Interregional collaboration: opportunities for S3 and place-based policies

5 May 2025

Ron Boschma, Simona Iammarino, Agnieszka Olechnicka

Table of Contents

1. INTRODUCTION

The 2014–2020 EU programming period introduced S3 as an ex-ante conditionality for ERDF funding, requiring EU regions to develop research and innovation strategies based on their unique competitive advantages. The reliance on entrepreneurial discovery processes as a key mechanism for place-based strategy often encouraged an inward-looking approach (Foray et al., 2018). However, S3 also included from its start an emphasis on cross-border and trans-regional cooperation which was expected to add significant value to the innovation potential of individual regions (Foray et al., 2009), building on research highlighting the critical role of extra-regional networks in fostering innovation (e.g., Bathelt et al., 2004; Hauser et al., 2007; Boschma and Iammarino, 2009). In the current European and global division of labour, strengthening regional innovation systems (RISs) entail assessing their integration in continental and global value chains (GVCs), monitoring and supporting their upgrading in knowledge and production collaboration, networks and linkages.

However, there is a strong need to bring more clarity to the role of inter-regional linkages from a policy perspective. First, there is substantial evidence that collaborations are strongly influenced by proximities that undermine the innovative potential of regions. That is, actors in Europe tend to collaborate with others who are located in the same place, they had previous interactions with, and with whom they share the same language, norms and values. This may lead to lock-in that have detrimental effects on innovation (Boschma 2005). This is confirmed by studies demonstrating that there is a large untapped potential in the way regions connect to other regions within Europe. While strong complementarities for industrial and technological upgrading can be found in regions in other member states, current interregional linkages often show a strong national bias (Bachtrögler-Unger et al., 2023). In order to promote innovation in the EU, this lock-in tendency of inter-regional linkages should be tackled. Second, addressing the innovation divide among EU regions implies considering their connectivity, beyond regional and national borders (Crescenzi and Iammarino, 2018). How to leverage on the potential of GVCs and, especially, continental networks, is still an underdeveloped policy area (e.g., Comotti et al., 2020; Crescenzi and Harman, 2023). Third, while there is increasing focus on the role of such interregional linkages in S3 policy, it remains a challenge how to incorporate them and make them an effective part of regional and industrial policy (Iacobucci and Guzzini, 2016; Barzotto et al., 2019). Despite the fact that interregional collaboration was part of S3 during 2014–2020, it is still assessed as underutilised and inefficiently applied because the benefits of interregional cooperation are often poorly understood, and regions lack sufficient institutional capacity to analyse, support and manage such initiatives within the S3 framework (Radosevic and Ciampi Stancova, 2018).

The objective of this paper is to inform European policy makers on how inter-regional linkages could be incorporated in place-based strategies for ensuring regional upgrading and economic development. **Our study shows how statistical data on the amount and nature of different types of inter-regional linkages are crucial to inform policy how inter-regional linkages could**

be exploited to promote specific activities. In this report, we provide some operational examples of regional collaboration links in a number of regions which have implemented S3 strategies in relation to a specific value chain, that is the Automotive industry. The latter has been selected as arguably one of the most GVC-sensitive and entrenched within the EU boundaries, at the same time being strongly impacted by the dual technological transition (e.g., Comotti et al., 2020; Casadei et al., 2022; Pavlinek 2025). Five regions are compared and assessed with respect to three dimensions of interregional collaboration: FDI/GVC linkages, co-publication linkages and co-invention linkages – with particular attention to intra-EU interregional linkages. We explore and discuss the implications for S3, and make these explicit for the regional case-studies. **While the focus is on automotives, our analysis can be applied to any activity, as inter-regional collaboration patterns will look different for each activity and for each region, and therefore, any policy actions should be activity-specific and place-based.**

This concise paper is structured as follows. Section 2 will briefly introduce the way inter-regional collaborations has been introduced in S3. Section 3 will introduce the case of automotives, the five case-study regions, the three types of inter-regional linkages, and the data sources used. Section 4 will present the main empirical outcomes. Section 5 will conclude and draw the main policy implications.

2. ADVANCING INTERREGIONAL COLLABORATION IN S3

From its start, S3 aimed to promote trans-regional cooperation which was expected to enhance the innovation potential of regions (e.g., Foray et al., 2009; Gianelle et al., 2016; Rodríguez-Pose, 2023; McMaster and Maguire, 2024). Some regions successfully implemented interregional collaboration within the S3 framework. This collaboration employed both bottom-up and top-down approaches. Bottom-up efforts included macro-regional strategies, such as the Baltic Sea Region and Danube Strategy, which promoted transnational cooperation and investment around shared S3 priorities. A notable example is Galicia in Spain and Norte in Portugal, which adopted the EU's first joint S3 in 2015, fostering strategic cooperation and joint initiatives. Interreg Europe played a significant role in promoting outward-looking approaches in S3 by supporting actions that advanced joint initiatives, strengthened GVCs, and fostered cluster partnerships. Top-down measures, such as Thematic Smart Specialisation Platforms launched in 2016, further supported extra regional linkages for S3 development. Initially, these platforms focused on knowledge exchange and regional matchmaking. The 2017 pilot program marked a shift by supporting commercialisation and scaling in key sectors like 3D printing and bioeconomy, setting the stage for outward-oriented policies in subsequent periods (Morisson and Pattinson, 2020; Woolford et al., 2021).

Although interregional collaboration in S3 policies during 2014–2020 became more visible, it is still assessed as underutilised and inefficiently applied. Regional strategies primarily

focused on aligning priorities and engaging in policy learning networks, with more substantial forms of collaboration, such as cross-border structures, investments or shared programs, being rare (Uyarra et al., 2018). The "Seal of Excellence" mechanism and the 15% rule, designed to foster interregional collaboration through ESI Funds, were seldomly exploited, particularly in Central and Eastern and Southern Europe, due to implementation challenges and siloed fund management practices (Kelchtermans et al., 2021). Moreover, regional actors often favoured low-intensity cooperation to achieve tangible benefits over deeper, more impactful forms of exchange and collaboration (Kroll, 2016).

The 2021–2027 implementation period has been marked by the intensification and institutionalisation of interregional collaboration in S3. Fulfilment of ex-ante conditionality requires S3 strategies to meet the criterion of enhancing cooperation with partners across Member States in priority areas . Several initiatives to foster interregional collaboration have been introduced or bolstered (McMaster and Maguire, 2024):

- Interregional Innovation Investments (I3) Instrument: supports projects developing European value chains and facilitating the commercialisation of innovations, enhancing the integration of regional ecosystems in shared smart specialisation areas.
- S3 Thematic Platforms: continued under new institutional settings to encourage collaboration in Agri-Food, Energy, Industrial Modernization, and Sustainable Blue Economy, supporting interregional partnerships and value chains.
- Regional Innovation Valleys (RIVs): part of the New European Innovation Agenda, RIVs promote deep-tech innovation across EU territories, advancing cohesion and addressing challenges like energy transformation and healthcare.
- Partnerships for Regional Innovation (PRI): building on smart specialisation strategies, PRIs enhance coordination across regional, national, and EU policies to implement Europe's green and digital transitions and reduce the innovation divide.

Despite this progress in outward-looking approaches, challenges remain, particularly regarding the availability of information bases at the sub-national level and evidence-based interregional policy instruments, and the coordination of multi-level governance. In less-developed and peripheral regions, the interregional S3 approach, leveraging the "borrowed size" principle, promotes knowledge transfer and co-creation of innovation with more advanced regions, fostering inclusion in interregional value chains (Kruse and Wedemeier, 2022). Recent research emphasises the need to balance exploration—accessing external knowledge through collaboration—and exploitation, which focuses on strengthening internal absorption and innovation capacities (Giustolisi et al., 2023; De Noni and Ganzaroli, 2024).

3. SELECTION OF 5 REGIONS, INTERREGIONAL LINKAGES, AND DATA SOURCES

Five regional cases involved in the European value chain in the Automotive industry have been selected on the basis of their S3 in the thematic S3 platforms 2014-20 and/or 2021-27[1],[2]. We selected 1 more developed region, 2 transition regions, and 2 less developed regions. Although our focus is on the latter 2 categories, to have a benchmarking in terms of interregional linkages was deemed crucial for assessing regional relative position and policy implications.

The 5 regions are the following:

- More developed region: Baden-Württemberg, Germany (DE1): automotive priority in both periods, but more explicitly in 2014-2020.
- Transition regions: Dolnośląskie, Poland (PL51): automotive priority in both periods; Normandie, France (FRD): automotive priority only in 2021-2027.
- Less developed regions: Centru, Romania (RO12): automotive priority in both periods; Andalusia, Spain (ES61): automotive priority in both periods.

