The Role of Industrial Policies: A Comparative Analysis

Rosanna Fornasiero and Tullio A. M. Tolio

Abstract The aim of this chapter is to analyse and compare European, Italian and regional industrial policies aimed at promoting the research and innovation activities, with focus on manufacturing sector. The analysis is based on secondary data collected from websites, documents issued by related governmental bodies and grey literature which are compared along scientific topics of interest. Moreover, the chapter discusses how these policies are expected to have an impact on industrial competitiveness and how these policies are interconnected each other. A comparative analysis of the regional and national priorities is also proposed as the result of an iterative collaboration with regional actors. The chapter closes with the analysis of the role of the cluster in supporting industrial policies.

Keywords Industrial policy · Research policy · Public–private partnerships · Europe · Italy · Regions

1 The European Research Strategy and Actions

The ongoing plan Horizon Europe set out in 2021 is an ambitious research and innovation programme to allow the EU both to strengthen the outcomes achieved with H2020 and fortify Europe's frontline position in the research and innovation sector at the global level. Horizon Europe's purpose is to boost the scientific, social and economic impact of European research funds. Several programmes have a strong focus on close-to market activities including innovative financial instruments, and aspires to meet research needs by placing emphasis on widespread generation of knowledge generated through activities supported from basic research to the market.

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The strength of Europe starts on the back foot, grounded on delivering 17% of worldwide research and 25% of high-quality scientific publications with an average investment in research and development amounting to 1.5% of GDP, which is still very low compared to other high-tech countries, such as the US (2.1%), Japan (2.6%) and Korea (3.6%) (EU, 2020).

With a budget of 95.5 billion euros, the programme Horizon Europe is implemented over the course of 2021–2027 through 3 pillars (Excellent Science, Global Challenges and European Industrial Competitiveness, Innovative Europe). Horizon Europe stands out from previous programmes for its more integrated approach of pooling various financing instruments and, above all, is much more focused on achieving tangible application outcomes.

Of the three pillars, two are explicitly geared towards applied research in areas defined as priority areas for European industrial competitiveness in response to major global challenges (Pillar II) and towards radical product and process innovations by European companies (Pillar III) respectively, with a view to helping them achieve commercial success in global markets.

Within pillar II, the most important area for the manufacturing sector is cluster 4 "Digital, Industry and Space", whose goal is to support investments in competitive and trusted technologies for a European industry with global leadership in key areas, with production and consumption models that respect the planet, maximizing benefits for society in the different social, economic and regional contexts in Europe.

The overarching aim is to create a competitive, digital, circular, low-carbon industry, with the goal of ensuring the sustainable supply of raw materials, developing advanced materials, and introducing innovation to meet global challenges in society. More specifically, within the cluster 4 programme, medium-term goals (referred to as destinations) have been defined that, in turn, are broken down into calls for collaborative projects (like RIA, IA and CSA); for the first two years of Horizon Europe, these goals are:

- Climate neutral, circular and digitized production;
- Increased autonomy in key strategic value chains for resilient industry;
- World-leading data and computing technologies;
- Digital and emerging technologies for competitiveness and fit for the green deal;
- Open strategic autonomy in developing, deploying and using global space-based infrastructures, services, applications and data;
- A human-centred and ethical development of digital and industrial technologies.

Going in particular to analyse the manufacturing sector, Made in Europe is the new partnership established as part of the Horizon Europe Framework Programme (2021–2027) specifically focused on this sector. The creation of the Made in Europe partnership has been discussed between the relevant bodies involved, European Commission, member states and EFFRA association since 2019. The partnership's reach and ambitions were defined in the Made in Europe orientation paper and, in 2021, the Strategic agenda for research and innovation was published.

The European partnership involves the whole manufacturing value chain in Europe to support the promotion of manufacturing excellence among companies, especially

SMEs, to ensure competitiveness and sustainability across the European manufacturing industry, defending Europe's technological leadership around the world, as well as the prosperity and wellbeing of employees, consumers and society.

Made in Europe will make a substantial contribution for facilitating the networking between the main actors who steer and/or implement manufacturing innovation initiatives at the national and regional level, and its goal is to engage in dialogue with new actors, such as local authorities tasked with drawing industry to their cities and municipalities. In particular, the goal of the Made in Europe partnership is to propel European manufacturing ecosystems towards global leadership in manufacturing technologies in line with sustainability principles. The partnership is working to create a competitive, green, digital, resilient and human-centred manufacturing industry in Europe.

