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Advanced Technologies for Industry

Impact of technological transformation on regional development

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Section 1

1. Background

This Policy Brief has been developed in the framework of the Advanced Technologies for Industry (ATI) project, initiated by the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), and the European Innovation Council and Small and Medium-sized Enterprises Executive Agency (EISMEA). Policy Briefs analyse national and regional policy measures focused on a specific challenge, technological area or mode of implementation, and they explore policy tools designed and implemented with the aim of fostering the generation and uptake of advanced technologies. The reports provide a comparative analysis and bring examples of relevant national and regional policy measures in the EU.

This report focuses on highlighting recent research findings about the impact of technological transformation on regional development and discuss the related policy implications by bringing examples of concrete policy measures. This topic is particularly relevant in a time when technological including digital and green transformation has accelerated, but at the same time the opportunities of regions to develop have profoundly changed. The Covid-19 pandemic has affected regional and local industrial structures to a different extent across Europe. The impact of the crisis on economies has brought about widening regional disparities in terms of economic growth but also digitalisation according to a recent report of the OECD[1]. Changes in local demand, access to materials and components, and global trade have affected specific industries more than others. It is therefore clear that regions more dependent on severely affected industries have had their economies hit harder by the pandemic.

In this context, the specific objectives of this analysis have been to:

- Provide a snapshot of recent literature dealing with the impact of technological change on regional disparities and regional development
- Showcase policy measures from national and regional level addressing various challenges of regional technological development
- Explore any policy gaps in support of technological transformation and provide inspiration for policy action

The report is made up of three parts. The first section identifies the key policy challenges. The second section analyses policy responses and policy measures at national and regional levels. The third section lists a range of ideas for further policy consideration.

This study is based on a literature review, desk research and expert assessment.

[1] OECD (2020). OECD Regions and Cities at a Glance 2020

Section 2

2. Impact of technological transformation on regional development

Key messages

Regions across Europe have been confronted with transformational challenges as a result of rapidly developing technologies. Regional development pathways have been exarbated by the Covid-19 pandemic that has further accelerated the importance of digitalisation. Nevertheless, regions are impacted by technological transformation to a different extent depending on their economic structure, level of education of their workforce and their capabilities to adjust and foster the emergence of new industries and new business models. **Regional differences imply the need for differentiated regional innovation policy responses.**

Higher level of manufacturing activity is expected to favour the adoption of advanced technologies. Differences in education levels, problem-solving skills of the population but also **local demand for novel and innovative products and services and solutions,** (including the willigness to buy and adopt new products by local companies, public sector, communities and individuals) will determine to what extent technologies can diffuse to sectors and transform the regional economic fabric.

The literature highlights that different specialisation profiles and positions in the industrial value chain leads to distinct level of technological advancements across regions. The impact of technology adoption on regional GDP per capita growth is the highest when adoption refers to the technology that characterises best a region. Evidence has been also provided by the existing literature that spatial diffusion of technologies often occurs across regions contiguous to each other, for instance with complementary economic profiles or as a result of mobility of relevant professionals.

2.1 Regional impact of technological change

There is a large body of literature dealing with the regional effects of technological change, highlighting that economic activity is 'spiky' and technological development is concentrated in relatively few areas (see for instance the well-known work of Richard Florida, 2008). The investigation of the regional impact of technology change is embedded in theories about the regional innovation system, the broader innovation system/sectoral innovation system and are also linked to economic geography, the triple-helix model[2] and cluster theory.

Technological breakthroughs open up new opportunities for new industries to emerge or existing ones to transform[3]. Nonetheless, technology is affecting regions in different ways and regional growth across Europe measured in terms of GDP per capita[4] has been diverse. The ability to generate and adopt advanced technologies needs support from the knowledge and institutional framework of each region and **depends very much on the strengths of the regional innovation system** as Asheim (2019) and many other scholars have stressed in their research.

Technological change tends to rearrange existing spatial industrial structures. Certain locations with a certain group of industries become inevitably disadvantaged, while other places are offered a new opportunity to grow[5].

In order to harness technological advancements, various types of knowledge need to be available in the region as pointed out by Fagerberg, Isaksen or Trippl (2019)[6]:

- Knowledge of scientific fields and disciplines,
- Know-how to utilise technology to produce new products or support the business operation,
- Competence in developing new or renewed products and services,
- Ability to embed new products into the production and distribution system.

Isaksen (2019) argued that both industry and the public sector including the regional knowledge infrastructure needs to be ready not just to develop/acquire but also to exploit the new technological knowledge. Public policy has to be adapted to the new circumstances profoundly at the regional level.

