Cluster 2: Higher correspondence with the technological structure	Cluster 3: Higher correspondence with the scientific structure	Cluster 4: Lower correspondence but high ambition
N. S3 strategies	33	62	61	53
Average PCA1 (scientific profile)	0.17	-0.86	1.71	-1.07
Average PCA2 (technological profile)	0.19	1.43	-0.25	-1.5
Average PCA3 (economic profile - static)	2.23	-0.33	-0.44	-0.50
Average PCA1 economic profile – pre-S3 growth)	0.50	0.03	-0.10	-0.22
Average Ambition	-0.30	-0.67	0.23	0.71

Source: Prognos / CSIL (2021).

To check the robustness of the results, the agglomerative hierarchical cluster analysis was performed on the original ten normalised Pearson's coefficients. The two clustering approaches produce the same results for 161 S3 strategies analysed out of 209 (77%) (Table 9-28).

Table 9-28: Results of the Hierarchical cluster analysis on individual variables or principal components: number of S3 strategies in each cluster

		Hierarchical clusters on individual variables				
		Higher economic correspondence	Higher technological correspondence	Higher scientific correspondence	Lower correspondence	Total
Hierarchical clustering on PCA	Higher economic correspondence	13	7	13		33
	Higher technological correspondence	5	45	6	6	62
	Higher scientific correspondence			56	5	61
	Lower correspondence	2	2	2	47	53
	Total	20	54	77	58	209

Source: Prognos / CSIL (2021).

As an additional robustness check, the k-means clustering method was applied on the same variables used for the hierarchical clustering, i.e., the four components identified with the PCA and the indicator of technological ambition. The two clustering methods produce the same results for 142 S3 strategies analysed out of 209 (68%), as shown in Table 9-29.

Table 9-29. Results of the K-means and Hierarchical cluster analysis at comparison: number of S3 strategies in each cluster

		K-means clustering				
		Higher economic correspondence	Higher technological correspondence	Higher scientific correspondence	Lower correspondence	Total
Hierarchical clustering	Higher economic correspondence	12		10	11	33
	Higher technological correspondence	32	27	1	2	62
	Higher scientific correspondence	2		59		61
	Lower correspondence		3	6	44	53
	Total	46	30	76	57	209

Source: Prognos / CSIL (2021).

Table 9-30 lists the S3 strategies included in the analysis and their respective cluster according to the hierarchical and the k-means clustering method.