More specifically, manufacturing will be central to the twin transition (green and digital) in line with the European Commission's Green Deal, given that the sector is both an engine driving such changes in other sectors and it is itself on the receiving end of these innovations.

There are several European initiatives supporting industry and one of the most recent with the actions that may affect manufacturing is the Chips Act. The European Commission has proposed a comprehensive series of measures aimed at ensuring supply security, resilience and technological leadership for the EU in semiconductor technologies and applications. The European Chips Act has the goal of strengthening Europe's competitiveness and resilience, and it can help bring about both the digital and the green transition.

The European Commission has set out to mobilize over 43 billion euros in public and private investments through measures designed to prevent, prepare for, anticipate and respond rapidly to any future supply chain interruptions, together with member states and our international partners, with the aim of achieving its ambition of doubling its current market share in this sector to 20% by 2030.

More specifically, the objectives of the European Chips Act are:

- Strengthen European leadership in research and technology development towards smaller and faster chips;
- Build and reinforce its capacity to innovate in the design, manufacture and packaging of advanced chips;
- Put in place an adequate framework to increase its production capacity to 20% of the global market by 2030;
- Address skills shortage, attract new talent, and support the emergence of a skilled workforce;
- Develop an in-depth understanding of global semiconductor supply chains.

The Chips for Europe initiative will pool the resources of the Union, member states and third-party countries involved with the Union's existing programmes, as well as those of the private sector, by means of the "Chips Joint Undertaking" resulting from the reorientation of the existing Key Digital Technologies Joint Undertaking.

A substantial 11 billion-plus euros will be made available to support research, development and innovation in the sector and to ensure the use of advanced semiconductors, in innovative applications. Actions will also be identified aimed at training and reskilling in the industry, and at the development of the research and innovation ecosystem and relevant value chain.

There are plans for a new framework to ensure supply security by attracting greater investments and manufacturing capacity, required to promote innovation in advanced nodes, and innovative, energy-efficient chips.

Moreover, a Chips Fund will facilitate access to funding for start-ups in order to assist them in bringing their innovations to fruition and attracting investors. It will also include a share investment mechanism focused on semiconductors as part of the InvestEU programme to support scale-ups and SMEs to facilitate expansion of their market.

2 The Matching Between Cluster Objectives with European Goals and SDGs

In defining the roadmap objectives, the Cluster of Intelligent Factories refers to a number of strategic documents at the international and European level. More specifically, the Cluster aims to contribute to the definition of research and innovation themes aligning with a number of important European policies and, beside the aforementioned, other policy documents are: A new industrial strategy for Europe (EU 2021), The European Green Deal (EU 2019), A Europe fit for the digital age (EU 2021), An economy that works for people/Building a strong social Europe (EU 2021).

The Cluster works closely with the Made in Europe Co-programmed partnership and with the Manufuture European platform—since a number of actors within the Cluster also operate at the European level—and sets out to define research and innovation priorities that help manufacturing achieve the following European goals:

- Making manufacturing a carbon–neutral sector by 2050;
- Raising manufacturing's share of GDP to 20%;
- Reducing the use of virgin raw materials by 20% over the next decade;
- Increasing technological leadership and the resilience of ecosystems.

At international level, the Sustainable Development Goals (SDG) of the United Nations (UN 2019) are considered as a parameter to evaluate the impact of manufacturing in terms of performance. Moreover, in defining research and innovation priorities, the Cluster endeavours to analyse how manufacturing can contribute directly to the pursuit of the following UN goals:

- Goal 8: Decent work and economic growth
- Goal 9: Industry, innovation and infrastructure
- Goal 12: Sustainable consumption and production patterns
- Goal 13: Action to combat climate change

During the activities set up with the Scientific Board of the Cluster aimed to identify the overall goals, it was possible to identify the links between the Cluster's goals, the EU's strategic documents and UN goals (see Table 1).