[2] The triple helix captures the interactions between academia, industry and government. Etzkowitz, Leydesdorff (1995)
[3] Perez (2010)
[4] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=GDP_at_regional_level
[5] Koutroumpis, P. and Lafond, F. (2018)
[6] Isaksen et al; (2019), Fagerberg (2010)

The literature has underlined several factors that determine the regional impact of new technology including inherent regional characteristics such as:

- Existing research portfolio,
- Industrial structure,
- Technology infrastructure,
- Proximity to global knowledge networks,
- Proximity to markets and resources,
- Physical geography.

In the first place the region's accessibility determines the exposure of the region to new technologies and the concomitant knowledge. In the second place the region's absorptive capacity as well as its capacity to diffuse (or in other words to internalise new technologies and knowledge and to communicate or trade it with other actors) are very relevant features[7]. The dynamic interactive processes of technology and innovation involve individuals, firms and institutions which absorb, apply and diffuse technology. Therefore a broad set of framework conditions matter for maximising the impact of technologies. The adoption of advanced technologies is very much determined by the level of education, the entrepreneurial ecosystem, the openness of the region and the industrial structure.

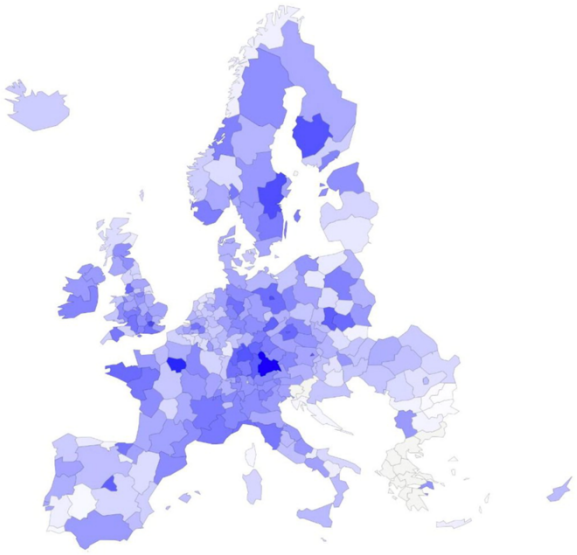
Wintjes and Hollanders (2010) highlighted that excellence in technology generation does not necessary lead to regional economic benefits. Even those regions which would benefit most from excellence-based research policy might need place-based innovation policy to enhance knowledge absorption and diffusion capacity in order to maximise regional impact. At regional level, application of technology is more important for future innovation than hosting basic research.

In many regions, new technologies originate from outside the region. Besides promoting research and development (R&D) and technology generation, other aspects of knowledge economies, such as education, digitalisation, life-long learning and high- and medium-high tech manufacturing are more important for absorbing and applying technologies developed elsewhere and therefore play an important role in processes of convergence and catching up at regional level (ibid).

Core regions have a key role to play in the development of surrounding areas. Promoting technological spillovers and strengthening cross-border linkages constitute a major policy challenge, especially in the 'low-GDP-periphery', including regions in Southern and Eastern parts of the EU. Technological spillovers are not given and they should be actively promoted by policies in order to materialise.

Regions are more likely to branch into technologically related industries as stressed by Neffke, Henning and Boschma (2009) and also reiterated by Balland and Boschma (2021). **Technological relatedness between manufacturing industries has been highlighted as another important factor to influence the technological trajectory of regions.** Neffke, Henning and Boschma (2009) further analysed regional economic evolution using detailed plant-level data and showed that the long-term evolution of the economic landscape in Sweden was subjected to path dependency. New industrial activity that was technologically related to existing industries in a region had a higher probability to take hold in the region. Balland and Boschma (2021) concluded based on patent analysis that regions with a high potential in terms of a strong local presence of related technologies are more likely to diversify successfully in advanced technologies.