Figure 1 shows how specialised the 5 regions are in technologies (Relative Technological Specialization, or RTA) and scientific fields (Relative Scientific Specialization, or RSA) in automotives[3]. Columns 3 and 6 show the technological and scientific potential of the 5 regions to develop and upgrade automotives (see Appendix 2 for method). It captures the presence of relevant local capabilities in and around automotives. This is in line with place-based S3, with a special focus on local capabilities (Foray, 2015). This has been captured by the principle of relatedness (Boschma, 2017): the more related an activity is to existing activities in a region, the lower the regional costs to develop and upgrade it (Neffke et al., 2011).

Figure 1. Technological and scientific capabilities in automotives in 5 European regions.

	number of patents 2020-2023	technological specialisation (RTA) 2020-2023	technological potential (relatedness) 2020-2023	number of scientific publications 2020-2024	scientific specialisation (RSA) 2020-2024	scientific potential (relatedness) 2020-2024
Andalusia	50	0.30	10.5	131	0.57	20.1
Baden-Württemberg	8,910	2.06	72.5	1,558	2.86	64.5

[1] The latter period turned out be more complicated to investigate, as many Member States set up broader priorities, like digitalization.

[2] Research assistance by Pierre-Alex Balland, Fiammetta Boschma and Sebastiano Comotti is acknowledged.

[3] We use patent data (OECD REGPAT dataset) and scientific publication data (Open Alex dataset) to identify the capabilities of the 5 regions in the field of automotives.

Centru	26	4.27	49.7	0	0	0
Dolnośląskie	57	1.04	45.7	214	1.64	56.5
Normandie	90	0.54	18.5	65	1.36	54.1

Baden-Württemberg is the only region that shows very strong technological and scientific specialisation in automotives. This comes as no surprise, as the region has (also historically) solid capabilities in the industry, being one of the top EU cores for the value chain (Casadei et al., 2023). Centru has a remarkable technological specialisation in automotives (though its absolute patent intensity is low), but not a scientific one. Dolnośląskie instead is specialised in scientific terms, but hardly so in technological ones, although it seems to have the technological capacity to do so. Normandie is similar to Dolnośląskie concerning its scientific capacity, but technologically rather weak. Andalusia has neither technological nor scientific specialisation in automotives, with doubtful capacity to develop it.

Regions might lack relevant capabilities, but other regions might have them. Interregional linkages – such as GVC participation through FDI, scientific and technological collaborations – can give access to such capabilities. For each of the 5 regions, we map the extent to which they are connected to other EU regions to assess the opportunities to exploit interregional linkages further to promote and develop development priorities. We distinguish between three types of interregional linkages relevant to automotives:

1. GVC participation through FDI: data from fDiMarkets[4], by Financial Times, monitoring cross-border greenfield inward and outward FDI, by sector and GVC stage/function, geo-localised at subnational level, covering the period between 2003 and 2023;
2. Scientific co-publications: data from Open Alex database, differentiating between about 65,000 scientific concepts and 23 scientific fields, based on the title of the article, the abstract, and the title of the scientific journal, for the period 2020-2024;
3. Co-inventor linkages: data from OECD REGPAT database: 541 technologies at 4-digit level and 35 WIPO technologies at 2-digit level, covering the period 2020-2023.

The three types of interregional linkages capture different dimensions of collaboration relevant to automotives. While GVC participation through FDI takes up production and innovation linkages between regions, the two other types of collaboration represent flows of scientific and technological knowledge relevant to automotives. Whilst FDI data here focusses in particular on intra-EU27 interregional linkages, the analysis on scientific and collaboration data also include interregional linkages within countries. These three dimensions of inter-regional collaboration – investment, scientific and technological – capture distinct but complementary aspects of regional upgrading. While the selected indicators provide robust proxies for inter-regional collaboration, they do not capture informal, institutional or emergent forms of cooperation. Moreover, data gaps in some regions may affect the interpretation of results.

To complement the quantitative analysis and better understand regional constraints and institutional contexts, a case study of the Dolnośląskie region was conductedA case study of

[4] The details on fDiMarkets datasets are reported in Comotti et al. (2022): here we use the updated version covering up to 2023.

the Dolnośląskie region was conducted using desk research, focus interviews with representatives of the Marshal's Office responsible for S3 implementation in the current and previous programming periods, and semi-structured interviews with representatives of the automotive and aerospace clusters as well as two firms from the space sector. The case study was carried out between February and March 2025.

4. EMPIRICAL ANALYSIS: INTERREGIONAL LINKAGES IN AUTOMOTIVES

a. Interregional linkages through European Value Chain participation/FDI

As illustrated in Map A1.1 in Appendix 1, whilst Baden-Württemberg is both a FDI receiver and, especially, an FDI sender in automotives – being a real node in the EU automotive network – the other 4 regions are mainly just FDI recipients. Dolnośląskie and Centru display similar amounts of IFDI in absolute values, whilst Andalusia and, particularly, Normandie are much weaker in terms of attractiveness in the industry; of these 4 regions only Andalusia experienced minimal OFDI outflows in the period observed.

Turning to FDI functions (see Table A1.2 in Appendix 1), while the highest shares of flows are normally in Production, regions position themselves quite differently: whilst Baden-Württemberg and Centru have rather large shares (above 14%) of IFDI in R&D & Innovation functions, and a generally more diversified functional distribution of IFDI, the other 3 regions receive inflows in Production above 93% of the total. Outflows from Baden-Württemberg also seem to target different stages of the automotive GVC (the share of R&D & Innovation in OFDI is above 8%).

Considering the geography of interregional FDI flows, with a focus particularly on intra-EU27, most FDI in automotive in/from Baden-Württemberg (see Map A1.2) – around 70% of IFDI and 74.5% of OFDI in the two decades– are from/towards the rest of the world outside Europe (not captured in the maps reported in Appendix 1). Such figures alone signal the global extent of Baden-Württemberg production and innovation networks, and its position as a major European and global node in the world automotive industry. OFDI from Baden-Württemberg to the other EU27 regions are geographically spread, spanning particularly across eastern EU regions but concerning also French, Austrian, Spanish and Italian regions. Interestingly, the strongest (top in the 5th quintile) outward connections of Baden-Württemberg are with Hungarian regions (Észak-Magyarország and Észak-Alföld), País Vasco in Spain, and both the transition region of Dolnośląskie and the less developed Centru studied here.

Turning to our transition (Maps A1.3 in Appendix 1) and less developed (Maps A1.4) regions, we consider only linkages from inward FDI (as the OFDI are null or very small). The EU27 share of automotive IFDI into Dolnośląskie (Map A1.3a) is 52%, the lowest after the 30% of Baden-Württemberg: having a 48% of IFDI coming from the rest of the world is a signal that the Polish region – despite the still prevalent role of the Production stage in the industry GVC, and the

null active engagement abroad – is indeed possibly transitioning towards different configurations in the automotive value chain (or related industries), with more geographically-spread connections and collaborations. Unsurprisingly, intra-EU IFDI comes primarily from the German neighbours: the top EU27 investor regions are Baden-Württemberg – the most prominent, as seen also above –, Niedersachsen, Bayern and Nordrhein-Westfalen; in the first two quintiles we also found big investments from Ile-de-France, Comunidad de Madrid and Stockholm. Normandie (Map A1.3b), with its overall much smaller and intermittent inflow of IFDI during the two decades analysed – and with a share of intra-EU on the total above 89% – shows far more concentrated interregional links, essentially with the two Swedish regions of Västsverige and Stockholm.

Both our less developed regions display a large majority of intra-EU27 IFDI in automotive, above 86%. The EU biggest investor region in Centru (Map A1.4a) is Ile-de-France, followed by exactly the same German regions which invested in Dolnośląskie (Baden-Württemberg, Niedersachsen, Bayern and Nordrhein-Westfalen); among the geographical links through IFDI, in Centru we found also strong ties with the Stockholm region, Pays de la Loire and Limousin, the Austrian Vorarlberg, and Praha. As previously seen, Centru received a sizeable share of its IFDI in R&D & Innovation functions: top investors coincide with the largest investor regions (i.e. Ile-de-France and the German regions). For Andalusia (Map A1.4b), the major investing EU regions are again, Ile-de-France and, to a far smaller extent, Baden-Württemberg.

b. Interregional linkages through co-inventions and scientific co-publications

Besides GVC participation through FDI, interregional linkages and collaborations can also be identified by co-inventor links for technological collaborations and co-publications for scientific collaborations. The former concerns inventors in different regions that collaborate on a patent. The latter concerns researchers in different regions that collaborate on a publication in a scientific journal.

Connecting to other places is useful for a region when giving access to relevant capabilities that are complementary to the local capabilities (Boschma and Iammarino, 2009). To measure such complementarities in interregional linkages, Balland and Boschma (2021) developed an indicator that captures linkages that give access to additional relevant capabilities in other regions that are missing in the focal region (see Appendix 3 on method). These complementary linkages will be compared with their actual collaborations. In other words, does the region connect to regions that give access to relevant capabilities? If not, this indicates untapped potential in exploiting interregional collaborations in automotives. Figures A4.1-4.5 in Appendix 4 present for each of the 5 regions with which regions in Europe they collaborate most on automotives, and whether these involve the regions that could offer the best complementarities in automotives.