Table 1 Breakdown of EU and SDG goals versus the Cluster's goals

EU strategic documents	SDG goals	Cluster CFI goals
• A new industrial strategy for Europe • A Europe fit for the digital age	Goal 9: Industry, innovation and infrastructure	The Cluster firmly believes that companies must have access to physical and digital infrastructure, and to innovative technologies, in order to operate within distributed collaborative networks. Companies need stable conditions and need to be able to operate in innovation-oriented environments. The Cluster's aim is to support the research and development of advanced technologies in this direction.
• An economy that works for people/ Building a strong social Europe • A Europe fit for the digital age	Goal 8: Decent work and economic growth	Manufacturing can create new jobs, with improved human–machine interaction. The Cluster believes that manufacturing should be human-centric, and that machines must be conceived to support operators and facilitate their work. Manufacturers must set goals of promoting worker growth with empowering actions.
• The European Green Deal	Goal 12: Responsible consumption and production	Industry must make substantial progress towards circular and carbon–neutral manufacturing It is important for the Cluster to promote the research and development of new clean technologies, and technologies that reduce dependence on virgin raw materials, as well as tools and solutions for assessing the environmental impact of processes and products. In addition, it is hoped that technologies can be developed to remanufacture products and materials to enable their continued reuse.
The European Green Deal	Goal 13: climate action	Industry is responsible for a third of greenhouse gas emissions, and the Cluster strongly believes that research and innovation activities should also be oriented to develop new products and processes to enable more efficient use of energy and resources. More specifically, manufacturing can make the products to reduce atmospheric emissions, to facilitate the use of renewable energy and to store energy. Moreover, it can make products designed for environmentally friendly use.

3 The National Research Strategy

In the last years, the Italian Government has set some strategies to support industrial policy with research and innovation activities that can be mainly recognized in the multi-year National Research Programme (PNR) and the National Plan for Recovery and Resilience (PNRR).

The National Research Programme (PNR) is a periodic document that orients research policy in Italy, identifying priorities, goals and actions aimed at supporting coherence, efficiency and effectiveness across the national research system, defining guidelines at the national level (PNR 2020). The ongoing PNR 2021–2027 has been structured to track alongside the Horizon Europe programme in terms of timelines and themes, breaking the six clusters included in pillar II into six broad research and innovation areas developed through intervention areas such as:

- Health;
- Human-centred culture, creativity, social transformations, inclusive society;
- Security for social systems;
- Digital, industry, aerospace;
- Climate, energy, sustainable mobility;
- Food products, bioeconomy, natural resources, agriculture and environment.

Thus, the national strategic vision is aligned with European programmes, including elements of complementarity aimed at promoting interventions to help Italian research system to increase its competitiveness and to become an increasingly key player on the European stage.

The potential ensuing advantages are not limited to the possibility of achieving shared access to R&I funding, instead there are inherent benefits to collaborative research, most notably those resulting from sharing outcomes and collaboration with other countries' national R&I systems.

These R&I areas covered in the PNR also allow to tie in with the goals of the European Green Deal, hence making the PNR a tool designed to provide a significant contribution to the green transition, in which the conservation of natural capital, biodiversity and the processes that depend on it—and on which the very life of the planet depends—becomes a necessary common condition for the pursuit of the goals of prosperity and wellbeing identified by the European Green Deal.

Another of the priorities identified in the plan is promoting the flow of knowledge and skills between research organisations and the manufacturing system, and exploiting research outcomes through a virtuous cross-fertilisation process to ensure the country's competitiveness, even more in the current twin transition, both green and digital.

The document states that public intervention is required to help kick-start this cross-fertilisation, and indicates the challenges to be tackled, the goals to be achieved and setting out consistent action lines. The PNR stresses that in policy planning, it is necessary to take into account the starting conditions and, above all, the gap by which

Italy lags behind other European countries in terms of the propensity of businesses to cooperate on innovation.

This gap is also underlined in the European Innovation Scoreboard (EIS 2020), which, for years, has been putting our country in the "moderate innovators" category, with performance trailing behind the European average in terms of collaboration between enterprises, and between enterprises and the public research system. Hence, promoting innovation necessarily goes hand in hand with strengthening relationships between research and the manufacturing system, fostered by mobility programmes between the research institutions and industry, and targeted technology-transfer strategies that facilitate the transition from fundamental and applied research to ideas delivered to the market more successfully.

As part of the National strategy for research and innovation, it is useful to analyse also the National Plan for Recovery and Resilience (PNRR) conceived as a planning document for specific investments and reforms for Italy after the response of the European Union to the pandemic crisis with Next Generation EU (NGEU). The document is set for planning investments and reforms to speed up the green and digital transition, improve worker training and achieve greater gender, regional and generational equity.

For Italy, NGEU represents an opportunity for development and investment that it cannot afford to squander. Italy must modernize its government bodies, strengthen its manufacturing system, and step up its efforts to fight poverty, social exclusion and inequality. NGEU might be just the opportunity to resume a sustainable and lasting economic growth path, removing the obstacles that have stood in the way of Italian growth in recent decades.