Figure 1: Relatedness density in Industry 4.0 technology



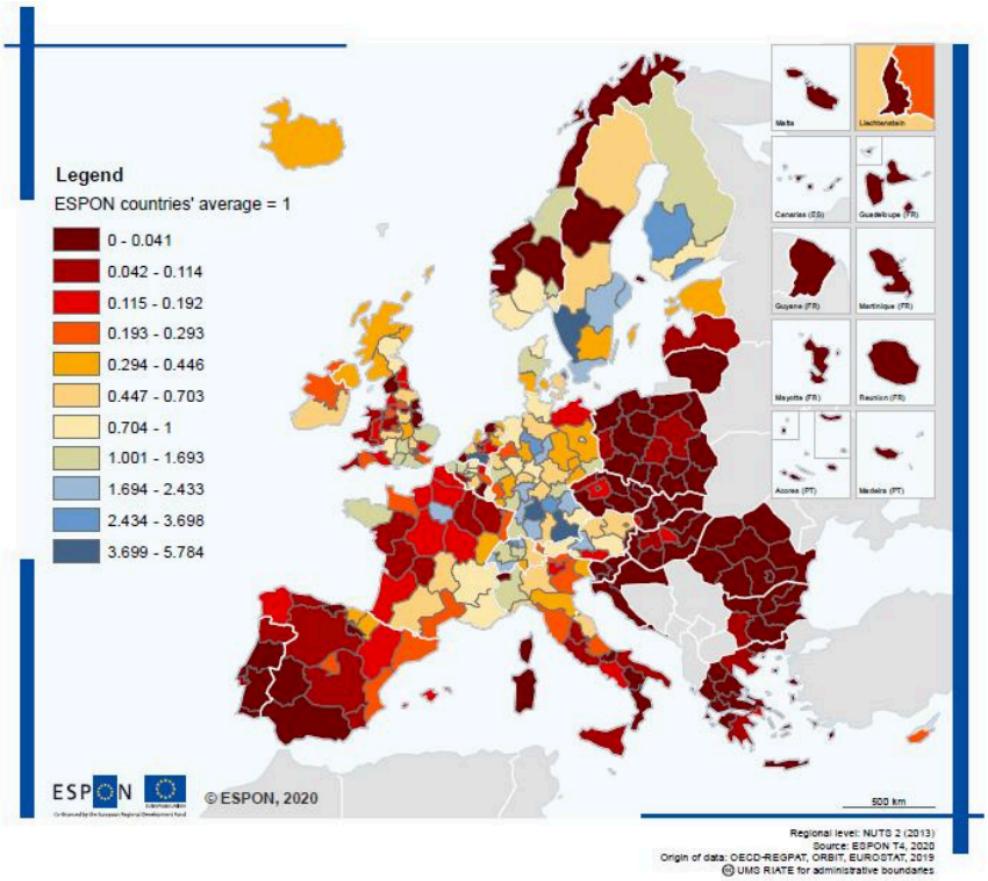
Source: Balland and Boschma, 2021

A recent analysis conducted by Polimi on behalf of ESPON (2020)[8] on the impacts of 4.0 technology adoption on GDP growth found that after controlling for many other explanatory factors, **the highest GDP per capita growth is registered in the most complex and articulated technological transformations.** Regions where the adoption is limited to niches of excellence (e.g. niches of robotisation) are characterised by the lowest rates of GDP per capita growth. Over time, the impact of adoption slightly decreases for technologies that require a more complex adoption and increases for technologies that need a simpler adoption. This result suggests that a learning process is required to adopters on how to exploit simple technologies in a strategic way.

[7] Wintjes, R., Hollanders, H. (2010). The regional impact of technological change in 2020

[8] ESPON (2020). T4–Territorial Trends in Technological Transformations Final Report (2020)

Figure 2: Number of applicative recombinatorial 4.0 patents per 1 000 inhabitants with reference to ESPON countries[4] average, 2000-2009



Source: ESPON (2020)

The impact of technology adoption on regional GDP per capita growth is the highest when adoption refers to the technology that characterises a region.

The study also highlights the fact that the share of applicative recombinatorial 4.0 patents (patents that apply basic digital technologies to a specific domain of application) has increased more than the share of basic digital technology patents (hardware, software and connectivity). Recombinatorial inventions targeting specific applications are diffused also in regions traditionally considered as less knowledge and patent intensive.

Similarly, the Regional Innovation Scoreboard 2021 edition[9] points out that despite the variation in regional performance within countries, regional performance groups largely match the corresponding country performance groups. Notably, all regional innovation leaders belong to countries identified as leaders (see Figure 3).

As revealed by a recent analysis of the OECD[10], advanced regions can build on their existing scientific and industrial advantages, but laggard regions often lack the ability to harness the new opportunities of technological change. Many scholars also expect that more dynamic and technology-savvy regions will exarbate the existing socioeconomic and regional divides.

Marques and Morgan[11] call the attention to the fundamental paradox that "*those regions with the greatest need for innovation support are the ones that have the lowest institutional and thus governance capacity to benefit from the policy instruments available to them*".

Evidence provided by Evangelista et al. (2018) shows that regions specialised in advanced technologies are concentrated in Central Europe. However, over the period taken into account (notably 1996–2011 in the study referenced), less innovative and peripheral EU regions have been increasing their specialisation in technological areas at the expense of the most advanced regions[12].