Table 9-30. Results of the cluster analysis by S3 strategy

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
AT	Austria	Becoming an Innovation Leader - Strategy for research, technology, and innovation of the Austrian federal government	2011	Correspondence with scientific profile	Correspondence with scientific profile
BE	Brussels Region	Mise à jour du Plan Régional pour l'Innovation de la Région de Bruxelles-Capitale 2007-2013	2012	Correspondence with technological profile	Correspondence with technological profile
BE	Brussels Region	Plan Régional pour l'Innovation 2016 - 2020	2016	Correspondence with technological profile	Correspondence with technological profile
BE	Flanders	THE STRATEGIC POLICY FRAMEWORK for SMART SPECIALISATION in FLANDERS	2014	Correspondence with scientific profile	Correspondence with scientific profile
BE	Walloon Region	STRATEGIE DE TRATEGIE SPECIALISATION INTELLIGENTE DE LA WALLONIE	2014	Low correspondence with any profile	Low correspondence with any profile
BG	Bulgaria	Иновационна стратегия за интелигентна специализация на Република България 2014-2020	2015	Correspondence with technological profile	Correspondence with technological profile
BG	Bulgaria	Иновационната стратегия за интелигентна специализация на Република България 2014-2020 г. (първа актуализация на тематичните подобласти, 18.12.2018)	2018	Correspondence with technological profile	Correspondence with technological profile
CY	Cyprus	ΣΤΡΑΤΗΓΙΚΗΕΞΥΠΝΗΣ ΕΞΕΙΔΙΚΕΥΣΗΣγια την Κύπρο	2015	Correspondence with technological profile	Correspondence with technological profile
CZ	Czechia	National Research and Innovation Strategy for Smart Specialisation of the Czechia (National S3 Strategy) as of June 2016. Government of the Czechia. Department for Analysis and Coordination of Science, Research and Innovation.	2016	Correspondence with technological profile	Correspondence with economic profile
CZ	Czechia	Národní výzkumná a inovační strategie pro inteligentní specializaci České republiky (Národní S3 strategie) 2014 – 2020 (aktualizace 2018). Ministerstvo průmyslu a obchodu. Sekce technologií 4.0	2018	Correspondence with scientific profile	Correspondence with scientific profile
DE	Baden Wurttemberg	Innovationsstrategie Baden-Württemberg	2013	Correspondence with economic profile	Low correspondence with any profile
DE	Bavaria	Gesamtkonzept für die Forschungs-, Technologie und Innovationspolitik der Bayerischen Staatsregierung - Regionale Innovationsstrategie für Bayern (Strategie für „Intelligente Spezialisierung")	2013	Correspondence with scientific profile	Correspondence with scientific profile
DE	Berlin	Gemeinsame Innovationsstrategie der Länder Berlin und Brandenburg (innoBB)	2011	Correspondence with technological profile	Correspondence with economic profile
DE	Brandenburg	Gemeinsame Innovationsstrategie der Länder Berlin und Brandenburg (innoBB)	2011	Correspondence with technological profile	Correspondence with technological profile
DE	Bremen	Innovationsprogramm 2020 und Clusterstrategie 2020 als „regionale Innovationsstrategie für	2015	Correspondence with technological profile	Correspondence with technological profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
		intelligente Spezialisierung" (S3) für das Land Bremen			
DE	Hamburg	Regionale Innovationsstrategie 2020 der Freien und Hansestadt Hamburg	2014	Correspondence with technological profile	Correspondence with technological profile
DE	Hesse	Hessische Innovationsstrategie 2020	2013	Low correspondence with any profile	Low correspondence with any profile
DE	Mecklenburg-West Pomerania	Regionale Innovationsstrategie 2020 für das Land Mecklenburg-Vorpommern	2014	Correspondence with scientific profile	Correspondence with scientific profile
DE	Lower Saxony	Regional- und Strukturpolitik der EU im Zeitraum 2014-2020 – Niedersächsische regionale Innovationsstrategie für intelligente Spezialisierung (S3)	2014	Correspondence with technological profile	Correspondence with economic profile
DE	North Rhine-Westphalia	Regionale Innovationsstrategie des Landes Nordrhein-Westfalen im Rahmen der EU-Strukturfonds 2014-2020	2014	Low correspondence with any profile	Low correspondence with any profile
DE	Rhineland Palatinate	Innovationsstrategie Rheinland-Pfalz	2013	Low correspondence with any profile	Low correspondence with any profile
DE	Saarland	Strategie für Innovation und Technologie Saarland 2016 - 2023	2015	Correspondence with scientific profile	Correspondence with scientific profile
DE	Saxony	Innovationsstrategie des Freistaates Sachsen	2013	Correspondence with economic profile	Correspondence with scientific profile
DE	Saxony-Anhalt	Regionale Innovationsstrategie Sachsen-Anhalt 2014-2020	2014	Correspondence with technological profile	Correspondence with technological profile
DE	Schleswig-Holstein	Regionale Innovationsstrategie Schleswig-Holstein	2014	Low correspondence with any profile	Low correspondence with any profile
DE	Thuringia	Regionale Forschungs- und Innovationsstrategie für intelligente Spezialisierung für Thüringen	2014	Correspondence with technological profile	Correspondence with economic profile
DK	Denmark	#N/D	2012	Correspondence with economic profile	Correspondence with scientific profile
EE	Estonia	Nutikas spetsialiseerumine „Teadmistepõhine Eesti"	2014	Correspondence with technological profile	Correspondence with technological profile
EL	Greece	Εθνική Στρατηγική Έρευνας και Καινοτομίας για την Έξυπνη Εξειδίκευση 2014-2020	2015	Correspondence with scientific profile	Correspondence with scientific profile
EL	Attica	Στρατηγική Έξυπνης Εξειδίκευσης της Περιφέρειας Αττικής	2015	Correspondence with technological profile	Low correspondence with any profile
EL	North Aegean	Στρατηγικό πλαίσιο για την "έξυπνη εξειδίκευση" στην Περιφέρεια Βορείου Αιγαίου για την προγραμματική περίοδο 2014-2020	2015	Low correspondence with any profile	Correspondence with scientific profile
EL	South Aegean	Στρατηγική Έξυπνης Εξειδίκευσης για την Περιφέρεια Νοτίου Αιγαίου	2015	Correspondence with economic profile	Low correspondence with any profile
EL	Crete	Στρατηγική Έξυπνης Εξειδίκευσης Περιφέρειας Κρήτης	2015	Correspondence with economic profile	Correspondence with economic profile
EL	Eastern Macedonia and Thrace	Περιφέρεια Ανατολικής Μακεδονίας-Θράκης: Περιφερειακή Στρατηγική Καινοτομίας Έξυπνης Εξειδίκευσης	2015	Low correspondence with any profile	Correspondence with scientific profile
EL	Central Macedonia	Η Στρατηγική Ευφυούς Εξειδίκευσης (S3) στην Περιφέρεια Κεντρικής Μακεδονίας	2015	Correspondence with scientific profile	Correspondence with economic profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
EL	Western Macedonia	Σχέδιο Στρατηγικής Έξυπνης Εξειδίκευσης Περιφέρειας Δυτικής Μακεδονίας 2014 –2020	2015	Correspondence with economic profile	Correspondence with economic profile
EL	Epirus	Στρατηγική Έξυπνης Εξειδίκευσης για την Περιφέρεια Ηπείρου	2015	Low correspondence with any profile	Low correspondence with any profile
EL	Thessaly	Περιφερειακή Στρατηγική Καινοτομίας Έξυπνης Εξειδίκευσης της Περιφέρειας Θεσσαλίας για την Προγραμματική Περίοδο 2014-2020	2015	Correspondence with scientific profile	Correspondence with scientific profile
EL	Ionian Islands	Στρατηγική Έξυπνης Εξειδίκευσης για την Περιφέρεια Ιονίων Νήσων	2015	Correspondence with economic profile	Low correspondence with any profile
EL	Western Greece	Στρατηγική Έξυπνης Εξειδίκευσης για την Περιφέρεια Δυτικής Ελλάδας	2015	Correspondence with technological profile	Correspondence with technological profile
EL	Central Greece	Στρατηγική Έξυπνης Εξειδίκευσης για την Περιφέρεια της Στερεάς Ελλάδας	2015	Correspondence with economic profile	Low correspondence with any profile
EL	Peloponnese	Έξυπνη Εξειδίκευση Έρευνας, Τεχνολογίας και Καινοτομίας στις επιχειρήσεις και τον αγροτικό τομέα της Περιφέρειας Πελοποννήσου, για την περίοδο 2014 – 2020	2014	Correspondence with economic profile	Low correspondence with any profile
ES	Spain	Estrategia Nacional de Ciencia Tecnología y Innovación 2013-2020	2013	Correspondence with scientific profile	Correspondence with scientific profile
ES	Galicia	Estrategia de Especialización de Galicia-S3	2014	Correspondence with technological profile	Low correspondence with any profile
ES	Principado de Asturias	Asturias S3 2014 - 2020	2014	Correspondence with scientific profile	Correspondence with scientific profile
ES	Cantabria	Estrategia de Investigación e Innovación 2020 para la Especialización Inteligente de Cantabria	2013	Low correspondence with any profile	Low correspondence with any profile
ES	País Vasco	PCTI EUSKADI 2020 - Una estrategia de especialización inteligente - Research & Innovation Smart Specialisation Strategy - S3	2014	Correspondence with technological profile	Correspondence with economic profile
ES	Comunidad Foral de Navarra	Estrategia de especialización inteligente de Navarra	2016	Correspondence with scientific profile	Correspondence with scientific profile
ES	La Rioja	ESTRATEGIA DE ESPECIALIZACIÓN INTELIGENTE DE LA RIOJA 2014-2020	2015	Low correspondence with any profile	Low correspondence with any profile
ES	La Rioja	Revisión y actualización de la Estrategia Regional de Especialización Inteligente de La Rioja	2019	Low correspondence with any profile	Low correspondence with any profile
ES	Aragón	Estrategia Aragonesa de Investigación e Innovación para una Especialización Inteligente - S3 Aragón	2015	Correspondence with scientific profile	Correspondence with scientific profile
ES	Comunidad de Madrid	ESTRATEGIA REGIONAL DE INVESTIGACIÓN E INNOVACIÓN PARA UNA ESPECIALIZACIÓN INTELIGENTE DE LA COMUNIDAD DE MADRID	2014	Correspondence with technological profile	Correspondence with economic profile
ES	Comunidad de Madrid	PLAN DE ACCIÓN DE LA RIS 3 DE LA COMUNIDAD DE MADRID, 2014-2020	2019	Correspondence with technological profile	Correspondence with economic profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
ES	Castilla y León	Estrategia Regional de Investigación e Innovación para una Especialización inteligente (S3) de Castilla y León 2014-2020	2014	Correspondence with scientific profile	Correspondence with scientific profile
ES	Castilla y León	Actualización para el periodo 2018-2020 de la ESTRATEGIA REGIONAL DE INVESTIGACION E INNOVACION PARA UNA ESPECIALIZACION INTELIGENTE (S3) DE CASTILLA Y LEON 2014-2020	2018	Correspondence with scientific profile	Correspondence with scientific profile
ES	Castilla-La Mancha	Estrategia de Especialización Inteligente de Castilla-La Mancha 2014-2020.	2014	Correspondence with scientific profile	Correspondence with scientific profile
ES	Castilla-La Mancha	Estrategia de Especialización Inteligente de Castilla-La Mancha 2014-2020. PLAN DE ACCIÓN PARA EL CUMPLIMIENTO DE LA EAC T.01.1 28/12/2016	2016	Correspondence with scientific profile	Correspondence with scientific profile
ES	Extremadura	Estrategia S3 Extremadura	2015	Correspondence with scientific profile	Correspondence with scientific profile
ES	Cataluña	L'Estratègia de recerca i innovació per a l'especialització intel·ligent de Catalunya (S3CAT)	2014	Low correspondence with any profile	Low correspondence with any profile
ES	Comunidad Valenciana	S3-CV Estratègia d'Especialització Intel·ligent per a la Investigació i Innovació a la Comunitat Valenciana	2016	Low correspondence with any profile	Low correspondence with any profile
ES	Illes Balears	Estrategia Regional De Innovacion Para La Especializacion Inteligente de Las Illes Balears 2014	2014	Correspondence with economic profile	Low correspondence with any profile
ES	Illes Balears	ESTRATEGIA REGIONAL DE INNOVACIÓN PARA LA ESPECIALIZACIÓN INTELIGENTE DE LAS ILLES BALEARS 2017	2017	Correspondence with economic profile	Low correspondence with any profile
ES	Andalucía	ESTRATEGIA DE INNOVACIÓN DE ANDALUCÍA 2020 S3 ANDALUCÍA	2013	Correspondence with scientific profile	Correspondence with scientific profile
ES	Región de Murcia	ESTRATEGIA DE INVESTIGACIÓN E INNOVACIÓN PARA LA ESPECIALIZACIÓN INTELIGENTE DE LA REGIÓN DE MURCIA	2014	Correspondence with economic profile	Correspondence with economic profile
ES	Canarias	Estatregia de Especialización Inteligente de Canarias 2014-2020	2013	Correspondence with scientific profile	Correspondence with scientific profile
FI	Länsi-Suomi	Keski-Suomen maakuntaohjelma 2018–2021; Älykäs ja erottuva – Etelä-Pohjanmaan älykkään erikoistumisen strategia; Pohjanmaan innovaation ja kasvun strategia 2019–2022: Älykäs erikoistuminen; Yhä rohkeempi ja sopii sulle edelleen! – Pirkanmaan maakuntaohjelma 2018–2020	2017	Correspondence with technological profile	Correspondence with economic profile
FI	Helsinki-Uusimaa	Älykäs erikoistuminen Uudellamaalla – Aluekehityksen tutkimus- ja innovaatistrategia 2014–2020	2015	Correspondence with economic profile	Correspondence with economic profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