The PNRR has been formulated following an intense preliminary analysis and research phase, and comprises sixteen components, grouped into six Missions:

- Mission 1: Digitalization, innovation, competitiveness, culture and tourism
- Mission 2: Green revolution and ecological transition
- Mission 3: Infrastructure for sustainable mobility
- Mission 4: Education and research
- Mission 5: Cohesion and inclusion
- Mission 6: Health

With this document, the government plans to update national strategies around development and sustainable mobility; environment and climate; hydrogen; automotive; and the healthcare supply chain. In addition, the PNRR contains a very important chapter on training for companies to ensure the growth of human capital required to successfully bring about the twin digital-sustainable transition.

In terms of the competitiveness and resilience of the manufacturing system, the PNRR plans to pull different levers to strengthen and modernize the operational capability of companies in our country; more specifically, part of the plan is to promote digital transformation processes in Italian companies, and boost tools for the digital transition of the manufacturing system, and complete the digital infrastructure rollout process through the twin digital-sustainable transition.

4 Regional Specialization Strategies for the Manufacturing Sector

A look at the way the manufacturing sector is distributed across the Italian regions reveals heterogeneous situation in terms of concentration, value added and other important indicators. In particular, there is a strong concentration of manufacturing companies in Lombardy, which accounts for 27% of Italian value in terms of turnover and value added, with values across all 4 dimensions (companies, turnover, value added and number of employees) representing at least double the value individually reported by the next 3 top-ranked regions (Veneto, Emilia-Romagna and Piedmont).

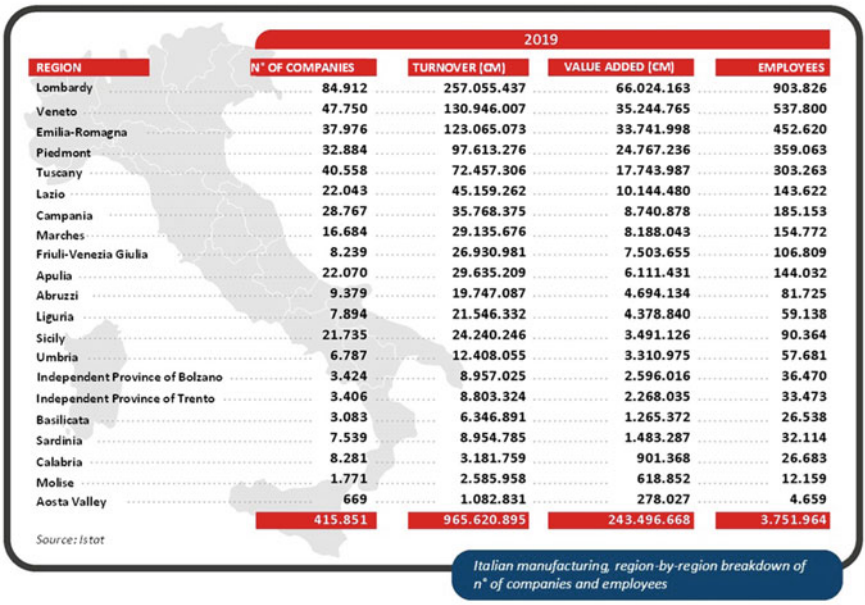
In the international rankings, four of the European Union's top ten manufacturing regions are Italian: Veneto, Emilia-Romagna, Lombardy and Piedmont. According to the NUTS2 rankings, Lombardy is the EU region with the second highest number of employees in manufacturing companies, behind the French Paris region, Île de France. Out of the top ten European manufacturing regions, Veneto sits in second place for the ratio of manufacturing employment to population, with 10.6 employees in manufacturing companies per 100 inhabitants, behind Stuttgart (14.4 manufacturing company employees per 100 inhabitants). Emilia-Romagna, Lombardy and Piedmont placed 4th, 6th and 8th respectively, with 9.9, 8.9 and 8.1 employees per 100 inhabitants. Moreover, Emilia-Romagna has a per-capita manufacturing value added of 7899 euros against the Italian average per-capita value of 4,278 euros, followed by Veneto on 7,335 euros per capita and Lombardy on 7,030 euros per capita.

Looking at research spending in 2018 (Fig. 1), over a third of R&D is conducted in the Northeast, while the combined contribution of the Southern regions and islands comes to almost 15%. Notably, 68.1% of total spending, amounting to around 17.2 billion euros, is concentrated in five regions, namely Lombardy on 20.6%, Lazio on 13.7%, Emilia-Romagna on 13.0%, Piedmont on 11.8% and Veneto on 9.0%.