There is also evidence that spatial diffusion of technologies often occurs across regions

[9] Regional Innovation Scoreboard 2021 : https://ec.europa.eu/docsroom/documents/46032
[10] Koutroumpis and Lafond (2018)
[11] Marques and Morgan (2019)
[12] Evangelista, Meliciani, Vezzani (2018)

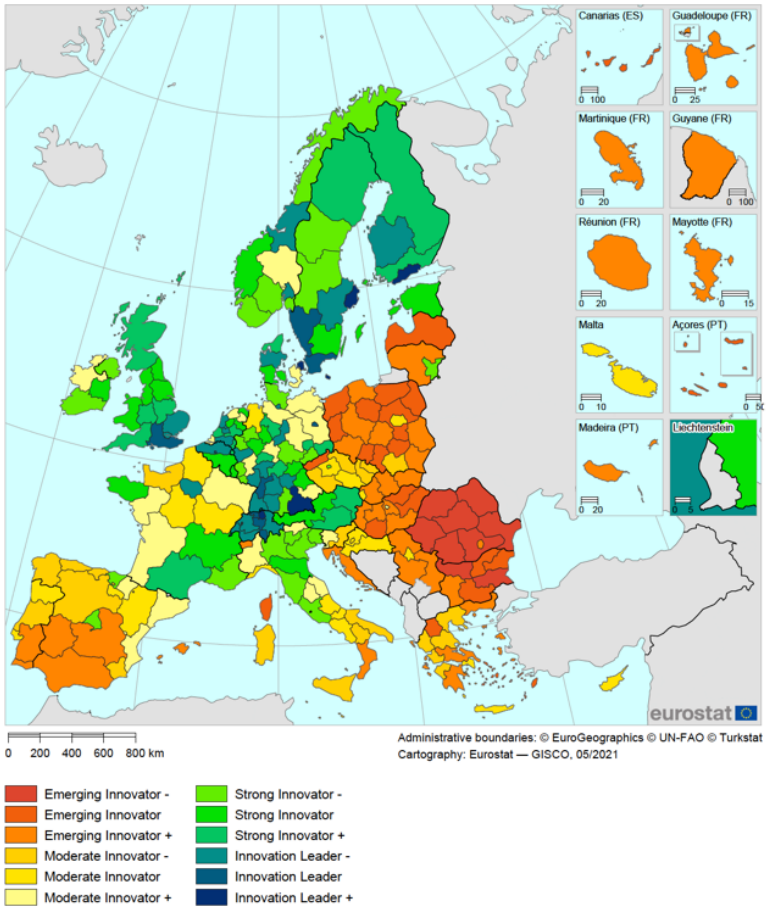
contiguous to each other. The results of the econometric estimations show that being specialised in technologies affects regional economic growth (gross domestic product per capita) and that this effect is stronger in the case of less innovative EU regions. Overall, these results hint at the pervasive nature and enabling role of advanced technologies and demonstrate the importance for EU regions to target these technologies as part of their smart specialisation strategies.

Locally embedded knowledge accompanied by strong presence of industry and assisted by proper governance facilitate the implementation of Industry 4.0[13].

2.2 Policy implications

Public policy plays a critical role in fostering the evolution of regional innovation ecosystems. Given the fact that industrial capacities to cope with transformative technological change are influenced by the regional framework conditions, regional innovation policies do and will play a key role in paving the way for future regional development. The key question is how existing public policy can be adapted in order to more effectively influence the path-dependent technological trajectory of regions[14]. As innovation policy and industrial policy are closely interrelated[15], the regional and local dimension of technology diffusion needs to be more explicitly recognised by both[16].

Figure 3: Regional Performance Groups



Source: Regional Innovation Scoreboard 2021

Some of the lessons learnt from past research and the existing literature on technological change have several regional-level policy implications:

- The complexity of advanced technologies requires policymakers to invest throughout the research and innovation lifecycle and across the regional socio-economic fabric. Public interventions are expected to be successful in those regions that have related technological capabilities[17].
- Policymakers need to focus not only on technology generation, but its local application in order to achieve economic impact[18] and foster firm-level innovation.
- Increasing the institutional capacity of laggard regions to adapt to the fast-paced technological change continues to be a critical element to be addressed by policy among the first priorities.
- Research and development policies need to be aligned with place-based smart specialisation and related policies at various levels need to be connected.
- There is a need for extensive knowledge exchange and boundary spanning both across regions and sectors. The objective should be not just specialisation in emerging fields but to enhance performance of traditional industries[19].
- Policies shall foster innovation but at the same time also mitigate the immediate social consequences of declining old industries which is a most acute problem at regional level.

[13] Götz (2021)
[14] Uhlbach, Balland and Scherngell (2017)
[15] Marques et Morgan (2019)
[16] Bailey et al. (2019)
[17] See Balland et Boschma (2021)
[18] Wintjes et Hollanders (2010) 0
[19] Bailey et al. (2019)

Section 3

3. Policy strategies and policy measures

Key messages

The impact of technological transformation on regional development and cohesion can be mitigated by various types of policy measures at the level of the EU, nations and regions. National research and innovation programmes often include an important regional dimension accounting for the objective to address regional disparities. Types of national policy measures addressing the regional challenge of technological development range from competence centres, skills and regional education initiatives, and cluster initiatives to industrial parks and strategic economic zones.