In line with what was observed for FDI, Baden-Württemberg collaborates most intensively with many others (see Figure A4.1 in Appendix 4). This concerns almost exclusively other German regions. Ten out of the thirteen top partner regions of Baden-Württemberg are found

in Germany, both for technological and scientific collaborations. In other words, there is a strong national bias in the collaborations on automotives that Baden-Württemberg has established (see Bachtrögler-Unger et al. 2023 for a similar finding on the Twin Transition technologies in the EU). While the region has already strong technological capabilities relevant to automotives, it has also external technological links within-country, that provide a good deal of complementarities, such as those with Schwaben and Oberbayern. The most important scientific partner regions of Baden-Württemberg are also highly scientific relevant, such as Köln and Île-de-France. However, the region also tends to connect to less relevant scientific partner regions (in terms of complementarities for automotive) such as Oberbayern, Darmstadt and Hannover.

Turning to the selected less developed regions, Andalusia shows, as expected, completely different features (see Figure A4.2). The region has also almost no technological collaborations in automotives; it has some ongoing scientific collaborations, especially with the capital region of Comunidad de Madrid. However, Andalusia has not much to offer in terms of complementarities. The less developed Romanian region of Centru displays some technological capabilities in automotives, but it collaborates on automotive technologies only to a limited extent (Figure A4.3). The region has no scientific collaborations in automotives.

The transition region of Dolnośląskie has some technological collaborations, but not always with the regions that appear most relevant in terms of complementarities (see Figure A4.4). The technological collaboration profile of the region is international, not limited to Polish regions. This is very different from its scientific collaboration pattern. For the latter, partner regions within-country dominate: especially strong is the scientific collaboration with the region of Małopolskie. However, such regional linkages do not always offer access to the most relevant scientific capabilities for the Dolnośląskie region. The other transition region, Normandie, displays strong technological collaborations with other regions, especially with the capital region of Île-de-France (Figure A4.5). Collaborations with other French regions dominate, most of which (but not all) have relevant capabilities for Normandie. A similar pattern can be observed in the case of scientific collaborations. However, the top partner regions are not always the most relevant ones for Normandie in terms of scientific capabilities.

c. A case study: Dolnośląskie, Poland (PL51)

Dolnośląskie (19,947 km², 2.9 million inhabitants) contributes 8.6% to national GDP and boasts a per capita GDP 12.2% above the national average. Classified as an Emerging Innovator+ in the EIS 2024, the region reports R&D expenditure at 1.48% of GDP—above the national average—with 21.4% of industrial firms investing in innovation. Its capital, Wrocław, known as “Poland’s Silicon Valley,” ranks as the top mid-sized city in European Cities and Regions of the Future 2024, and the second most business-friendly location for start-ups in Poland[5]. Dolnośląskie's economic attractiveness is underpinned by a diversified economy, tax incentives, preferential SEZ conditions, access to brownfield sites, and supply of skilled labour.

[5] https://startuppoland.org/wp-content/uploads/2024/11/POLSKIE-STARTUPY-2024-1.pdf

The development of high-value-added industries in the Dolnośląskie—in advanced engineering, shared services, home appliances, ICT, and automotive—has been driven primarily by FDI, as also seen in section 4.a above. The region's industrial trajectory was shaped by 1990s SEZs, which catalysed Toyota's investment and a wave of German-led FDI, building on its socialist-era automotive tradition (Domański et al., 2024). Foreign capital automotive enterprises account for 90% of firms, 96% of investment outlays, and 92% of newly created and sustained jobs in the sector (Dorożyński, Świergocki, 2022). Although historically reliant on German-led supply chains, recent diversification of FDI sources towards Asia and North America indicates a shift in interregional investment dynamics. Changes in production structures are evident in electromobility and automation. Battery production integrates advanced materials research and chemical engineering, linking the region to knowledge-intensive sectors. Dolnośląskie remains a hub for conventional automotive components—seating, suspensions, braking mechanisms—with Tier-1 supplier dominance, but faces structural disadvantages from lower automation compared to neighbouring countries. The dominance of labour-intensive processes in SMEs, often founded by former OEM employees and generally inactive in R&D, indicates persistent technological bottlenecks.

While integrated into global production networks, the sector's innovation capacity remains weakly embedded at the regional level, limiting potential for interregional co-invention or knowledge collaboration. The internal constraints are combined with external pressures, including initial cases of production relocation and investment outflow driven by more favourable conditions abroad in terms of operating costs, incentives, and renewable energy availability[6]. The sector faces intensifying competition from Chinese manufacturers leading battery and EV component supply chains, whose cost advantages and aggressive strategies undermine European price competitiveness. Geopolitical risks and export restrictions further increase supplier vulnerability (Dessì et al., 2025). The transition to electromobility is slowed by regulatory uncertainty and infrastructure deficits. While the EU plans to phase out combustion engines by 2035, possible hybrid exemptions create investment ambiguity. Rising input costs, limited charging infrastructure, and unclear industrial support mechanisms delay progress. Energy, labour, and material cost increases—combined with regulatory burdens—erode competitiveness of Dolnośląskie firms.

The automotive industry was prioritised in Dolnośląskie's S3 (2011–2020) under "Spatial Mobility" and validated in the 2015 EDP. In 2021–2027, it was integrated into the "Auto-Moto-Aero-Space" (AMAS) priority which covers two technology groups: (1) low-/zero-emission land and water vehicles (hydrogen, electric, hybrid, autonomous systems); (2) aviation and space technologies, including propulsion and components. This strategic relabelling reflects both a consolidation of priorities and an adaptation to emerging technological domains, indicating S3 reduced focus on traditional automotive value chains.

Multinational automotive firms demonstrated limited engagement with regional innovation support and S3 instruments – they rely on internal R&D and SEZ-based incentives. Local suppliers to OEMs, constrained by global client demands and cost pressures, participated weakly in EDP. Many benefited from SEZ tax relief, reducing their incentive to engage with

[6] LG Energy Solution's lithium-ion battery production moved to the US: https://psnm.org/2024/raport/podsumowanie-2024-bardzo-trudny-rok-dla-zrownowazonego-transportu/

S3. The limited involvement of business support institutions further impeded the integration of the automotive sector into the S3 policy. The Dolnośląskie Automotive Cluster supports firms and fosters interregional cooperation (Appendix 5), but its role in the S3 policy has remained modest due to ownership ties to the SEZ, and the lack of national cluster status.

Given the automotive sector's limited participation in S3 policy implementation, regional AMAS priorities shifted towards more engaged sectors, especially aviation and space, which articulated stronger public funding needs. The emerging space sector, with its high capital intensity, became a key focus for regional authorities. This reallocation reflects the perceived innovation potential and capacity for interregional cooperation in high-tech sectors. However, numerous initiatives, organised by the Marshal Office, have been launched to strengthen interregional collaboration such as strategic partnerships, study visits, and participation in European networks (Appendix 5).

An obstacle to strengthening S3 implementation by interregional collaborations is the perceived limited endogenous innovation capacity within Dolnośląskie's automotive sector. The low embeddedness of local innovation networks hampers the effective technology transfer. While R&D oriented FDI inflows is rising, the automotive sector's innovative capacity relies on external knowledge flows. As a result, co-invention linkages remain marginal, with parent companies primarily driving innovation, leaving local adaptations organisational rather than technological. It leads to a fragmented diffusion of new technologies, as evidenced by the zero outflow FDI (see section 4.a). Moreover, technology remains concentrated within MNEs and poorly transferred locally.

Another obstacle is limited, politically driven interregional cooperation among Polish regions, focused mainly on institutional knowledge exchange, European integration, and cohesion policy. It primarily involved trade missions and bilateral agreements rather than value chain-oriented networks. Additionally, there is a noteworthy scale mismatch between the network of public organisations and the business network operating within the Dolnośląskie region. The latter, deeply embedded in GVCs led by MNEs, contrasts with the regional public network, which is often constrained by human and financial capacities and shaped by the complexities of political decision-making.

Also, the automotive sector is currently experiencing multifaceted challenges stemming from economic, political and regulation factors, including reduced orders, supply chain disruptions, and uncertainty over the shift towards electric vehicles versus other alternatives. In this context, companies prioritise operational problem-solving and short-term survival over collaborative innovation or inter-regional partnerships. In parallel, a shift in EU investment priorities—driven by geopolitical tensions and growing focus on military security—may redirect resources towards defence, reducing support for S3 and interregional collaboration in the traditional automotive sector.

5. POLICY IMPLICATIONS FOR S3

Earlier, we emphasised it remains a challenge to incorporate the role of interregional linkages in S3 and place-based policies and make them an effective part of regional development and industrial policy. Our analysis of three types of interregional collaboration (FDI linkages, Co-publications and Co-inventions) informs policy makers about the extent to which their region already exploits several types of collaborations to develop priorities set in their S3 strategies, and where they could improve when essential linkages are currently missing. Below, we make these explicit for the regional case-studies.