FI	Etelä-Suomi	Varsinais-Suomen maakuntaohjelma 2018–2021; Häme-ohjelma 2018+ – Maakuntasuunnitelma 2040, maakuntaohjelma 2018–2021 ; Päijät-Häme – Maakuntastrategia ja -ohjelma 2018–2021 ; Kymenlaakso's smart specialisation S3 strategy 2016–2020 ; Etelä-Karjalan innovaatiostrategia 2018–2021	2017	Low correspondence with any profile	Low correspondence with any profile
FI	Etelä-Suomi	Varsinais-Suomen älykkään erikoistumisen toimintasuunnitelma vuosille 2019–2021	2019	Correspondence with technological profile	Correspondence with technological profile
FI	Pohjois- ja Itä-Suomi	Etelä-Savon älykkään erikoistumisen strategia; Kainuu-ohjelma – Maakuntaohjelma 2018–2021; Keski-Pohjanmaan maakuntasuunnitelma 2040 ja maakuntaohjelma 2018–2021 ; Pohjois-Pohjanmaan älykäs erikoistuminen ; Lapin arktisen erikoistumisen ohjelma	2016	Correspondence with economic profile	Correspondence with economic profile
FI	Pohjois- ja Itä-Suomi	Lappi: arktinen ja kansainvälinen menestyjä – kansainvälistymisen ja älykkään erikoistumisen strategiset prioriteetit 2018–2022	2018	Correspondence with technological profile	Correspondence with technological profile
FR	Ile-de-France	Stratégie de spécialisation intelligente de l'Ile de France	2013	Correspondence with technological profile	Correspondence with economic profile
FR	Champagne-Ardenne	Stratégie de Spécialisation Intelligente	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Picardie	STRATÉGIE DE SPÉCIALISATION INTELLIGENTE (Smart Specialisation Strategy)	2013	Correspondence with scientific profile	Correspondence with scientific profile
FR	Haute Normandie	Elaboration d'une Stratégie de Recherche et d'Innovation basée sur une Spécialisation Intelligente	2013	Correspondence with technological profile	Correspondence with economic profile
FR	Haute Normandie	NO UPDATE OF THE S3, BUT ADDITION OF SRESRI/SRDEII AND HYDROGEN PLAN PRIORITIES (Implementation Documents of the OP adjusted accordingly)	2016	Correspondence with technological profile	Correspondence with economic profile
FR	Centre	Vers une stratégie regionale de l'innovation pour une spécialisation intelligente en region Centre	2013	Correspondence with technological profile	Correspondence with technological profile
FR	Centre	No published document (adaptation based on a midterm evaluation in 2017, active in 2018, formal validation in 2020)	2018	Low correspondence with any profile	Low correspondence with any profile
FR	Basse Normandie	Stratégie régionale de recherche et d'innovation pour une spécialisation intelligente en Basse-Normandie 2014-2020	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Basse Normandie	NO UPDATE OF THE S3, BUT ADDITION OF SRESRI/SRDEII AND HYDROGEN PLAN PRIORITIES (Implementation Documents of the OP adjusted accordingly)	2016	Correspondence with scientific profile	Correspondence with scientific profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
FR	Bourgogne	La Stratégie Régionale d'Innovation en Bourgogne Vers une spécialisation intelligente	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Nord-Pas-de-Calais	Stratégie Recherche Innovation pour une Spécialisation Intelligente (SRI-SI) Nord-Pas de Calais 2014-2020	2013	Low correspondence with any profile	Low correspondence with any profile
FR	Lorraine	STRATEGIE REGIONALE D'INNOVATION DE LA REGION LORRAINE SPECIALISATION INTELLIGENTE	2013	Correspondence with scientific profile	Correspondence with scientific profile
FR	Alsace	La Stratégie de Spécialisation Intelligence en Alsace	2013	Correspondence with economic profile	Correspondence with scientific profile
FR	Franche-Comté	La Stratégie de Spécialisation Intelligente (S3) 2014-2020 pour la Franche-Comté	2014	Correspondence with economic profile	Correspondence with scientific profile
FR	Pays de la Loire	Stratégie Régionale d'Innovation pour une Spécialisation Intelligente (SRI-SI)	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Bretagne	Stratégie de Soutien à l'Innovation "S3" (Annexe du SRDEII)	2013	Correspondence with scientific profile	Correspondence with economic profile
FR	Poitou-Charentes	STRATÉGIE RÉGIONALE D'INNOVATION POUR UNE SPÉCIALISATION INTELLIGENTE (S3) POITOU-CHARENTES 2014-2020	2014	Correspondence with technological profile	Correspondence with economic profile
FR	Aquitaine	Stratégie de Spécialisation Intelligente en Aquitaine	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Midi-Pyrénées	Stratégie régionale de l'innovation pour une spécialisation intelligente en Midi-Pyrénées - 2014/2020	2013	Correspondence with economic profile	Correspondence with scientific profile
FR	Midi-Pyrénées	La spécialisation intelligente Occitanie	2017	Correspondence with scientific profile	Correspondence with scientific profile
FR	Limousin	La Stratégie de Spécialisation Intelligente en Limousin 2014-2020	2013	Correspondence with scientific profile	Correspondence with scientific profile
FR	Rhône-Alpes	Stratégie d'innovation de la Région Rhone-Alpes au regard de la "Spécialisation Intelligente"	2013	Correspondence with scientific profile	Correspondence with scientific profile
FR	Auvergne	Stratégie de Spécialisation Intelligente Auvergne	2014	Low correspondence with any profile	Low correspondence with any profile
FR	Languedoc-Roussillon	Stratégie Régionale d'Innovation de Spécialisation Intelligente (3S) Languedoc-Roussillon 2014-2020	2014	Correspondence with scientific profile	Correspondence with scientific profile
FR	Languedoc-Roussillon	La spécialisation intelligente Occitanie	2017	Correspondence with technological profile	Correspondence with economic profile
FR	Provence-Alpes-Côte d'Azur	Stratégie Régionale d'Innovation	2014	Correspondence with technological profile	Correspondence with economic profile
FR	Rhône-Alpes	NO FORMAL S3 UPDATE, but an alignment of priorities on those of the regional economic strategy (SRDEII), with a revision of the ERDF OP to take them into account	2017	Correspondence with technological profile	Correspondence with economic profile
FR	Corse	Stratégie de Spécialisation Intelligente (3S) en Corse	2014	Correspondence with scientific profile	Correspondence with scientific profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
HR	Croatia	Strategije pametne specijalizacije Republike Hrvatske za razdoblje od 2016. do 2020. godine	2016	Correspondence with technological profile	Correspondence with technological profile
HU	Hungary	Nemzeti Intelligens Szakosodási Stratégia	2014	Correspondence with technological profile	Correspondence with economic profile
IE	Ireland	Ireland's Smart Specialisation Strategy for Research and Innovation	2014	Correspondence with economic profile	Correspondence with economic profile
IT	Italy	Strategia nazionale di specializzazione intelligente	2016	Low correspondence with any profile	Correspondence with scientific profile
IT	Piedmont	Strategia per la specializzazione intelligente del Piemonte	2016	Correspondence with technological profile	Correspondence with economic profile
IT	Valle d'Aosta	SMART SPECIALISATION STRATEGY IN VALLE D'AOSTA	2014	Correspondence with technological profile	Correspondence with technological profile
IT	Valle d'Aosta	SMART SPECIALISATION STRATEGY IN VALLE D'AOSTA	2019	Correspondence with scientific profile	Correspondence with scientific profile
IT	Liguria	Smart Specialisation Strategy Regione Liguria	2015	Correspondence with technological profile	Correspondence with economic profile
IT	Liguria	Smart Specialisation Strategy Regione Liguria	2019	Correspondence with technological profile	Correspondence with economic profile
IT	Lombardy	STRATEGIA DI SPECIALIZZAZIONE INTELLIGENTE PER LA RICERCA E L'INNOVAZIONE - SMART SPECIALISATION STRATEGY	2013	Low correspondence with any profile	Low correspondence with any profile
IT	Lombardy	STRATEGIA REGIONALE DI SPECIALIZZAZIONE INTELLIGENTE PER LA RICERCA E L'INNOVAZIONE - SMART SPECIALISATION STRATEGY: AGGIORNAMENTO (First update - 2014); LA STRATEGIA DI SPECIALIZZAZIONE INTELLIGENTE PER LA RICERCA E L'INNOVAZIONE DI REGIONE LOMBARDIA - SMART SPECIALISATION STRATEGY (S3) (Second update - 2015); LA STRATEGIA DI SPECIALIZZAZIONE INTELLIGENTE PER LA RICERCA E L'INNOVAZIONE DI REGIONE LOMBARDIA - SMART SPECIALISATION STRATEGY (S3) (Third update - 2017)	2017	Low correspondence with any profile	Low correspondence with any profile
IT	Abruzzo	S3 ABRUZZO - STRATEGIA REGIONALE DI SPECIALIZZAZIONE INTELLIGENTE	2015	Correspondence with scientific profile	Correspondence with scientific profile
IT	Abruzzo	S3 ABRUZZO - STRATEGIA REGIONALE DI SPECIALIZZAZIONE INTELLIGENTE (First update - 2016); S3 ABRUZZO - STRATEGIA REGIONALE DI SPECIALIZZAZIONE INTELLIGENTE (Second update - 2017)	2017	Correspondence with scientific profile	Correspondence with scientific profile
IT	Molise	Le strategie di R&I per la specializzazione intelligente – Regione Molise	2016	Correspondence with scientific profile	Correspondence with scientific profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
IT	Campania	S3 CAMPANIA 2014-2020	2016	Correspondence with scientific profile	Correspondence with scientific profile
IT	Apulia	SmartPuglia 2020	2014	Low correspondence with any profile	Low correspondence with any profile
IT	Basilicata	Strategia Regionale per L'Innovazione e la Specializzazione Intelligente 2014-20	2015	Low correspondence with any profile	Low correspondence with any profile
IT	Basilicata	Strategia Regionale per L'Innovazione e la Specializzazione Intelligente 2014-20	2016	Correspondence with technological profile	Correspondence with economic profile
IT	Calabria	STRATEGIA REGIONALE PER L'INNOVAZIONE E LA SPECIALIZZAZIONE INTELLIGENTE	2015	Correspondence with scientific profile	Correspondence with scientific profile
IT	Calabria	STRATEGIA REGIONALE PER L'INNOVAZIONE E LA SPECIALIZZAZIONE INTELLIGENTE	2016	Correspondence with scientific profile	Correspondence with scientific profile
IT	Sicily	Strategia Regionale dell'innovazione per la specializzazione intelligente	2015	Correspondence with technological profile	Correspondence with economic profile
IT	Sicily	Strategia Regionale dell'innovazione per la specializzazione intelligente	2016	Correspondence with technological profile	Correspondence with economic profile
IT	Sardinia	STRATEGIA DI SPECIALIZZAZIONE INTELLIGENTE DELLA SARDEGNA	2015	Correspondence with scientific profile	Correspondence with scientific profile
IT	Sardinia	STRATEGIA DI SPECIALIZZAZIONE INTELLIGENTE DELLA SARDEGNA	2016	Correspondence with scientific profile	Correspondence with scientific profile
IT	Autonomous Province of Bolzano	SMART SPECIALISATION STRATEGY PER LA PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE	2014	Low correspondence with any profile	Low correspondence with any profile
IT	Autonomous Province of Trento	Strategia di Specializzazione Intelligente	2014	Low correspondence with any profile	Low correspondence with any profile
IT	Autonomous Province of Trento	Strategia di Specializzazione Intelligente	2016	Low correspondence with any profile	Low correspondence with any profile
IT	Veneto	SMART SPECIALISATION STRATEGY DELLA REGIONE DEL VENETO	2015	Low correspondence with any profile	Low correspondence with any profile
IT	Friuli-Venezia Giulia	Strategia regionale di ricerca e innovazione per la specializzazione intelligente del Friuli-Venezia Giulia	2015	Low correspondence with any profile	Low correspondence with any profile
IT	Friuli-Venezia Giulia	Strategia regionale di ricerca e innovazione per la specializzazione intelligente del Friuli-Venezia Giulia (First update - 2016); Strategia regionale di ricerca e innovazione per la specializzazione intelligente del Friuli Venezia Giulia (Second update - 2017); Strategia regionale di ricerca e innovazione per la specializzazione intelligente del Friuli Venezia Giulia (Third update - 2019)	2019	Low correspondence with any profile	Low correspondence with any profile
IT	Emilia-Romagna	Strategia Regionale di Ricerca e Innovazione per la Specializzazione Intelligente S3ER	2015	Correspondence with technological profile	Correspondence with economic profile
IT	Tuscany	Strategia di Ricerca e Innovazione per la Smart Specialisation in Toscana	2014	Low correspondence with any profile	Low correspondence with any profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
IT	Tuscany	Strategia di Ricerca e Innovazione per la Smart Specialisation in Toscana - NOTA di AGGIORNAMENTO di MEDIO PERIODO	2019	Low correspondence with any profile	Correspondence with scientific profile
IT	Umbria	LA STRATEGIA REGIONALE DI RICERCA E INNOVAZIONE PER LA SPECIALIZZAZIONE INTELLIGENTE	2015	Correspondence with scientific profile	Correspondence with scientific profile