Overall, companies in the five major manufacturing regions account for 75% of national research in the sector. More specifically, out of the most virtuous regions, Lombardy makes the biggest contribution to total spending with 25%. In 2018, Lombardy, Lazio and Emilia-Romagna were again the regions where universities had invested the most in R&D and, together with Campania and Tuscany, they accounted for 55.7% of total R&D spending in this sector. Looking at the incidence of R&D spending as a percentage of GDP (Fig. 2), the regions' rankings range from Piedmont's top rate (2.17%) to Aosta Valley's lowest rate (0.48%). In addition to Piedmont, the regions with the highest R&D spending as a percentage of GDP are Emilia-Romagna (2.03%), Lazio (1.75%), Friuli-Venezia Giulia (1.67%), Province of Trento (1.56%) and Tuscany (1.55%).

In terms of research policies, national and regional research and innovation strategies for smart specialization (RIS3) are integrated, place-based economic transformation agendas designed towards five important actions:

(1) Focus policy support and investments on key national and regional priorities, challenges and needs for knowledge-based development;



REGION	2019 N° OF COMPANIES	TURNOVER [CM]	VALUE ADDED [CM]	EMPLOYEES
Lombardy	84.912	257.055.437	66.024.163	903.826
Veneto	47.750	130.946.007	35.244.765	537.800
Emilia-Romagna	37.976	123.065.073	33.741.998	452.620
Piedmont	32.884	97.613.276	24.767.236	359.063
Tuscany	40.558	72.457.306	17.743.987	303.263
Lazio	22.043	45.159.262	10.144.480	143.622
Campania	28.767	35.768.375	8.740.878	185.153
Marches	16.684	29.135.676	8.188.043	154.772
Friuli-Venezia Giulia	8.239	26.930.981	7.503.655	106.809
Apulia	22.070	29.635.209	6.111.431	144.032
Abruzzi	9.379	19.747.087	4.694.134	81.725
Liguria	7.894	21.546.332	4.378.840	59.138
Sicily	21.735	24.240.246	3.491.126	90.364
Umbria	6.787	12.408.055	3.310.975	57.681
Independent Province of Bolzano	3.424	8.957.025	2.596.016	36.470
Independent Province of Trento	3.406	8.803.324	2.268.035	33.473
Basilicata	3.083	6.346.891	1.265.372	26.538
Sardinia	7.539	8.954.785	1.483.287	32.114
Calabria	8.281	3.181.759	901.368	26.683
Molise	1.771	2.585.958	618.852	12.159
Aosta Valley	669	1.082.831	278.027	4.659
	415.851	965.620.895	243.496.668	3.751.964

Source: Istat

Italian manufacturing, region-by-region breakdown of n° of companies and employees

Fig. 1 Italian manufacturing distribution per Region

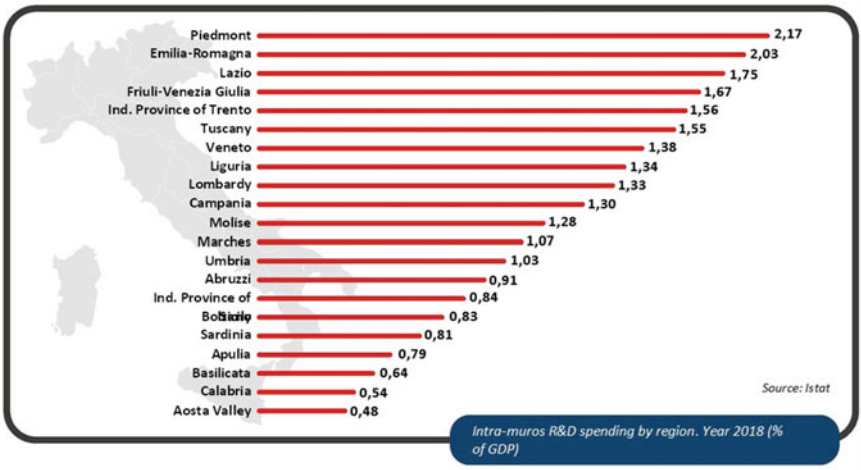


Fig. 2 Intra-muros R&D spending by Region, 2018 (%GDP)

(2) Build on each country's or region's strengths, competitive advantages and potential for excellence;
(3) Support technological innovation and stimulate private sector investment;
(4) Get stakeholders fully involved and encourage innovation and experimentation;
(5) Take an evidence-based approach that includes sound monitoring and evaluation systems.

All the regions participating in the Cluster CFI activities, as part of their respective specialization strategies, have defined priorities and goals that concern the promotion of models, methods and technologies to support the implementation of intelligent factories, as a path to the economic and industrial growth of the region, as well as the improvement of social integration with a new role for industry.