- **Baden-Württemberg**: one of the EU regions that have played a key role in the development of the automotive industry (being home to the automaker MNEs Mercedes-Benz Group, Porsche and Audi), representing a historical national "champion" for Germany (Casadei et al., 2023) in a highly diversified range of industries, both high- and medium-tech. As an EU core in automotive (still accounting almost for one in four jobs and a quarter of turnover in the German automotive sector), the region is emblematic in terms of the global extent of interregional and international linkages through FDI, particularly in terms of R&D and Innovation GVC functions, and as a net investor abroad. Regarding technological and scientific collaborations, Baden-Württemberg collaborates intensively with many other regions, especially German regions. Despite the strong national bias of its collaboration network, Baden-Württemberg seems to connect to regions that provide high complementarities, especially where it concerns technological collaborations. More generally, interregional linkages and collaborations are well integrated in S3 and place-based strategies, defining the leading position of the region in the green and digital technological transition in automotives and related industries.
- **Dolnośląskie**: the transitioning region has been a major location for FDI projects in automotive, supporting a re-localisation of automotive production within Europe – evident in its strong links with Baden-Württemberg investors – and beyond the EU. Yet, the high attractiveness of the region has not been complemented by linkages through IFDI in R&D functions and outward strategies/connectivity in the industry. At the same time, the region's industrial base is very diversified – It has been the recipient of one of the largest shares of IFDI in electronics in the post-crisis period, with almost 7% of total investments of electronics in Europe (Casadei et al., 2023). While the space sector expresses great demand for innovation support, automotive faces slow down and increasing instability. The region is gradually shifting towards diversification through S3 policies, as exemplified by "Auto-Moto-Aero-Space" priority. Place-based and S3 policy could play a role in connecting Dolnośląskie with regions offering the most relevant capabilities, supporting the transformation of the automotive sector in line with technological and geopolitical trends. The potential actions are:

  i. **Leveraging further FDI, both inward and outward,** to support R&D and innovation and the transformation/upgrading of the automotive industry by strengthening linkages with local SMEs, thereby promoting knowledge diffusion, enhancing local value capture, and deepening interregional embeddedness. This effort can build on established mechanisms such as dedicated matchmaking platforms, supplier qualification schemes, and targeted innovation support (see OECD 2024a, OECD 2024b).

  ii. **Prioritising structured collaboration with established and new interregional partnerships and innovation ecosystems**, focusing on regions that offer the most relevant complementary technological and scientific capabilities. As we saw in the analysis above, the region needs to upgrade in particular technological capabilities: current collaboration networks in Dolnośląskie often overlook regions offering the right complementarity, which reduces the effectiveness of interregional innovation efforts. Developing long-term cooperation — for example, through EU-led projects in the Regional Innovation

Valleys framework with two or three experienced partner regions — could help better align S3 priorities with the capabilities most relevant to the region's transformation.

iii. **Supporting synergies between the automotive and aerospace industries** by leveraging shared manufacturing capacities and systematically exploring technological convergence areas such as electric propulsion, autonomous systems, software integration, and automation. Currently, the region boasts both a strong automotive and aerospace industry and an emerging space sector, but direct linkages and the potential for a comprehensive transformation of automotive towards aerospace/space applications remain limited. Existing connections are primarily indirect, relying largely on a shared pool of engineering talent and the common supply of standardised components.

iv. **Integrating the growing potential of companies (both domestic and MNEs) specialising in electronics and dual-use technologies** into regional development by applying tools such as Territorial Impact Assessments and Foresight planning. These instruments can guide firms in defining their development paths and better align regional priorities with evolving European strategic and security agendas.

v. **Prioritising the creation of a stable and adaptable environment for the automotive sector**, in response to the growing sense of instability and uncertainty in the region. This is evidenced by (so far) isolated examples of companies leaving or bypassing the region when considering investments. The policy should focus on enhancing the resilience of local sub-suppliers and facilitating their transition towards new technologies and markets beyond traditional automotive production.

The prerequisite to translate the above recommendations into practice **is strengthening institutional capacity** in Dolnośląskie. This is essential for the region's effective engagement in initiatives that support interregional linkages and the transformation of the automotive sector within smart specialisation priorities. Identified bottlenecks—such as the lack of dedicated teams and staff, who are primarily focused on day-to-day policy implementation—need to be addressed in order to successfully carry forward still early-stage initiatives, such as partnerships within the Regional Innovation Valleys, and to ensure their continuity and strategic integration.

- **Normandie**: the transition region of Normandie is, in the selected group studied here, the least attractive to IFDI in automotive with very sparse international interregional connections in the industry in terms of IFDI (one only major foreign investor, Volvo). However, as the local industry, although declining , has shown a critical mass – given also the presence of major French groups such as PSA Peugeot Citroën and Renault – and has been a robust recipient of IFDI in R&D & Innovation in electronics, the region may pursue stronger and narrower specialisation in specific echelons of the GVC (e.g. electric truck assembly lines, as seen also from the analysis of IFDI in the automotives subsectors), relying on more specific S3 strategies. Normandie has strong technological collaborations with other regions, especially in France, most of which (but not all) provide relevant capabilities for Normandie. Its top partner regions in terms of scientific collaborations are not always the most relevant ones though.
- **Centru**: the less developed Centru region in Romania has been a successful case of delocalisation strategies of automotive MNE in the EU, supporting automotive employment and production facilities in the region. Big MNEs – particularly, as seen above, but not exclusively, located in Île de France – sent the largest amount of R&D investments to Centru. Although the region is not yet opening outwardly, the steady inflows of FDI in automotives (in the 21 years observed, only 2020 does not record IFDI, a clear Covid effect), rather broadly distributed across subsectors, the large share attracted in the GVC stage of R&D & Innovation, and the generally more diversified functional distribution of automotive IFDI, make it a promising case for regional upgrading in the industry by extending interregional linkages especially within the EU. Centru has some technological capabilities in automotives, but it collaborates on automotive technologies only to a limited extent. A major deficiency of the region is a lack of scientific collaborations on automotives.
- **Andalusia**: similarly to the transition region of Normandie, the less developed Andalusia shows a relatively small and unstable extent of international interregional linkages through IFDI in automotive. Some major

French and German MNEs operating in the industry are there present (e.g. Renault, Mercedes-Benz), and the relatively high internationalisation through IFDI in electronics production may (like in Normandie) provide grounds for fostering more external linkages with other EU regions in specific segments or in related industries. However, its technological capabilities are weak, with almost no technological collaborations: some scientific collaborations are present, but they offer little complementarities. This raises the question why Andalusia has prioritised automotives in its S3 strategy in the first place.

Our analysis of different types of inter-regional linkages provides crucial information to policy makers to make inter-regional linkages part of an effective regional innovation policy. **Our study shows that a place-based policy to innovation in Europe is absolutely crucial.** This is not only because capabilities differ widely between regions in Europe, and therefore, their opportunities (and constraints) to move into new activities are very different. Our analysis shows this also applies to the intensity and the nature of inter-regional linkages that regions have developed over time. **Inter-regional linkages turn out to be place- and activity-specific.** A region like Baden-Wurttemberg has an excellent opportunity to exploit their inter-regional network inside Europe in automotives, but less so in the case of artificial intelligence, as it lags behind in this activity. By contrast, the case of Dolnośląskie highlights the challenges faced by transition regions, where inter-regional linkages are shaped by established collaboration patterns, often overlooking partnerships that offer greater complementarities and more sustainable modes of collaboration. Our study reveals that regional innovation policy can only be made effective when it follows a place-based policy that includes the role of inter-regional linkages. **Our data analysis on inter-regional linkages around a specific activity provides a crucial tool to inform policy where are the strengths and weaknesses in their interregional networks on different dimensions (GVC, science, technology), and where policy intervention should tackle bottlenecks in their networks and exploit complementarities across regions in the EU.** Targeted informational and operational tools are especially needed by peripheral and transitioning regions with relatively limited human and institutional capacity, to engage meaningfully in emerging EU frameworks such as the Regional Innovation Valleys. Information on other types of collaborations that are difficult to capture by secondary data, such as informal and institutional collaborations, could be included as well by involving local stakeholders, to get a more comprehensive view. But the message would remain the same: **inter-regional linkages can only be made part of an effective and evidence-based regional innovation policy when it is place-based and activity-specific.**

REFERENCES

Bachtrögler-Unger, J., P.A. Balland, R. Boschma and T. Schwab. 2023. 'Technological capabilities and the twin transition in Europe. Opportunities for regional collaboration and economic cohesion', report, Bertelsmann Stiftung, Berlin, 82 pp.

Balland, P.A. and R. Boschma. 2021. 'Complementary inter-regional linkages and Smart Specialisation. An empirical study on European regions', Regional Studies 55 (6):1059-1070.