IT	Umbria	LA STRATEGIA REGIONALE DI RICERCA E INNOVAZIONE PER LA SPECIALIZZAZIONE INTELLIGENTE	2019	Correspondence with technological profile	Correspondence with technological profile
IT	Marche	Strategia per la ricerca e l'innovazione per la smart specialisation	2016	Correspondence with scientific profile	Correspondence with scientific profile
IT	Lazio	SMART SPECIALISATION STRATEGY (S3) REGIONE LAZIO	2016	Correspondence with scientific profile	Correspondence with scientific profile
LT	Lithuania	PRIORITETINIŲ MOKSLINIŲ TYRIMŲ IR EKSPERIMENTINĖS (SOCIALINĖS, KULTŪRINĖS) PLĖTROS IR INOVACIJŲ RAIDOS (SUMANIOS SPECIALIZACIJOS) KRYPČIŲ IR JŲ PRIORITETŲ ĮGYVENDINIMO PROGRAMA	2014	Correspondence with technological profile	Correspondence with technological profile
LT	Lithuania	PRIORITETINIŲ MOKSLINIŲ TYRIMŲ IR EKSPERIMENTINĖS PLĖTROS IR INOVACIJŲ RAIDOS (SUMANIOS SPECIALIZACIJOS) PRIORITETŲ ĮGYVENDINIMO PROGRAMA	2019	Low correspondence with any profile	Low correspondence with any profile
LU	Luxembourg	Luxembourg Strategy for Smart Specialisation	2014	Low correspondence with any profile	Correspondence with scientific profile
LU	Luxembourg	Research and Innovation Smart Specialisation Strategy (S3)	2017	Correspondence with scientific profile	Correspondence with scientific profile
LV	Latvia	Viedās specializācijas stratēģija	2013	Correspondence with scientific profile	Correspondence with scientific profile
MT	Malta	National Research and Innovation Strategy 2020	2014	Low correspondence with any profile	Low correspondence with any profile
NL	North Netherlands	Research and Innovation Strategy for Smart Specialization (S3) Noord-Nederland	2013	Correspondence with technological profile	Correspondence with technological profile
NL	East Netherlands	Slimme specialisatiestrategie Oost-Nederland	2013	Correspondence with technological profile	Correspondence with technological profile
NL	West Netherlands	S3 Slimme specialisatiestrategie West-Nederland, Definitieve versie	2014	Low correspondence with any profile	Low correspondence with any profile
NL	South Netherlands	Smart Specilisation Strategy: S3 Zuid: De kunst van het combineren	2013	Low correspondence with any profile	Low correspondence with any profile
PL	Poland	Strategia Innowacyjności i Efektywności Gospodarki (SIiEG) -> Krajowa inteligentna specjalizacja	2013	Correspondence with scientific profile	Correspondence with scientific profile
PL	Łódzkie	Regionalna Strategia Innowacji dla Województwa Łódzkiego LORIS 2030	2013	Correspondence with economic profile	Correspondence with scientific profile
PL	Mazowieckie	Regionalna Strategia Innowacji dla Mazowsza do 2020 roku. System wspierania innowacyjności oraz inteligentna specjalizacja regionu	2015	Correspondence with economic profile	Low correspondence with any profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
PL	Małopolskie	Regionalna Strategia Innowacji Województwa Małopolskiego 2013-2020	2012	Correspondence with scientific profile	Correspondence with scientific profile
PL	Małopolskie	Program strategiczny Regionalna Strategia Innowacji Województwa Małopolskiego 2020	2016	Correspondence with technological profile	Correspondence with economic profile
PL	Śląskie	Regional Innovation Strategy of the Śląskie Voivodeship for the years 2013-2020	2012	Correspondence with scientific profile	Correspondence with scientific profile
PL	Lubelskie	Regional Innovation Strategy for the Lubelskie Voivodeship 2020 (2014)	2014	Correspondence with scientific profile	Correspondence with scientific profile
PL	Podkarpackie	Regionalna Strategia Innowacji Województwa Podkarpackiego na lata 2014-2020 na rzecz inteligentnej specjalizacji (S3)	2015	Low correspondence with any profile	Correspondence with scientific profile
PL	Podkarpackie	Regionalna Strategia Innowacji Województwa Podkarpackiego na lata 2014-2020 na rzecz inteligentnej specjalizacji (S3) (aktualizacja, 2016 r.)	2016	Correspondence with scientific profile	Correspondence with scientific profile
PL	Świętokrzyskie	Strategia Badań i Innowacyjności (S3), Od absorpcji do rezultatów – jak pobudzić potencjał województwa świętokrzyskiego 2014-2020+	2014	Correspondence with economic profile	Low correspondence with any profile
PL	Podlaskie	Plan rozwoju przedsiębiorczości w oparciu o inteligentne specjalizacje województwa podlaskiego na lata 2015-2020+ (S3)	2016	Correspondence with economic profile	Low correspondence with any profile
PL	Wielkopolskie	Regionalna Strategia Innowacji dla Wielkopolski na lata 2015-2020	2015	Correspondence with economic profile	Correspondence with scientific profile
PL	Zachodniopomorskie	Regionalna Strategia Rozwoju Inteligentnych Specjalizacji Województwa Zachodniopomorskiego 2020+	2016	Correspondence with economic profile	Correspondence with scientific profile
PL	Lubuskie	Program Rozwoju Innowacji Województwa Lubuskiego	2016	Correspondence with technological profile	Correspondence with economic profile
PL	Lubuskie	Program Rozwoju Innowacji Województwa Lubuskiego	2018	Correspondence with technological profile	Correspondence with economic profile
PL	Dolnośląskie	1. Regionalna Strategia Innowacji dla Województwa Dolnośląskiego na lata 2011-2020 + 2. załącznik: Ramy strategiczne na rzecz inteligentnych specjalizacji Dolnego Śląska	2015	Correspondence with technological profile	Correspondence with economic profile
PL	Opolskie	Regionalna Strategia Innowacji Województwa Opolskiego do roku 2020	2014	Low correspondence with any profile	Low correspondence with any profile
PL	Opolskie	Regionalna Strategia Innowacji Województwa Opolskiego do roku 2020	2017	Correspondence with technological profile	Correspondence with technological profile
PL	Kujawsko-Pomorskie	Regionalna Strategia Innowacji Województwa Kujawsko-Pomorskiego na lata 2014-2020 (2015) + Inteligentne specjalizacje województwa kujawsko-pomorskiego (2016)	2015	Correspondence with technological profile	Correspondence with technological profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
PL	Warmińsko-Mazurskie	Strategia rozwoju społeczno-gospodarczego województwa warmińsko-mazurskiego do roku 2025	2013	Correspondence with economic profile	Correspondence with economic profile
PL	Pomorskie	Regionalny Program Strategiczny w zakresie rozwoju gospodarczego - Pomorski Port Kreatywności.	2013	Correspondence with scientific profile	Correspondence with scientific profile
PL	Pomorskie	Regionalny Program Strategiczny w zakresie rozwoju gospodarczego - Pomorski Port Kreatywności.	2018	Correspondence with technological profile	Correspondence with scientific profile
PT	Portugal	Estratégia de Investigação e Inovação para uma Especialização Inteligente (EI&I)	2014	Correspondence with scientific profile	Correspondence with scientific profile
PT	Norte	Norte2020 Estratégia Regional de Especialização Inteligente	2014	Correspondence with scientific profile	Correspondence with scientific profile
PT	Algarve	S3 - Algarve 2014-2020 Estratégia Regional de Investigação e Inovação para a Especialização Inteligente	2015	Low correspondence with any profile	Low correspondence with any profile
PT	Centro	S3 do Centro de Portugal - Estratégia de Investigação e Inovação para uma Especialização Inteligente	2014	Correspondence with economic profile	Correspondence with scientific profile
PT	Centro	S3 do Centro de Portugal 2020	2016	Correspondence with economic profile	Correspondence with scientific profile
PT	Lisbon	Especialização Inteligente de Lisboa 2014 – 2020	2015	Correspondence with technological profile	Correspondence with economic profile
PT	Alentejo	Uma estratégia de especialização inteligente para o Alentejo	2014	Low correspondence with any profile	Low correspondence with any profile
PT	Azores	Estratégia de Investigação e Inovação para a Especialização Inteligente da Região Autónoma dos Açores - S3 Açores	2014	Correspondence with scientific profile	Correspondence with scientific profile
PT	Madeira	Madeira 2020: Estratégia Regional de Especialização Inteligente	2015	Low correspondence with any profile	Low correspondence with any profile
RO	Romania	Strategia națională de cercetare, dezvoltare și inovare 2014-2020	2014	Correspondence with scientific profile	Correspondence with scientific profile
RO	Romania	Strategia națională de cercetare, dezvoltare și inovare 2014-2020, updated by HG 81/2017	2017	Correspondence with scientific profile	Correspondence with scientific profile
RO	NORTH-WEST/NORD-VEST	Strategia de Specializare Inteligentă a Regiunii de Dezvoltare Nord-Vest – S3 NV	2019	Correspondence with technological profile	Correspondence with economic profile
RO	Centre / Centru	Strategia de Specializare Inteligentă a Regiunii Centru 2014-2020	2015	Correspondence with economic profile	Correspondence with economic profile
RO	Centre / Centru	Strategia de Specializare Inteligentă a Regiunii Centru 2014-2020	2017	Correspondence with economic profile	Correspondence with economic profile
RO	North-East / Nord-Est	Strategia pentru Cercetare și Inovare Regională prin Specializare Inteligentă S3 NORD-EST	2014	Correspondence with economic profile	Correspondence with economic profile
RO	North-East / Nord-Est	Strategia pentru Cercetare și Inovare Regională prin Specializare Inteligentă S3 NORD-EST	2017	Correspondence with economic profile	Correspondence with economic profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
RO	Sud-Est/South-East	Strategia de Specializare Inteligentă a Regiunii de Dezvoltare Sud-Est	2017	Correspondence with scientific profile	Correspondence with scientific profile
RO	Sud Muntenia/South Muntenia	Strategia pentru Specializare Inteligentă în regiunea Sud Muntenia	2015	Correspondence with technological profile	Correspondence with economic profile
RO	Sud-Vest Oltenia	Studiul Strategia Regionala de Inovare pentru Specializare Inteligenta	2015	Correspondence with economic profile	Low correspondence with any profile
RO	West/Vest	REGIUNEA VEST ROMÂNIA – STRATEGIA REGIONALĂ DE SPECIALIZAREA INTELIGENTĂ	2016	Correspondence with economic profile	Correspondence with economic profile
SE	Östra Mellansverige	Strategi för Smart specialisering i Sörmland ; Smart specialiseringsstrategi för Östergötland ; Innovationsstrategi Örebroregionen, En strategi för Smart specialisering ; Affärsplan Västmanland – en strategi för tillväxt, innovationskraft och näringslivsutveckling	2015	Low correspondence with any profile	Low correspondence with any profile
SE	Sydsverige	En internationell innovationsstrategi för Skåne 2012-2020 / An International Innovation strategy for Skåne 2012-2020	2011	Low correspondence with any profile	Low correspondence with any profile
SE	Västsverige	Smart specialisering i Västra Götaland	2013	Correspondence with scientific profile	Correspondence with scientific profile
SE	Norra Mellansverige	Värmlands forsknings- och innovationsstrategi – för smart specialisering; Värmlands forsknings- och innovationsstrategi – för smart specialisering ; Mobilisera för Tillväxt - Agenda för Smart Specialisering i Dalarna ; Regional innovationsstrategi för smart specialisering Gävleborg	2015	Correspondence with technological profile	Correspondence with economic profile
SE	Mellersta Norrland	Innovativa Jämtland Härjedalen 2025	2013	Low correspondence with any profile	Low correspondence with any profile
SE	Övre Norrland	Innovationsstrategi Västerbotten 2014 – 2020; Innovationsstrategi för Norrbottens län 2013 – 2020	2014	Correspondence with technological profile	Correspondence with economic profile
SE	Övre Norrland	Norrbottens innovationsstrategi 2019-2030	2019	Low correspondence with any profile	Low correspondence with any profile
SI	Slovenia	Slovenska strategija pametne specializacije	2015	Low correspondence with any profile	Low correspondence with any profile
SK	Slovakia	Poznatkami k prosperite - Stratégia výskumu a inovácií pre inteligentnú špecializáciu Slovenskej republiky	2013	Low correspondence with any profile	Low correspondence with any profile
UK	England - North East	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Low correspondence with any profile	Low correspondence with any profile
UK	England - North West	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Low correspondence with any profile	Low correspondence with any profile
UK	Yorkshire and the Humber	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Low correspondence with any profile	Low correspondence with any profile
UK	East Midlands	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Low correspondence with any profile	Low correspondence with any profile
UK	West Midlands	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Correspondence with technological profile	Correspondence with technological profile