These policies have been developed based on analysis of the industrial and research system's local conditions, compared with state of the art of technologies and global trends, backed by the application of foresight and roadmapping methodologies.

The regional strategies analysed as part of the Cluster's activities share a common far-reaching vision of innovation, with approaches based on—but certainly not limited by—technology and the main, cross-cutting drivers associated with it. They have all paired a monitoring system with shared output, specialization, transition and outcome indicators coordinated nationally for monitoring of the national S3.

All regional authorities have worked over this period on defining the proposal on how to update their individual S3 for the 2021–2027 period, formulated in light of: the changes observed in the regional manufacturing system and relevant innovation challenges identified; the strategic-planning reference framework at the European, national and regional level; the outcomes from various exchange and feedback sessions with regional stakeholders; and also building on the experience gained over the 2014–2020 agenda period.

During the course of 2020, under the aegis of the Cohesion Agency, the Cluster has turned the spotlight on the interregional table, which involves both the regional authorities already formally partnering with the Cluster, as well as candidate authorities (Friuli-Venezia Giulia, Province of Trento, Umbria and Basilicata), for the sharing of new specialization strategies.

For the sake of this work, the roadmapping group of the Cluster, with the support of the bodies representing the regional authorities in the Cluster Management Board, carried out a deep analysis of the strategies for research and innovation developed by each region in the RIS3 to align the Cluster proposals with these requirements, endeavouring to map the research priorities and strategic lines of the two analysis levels (regional and national). As illustrated by the diagram below (Figs. 3 and 4), the Cluster research and innovation priorities (which will be described in the coming chapters) can be seen as a macro container collecting the interests of the various regional stakeholders. Each region has its own specificities, and some regional priorities have been mapped along different strategic action lines.