Balland, P.A., R. Boschma, J. Crespo and D. Rigby. 2019. 'Smart specialisation policy in the EU: Relatedness, knowledge complexity and regional diversification', Regional Studies 53 (9): 1252-1268.

Barzotto, M., C. Corradini, F.M. Fai, S. Labory and P.R. Tomlinson. 2019. 'Enhancing innovative capabilities in lagging regions: an extra-regional collaborative approach to RIS3', Cambridge Journal of Regions, Economy and Society, doi:10.1093/cjres/rsz003.

Bathelt, Harald, Anders Malmberg, and Peter Maskell. 2004. 'Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation'. Progress in Human Geography 28(1):31–56. doi: 10.1191/0309132504ph469oa.

Boschma, Ron. 2005. 'Proximity and Innovation: A Critical Assessment'. Regional Studies 39(1):61–74. doi: 10.1080/0034340052000320887.

Boschma, R. 2017. 'Relatedness as driver behind regional diversification: a research agenda', Regional Studies 51 (3): 351-364.

Boschma, R.A. and S. Iammarino. 2009. 'Related variety, trade linkages and regional growth', Economic Geography, 85 (3): 289-311.

Casadei, P. Comotti, S., Crescenzi, R. and Iammarino, S. 2023. 'Where Global Value Chains go local: EU regions, global value chain creation and local upgrading', European Commission, DG Regio:

https://op.europa.eu/en/publication-detail/-/publication/ad85a19e-fb73-11ed-a05c-01aa75ed71a1/language-en/format-PDF/source-287868243

Comotti, S., Crescenzi, R. and Iammarino, S. 2020. 'Foreign direct investment, global value chains and regional economic development in Europe', European Commission, DG Regio, Contract no. 2018CE160AT082: http://bit.ly/2EBX4Yy

Crescenzi, R. and Harman, O. 2023. Harnessing global value chains for regional development: How to upgrade through regional policy, FDI and trade. Routledge.

De Noni, Ivan, and Andrea Ganzaroli. 2024. 'Enhancing the Inventive Capacity of European Regions through Interregional Collaboration'. Regional Studies 58(7):1425–45. doi: 10.1080/00343404.2023.2271516.

Dessì, D., Iammarino, S. And Usai, S. (2025). Critical Raw Materials in the EU Regions. Are there tensions between the Open Strategic Autonomy and technological transitions? University of Cagliari , in progress.

Domański, B., Micek, G., Guzik, R., Gwosdz, K., & Kocaj, A. (2024). The evolution of European manufacturing industries: the dynamics of core-periphery relationships. Taylor & Francis, pp. 78-115.

Domański, B., & Gwosdz, K. (2018). Changing geographical patterns of automotive industry in Poland. Studies of the Industrial Geography Commission of the Polish Geographical Society, 32(4), 193-204.

Dorożyński, T., & Świerkocki, J. (2022). Specjalne strefy ekonomiczne w Polsce. Doświadczenia i perspektywy. Wydawnictwo Uniwersytetu Łódzkiego.

European Commission. (2024). Regional Innovation Scoreboard 2024. European Commission. Retrieved from https://ec.europa.eu/growth/industry/innovation/regional-innovation-scoreboard_en.

Foray, D. 2015. Smart Specialisation: Opportunities and Challenges for Regional Innovation Policy. London: Routledge.

Foray, Dominique, Paul A. David, and Bronwyn Hall. 2009. 'Smart Specialisation – The Concept'. Knowledge Economists Policy Brief 9.

Foray, Dominique, Kevin Morgan, and Slavo Radosevic. 2018. 'The Role of Smart Specialisation in the EU Research and Innovation Policy Landscape'.

Gianelle, Carlo, Fabrizio Guzzo, and Krzysztof Mieszkowski. 2020. 'Smart Specialisation: What Gets Lost in Translation from Concept to Practice?' Regional Studies 54(10):1377–88. doi: 10.1080/00343404.2019.1607970.

Gianelle, C., D. Kyriakou, C. Cohen and M. Przeor (eds) (2016), Implementing Smart Specialisation: A Handbook, Brussels: European Commission, EUR 28053 EN, doi:10.2791/610394

Giustolisi, Alessio, Maximilian Benner, and Michaela Trippl. 2023. 'Smart Specialisation Strategies: Towards an Outward-Looking Approach'. European Planning Studies 31(4):738–57. doi: 10.1080/09654313.2022.2068950.

Hauser, Christoph, Gottfried Tappeiner, and Janette Walde. 2007. 'The Learning Region: The Impact of Social Capital and Weak Ties on Innovation'. Regional Studies 41(1):75–88.

Iacobucci, D. and E. Guzzini. 2016. 'Relatedness and connectivity in technological domains: missing links in S3 design and implementation', European Planning Studies 24 (8):1511-1526.

Iammarino, S., & McCann, P. 2013. Multinationals and economic geography: Location, technology and innovation. Edward Elgar Publishing.

Kelchtermans, Stijn, Marcin Kardas, and Krzysztof Klincewicz. 2021. 'Implementing Smart Specialisation Strategies'. JRC Publications Repository. Retrieved 14 January 2025 (https://publications.jrc.ec.europa.eu/repository/handle/JRC125959).

Kroll, Henning. 2016. Policy Brief on Smart Specialisation. Karlsruhe: Fraunhoffer ISI.

Kruse, Mirko, and Jan Wedemeier. 2022. 'Smart Specialisation Policy Strategy for Interregional Cooperation: Pushing Less-Developed Regions'. Eastern Journal of European Studies 13(1):254–70. doi: 10.47743/ejes-2022-0112.

McMaster, Irene, and Rachel Maguire. 2024. INNOVATION GAPS, BRIDGES AND TERRITORIAL COOPERATION. 24/5. EoRPA Regional Policy Research Consortium, European Policies Research Centre, University of Strathclyde, Glasgow and EPRC Delft.

Morisson, A., and M. Pattinson. 2020. Smart Specialisation Strategy (S3). Policy Brief from the Policy Learning Platform on Research and Innovation. Lille: Interreg Europe Policy Learning Platform.

Neffke F., Henning M. and Boschma, R. .2011. How do regions diversify over time? Industry relatedness and the development of new growth paths in regions, Economic Geography 87(3): 237–265.

OECD (2024a), "The future of the automotive value chain: Implications for FDI-SME linkages", OECD SME and Entrepreneurship Papers, No. 64, OECD Publishing, Paris, https://doi.org/10.1787/cb730d65-en.

OECD (2025b), Strengthening FDI and SME Linkages in Poland, OECD Publishing, Paris, https://doi.org/10.1787/cb08eb93-en.

Pavlinek, P. (2025) Europe's Auto Industry. Global Production Networks and Spatial Change, Cambridge: Cambridge University Press.

Radosevic, Slavo, and Katerina Ciampi Stancova. 2018. 'Internationalising Smart Specialisation: Assessment and Issues in the Case of EU New Member States'. Journal of the Knowledge Economy 9(1):263–93. doi: 10.1007/s13132-015-0339-3.

Radosevic, Slavo, and Tomislav Zoretic. 2024. 'EU Smart Specialization Policy between Experimentation and Accountability: Dynamic Policy Cycle Perspective'. European Planning Studies 32(8):1693–1712. doi: 10.1080/09654313.2024.2359669.

Rodríguez-Pose, A. 2023. Connectivity and Regional Innovation. Seville, Spain: European Commission, JCR.

UNCTAD 2005, Training Manual on Statistics for FDI and the Operations of TNCs, p.98, unctad.org/en/docs/diaeia20091_en.pdf).

Uyarra,Elvira, Sörvik, Jens, and Midtkandal,Inger. 2014. 'Inter-Regional Collaboration in Research and Innovation Strategies for Smart Specialisation (RIS3).' S3 Working Paper Series 06.

Uyarra, Elvira, Chiara Marzocchi, and Jens Sorvik. 2018. 'How Outward Looking Is Smart Specialisation? Rationales, Drivers and Barriers'. European Planning Studies 26(12):2344–63. doi: 10.1080/09654313.2018.1529146.

Woolford, Jayne, Effie Amanatidou, Elisa Gerussi, and Mark Boden. 2021. Interregional Cooperation and Smart Specialisation: A Lagging Regions Perspective. Luxembourg: Publications Office of the European Union.

APPENDIX 1. LINKAGES THROUGH FDI AS A PROXY FOR AUTOMOTIVE GVCs IN THE 5 REGIONS

FDI is crucial for regional upgrading and the establishment of international and interregional linkages (Crescenzi & Iammarino, 2018; Comotti et al., 2020; Crescenzi & Harman, 2023). The focus on greenfield[7] investment allows to capture the capacity of internationalisation processes and interregional linkages to bring to the regional economy new activities, and to allow it to actively internationalise in other regions. As extensively discussed in Comotti et al. (2020) and Casadei et al. (2023), GVCs and FDI are closely interlinked phenomena, as the latter is a relevant mode of governance of GVCs, with multinationals enterprises (MNEs) often acting as lead firms in a variety of GVC configurations (Crescenzi et al., 2014).