Country	NUTS label	S3 name	S3 year	Results of the hierarchical clustering	Results of the k-means clustering
UK	East of England	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Correspondence with technological profile	Correspondence with technological profile
UK	London	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Correspondence with technological profile	Correspondence with technological profile
UK	South East	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Correspondence with technological profile	Correspondence with technological profile
UK	South West	Smart Specilisation in England, Department for Business Innovation and Skills	2015	Correspondence with technological profile	Correspondence with technological profile
UK	Wales	Innovation Wales	2014	Low correspondence with any profile	Correspondence with technological profile
UK	Scotland	Scotland Can Do Action Framework	2013	Low correspondence with any profile	Correspondence with technological profile
UK	Northern Ireland	Northern Ireland Framework for Smart Specialisation	2014	Low correspondence with any profile	Correspondence with technological profile

Source: Prognos / CSIL (2021).

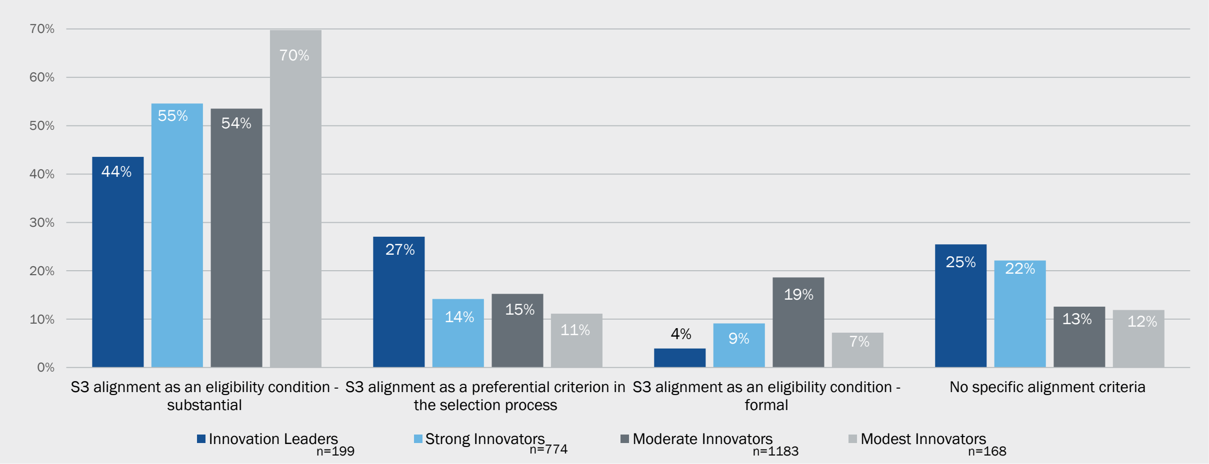
9.4 Chapter 6 – Further information concerning the implementation phase

Table 9-31: Excerpt of the database of the calls for proposals

General Information			Governance			Funding	RIS3 alignment	
Country	Region(s)	Name of the call for proposals	Type of call	Type of policy instrument	Eligible beneficiaries	Type of funding	Criteria used to incentivize alignment with RIS3 priorities	RIS3 priority areas adressed (if applicable). Please separate by
Belgium	Brussels Region	Appel à projets publics FEDER n°1 (	Closed call	Other	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	All priority fields
Belgium	Brussels Region	BRUSEED	Open call	Support to innovative SMEs c	Single start-ups and sp	Support through financial in	S3 alignment as a preferential criterion in the selectior	All priority fields
Belgium	Brussels Region	PROJECTOPROEP : LIVING LABS BRU	Closed call	Support to RTD&I projects	Consortia of enterprise	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Sustainable development - Construction and sus
DK	Denmark	Overgangspulje til klyngekonsoliderir	Closed call	Support to business support (	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Environmental technology; energy; food; maritime
DK	Denmark	Innovationssamarbejder mellem virk	Closed call	Support to RTD&I projects	Consortia of enterprise	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Maritime; Water, bio and environmental solutions
DK	Denmark	Restmidler fra overgangspulje til klyı	Closed call	Support to business support (	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Environmental technology; energy; food; maritime
DK	Denmark	Innovationssamarbejder mellem virk	Closed call	Support to RTD&I projects	Consortia of enterprise	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Maritime; Water, bio and environmental solutions
DK	Denmark	Omsætning af spildprodukter til væk	Closed call	Other	Single public administr	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Water, bio and environmental solutions; Energy a
DK	Central Jutland	Udviklingsprogram for underleveran	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Energy
DK	Central Jutland	Innovativ brug af big data	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Digital technologies
DK	Central Jutland	Midtnet Kina	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Food
DK	Central Jutland	Innovationsdrevet vækst hos virkso	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Health ad welfare solutions
DK	Central Jutland	Smart industri	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Advavanced manufacturing
DK	Central Jutland	Fremme af innovation indenfor grøn	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Energy
DK	Central Jutland	Innovationssamarbejder om udnytte	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Environmental technology
DK	Central Jutland	Cirkulær Byinnovation	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Environmental technology
DK	Central Jutland	Future Food Innovation	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Food
DK	Central Jutland	Innovationsdrevet vækst i fødevare	Closed call	Support to innovative SMEs c	Other	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Food
Spain	Aragón	CONVENIO DE COLABORACIÓN ENTF	Closed call	Support to RTD&I projects	Single research organi	Non-repayable grant	S3 alignment as an eligibility condition - substantial	All Priority fields
Spain	Aragón	CONTRATO-PROGRAMA ENTRE EL G(	Closed call	Support to RTD&I projects	Single research organi	Non-repayable grant	S3 alignment as an eligibility condition - substantial	All Priority fields
Spain	Aragón	Reparación, mantenimiento y puest	Closed call	Support to RTD&I projects	Single research organi	Non-repayable grant	No specific alignment criteria	not applicable
Spain	Aragón	CONVENIO DE COLABORACIÓN ENTF	Closed call	Support to RTD&I projects	Single research organi	Non-repayable grant	S3 alignment as an eligibility condition - substantial	All Priority fields
DE	Rheinland-Pfalz	Auf- und Ausbau von anwendungsor	Open call	Support to research infrastru	Single research organi	Non-repayable grant	S3 alignment as a preferential criterion in the selectior	All priority fields
DE	Rheinland-Pfalz	Auf- und Ausbau von technologieorie	Open call	Support to research infrastru	Single research organi	Non-repayable grant	S3 alignment as a preferential criterion in the selectior	All priority fields
CZ	Střední Čechy, Jih	Výzva I programu podpory Služby inf	Closed call				S3 alignment as an eligibility condition - substantial	connection to strategic objective of the National
CZ	Střední Čechy, Jih	Výzva I programu podpory Spolupráce	Closed call				S3 alignment as an eligibility condition - substantial	connection to strategic objective of the National
PL	ŁÓDZKIE	I.1: Rozwój infrastruktury badań i inı	Open call	Support to research infrastru	Single research organi	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Modern Textile And Fashion Industries (including (
PL	ŁÓDZKIE	I.1: Rozwój infrastruktury badań i in	Closed call	Support to research infrastru	Single research organi	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Modern Textile And Fashion Industries (including (
France	Ile-de-France	« Actions d'accompagnement individ	Closed call				S3 alignment as an eligibility condition - formal	Digital creation ; Complex systems and software (
France	Ile-de-France	« Projets de R&D&I collaborative dai	Closed call				S3 alignment as an eligibility condition - substantial	Digital creation ; Complex systems and software (
EL	Attica	Support to Research Inrastructures	Closed call	Support to research infrastru	Consortia of research	Non-repayable grant	S3 alignment as an eligibility condition - substantial	Creative Economy; Blue Economy; Sustainable Ec
EL	Central Macedon	Strengthening public research and ii	Closed call	Support to research infrastru	"Single research organ	Non-repayable grant	S3 alignment as a preferential criterion in the selectior	Agrofood; Building materials; Textiles and clothing

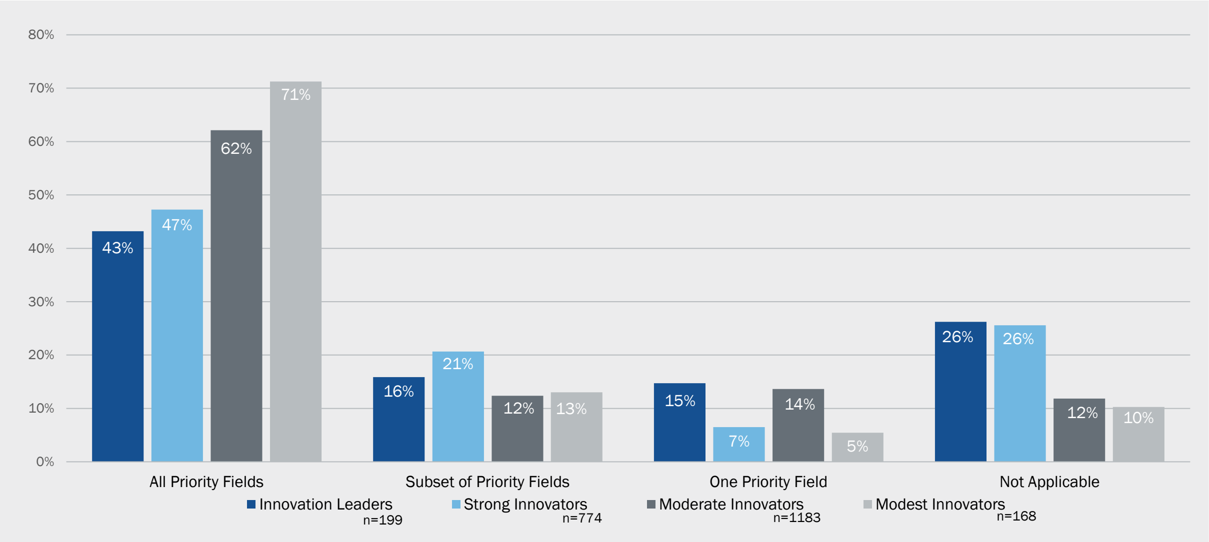
Source: Prognos / CSIL (2021).

Figure 9-10: S3 alignment criteria (Innovation Scoreboard Regions)



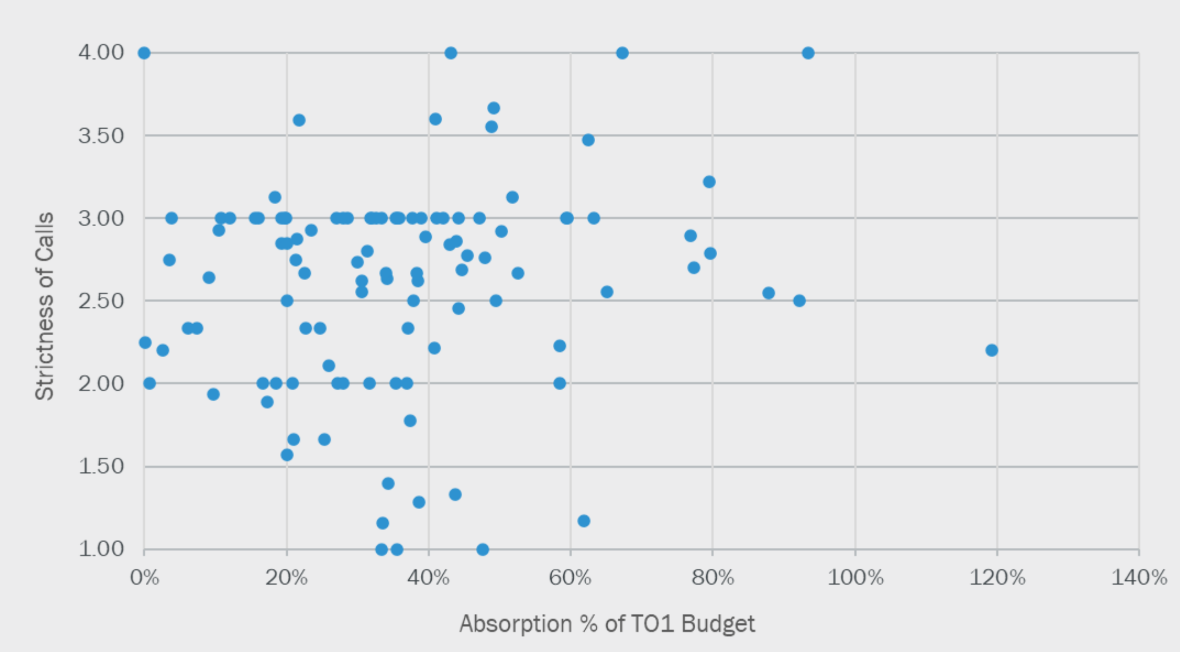
Source: Prognos / CSIL (2021).