At regional level, smart specialisation strategies are key to facilitate that the potential of technology diffusion is optimised. With the help of the smart specialisation process, regions, countries and the EU can combine a concentration on common goals such as the green and digital transition with the competitive capacities of each region[20].

European regions are currently implementing a range of measures aiming at digital and technological transformation and support the post Covid-19 recovery. The implementation of these measures are enhanced also by the EU Recovery and Resilience Facility and the NextGenerationEU plan.

3.1 European cohesion policy and technological change

The European Union's Cohesion policy has reinforced its focus on innovation as a driver of regional development with the launch of Smart Specialisation Strategies. For the period 2021-2027, €392 bn was set aside for funding cohesion policy objectives.

More specifically, the Research and Innovation Strategies for Smart Specialisation (RIS3) initiative aims to address the challenge of regional catch-up in technology and innovation. Smart specialisation strategies (S3) have become the main component of EU, national and regional policies since the EU's 2014–2020 'Innovation Union'[21] and have been seen as **key place-based approaches to industrial policy**[22]. Smart specialisation revolves around public–private partnerships in which public funds are allocated to activities and technological fields, which demonstrate the highest potential for knowledge spill-overs, innovation, agglomeration and commercial exploitation[23].

Smart specialisation strategies build upon clusters and cluster policies that are considered as an important economic development tool to support industrial innovation at the regional and local levels. To this end, the European Cluster Collaboration Platform (ECCP)[24] is the main hub facilitating cluster cooperation and sharing of good practices within the EU and beyond.

3.2 National research, technology and innovation policies with a regional dimension

Policymakers at all levels have increasingly realised the significance of regional innovation policies and supported the diffusion of knowledge across their territories since the 1990s. Innovation studies have also dealt extensively with the topic of regional innovation policies for more than two decades[25]. Regional policies used to be an instrument for compensating lagging regions through subsidies. However, in many countries the emphasis shifted from a purely top-down approach to policies that build upon key local strengths and aim at unfolding regional potential for development and also technological specialisation among others (in a smart specialisation perspective).

Various national innovation programmes include an important regional dimension accounting for the objective to address regional disparities. Despite the importance of these national measures, the European Structural and Investments Funds remain the main source of financing of policies explicitly addressing economic and territorial cohesion challenges in particular in Eastern and Southern European Members States (except for Italy)[26].

[20] FoSS (2020). Mainstreaming Smart Specialisation in Europe
[21] Radosevic et al., (2017), see Marques and Morgan (2019)
[22] McCann and Ortega-Argiles (2015)
[23] Bailey et al, (2019) and Foray, (2015)
[24] https://clustercollaboration.eu/
[25] González-López et al. (2019)
[26] Prognos, Polimi and Technopolis Group (2019). Study on National Policies and Cohesion

Table 1: Typology of national technology related programmes with a regional dimension

Type	Example
Competence centres programmes and regional research and development	Austria: COMET and AplusB and REGplus
Research and technology infrastructure	Czechia: Large Infrastructures for Research, Experimental Development and Innovation
Special economic zones, industry parks	Poland: Special Economic Zones (SEZ)
Industry and technology clusters	Italy: National Technology Clusters
Higher education and skills development	Croatia: Lifelong Career Guidance Centre/Lifelong learning for crafts[27]

Source: authors

For instance in **Italy, the 'National Technology Cluster'[28]** initiative launched by the Ministry of Education, Universities and Research (MIUR) since 2012 is closely linked to the regional cluster initiatives. The aim of this national policy is to aggregate regional technological districts on some specific issues of strategic interest to the national domestic industry, promoting the development or the creation of a single nation-wide cluster for each area.

In Austria, a successful example of how federal R&D&I policies can interact with the regional level is the **competence centre programmes** launched by the Ministry. Since 1998 the Kplus, K_ind and K_net competence centre programmes have been implemented in 45 centres and networks in Austria[29]. This programme supported research platforms that brought together scientific research and innovative firms. Public funding was provided jointly by the federal and regional governments. The federal R&D&I policy set programme goals and defined the rules for implementation. The regions co-funding increased commitment to the programme and to the established platforms. Other examples include programmes **AplusB**[30] **and REGplus**[31]**.** AplusB supported incubator facilities at universities or other public research institutions. REGplus focused on technology centres and supported regional competence building and networking. These examples showcase that the co-ordination mostly takes place on the basis of specific programmes.