While FDI data might not capture the geography of production and innovation in its entirety and complexity, they can offer key insights on interregional linkages and value creation across EU regions, and thus for S3 strategies and place-based policies. In addition, the analysis of the functional nature of FDI – Headquarters, R&D & Innovation, Sales, Production, Logistic & Distribution – offers relevant insights on the GVC stage of both active and passive internationalisation patterns at the regional level (Crescenzi et al., 2014). The descriptive picture of connectivity through FDI covers both inward FDI (i.e., investments made in the regional economy by firms based in regions of other EU members or the rest of the world) and outward FDI (i.e., investments made by firms based in the focal region towards regions of other EU member states or outside the EU) flows to capture nature, directionality, and functional profile of such connections in the automotive value chain.

The relative position in terms of overall FDI connectivity of each of our selected regional economies differ with respect to their national contexts. The advanced region of Baden-Württemberg – providing a benchmark for the automotive industry – accounts respectively for 6.8% and 18% of total IFDI and OFDI in/from Germany over the 21 years here considered; in automotive, the region represents a similar share for IFDI (6.7%), but a much larger one for OFDI (35.7%, second only to Niedersachsen's), positioning itself as a net investor abroad. Trends over the period 2003-23 see rather constant inflows and, especially, outflows.

In the case of our transition regions, Dolnośląskie is 3rd (after Łódzkie and Warszaw) in terms of overall attractiveness with 12.7% of total IFDI in Poland, representing 4.3% of national OFDI; whilst it even manages to strengthen its position with respect to IFDI in automotive – being the 2nd attractor after Śląskie, with continual inflows over the time observed –, the capacity of the region to internationalise abroad is null for the industry. Normandie, on the other hand, accounts for much smaller shares of the French total, 4.6% and 0.1% respectively for IFDI and OFDI; and it accounts for an even smaller share of inward FDI in automotive

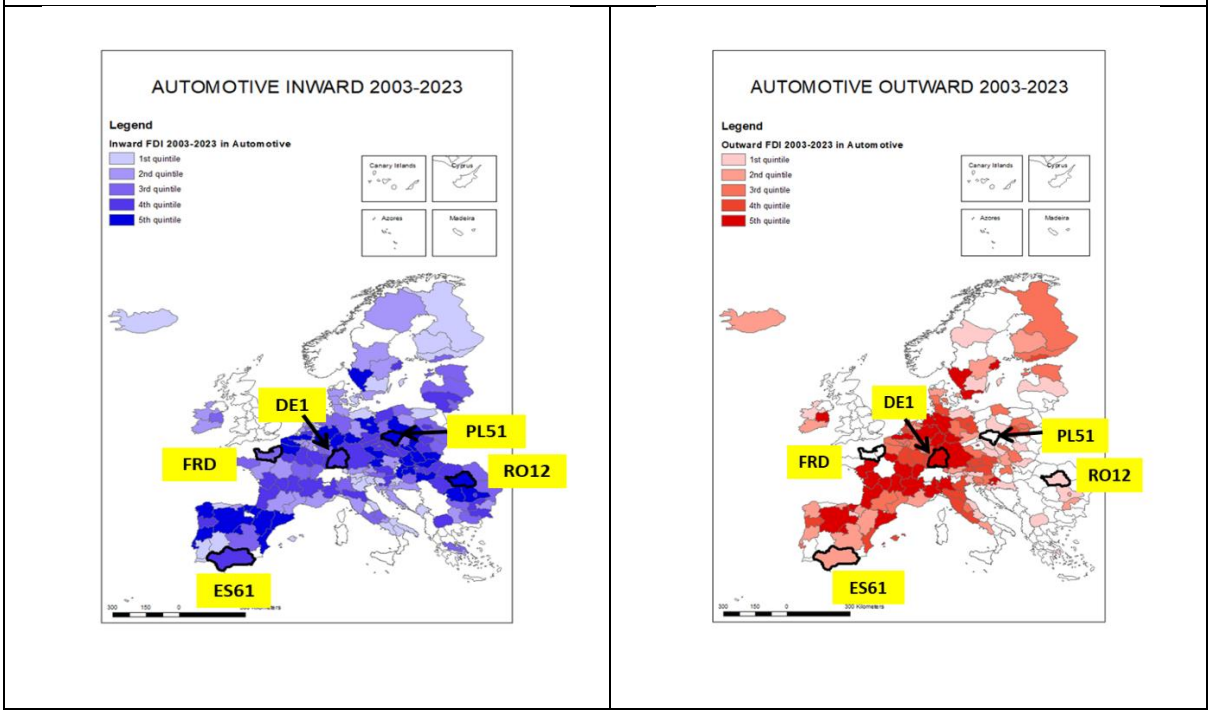
[7] "Greenfield FDI relates to investment projects that entail the establishment of new entities and the setting up of offices, buildings, plants and factories from scratch. (…) Greenfield FDI involves capital used for the purchase of fixed assets, materials, goods, and services, and to hire workers in the host country" (UNCTAD 2005, Training Manual on Statistics for FDI and the Operations of TNCs, p.98, unctad.org/en/docs/diaeia20091_en.pdf).

(3.1%), mostly occurring in a few time windows (2006-08 and 2021-23) and being null for the rest of the period.

Looking at the two less developed regions, Centru is the most attractive region in Romania in the years observed, with 37% of national IFDI, and 2nd after the capital region in terms of OFDI (with 15.5%). The Romanian region leads also with respect to IFDI in the automotive sectors (30.6% of the national total), with inward investment flows particularly intense up to 2015; OFDI, instead, accounts only for 2.0%. Andalusia is 3rd after Madrid and Comunitat Valenciana in overall IFDI, with a share of the total of 16.2%, yet contributing much less to Spanish OFDI (5.4%); however, the region receives less than 3% of Spanish IFDI in automotive (the big attractor being Cataluña) – with a somehow irregular trend over time – and accounts for 0.6% of sectoral OFDI.

Map A1.1 shows total (global) automotive greenfield investments into (IFDI) and from (OFDI) the EU27 regions between January 2003 and December 2023; our selected regions are highlighted.

Map. A1.1 – Global greenfield inward and outward FDI in automotive, 2003-2023 (mil. USD), EU27 regions (IFDI = from RoW + from other EU; OFDI = to RoW + to other EU)



In order to assess to the potential for regional diversification – Table A1.1 below reports the shares of each invested sub-sector on the total regional IFDI in automotive. What emerges is that, while the advanced Baden-Württemberg, together with both the quite attractive transition region of Dolnośląskie and the less advanced Centru, have a rather wide distribution of IFDI across subsectors, Andalusia and, again especially, Normandie not only have a narrower range of sub-sectors in automotives implicated by IFDI, but most of it is highly concentrated in just one sub-sector (59% in Automobiles in the former region, and 76% in Heavy duty trucks in the latter). In terms of OFDI in automotive, as said above the only notable

investor abroad is, as expected, Baden-Württemberg, for which an even wider range of subsectors are concerned by active internationalisation strategies; investors based in Andalucia, with its limited extent of OFDI, are more concentrated in a few subsectors.

Table A1.1 - FDI in automotive by subsector (% of total FDI in automotive), 2003-2023, 5 selected regions

INWARD FDI AUTOMOTIVE 2003-2023 BY SUB-SECTOR (% of total Automotive)			
DE1			
All other transportation (Automotive OEM)	1.27		
Automobiles	5.16		
Heavy duty trucks	4.41		
Light trucks & utility vehicles	24.41		
Motor vehicle & parts dealers (Automotive OEM)	0.21		
Motor vehicle body & trailers	20.45		
Motor vehicle brake systems	1.02		
Motor vehicle electrical & electronic equipment	7.43		
Motor vehicle gasoline engines & engine parts	8.18		
Motor vehicle seating & interior trim	6.41		
Motor vehicle stamping	3.75		
Motor vehicle transmission & power train parts	5.14		
Other motor vehicle parts	12.15		
PL51		**FRD**	
All other transportation (Automotive OEM)	0.17	Heavy duty trucks	75
Automobiles	0.36	Motor vehicle body & trailers	5
Heavy duty trucks	0.31	Motor vehicle gasoline engines & engine parts	3
Motor vehicle body & trailers	3.11	Motor vehicle seating & interior trim	5
Motor vehicle brake systems	2.09	Motor vehicle transmission & power train parts	4
Motor vehicle electrical & electronic equipment	7.19	Other motor vehicle parts	5
Motor vehicle gasoline engines & engine parts	40.20		
Motor vehicle seating & interior trim	9.68		
Motor vehicle steering & suspension components	10.18		
Motor vehicle transmission & power train parts	11.02		
Other motor vehicle parts	15.69		
RO12		**ES61**	
All other transportation (Automotive OEM)	0.16	Automobiles	59
Automobiles	29.75	Heavy duty trucks	1
Heavy duty trucks	3.61	Light trucks & utility vehicles	10
Motor vehicle & parts dealers (Automotive OEM)	2.83	Motor vehicle & parts dealers (Automotive OEM)	0
Motor vehicle body & trailers	0.76	Motor vehicle brake systems	1
Motor vehicle brake systems	2.09	Motor vehicle electrical & electronic equipment	0
Motor vehicle electrical & electronic equipment	12.16	Motor vehicle gasoline engines & engine parts	1
Motor vehicle gasoline engines & engine parts	5.54	Motor vehicle steering & suspension components	19
Motor vehicle seating & interior trim	3.32	Motor vehicle transmission & power train parts	3
Motor vehicle stamping	0.57	Other motor vehicle parts	1
Motor vehicle steering & suspension components	1.42		
Motor vehicle transmission & power train parts	17.16		
Other motor vehicle parts	20.62		