Figure 9-11: Priority areas addressed by calls for proposal (Innovation Scoreboard Regions)



Source: Prognos / CSIL (2021).

Figure 9-12: Relationship between absorption capacity and the strictness of the calls for proposal



Source: Prognos / CSIL (2021) and from ESIF Open Data Portal (https://cohesiondata.ec.europa.eu/)

Note: Absorption capacity captures the share of the foreseen budget that has already been spent for TO1 related projects and the strictness of calls is represented by an index ranging from 1 (not strict) to 4 (strict). This index reflects the degree to which the calls for proposal were restricted to reflecting the priorities of the region.

9.5 Chapter 7 – The S3 Scoreboard by type of region and underlying data

Table 9-32: Underlying data of the S3 Scoreboard – Less Developed Regions (sorted by performance relative to LDR-average)

General information				Outcome Criteria			Process Criteria			Scoreboard ranking		
				Implementation of the S3	Granularity / Thematic broadness	Correspondence of S3 strategies	Development process of S3 (EDP)	Quality of the prioritisation approach	Implementation of the S3			
Region	Country	NUTS level	Strategy level	Share of matched budget	Bandwith index	Correspondence with regional profile	Degree of continuity of EDP	RATING: Explained share of prioritisation approach	Quality of the selection process	Weighted average	Performance relative to LDR-average	Scoregroup
Warmińsko-Mazurskie	Poland	NUTS 2	Regional	75%	16%	0.40	all stages	59%	3.0	0.79	137.9	S3 Leader
Dolnośląskie	Poland	NUTS 2	Regional	91%	49%	0.60	all stages	68%	3.0	0.78	137	S3 Leader
Lubelskie	Poland	NUTS 2	Regional	74%	29%	0.32	all stages	66%	3.1	0.74	130	S3 Leader-
Małopolskie	Poland	NUTS 2	Regional	54%	35%	0.46	all stages	63%	3.0	0.73	128	S3 Leader-
Poland	Poland	NUTS 0	National	86%	66%	0.53	all stages	72%	3.0	0.73	127	S3 Leader-
Śląskie	Poland	NUTS 2	Regional	50%	27%	0.49	all stages	60%	3.0	0.72	126	S3 Leader-
Pomorskie	Poland	NUTS 2	Regional	48%	34%	0.30	all stages	72%	3.0	0.71	124	Strong S3+
Łódzkie	Poland	NUTS 2	Regional	95%	36%	0.19	all stages	63%	2.9	0.70	122	Strong S3+
Wielkopolskie	Poland	NUTS 2	Regional	49.5%	39%	0.21	all stages	63%	3.0	0.68	119	Strong S3+
Slovenia	Slovenia	NUTS 0	National	74%	19.5%	0.27	two stages	36%	3.5	0.67	118	Strong S3+
Kujawsko-Pomorskie	Poland	NUTS 2	Regional	89%	44%	0.29	two stages	64%	3.0	0.66	116.0	Strong S3
Lubuskie	Poland	NUTS 2	Regional	23%	27%	0.50	all stages	48%	3.0	0.66	115	Strong S3
Opolskie	Poland	NUTS 2	Regional	32%	23%	0.07	all stages	77%	3.0	0.65	114	Strong S3
Podkarpackie	Poland	NUTS 2	Regional	55%	37%	0.30	all stages	63%	2.8	0.65	113	Strong S3
Świętokrzyskie	Poland	NUTS 2	Regional	35%	35%	0.18	all stages	59%	3.1	0.64	113	Strong S3

Czech Republic	Czechia	NUTS 0	National	56%	26%	0.26	two stages	61%	3.0	0.64	112	Strong S3
Lithuania	Lithuania	NUTS 0	National	89%	43%	0.13	two stages	64%	3.0	0.64	112	Strong S3
Epirus	Greece	NUTS 2	Regional	80%	9%	0.30	one Stage	38%	4.0	0.64	111	Strong S3
Podlaskie	Poland	NUTS 2	Regional	91%	37%	0.15	all stages	65%	1.8	0.63	111	Strong S3
Western Greece	Greece	NUTS 2	Regional	70%	18%	0.23	one Stage	50%	3.0	0.63	110	Strong S3
Hungary	Hungary	NUTS 0	National	73%	32%	0.37	one Stage	58%	3.6	0.63	110	Strong S3
Campania	Italy	NUTS 2	Regional	73%	37%	0.40	two stages	51%	2.1	0.62	108.4	Strong S3
Centro	Portugal	NUTS 2	Regional	45%	47%	0.21	all stages	52%	3.0	0.61	107	Strong S3-
Sicily	Italy	NUTS 2	Regional	18%	29%	0.55	two stages	53%	3.0	0.61	107	Strong S3-
Norte	Portugal	NUTS 2	Regional	49%	52%	0.27	all stages	65%	2.9	0.60	104	Strong S3-
Estonia	Estonia	NUTS 0	National	33%	33%	0.41	one Stage	74%	3.7	0.60	104	Strong S3-
Extremadura	Spain	NUTS 2	Regional	13%	32%	0.29	all stages	68%	2.8	0.59	103	Strong S3-
Zachodniopomorskie	Poland	NUTS 2	Regional	20%	49%	0.17	all stages	65%	3.0	0.59	102	Strong S3-
Greece	Greece	NUTS 0	National	77%	59%	0.18	one Stage	70%	3.1	0.58	102	Strong S3-
Central Macedonia	Greece	NUTS 2	Regional	93%	30%	0.29	one Stage	48%	2.8	0.57	100.4	Strong S3-
Romania	Romania	NUTS 0	National	49%	32%	0.28	one Stage	59%	3.1	0.57	100.2	Strong S3-
Croatia	Croatia	NUTS 0	National	78%	42%	0.24	two stages	56%	2.8	0.57	99.6	Moderate S3+
Portugal	Portugal	NUTS 0	National	50%	76%	0.28	all stages	68%	2.8	0.56	99	Moderate S3+
Bulgaria	Bulgaria	NUTS 0	National	98%	40%	0.27	one Stage	62%	2.6	0.56	98	Moderate S3+
Latvia	Latvia	NUTS 0	National	64%	32%	0.25	one Stage	65%	2.8	0.55	96	Moderate S3+
Slovakia	Slovakia	NUTS 0	National	66%	30%	0.30	one Stage	56%	2.3	0.55	96	Moderate S3+
Eastern Macedonia and Thrace	Greece	NUTS 2	Regional	13%	14%	0.54	one Stage	24%	4.0	0.54	94	Moderate S3+
NORTH-WEST/NORD-VEST	Romania	NUTS 2	Regional	49%	35%	0.32	all stages	58%	/	0.52	92	Moderate S3+
Azores	Portugal	NUTS 2	Regional		26%	0.14	all stages	57%	2.8	0.52	91	Moderate S3+
Basilicata	Italy	NUTS 2	Regional	39%	27%	0.18	one Stage	44%	3.0	0.52	90.1	Moderate S3+
Apulia	Italy	NUTS 2	Regional	6%	19%	0.21	two stages	46%	2.5	0.51	89.5	Moderate S3
Centre / Centru	Romania	NUTS 2	Regional	49%	52%	0.43	all stages	59%	/	0.50	88	Moderate S3
Sud Muntenia/South Muntenia	Romania	NUTS 2	Regional	49%	34%	0.21	all stages	54%	/	0.50	87	Moderate S3

North-East / Nord-Est	Romania	NUTS 2	Regional	49%	49%	0.33	all stages	60%	/	0.49	85	Moderate S3
Calabria	Italy	NUTS 2	Regional	48%	46%	0.22	one Stage	51%	2.6	0.45	79	Moderate S3-
South-West Oltenia / Sud-Vest Oltenia	Romania	NUTS 2	Regional	49%	41%	0.16	all stages	55%	/	0.45	79	Moderate S3-
La Réunion	France	NUTS 2	Regional	/	59.99%	/	all stages	54%	3.0	0.45	78	Moderate S3-
Sud-Est/South-East	Romania	NUTS 2	Regional	49%	50%	0.16	all stages	53%	/	0.45	78	Moderate S3-
Alentejo	Portugal	NUTS 2	Regional	60%	51%	0.15	n.a.	66%	2.0	0.43	75	Moderate S3-
Guadeloupe	France	NUTS 2	Regional	/	62%	/	all stages	58%	3.0	0.41	71	Moderate S3-
Thessaly	Greece	NUTS 2	Regional	/	16%	0.31	two stages	46%	/	0.41	71	Moderate S3-
Martinique	France	NUTS 2	Regional	0%	51%	/	two stages	61%	3.0	0.40	69	Modest S3+
West/Vest	Romania	NUTS 2	Regional	49%	26%	0.42	n.a.	55%	/	0.37	65	Modest S3+
Guyane	France	NUTS 2	Regional	/	58%	/	one Stage	58%	2.1	0.28	49	Modest S3-
Mayotte	France	NUTS 2	Regional	/	55%	/	one Stage	56%	1.8	0.23	39	Modest S3-

Source: Prognos / CSIL (2021), n= 55 regions. LDR-average= 0.57

Table 9-33: Underlying data of the S3 Scoreboard – Transition Regions (sorted by performance relative to TR-average)

General information				Outcome Criteria			Process Criteria			Scoreboard ranking		
				Implementation of the S3	Granularity / Thematic broadness	Correspondence of S3 strategies	Development process of S3 (EDP)	Quality of the prioritisation approach	Implementation of the S3			
Region	**Country**	**NUTS level**	**Strategy level**	**Share of matched budget**	**Bandwith index**	**Correspondence with regional profile**	**Degree of continuity of EDP**	**Explained share of prioritisation approach**	**Quality of the selection process**	**Weighted average**	**Performance relative to TR-average**	**Scoregroup**
Castilla-La Mancha	Spain	NUTS 2	Regional	88%	26%	0.05	all stages	62%	3.0	0.72	131	S3 Leader-
Thuringia	Germany	NUTS 1	Regional	45%	51%	0.42	all stages	66%	3.0	0.67	123	Strong S3+
Región de Murcia	Spain	NUTS 2	Regional	35%	34%	0.20	all stages	58%	3.6	0.65	118	Strong S3+
Franche-Comté	France	NUTS 2	Regional	62%	45%	0.34	two stages	62%	3.0	0.62	114	Strong S3
Ionian Islands	Greece	NUTS 2	Regional	39%	17%	0.13	two stages	55%	3.0	0.62	114	Strong S3