In the Czech Republic, the scheme called 'Support for R&D and innovation in Less Developed Regions' is one of the areas of national funding. One of the objectives of these programmes is to ensure the sustainability of several large research projects, funded in the 2007-2013 period, predominantly from the European Regional Development Fund (ERDF). Research infrastructures are part of the Roadmap of **Large Infrastructures for Research, Experimental Development and Innovation**. The European Structural and Investment Funds provide funding for the initial investment while the national budget covers the operating cost. During the period 2016-2022, the Ministry of Education will provide around €380 m for the operating costs of the infrastructures covering all regions. Half of them are located in Prague. The capital hosts a vast majority of the infrastructure regarding humanities and social sciences, while the largest research infrastructures in physical sciences (often built between 2007 and 2015 using ERDF) are generally located outside of the capital[32].

In Poland, **Special Economic Zones (SEZ)[33]** are administratively separated areas, where business operations are carried out on special and preferential terms. The key incentive is an exemption from income tax as the form of public aid for investors locating their projects in SEZ. There are currently 14 SEZ in Poland. The main objective of the recent legislation Act is to support the growth of private investments which will lead to the development of innovative areas of economic activity and the new technical and technological solutions and their application in the economy among others.

In Denmark in the 2014-2020 period, the **INNO+ initiative**[34] supported smart specialisation investments in the field of innovative production and innovative digital solutions among others. INNO+ has been devised as a part of the work on the Danish government's innovation strategy. INNO+ identified particularly promising areas of innovation for Denmark, on the basis of special Danish knowledge and commercial preconditions which can support increased export, growth and

[27] https://mingor.gov.hr/UserDocsImages/JavniPozivi/Program%20Cjelo%C5%BEivotno%20obrazovanje%20za%202020.%20godinu.pdf

[28] Research Italy: https://www.researchitaly.it/en/national-technology-clusters/

[29] FFG, (2020)

[30] AplusB: https://aplusb.biz

[31] REGplus:

[32] Prognos, Polimi and Technopolis Group (2019). National Policies and Cohesion

[33] https://www.paih.gov.pl/why_poland/investment_incentives/sez

[34] INNO+ initiative : https://ufm.dk/en/publications/2013/inno-catalogue/inno/inno-a-platform-for-inspiration-and-prioritisation-for-strategic-investments-in-innovation

employment. INNO+ has been used as the basis for the prioritisation of the topics for the future societal partnerships.

3.2 Regional development policies and policy measures

The autonomy of regional authorities to launch own regional innovation (or research and technology related) strategies varies markedly across countries and depends on the national institutional framework. Countries such as Austria, Germany or Belgium are federal countries where regions enjoy a high-level of autonomy, similarly in Spain or Italy where regions have their own financial resources and tax collection rights. In other cases the regional level has limited competences with a lack of funding. In some, such as Finland or the Netherlands sub-regional levels such as cities and municipalities have an important influence on policy (also thanks to cities and metropoles heavily lobbying for receiving financial resources from the national level). When comparing regional policies, the overall public administration of the respective countries needs to be kept in mind.

We can observe that regional autonomy keeps on being the strongest in federal countries such as in the case of Germany, Austria, Belgium and in regions where the government devolved a significant power to regional authorities such as in Italy and Spain. In France, the Netherlands, Poland and Sweden especially innovation policies as part of economic policy have been decentralised as it was also the case to some extent in Finland and Denmark. In these countries both regional authorities play an important role in the design and implementation of research, technology and innovation programmes. In some countries the regional level remained weak but it plays an important role to support regional innovation and development through the European Structural and Investment Funds such as in Ireland and Portugal. In Poland innovation policy at regional level is also substantially co-financed by European funds. Other unitary states with little regional power include a long list of countries such as Bulgaria, Czech Republic, Croatia, Greece, Hungary, Romania, Slovakia and Slovania. Moreover, the smallest countries naturally do not need and run a relevant regional policy.

In October 2020, the Spanish Chartered Community of Navarra designed and implemented the **Digital Strategy Navarra 2030**[35]. Navarra has been developing different policies to support digital technologies since 2013 with the implementation of the Digital Agenda of Navarra 2013 – 2016, which was aligned with the work done under the Smart Specialisation Strategy and the Plan Director de Banda Ancha 2021. The Digital Strategy is also aligned with the Reactivar Navarra – Nafarroa Suspertu 2020-2023 plan designed by the regional government to overcome the consequences of the Covid-19 pandemic. The most recent digital strategy has the objective of transforming the region into a fully digital smart region, improving living standards and guaranteeing social and economic development in response to the challeges posed by a global and digital world.

With a planned investment of €716 m, the strategy will contribute to:

- The development of the region's technological infrastructures;
- The modernisation and digital transformation of the Administration as a driving force for change in the region;
- Technological training and qualification of women and men; and the attraction of companies and technological talent for the consolidation and development of Navarre's business fabric.