OUTWARD FDI AUTOMOTIVE 2003-2023 BY SUB-SECTOR (% of total Automotive)			
DE1			
All other transportation (Automotive OEM)	0.13		
Automobiles	34.44		
Heavy duty trucks	13.88		
Light trucks & utility vehicles	8.76		
Motor vehicle & parts dealers (Automotive Components)	0.02		
Motor vehicle & parts dealers (Automotive OEM)	0.86	**ES61**	
Motor vehicle body & trailers	1.66	Automobiles	12
Motor vehicle brake systems	1.74	Heavy duty trucks	33
Motor vehicle electrical & electronic equipment	6.28	Motor vehicle brake systems	44
Motor vehicle gasoline engines & engine parts	12.64	Motor vehicle electrical & electronic equipment	5
Motor vehicle seating & interior trim	0.88	Other motor vehicle parts	3
Motor vehicle stamping	0.03		
Motor vehicle steering & suspension components	4.60		
Motor vehicle transmission & power train parts	3.60		
Other motor vehicle parts	10.48		

By looking at the business function, Table A1.2 allows us to gain a finer-scaled appreciation of the functional connectivity of our regions in the automotive value chain.

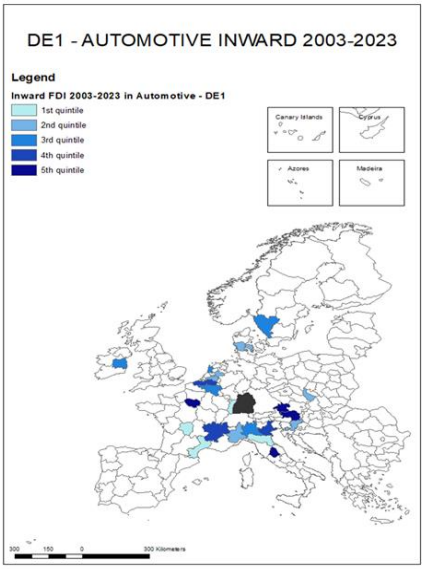
Table A1.2 - FDI in automotive by function (% of total FDI in automotive), 2003-2023, 5 selected regions

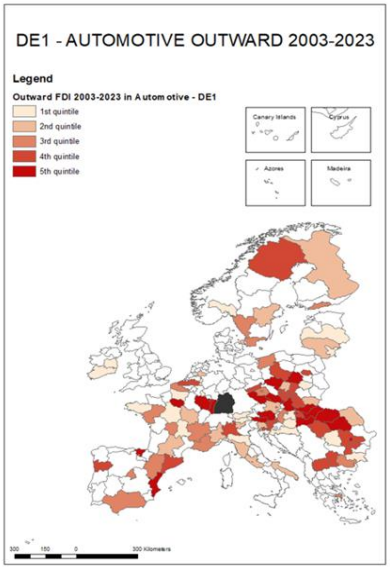
INWARD FDI AUTOMOTIVE 2003-2023 BY FUNCTION (%)			
DE1			
HQ	8.3		
R&D & INNO	14.5		
SALES	2.8		
PRODUCTION	66.9		
LOGISTIC & DIS	7.6		
PL51		**FRD**	
HQ	0.9	HQ	3.3
R&D & INNO	0.3	PRODUCTION	95.2
SALES	0.3	LOGISTIC & DIS	1.5
PRODUCTION	98.4		
LOGISTIC & DIS	0.1		
RO12		**ES61**	
HQ	1.2	R&D & INNO	1.2
R&D & INNO	14.8	SALES	3.1
SALES	4.1	PRODUCTION	93.1
PRODUCTION	79.5	LOGISTIC & DIS	2.6
LOGISTIC & DIS	0.4		

OUTWARD FDI AUTOMOTIVE 2003-2023 BY FUNCTION (%)			
DE1			
HQ	2.1		
R&D & INNO	8.1		
SALES	2.8		
PRODUCTION	85.4	**ES61**	
LOGISTIC & DIS	1.6	HQ	44.7
		R&D & INNO	12.7
		PRODUCTION	42.6

Maps A1.2 below (focal region marked in black on the maps) shows the intra-EU regional connections (inward and outward) of Baden-Württemberg, whilst Maps A1.3 and Maps A1.4 refer to the regional connections through IFDI in our transition and less developed regions respectively.

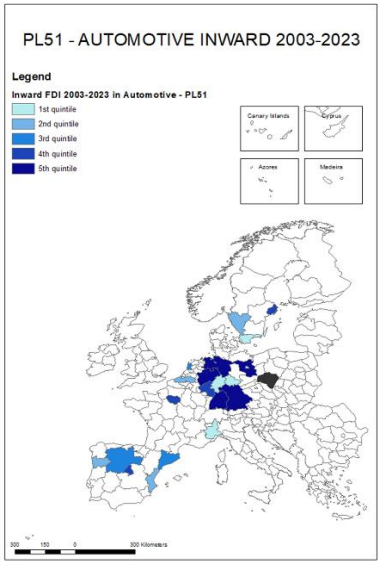
Map A1.2 - IFDI and OFDI in automotive in/from Baden-Württemberg (DE1) from/in other EU27 regions



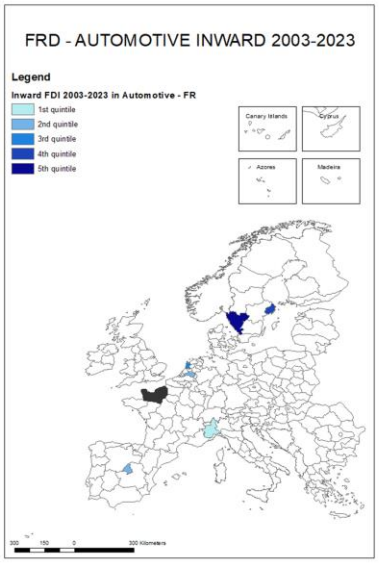


Map A1.3 - IFDI and OFDI in automotive in/from the 2 selected transition regions of Dolnośląskie (PL51) and Normandie (FRD) from other EU27 regions

a)

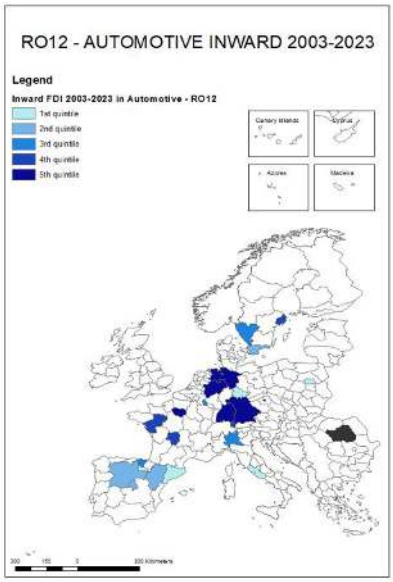


b)

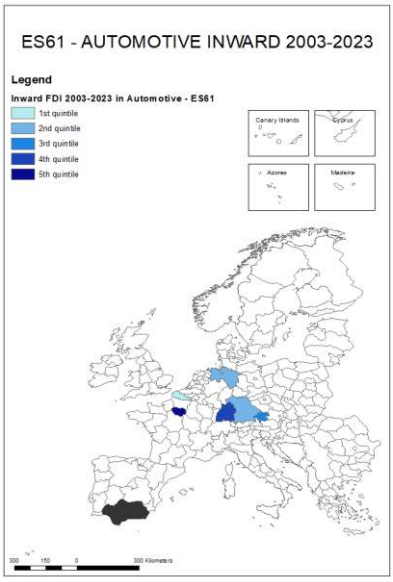


Map A1.4 - IFDI and OFDI in automotive in/from the 2 selected less developed regions of Centru (RO12) and Andalusia (ES61) from other EU27 regions

a)


RO12 - AUTOMOTIVE INWARD 2003-2023
Legend
Inward FDI 2003-2023 in Automotive - RO12
1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile
Canary Islands
Cyprus
Azores
Madeira

b)