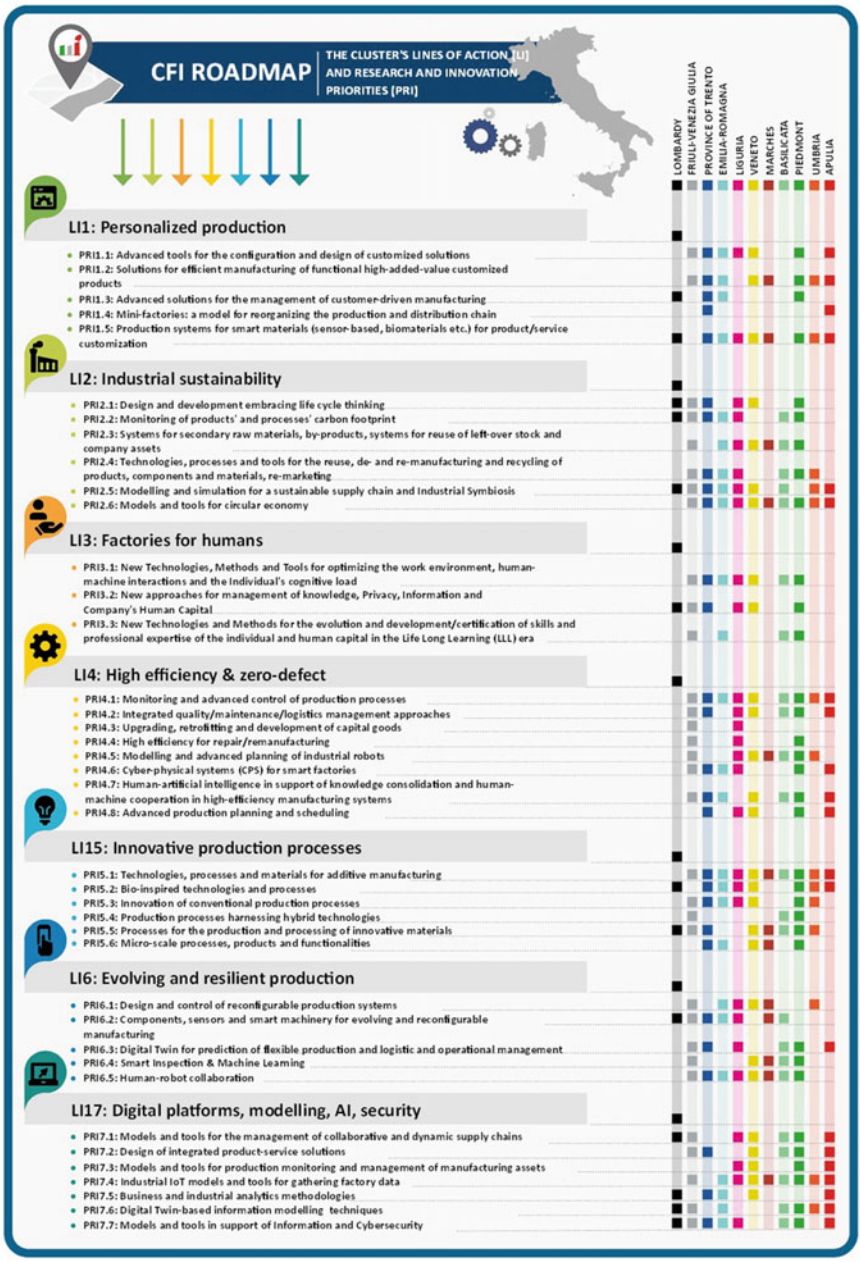


Fig. 3 Mapping Cluster research and innovation priorities to regional RIS3 objectives