In 2017, the French Department of Auvergne-Rhône-Alpes published its **Strategic Roadmap on the digital sector 2017-2021**[36]. The region is one of the most innovative in the country, after the Paris Île-de-France. The Strategic roadmap on the digital sector 2017-2021 (Feuille de route stratégique Numérique) has three specific ambitions: A fully connected region; A region that creates jobs; and A region that creates services.

To reach these objectives, the region has allocated a total budget of €650 m for the following actions:

- Deploying fixed and mobile infrastructures;
- Supporting the digital transition of companies in all sectors through awareness raising and financing, the acceleration of research and innovation, the implementation of an ambitious Industry of the Future plan, and the internationalisation of the region;
- Developing digital citizenship and trust; Federating all the actors in the region: the support ecosystem (competitiveness clusters, agencies, etc.), the Department councils, the EU, companies, citizens and local governments.

[35] Estrategia Digital Navarra 2030: https://gcpublica.navarra.es/publica01/EDN2030/Documents/EDN2030.pdf

[36] Strategic Roadmap on the Digital Sector 2017 – 2021: https://www.auvergnerhonealpes.fr/221-les-publications.htm

In Poland, regional policies that support technological transformation are recent and are part of the Strategy for Responsible Development Until 2020. Smart specialisation strategies address the challenges of an Industry 4.0. For instance, policy support measures provide support to the digitalisation of enterprises, promoting implementation of intelligent management systems and so-called e-services, popularising the Internet and its applications, improving digital competences.

The **Pomorskie Voivodeship Development Strategy 2020** presents Pomorskie as a region of innovative economy, attractive for domestic entrepreneurs. The above objectives were defined in the 'Pomeranian Port of Creativity' Regional Strategic Programme for Economic Development[37] launched in 2013 and they focus on: promotion of innovation in business and transfer of knowledge to economy, concentration of resources supporting smart regional specialisation using clusters as a tool, strengthening of external links and connections of the regional economy, professionalisation of businesses and adaptation of education to the labour market requirements.

The Pomorskie Voivodeship has been implementing a bottom-up process of defining smart specialisations. The four current platforms of specialisation include maritime and logistics, ICT, green power engineering and medicine. Gdańsk is also where Space3ac, the first European acceleration programme for the space industry was created.

[37] Pomorskie Voivodeship Development Strategy 2020: https://strategia.pomorskie.eu/rps-pomorski-port-kreatywnosci

Section 4

4. Policy considerations

In the current economic context, policies will play a key role in facilitating the adaptation process of regions to the fast-paced technological change.

At regional level, **adopting new technologies will require awareness, ability and willingness.** First, companies need to be aware of the advantages offered by the new technologies, the various possibilities how they may adopt and benefit from it in their processes, products and services as well as resources needed to learn and use advanced technologies. Second, companies need to have sufficient capabilities in the new technology and its use to be able to adopt and benefit from it in their business. Finally, they need a sufficient motivation to do so. These three factors can be often well addressed at regional level by relevant regional and local initiatives.

Awareness raising initiatives may often benefit from examples set by leading international companies. Their successful adoption of advanced technologies in developing improved and highly competitive products, services and processes into the global marketplace can often best showcase the benefits of these technologies. However, to be convincing, these examples should be from the industries highly relevant for the local companies.

Policy initiatives that foster technological awareness in companies are often more effective when combined with peer support and peer learning at local level, and when they extend over longer time periods. Finally, awareness raising initiatives should be closely linked with initiatives offering incentives to experiment and pilot with the new technologies in smaller scale. This can effectively lower the mental barrier for the adoption, give more realistic understanding of what the adoption may mean in practice, and start raising the ability of the company to eventually adopt the new technology.

The ability to adopt a new technology depends largely on the skills and competences within the company as well as those in its immediate network. Even if a new technology could be adopted by subcontracting it in the form of materials, components, equipment, methods, etc., adoption in processes, products and services requires sufficient understanding of the new technology in the company.

Regional policy initiatives play a key role in organising various types of training initiatives. These can be offered to individual companies or consortia of companies with similar needs. They may be limited to key individuals or extend more widely to majority of the technical staff. Like awareness, training may be enhanced by peer learning, which may be introduced in several ways, e.g. offering training to people from several companies, inviting more experienced people from the same industry with experience or integrating practical experimentation into the training scheme.

If the local research community has sufficient competences in new advanced technologies, they can take a major role in organising the training and especially complementing it with longer term educational initiatives as well as developing facilities to support experimentation and larger scale adoption projects. Training can be organised thematically (AI, cybersecurity, advanced materials, etc.), or based on specific needs of local companies (technological options available for developing specific features or functionalities, materials or processing options to reduce unit cost or improve recycling, etc.). If the need is perceived to be more long term, local universities and public research institutes may consider organising more permanent structures, e.g. in the form of dedicated joint institutes or competence centres with more advanced industry outreach activities and shared open access infrastructures.