Lorraine	France	NUTS 2	Regional	84%	59.6%	0.57	one Stage	72%	2.5	0.60	111	Strong S3
Languedoc-Roussillon	France	NUTS 2	Regional	35%	55%	0.44	all stages	65%	2.3	0.60	110	Strong S3
Canarias	Spain	NUTS 2	Regional	62%	30%	0.14	all stages	42%	2.3	0.60	110	Strong S3
North Aegean	Greece	NUTS 2	Regional	19%	11%	0.55	two stages	52%	2.5	0.60	110	Strong S3
Picardie	France	NUTS 2	Regional	76%	65%	0.24	all stages	65%	2.9	0.60	109	Strong S3
Crete	Greece	NUTS 2	Regional	90%	22%	0.41	one Stage	50%	2.7	0.59	108.38	Strong S3
Nord-Pas-de-Calais	France	NUTS 2	Regional	74%	64%	0.16	all stages	74%	2.7	0.59	108.2	Strong S3-
Poitou-Charentes	France	NUTS 2	Regional	74%	53%	0.61	one Stage	65%	2.5	0.59	107	Strong S3-
Algarve	Portugal	NUTS 2	Regional	55%	41%	0.03	all stages	58%	2.0	0.55	101	Strong S3-
Andalucía	Spain	NUTS 2	Regional	98%	54%	0.22	one Stage	61%	2.2	0.55	101	Strong S3-
Sardinia	Italy	NUTS 2	Regional	42%	34%	0.15	two stages	63%	2.7	0.55	100.03	Strong S3-
Wales	United Kingdom	NUTS 1	Regional	19%	19%	0.21	one Stage	54%	1.0	0.54	99.6	Moderate S3+
Abruzzo	Italy	NUTS 2	Regional	15%	21%	0.24	two stages	44%	3.0	0.54	99	Moderate S3+
Molise	Italy	NUTS 2	Regional	18%	11%	0.33	one Stage	37%	3.0	0.54	98	Moderate S3+
Central Greece	Greece	NUTS 2	Regional	0%	19%	0.38	one Stage	41%	4.0	0.52	95	Moderate S3+
Limousin	France	NUTS 2	Regional	91%	74%	0.28	one Stage	68%	2.6	0.52	95	Moderate S3+
Saxony-Anhalt	Germany	NUTS 1	Regional	35%	40.4%	0.39	all stages	54%	1.0	0.52	95	Moderate S3+
Walloon Region	Belgium	NUTS 1	Regional	51%	52%	0.08	two stages	68%	2.7	0.52	94	Moderate S3+
Mecklenburg-Western Pomerania	Germany	NUTS 1	Regional	45%	45%	0.15	all stages	66%	1.0	0.51	94	Moderate S3+
Auvergne	France	NUTS 2	Regional	57%	38%	0.08	two stages	61%	1.7	0.50	92	Moderate S3+
Malta	Malta	NUTS 0	National	69%	25%	0.09	one Stage	43%	2.0	0.49	90.3	Moderate S3+
Peloponnese	Greece	NUTS 2	Regional	1%	10%	0.15	two stages	42%	2.8	0.49	89	Moderate S3
Saxony	Germany	NUTS 1	Regional	48%	60.2%	0.42	two stages	71%	1.3	0.48	87	Moderate S3
Northern Ireland	United Kingdom	NUTS 1	Regional	12%	17%	0.43	two stages	55%	/	0.46	84	Moderate S3
Corse	France	NUTS 2	Regional	/	54%	0.19	one Stage	68%	3.0	0.45	82	Moderate S3

Spain	Spain	NUTS 0	National	88%	49%	0.28	n.a.	59%	1.2	0.43	79	Moderate S3-
Basse Normandie	France	NUTS 2	Regional	8%	62%	0.56	one Stage	68%	2.2	0.43	78	Moderate S3-
Western Macedonia	Greece	NUTS 2	Regional	0%	20.1%	0.26	one Stage	43%	2.3	0.41	74	Moderate S3-

Source: Prognos / CSIL (2021), n= 33 regions. TR-average= 0.55

Table 9-34: Underlying data of the S3 Scoreboard – More Developed Regions (sorted by performance relative to MDR-average)

General information				Outcome Criteria			Process Criteria			Scoreboard ranking		
				Implementation of the S3	Granularity / Thematic broadness	Correspondence of S3 strategies	Development process of S3 (EDP)	Quality of the prioritisation approach	Implementation of the S3			
Region	**Country**	**NUTS level**	**Strategy level**	**Share of matched budget**	**Bandwith index**	**Correspondence with regional profile**	**Degree of continuity of EDP**	**Explained share of prioritisation approach**	**Quality of the selection process**	**Weighted average**	**Performance relative to MDR-average**	**Scoregroup**
Autonomous Province of Bolzano	Italy	NUTS 2	Regional	98%	29%	0.57	two stages	53%	3.0	0.75	141	S3 Leader+
Mazowieckie	Poland	NUTS 2	Regional	79%	39%	0.28	all stages	66%	3.6	0.75	140.01	S3 Leader+
Baden-Württemberg	Germany	NUTS 1	Regional	74%	17%	0.21	all stages	45%	2.5	0.68	127	S3 Leader-
Pays de la Loire	France	NUTS 2	Regional	74%	70%	0.33	all stages	71%	3.0	0.67	126	S3 Leader-
Marche	Italy	NUTS 2	Regional	44%	17%	0.48	all stages	44%	2.6	0.67	126	S3 Leader-
Lower Saxony	Germany	NUTS 1	Regional	42%	46%	0.32	all stages	73%	3.0	0.66	124	Strong S3+
Bremen	Germany	NUTS 1	Regional	40%	44%	0.34	all stages	73%	3.0	0.66	124	Strong S3+
Cyprus	Cyprus	NUTS 0	National	97%	34%	0.20	two stages	69%	2.4	0.66	123	Strong S3+
Centre	France	NUTS 2	Regional	79%	59%	0.28	all stages	69%	2.2	0.66	123	Strong S3+
Bourgogne	France	NUTS 2	Regional	92%	63%	0.32	two stages	71%	3.5	0.64	121	Strong S3+
Lisbon	Portugal	NUTS 2	Regional	39%	28%	0.34	all stages	38%	3.0	0.64	121	Strong S3+

East Netherlands	the Netherlands	NUTS 1	Regional	55%	16%	0.50	one Stage	45%	4.0	0.64	120	Strong S3+
Schleswig-Holstein	Germany	NUTS 1	Regional	55%	38%	0.15	all stages	72%	2.0	0.64	120	Strong S3+
South Netherlands	the Netherlands	NUTS 1	Regional	76%	25%	0.17	two stages	47%	3.2	0.64	120	Strong S3+
Provence-Alpes-Côte d’Azur	France	NUTS 2	Regional	56%	69%	0.28	all stages	71%	3.0	0.63	119	Strong S3+
Principado de Asturias	Spain	NUTS 2	Regional	85%	41%	0.16	all stages	62%	2.3	0.63	119	Strong S3+
Comunidad de Madrid	Spain	NUTS 2	Regional	41%	27%	0.33	all stages	63%	2.3	0.63	118	Strong S3+
Friuli-Venezia Giulia	Italy	NUTS 2	Regional	39%	25%	0.12	all stages	52%	4.0	0.63	118	Strong S3+
Liguria	Italy	NUTS 2	Regional	55%	27%	0.19	all stages	60%	2.8	0.63	118	Strong S3+
Saarland	Germany	NUTS 1	Regional	54%	44%	0.28	all stages	78%	2.0	0.63	118	Strong S3+
La Rioja	Spain	NUTS 2	Regional	33%	27%	0.12	all stages	56%	3.0	0.63	118	Strong S3+
North Rhine-Westphalia	Germany	NUTS 1	Regional	72%	58%	0.23	all stages	63%	2.8	0.63	117	Strong S3+
Emilia-Romagna	Italy	NUTS 2	Regional	44%	34%	0.31	all stages	57%	2.9	0.62	117	Strong S3+
Lombardy	Italy	NUTS 2	Regional	53%	32%	0.17	all stages	62%	2.8	0.62	117	Strong S3+
Valle d’Aosta	Italy	NUTS 2	Regional	83%	14%	0.17	two stages	36%	2.2	0.62	115.5	Strong S3
Tuscany	Italy	NUTS 2	Regional	53%	26%	0.24	all stages	51%	2.7	0.62	115	Strong S3
Aragón	Spain	NUTS 2	Regional	30%	39.9%	0.33	all stages	62%	2.3	0.61	115	Strong S3
Satakunta	Finland	NUTS 3	Regional	62%	44%	0.31	all stages	56%	2.2	0.61	114	Strong S3
Midi-Pyrénées	France	NUTS 2	Regional	68%	62%	0.31	all stages	74%	2.2	0.61	114	Strong S3
Cantabria	Spain	NUTS 2	Regional	45%	27%	0.26	all stages	49%	2.0	0.60	113	Strong S3
Helsinki-Uusimaa	Finland	NUTS 3	Regional	95%	21%	0.20	one Stage	70%	2.2	0.60	112	Strong S3
Central Ostrobothnia	Finland	NUTS 3	Regional	69%	17%	0.11	two stages	45%	2.2	0.60	112	Strong S3
Kanta-Häme	Finland	NUTS 3	Regional	76%	20%	0.31	two stages	40%	2.2	0.59	111	Strong S3
South Karelia	Finland	NUTS 3	Regional	75%	20%	0.31	one Stage	73%	2.2	0.59	111	Strong S3
Comunidad Foral de Navarra	Spain	NUTS 2	Regional	36%	28%	0.18	two stages	56%	3.0	0.59	110	Strong S3
Galicia	Spain	NUTS 2	Regional	58%	22%	0.07	all stages	44%	2.0	0.59	110	Strong S3
North Netherlands	the Netherlands	NUTS 1	Regional	42%	13.5%	0.12	all stages	31%	2.9	0.59	110	Strong S3