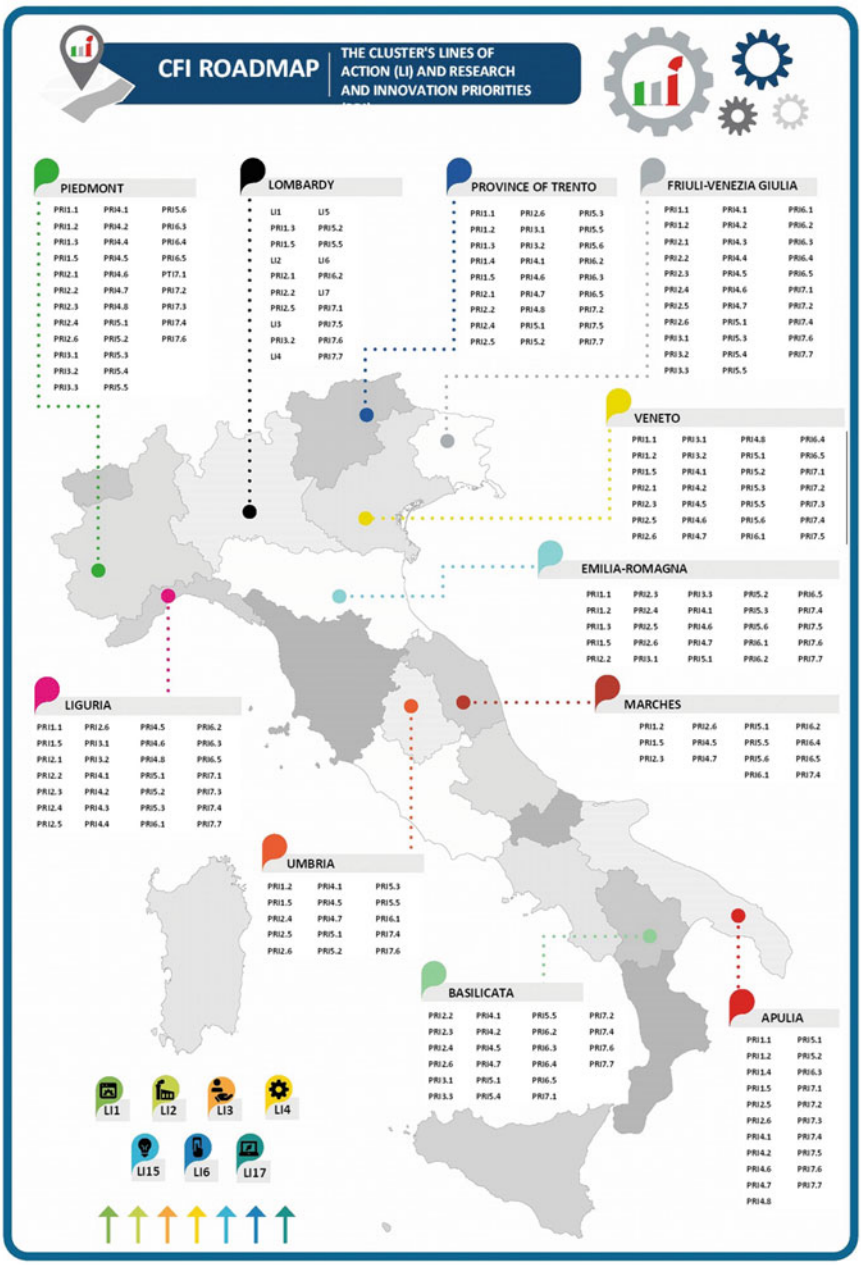


Fig. 4 Cluster research and innovation priorities per Region

5 The Role of Clusters in Definition of Industrial Policies

From this analysis, the definition of research and innovation roadmaps (at any level) leverages on the interconnection between the manufacturing system and public research and policy definition and this is where public–private collaboration models also come in, and initiatives like national and regional Clusters serve as a valuable tool in this direction. In countries where manufacturing accounting for such a significant portion of GDP and employment, it is clearly important to successfully overcome the strategic limit of the actual strategies, giving enough space to sectors that have demonstrated—backed up by figures—their worth as producers of wealth. Moreover, a new governance model should be developed to assign a leading role to partnerships that have been operating across the country for years, such as national and regional clusters, and design mechanisms to highlight specific priorities for capital goods. The role of networking stakeholders, mapping research needs, helping institutional communication, helping knowledge and technology transfer is enabled by these actors of soft governance.

Hence, the Cluster sets out pathways for the evolution of Italian manufacturing, bringing stakeholders like industries and researchers together into a national collective to support an ongoing dialogue with Ministries, Regional authorities and institutions, even at the European and international level, with a national vision for the manufacturing system defined through this roadmapping initiative.

To cement a stable position in the global competitive arena in the field of manufacturing, Italy must innovate its manufacturing sector to leverage the resources available to it and generate added value in both traditional and new markets.

This innovation must include, on the one hand, achieving greater productivity and, on the other, the development of new strategic industries, leveraging the existing successful production structure. In view of this, the roadmap defines visions for future manufacturing that can:

- Support policy makers (ministries, regional authorities, EU) in their efforts by proposing a consistent research, development and innovation framework that takes into account evolution on the international level and, at the same time, allows for the specificity of the national situation and of the individual regions.
- Provide a blueprint for defining initiatives for the achievement of common ends to the benefit of the country's strategic positioning and competitiveness.
- Provide a starting point in bilateral and multilateral relations with other countries to define cooperation programmes and shared actions.
- Provide a blueprint for developing national and regional S3s.

This role of the Cluster promotes coherence between the various practitioners, to overcome fragmentation issues, and improve the ability to implement actions that are coordinated and, where possible, concerted so as to ensure the sector's harmonious growth. This organic framework is set to benefit businesses as well as universities and research bodies, i.e. the practitioners of research and innovation.

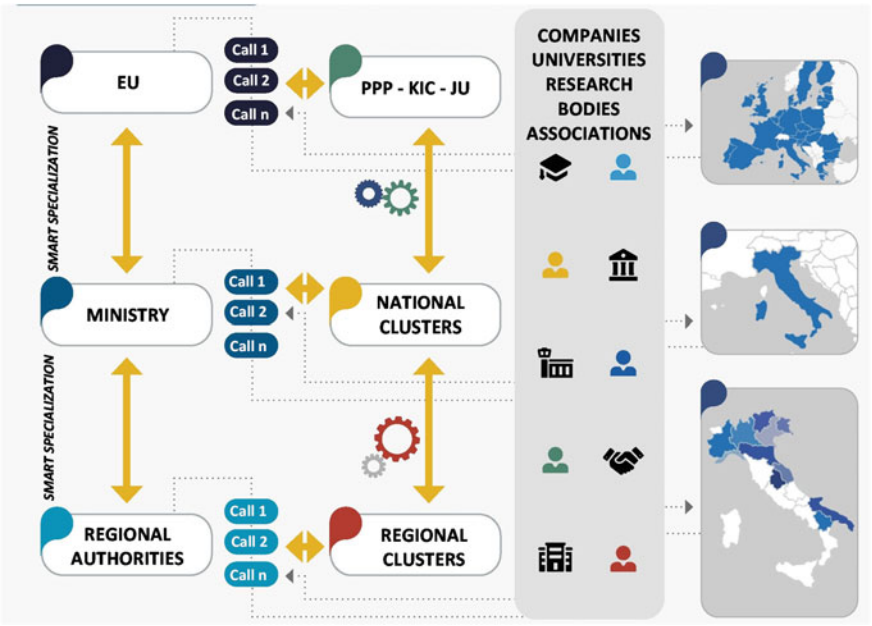


Fig. 5 Framework of integration between regional, national and European policy level

Backed by such a framework, each actor will actually be in a position to take part in regional, national and European initiatives through projects that—starting with the local and progressing to national and, ultimately, international projects—build on the expertise gained along this growth path. On the other hand, low TRL outcomes on the European or national level can be allowed to evolve further within the regions, possibly through demonstrators and pilot plants (Fig. 5). Lastly, multi-regional initiatives taken in different countries can lead to European-wide initiatives (e.g. Vanguard).

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