Providing access and initiatives for longer term mentoring and coaching by local or international experts both in the local adopting industries and the new technologies can be an effective way to support the adoption of advanced technologies. These may be supported by various hiring and placement initiatives, which allow companies to benefit from new graduates, experienced experts, etc. with the necessary complementary skills and competences with respect to relevant advanced technologies.

The main driver of any company is customer demand. Hence, it is also the most effective way

to motivate companies to adopt new technologies. The impulse to do so may come directly from customers in the form of new requirements such as new features and functionalities or lower pricing. These new requirements are often indirectly influenced by the new products and services brought to the market by competitors using advanced technologies.

Regional policy initiatives may be used to influence local demand. This can be done by offering local public sector organisations and other possible customers of the local industry similar initiatives as described here for the companies, i.e., awareness raising, training and promotional initiatives. The other approach is to promote and incentivise local procurement practices to demand products, services, processes and solutions with advanced features and functionalities which cannot or are difficult or too costly to achieve using existing technologies. Similarly, incentives could also be considered for local communities and residents for investing in e.g. new local or communal energy, environmental, or welfare solutions with similarly demanding features and functionalities. These may often need to be complemented by expert supported interactive and inclusive processes for identifying and defining the features and functionalities in a realistic, yet demanding way.

The more extensively the above mentioned three types of initiatives are integrated and implemented locally with strong peer support and networking, the more likely they are to have a real and significant impact. Regional policy initiatives should therefore emphasise collaboration and networking among local actors but also with actors from more advanced regions. Initiatives such as competence centres, industrial clusters are quite well known and can be very effective organisational arrangements and collaborative environments to implement the initiatives described above. These can be even more effective when extended to designing and developing shared resources, such as relevant research, innovation, experimentation, piloting and possibly also training and interdisciplinary educational infrastructures and platforms.

To achieve significant regional progress in adopting advanced technologies, regional innovation policies and strategies such as smart specialisation will play a key role. It is important that all relevant local actors align their activities and support awareness raising about the potential of advanced technologies. Skills development, capacity building but also fostering demand for innovative products will be critical. Policy design should follow the principles of participatory, inclusive, collaborative, transparent and open processes, and implement local policies accordingly.

Regional policies and strategies will need to be periodically revised in view of continuously changing global and local market conditions, local societal challenges, technological developments and unexpected environmental and societal occurrences, such as the Covid-19 pandemic. European twin green and digital transition objectives will have a major impact on the next period revision of regional programmes. While the digital transition will continue to feature strongly in many regional strategies, the shift towards ecological ambitions will require more investment and attention to low carbon and circular industry technologies. As a recent survey on the RIS3 strategies concluded, there is an agreement across the EU concerning the need to update the smart specialisation strategies with a long-term perspective, in view of the substantial technological developments and new ecological ambitions which have become prevalent in our times[38].

Technological transformation will need to be seen as a solution to societal challenges at the regional and local level with more concrete measures addressing the current challenges also brought out by the pandemic and coming up on the horizon.

The existing European, national and regional policy initiatives address many of the issues presented above. Hence, learning from the experiences, identifying and adopting good practices from other regions, enhancing interregional collaboration and networking as well as continuing to develop regional strategies along the smart specialisation principles will eventually ensure further progress.

Key factors that will make a difference include the following:

- better strategic alignment between regional actors,
- more attention to the sophistication of local demand,
- more emphasis on identifying and addressing local societal challenges,
- enhanced emphasis on developing local shared resources, infrastructures and platforms,
- establishing strong links from regions into larger international networks,
- shifting the focus from individual support to peer and collaborative support and networking.

[38] Fraunhofer ISI, 2021

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About the 'Advanced Technologies for Industry' project

The EU's industrial policy strategy promotes the creation of a competitive European industry. In order to properly support the implementation of policies and initiatives, a systematic monitoring of technological trends and reliable, up-to-date data on advanced technologies is needed. To this end, the Advanced Technologies for Industry (ATI) project has been set up. The project provides policymakers, industry representatives and academia with:

- Statistical data on the production and use of advanced technologies including enabling conditions such as skills, investment or entrepreneurship;
- Analytical reports such as on technological trends, sectoral insights and products;
- Analyses of policy measures and policy tools related to the uptake of advanced technologies;
- Analysis of technological trends in competing economies such as in the US, China or Japan;
- Access to technology centres and innovation hubs across EU countries.

You may find more information about the 16 technologies here: https://ati.ec.europa.eu.

The project is undertaken on behalf of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA) by IDC, Technopolis Group, Capgemini, Fraunhofer, IDEA Consult and NESTA.

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