Berlin / Brandenburg	Germany	NUTS1	Regional	48%	43%	0.47	two stages	73%	/	0.58	110	Strong S3
Austria	Austria	NUTS 0	National	50%	63%	0.38	two stages	69%	3.0	0.58	109	Strong S3
Rhône-Alpes	France	NUTS 2	Regional	62%	69%	0.56	two stages	71%	2.1	0.58	108.50	Strong S3
Etelä-Savo	Finland	NUTS 3	Regional	80%	17%	0.11	one Stage	56%	2.2	0.58	108.42	Strong S3
Aquitaine	France	NUTS 2	Regional	80%	69%	0.40	one Stage	69%	3.0	0.58	108.27	Strong S3-
Rheinland-Pfalz	Germany	NUTS 1	Regional	56%	40%	0.19	all stages	82%	1.8	0.57	107	Strong S3-
Illes Balears	Spain	NUTS 2	Regional	25%	17%	0.09	all stages	36%	2.0	0.56	105	Strong S3-
Päijät-Häme	Finland	NUTS 3	Regional	53%	20%	0.31	two stages	45%	2.2	0.56	105	Strong S3-
Brussels Region	Belgium	NUTS 1	Regional	81%	18%	0.38	n.a.	51%	2.7	0.56	105	Strong S3-
South Aegean	Greece	NUTS 2	Regional	21%	12%	0.02	two stages	44%	3.0	0.56	104	Strong S3-
Veneto	Italy	NUTS 2	Regional	52%	14%	0.06	one Stage	41%	3.0	0.55	104	Strong S3-
País Vasco	Spain	NUTS 2	Regional	45%	31%	0.32	all stages	47%	1.6	0.55	104	Strong S3-
Champagne-Ardenne	France	NUTS 2	Regional	83%	38%	0.38	one Stage	65%	1.3	0.55	103	Strong S3-
Lazio	Italy	NUTS 2	Regional	42%	46%	0.38	two stages	64%	2.7	0.55	102	Strong S3-
Pohjois-Savo	Finland	NUTS 3	Regional	82%	17%	0.11	n.a.	59%	2.2	0.53	99	Moderate S3+
Cataluña	Spain	NUTS 2	Regional	57%	40.8%	0.19	all stages	58%	1.9	0.53	99	Moderate S3+
Comunidad Valenciana	Spain	NUTS 2	Regional	24%	21%	0.21	two stages	57%	2.9	0.52	97	Moderate S3+
Bavaria	Germany	NUTS 1	Regional	48%	39%	0.29	two stages	55%	1.0	0.51	96	Moderate S3+
Hessen	Germany	NUTS 1	Regional	72%	45%	0.16	two stages	67%	1.9	0.51	95	Moderate S3+
Piedmont	Italy	NUTS 2	Regional	28%	31%	0.47	one Stage	54%	2.9	0.51	95	Moderate S3+
Autonomous Province of Trento	Italy	NUTS 2	Regional	23%	23%	0.20	one Stage	52%	3.0	0.51	95	Moderate S3+
Kymenlaakso	Finland	NUTS 3	Regional	69%	20%	0.31	n.a.	59%	2.2	0.50	94	Moderate S3+
Luxembourg	Luxembourg	NUTS 0	National	42%	38.7%	0.47	n.a.	66%	2.0	0.49	93	Moderate S3+
Hamburg	Germany	NUTS 1	Regional	61%	40%	0.27	one Stage	66%	1.3	0.49	92	Moderate S3+
Madeira	Portugal	NUTS 2	Regional	/	47%	0.23	all stages	55%	2.7	0.49	92	Moderate S3+

Norrbottens län	Sweden	NUTS 3	Regional	100%	5%	0.00	n.a.	62%	1.4	0.49	92	Moderate S3+
Castilla y León	Spain	NUTS 2	Regional	50%	46%	0.22	one Stage	72%	2.6	0.49	92	Moderate S3+
Ostrobothnia	Finland	NUTS 3	Regional	78%	44%	0.31	n.a.	68%	2.2	0.49	92	Moderate S3+
Umbria	Italy	NUTS 2	Regional	29%	24%	0.19	two stages	38%	2.7	0.49	92	Moderate S3+
North Karelia	Finland	NUTS 3	Regional	51%	17%	0.11	n.a.	63%	2.2	0.49	91	Moderate S3+
Ireland	Ireland	NUTS 0	National	69%	46%	0.39	one Stage	67%	1.4	0.49	91	Moderate S3+
Bretagne	France	NUTS 2	Regional	83%	80%	0.39	one Stage	67%	2.5	0.48	90.15	Moderate S3+
Southern Ostrobothnia	Finland	NUTS 3	Regional	75%	44%	0.31	n.a.	59%	2.2	0.47	88	Moderate S3
Flanders	Belgium	NUTS 1	Regional	41%	28%	0.24	n.a.	41%	3.0	0.47	87	Moderate S3
Southwest Finland	Finland	NUTS 3	Regional	58%	20%	0.31	n.a.	47%	2.2	0.46	87	Moderate S3
Central Finland	Finland	NUTS 3	Regional	71%	44%	0.31	n.a.	57%	2.2	0.46	86	Moderate S3
Italy	Italy	NUTS 0	National	29%	31%	0.18	one Stage	54%	2.6	0.46	86	Moderate S3
Northern Ostrobothnia	Finland	NUTS 3	Regional		17%	0.11	one Stage	63%	2.2	0.46	86	Moderate S3
Lapland	Finland	NUTS 3	Regional	71%	17%	0.11	n.a.	23%	2.2	0.45	85	Moderate S3
Jämtlands län	Sweden	NUTS 3	Regional	0%	5%	0.42	one Stage	61%	1.4	0.45	84	Moderate S3
Pirkanmaa	Finland	NUTS 3	Regional	60%	44%	0.31	n.a.	51%	2.2	0.43	81	Moderate S3
Attica	Greece	NUTS 2	Regional	43%	24%	0.12	one Stage	60%	1.7	0.43	81	Moderate S3
England	United Kingdom	consists of 9 NUTS 1 regions	National	26%	39%	0.24	n.a.	65%	2.5	0.43	80.3	Moderate S3
West Netherlands	the Netherlands	NUTS 1	Regional	59%	38%	0.08	one Stage	47%	1.2	0.43	79.7	Moderate S3-
Skåne län	Sweden	NUTS 3	Regional	3%	15%	0.31	one Stage	42%	1.4	0.41	76	Moderate S3-
Värmlands län	Sweden	NUTS 3	Regional	34%	39%	0.22	one Stage	43%	1.4	0.40	75	Moderate S3-
Östergötlands län	Sweden	NUTS 3	Regional	/	33%	0.15	two stages	50%	1.4	0.40	75	Moderate S3-

Ile-de-France	France	NUTS 2	Regional	0%	63%	0.36	one Stage	75%	2.6	0.39	74	Moderate S3-
Haute Normandie	France	NUTS 2	Regional	7%	53%	0.40	one Stage	71%	1.3	0.39	73	Moderate S3-
Denmark	Denmark	NUTS 0	National	57%	42%	0.05	n.a.	52%	2.9	0.39	72	Moderate S3-
Västra Götalands län	Sweden	NUTS 3	Regional	16%	25%	0.24	one Stage	49%	1.4	0.38	72	Moderate S3-
Alsace	France	NUTS 2	Regional	/	69%	0.30	one Stage	73%	2.5	0.38	71	Moderate S3-
Scotland	United Kingdom	NUTS 1	Regional	53%	45%	0.21	one Stage	69%	/	0.38	71	Moderate S3-
Gävleborgs län	Sweden	NUTS 3	Regional	/	39%	0.22	one Stage	62%	1.4	0.38	71	Moderate S3-
Örebro län	Sweden	NUTS 3	Regional	/	33%	0.15	one Stage	65%	1.4	0.37	69	Modest S3+
Kainuu	Finland	NUTS 3	Regional	/	17%	0.11	n.a.	42%	2.2	0.37	69	Modest S3+
Dalarnas län	Sweden	NUTS 3	Regional	1%	39%	0.22	one Stage	53%	1.4	0.36	68	Modest S3+
Västmanlands län	Sweden	NUTS 3	Regional	0%	33%	0.15	one Stage	50%	1.4	0.34	65	Modest S3+
Södermanlands län	Sweden	NUTS 3	Regional	/	33%	0.15	one Stage	49%	1.4	0.34	64	Modest S3+
Västerbottens län	Sweden	NUTS 3	Regional	0%	5%	0.00	n.a.	48%	1.4	0.30	57	Modest S3

Source: Prognos / CSIL (2021). n= 97 regions. MDR-average= 0.53. Note: The German regions Berlin / Brandenburg have one strategy, but the two regions belong to different cohesion groups (More Developed / Transition). However, when taken together they would be categorised as “More Developed”. Hence, in the Scoreboard both Berlin and Brandenburg are among the More Developed Regions.

Table 9-35: Underlying data of the S3 Scoreboard – National strategies (sorted by performance relative to national average)

General information				Outcome Criteria			Process Criteria			Scoreboard ranking		
				Implementation of the S3	Granularity / Thematic broadness	Correspondence of S3 strategies	Development process of S3 (EDP)	Quality of the prioritisation approach	Implementation of the S3			
Region	Country	NUTS level	Strategy level	Share of matched budget	Bandwith index	Correspondence with regional profile	Degree of continuity of EDP	RATING: Explained share of prioritisation approach	Quality of the selection process	Weighted average	Performance relative to National-average	Scoregroup
Poland	Poland	NUTS 0	National	86%	66%	0.53	all stages	72%	3.0	0.73	130	S3 Leader-
Slovenia	Slovenia	NUTS 0	National	74%	19.5%	0.27	two stages	36%	3.5	0.67	121	Strong S3+
Cyprus	Cyprus	NUTS 0	National	97%	34%	0.20	two stages	69%	2.4	0.66	118	Strong S3+
Czech Republic	Czechia	NUTS 0	National	56%	26%	0.26	two stages	61%	3.0	0.64	115	Strong S3
Lithuania	Lithuania	NUTS 0	National	89%	43%	0.13	two stages	64%	3.0	0.64	114	Strong S3
Hungary	Hungary	NUTS 0	National	73%	32%	0.37	one Stage	58%	3.6	0.63	113	Strong S3
Estonia	Estonia	NUTS 0	National	33%	33%	0.41	one Stage	74%	3.7	0.60	107	Strong S3-
Greece	Greece	NUTS 0	National	77%	59%	0.18	one Stage	70%	3.1	0.58	104	Strong S3-
Austria	Austria	NUTS 0	National	50%	63%	0.38	two stages	69%	3.0	0.58	104	Strong S3-
Romania	Romania	NUTS 0	National	49%	32%	0.28	one Stage	59%	3.1	0.57	103	Strong S3-
Croatia	Croatia	NUTS 0	National	78%	42%	0.24	two stages	56%	2.8	0.57	102	Strong S3-
Portugal	Portugal	NUTS 0	National	50%	76%	0.28	all stages	68%	2.8	0.56	101	Strong S3-
Bulgaria	Bulgaria	NUTS 0	National	98%	40%	0.27	one Stage	62%	2.6	0.56	101	Strong S3-
Latvia	Latvia	NUTS 0	National	64%	32%	0.25	one Stage	65%	2.8	0.55	99	Moderate S3+
Slovakia	Slovakia	NUTS 0	National	66%	30%	0.30	one Stage	56%	2.3	0.55	98	Moderate S3+
Malta	Malta	NUTS 0	National	69%	25%	0.09	one Stage	43%	2.0	0.49	89	Moderate S3
Luxembourg	Luxembourg	NUTS 0	National	42%	39%	0.47	n.a.	66%	2.0	0.49	89	Moderate S3
Ireland	Ireland	NUTS 0	National	69%	46%	0.39	one Stage	67%	1.4	0.49	87	Moderate S3

Italy	Italy	NUTS 0	National	29%	31%	0.18	one Stage	54%	2.6	0.46	82	Moderate S3
Spain	Spain	NUTS 0	National	88%	49%	0.28	n.a.	59%	1.2	0.43	77	Moderate S3-
England	United Kingdom	consists of 9 NUTS 1 regions	National	26%	39%	0.24	n.a.	65%	2.5	0.43	77	Moderate S3-
Denmark	Denmark	NUTS 0	National	57%	42%	0.05	n.a.	52%	2.9	0.39	69	Modest S3+

Source: Prognos / CSIL (2021), n= 22 regions. National average= 0.56

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