ES61 - AUTOMOTIVE INWARD 2003-2023
Legend
Inward FDI 2003-2023 in Automotive - ES61
1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile
Canary Islands
Cyprus
Azores
Madeira

APPENDIX 2. THE MEASUREMENT OF TECHNOLOGICAL AND SCIENTIFIC POTENTIAL OF REGIONS IN AUTOMOTIVES

We adopt the principle of relatedness to identify relevant regional capabilities to develop automotives. We identified which (and to what extent) technologies are related to automotives, and which (and to what extent) scientific fields are related to automotives. For this purpose, we did co-occurrence analysis to calculate the degree of relatedness between 35 WIPO technologies and between 23 scientific fields. This measures the frequency of occurrence of combinations of technology classes on a patent document and scientific fields on a scientific publication. Then, we calculated a relatedness density measure. It assesses how many technologies or scientific fields related to automotives a region is specialised in: the higher the relatedness density, the higher the potential of the region to develop automotives. Following, Hidalgo et al. (2007) and Boschma et al. (2015), the density of knowledge production around a given technology *i* in region *r* is derived from the relatedness of technology *i* to all other technologies *j* in which the region has a Relative Technological Advance (RTA), divided by the sum of relatedness of technology *i* to all the other technologies *j* in Europe as a whole. The same procedure has been run for scientific publications.

APPENDIX 3. THE MEASUREMENT OF COMPLEMENTARITIES IN INTER-REGIONAL LINKAGES

To measure complementarities in interregional linkages, we follow Balland and Boschma (2021). Their indicator measures the extent to which a region is linked with other regions that are specialised in technologies or scientific fields to which automotives is related (see Appendix 2 for the clarification of the measurement of the relatedness indicator), but that are missing in the region (that is, in which the region is not specialised). This variable aims to capture relevant capabilities that are missing in a region, but enhance the probability of developing or upgrading automotives when the region gets access to them through co-inventor linkages and/or scientific co-publications with other regions. To be precise, the variable measures the amount of Relatedness Density (see Appendix 2 for the clarification of the Relatedness Density measure) that another region can add to the Relatedness Density of the region in automotives.

APPENDIX 4. INTERREGIONAL COLLABORATIONS AND COMPLEMENTARITIES ON AUTOMOTIVES IN THE 5 REGIONS

Figures A4.1-4.5 present for each of the 5 regions with which regions in Europe they collaborate most on automotives. This is shown in column 1 for technological collaborations and in column 4 for scientific collaborations. Columns 3 and 6 provide information on how relevant these partner regions are in terms of complementary capabilities.

Figure A4.1. Baden-Württemberg

top partner regions	technological collaborations (#co-inventor linkages)	how technologically relevant is partner region?	top partner regions	scientific collaborations (#co-publications)	how scientifically relevant is partner region?
DE27 Schwaben	152	11.6	DE21Oberbayern	60	0.2
DE21 Oberbayern	123	10.6	DE30 Berlin	50	7.6
DE26 Unterfranken	68	7.5	DE71 Darmstadt	43	0.1
FR42 Alsace	64	9.1	DEA2 Köln	33	33.1
DE71 Darmstadt	48	10.1	DE92 Hannover	23	0.9
DE22 Niederbayern	47	4.9	FR10 Île-de-France	16	34.5
DE25 Mittelfranken	45	11.8	NL33 Zuid-Holland	16	33.5
DEB3 Rheinhessen-Pfalz	39	10.2	DEA1 Düsseldorf	15	2.2
DEA1 Düsseldorf	32	8.7	DE60 Hamburg	14	33.6
AT34 Vorarlberg	30	6.4	DE25 Mittelfranken	12	0.9
DE24 Oberfranken	29	11.3	CH04 Zurich	11	0.2
DEA2 Köln	28	12.1	DEA5 Arnsberg	11	7.0
DE94 Weser-Ems	27	9.8	SE11 Stockholm	10	1.1
DE23 Oberpfalz	25	5.0	DED2 Dresden	9	1.6

Figure A4.2. Andalusia

top partner regions	technological collaborations (#co-inventor linkages)	how technologically relevant is partner region?	top partner regions	scientific collaborations (#co-publications)	how scientifically relevant is partner region?
ES21 País Vasco	1	32.8	ES30 Comunidad de Madrid	15	10.7

ES51 Cataluña	1	11.8	UKG3 West Midlands	4	31.4
FR10 Île-de-France	1	54.6	DE21 Oberbayern	2	36.8
ES30 Comunidad de Madrid	1	21.6	ES52 Comunidad Valenciana	2	4.9
SE12 Östra Mellansverige	1	32.2	FR10 Île-de-France	2	79.2
			ITC1 Piemonte	2	41.5
			PT11 Norte	2	59.2
			SE23 Västsverige	2	64.3

Figure A4.3. Centru

top partner regions	technological collaborations (#co-inventor linkages)	how technologically relevant is partner region?	top partner regions	scientific collaborations (#co-publications)	how scientifically relevant is partner region?
RO31 Sud - Muntenia	3	24.3	-	0	0
DE25 Mittelfranken	2	37.6	-	0	0
RO11 Nord-Vest	2	15.1	-	0	0
DEF0 Schleswig-Holstein	1	22.8	-	0	0
FR53 Poitou-Charentes	1	26.6	-	0	0
IEO1 Border, Midland and Western	1	2.6	-	0	0
NL41 Noord-Brabant	1	21.4	-	0	0

Figure A4.4. Dolnośląskie

top partner regions	technological collaborations (#co-inventor linkages)	how technologically relevant is partner region?	top partner regions	scientific collaborations (#co-publications)	how scientifically relevant is partner region?
DE92 Hannover	6	11.5	PL21 Małopolskie	124	10.0
PL22 Śląskie	3	10.8	PL41 Wielkopolskie	17	1.4
SE23 Västsverige	2	9.6	PL11 Łódzkie	12	1.4
DE1 Baden-Württemberg	1	36.2	BG33 Severoiztochen	11	36.6
CH04 Zurich	1	23.0	PL31 Lubelskie	7	0

CH05 Eastern Switzerland	1	27.1	PL63 Pomorskie	5	42.5
DE21 Oberbayern	1	34.5	ITH5 Emilia-Romagna	4	32.1
DE25 Mittelfranken	1	41.8	AT12 Niederösterreich	3	36.3
ITI1 Toscana	1	19.2	DE60 Hamburg	3	31.9
PL21 Małopolskie	1	10.6	ES62 Región de Murcia	3	0.7
PL41 Wielkopolskie	1	23.3	PL12 Mazowieckie	3	6.5
PL43 Lubuskie	1	21.7	LT00 Lietuva	2	27.5
SE31 Norra Mellansverige	1	26.1	PL42 Zachodniopomorskie	2	26.1
UKD North West	1	27.1			

Figure A4.5. Normandie

top partner regions	technological collaborations (#co-inventor linkages)	how technologically relevant is partner region?	top partner regions	scientific collaborations (#co-publications)	how scientifically relevant is partner regi?
FR10 Île-de-France	29	50.8	FR10 Île-de-France	23	12.5
FR52 Bretagne	4	9.7	FR81 Languedoc-Roussillon	7	17.7
DE21 Oberbayern	2	69.8	FR30 Nord-Pas-de-Calais	5	12.4
FR22 Picardie	2	33.1	FR82Provence-Alpes-Côte d'Azur	3	12.8
FR53 Poitou-Charentes	2	49.9	FR71 Rhône-Alpes	3	12.2
FR71 Rhône-Alpes	2	32.0	UKI1 Inner London	2	0.6
DE1 Baden-Württemberg	1	66.3	PL41 Wielkopolskie	1	5.2
BE1 Bruxelles-Capitale	1	42.5	ITI4 Lazio	1	0.2
CH04 Zurich	1	14.3	ITH5 Emilia-Romagna	1	5.6
FR24 Centre	1	37.3	ITC4 Lombardia	1	0.2
FR26 Bourgogne	1	7.8	ITC3 Liguria	1	7.5
FR43 Franche-Comté	1	53.9	FR62 Midi-Pyrénées	1	17.5
FR51 Pays de la Loire	1	23.8	FR52 Bretagne	1	12.5
FR62 Midi-Pyrénées	1	56.9	DE1 Baden-Württemberg	1	24.7

APPENDIX 5. KEY INITIATIVES SUPPORTING INTERREGIONAL COLLABORATION IN THE DOLNOŚLĄSKIE AUTOMOTIVE SECTOR

Initiative/Project	Scope	Impact on the Automotive Sector	Initiator
Dolnośląskie–Saxony Partnership (International)	◦ A 17-year partnership between Dolnośląskie and Saxony fostering cooperation in key economic sectors, including automotive innovation and hydrogen technology. ◦ Organisation of industry events and study visits to strengthen economic ties. ◦ Example initiatives include: Saxon-Polish Innovation Days in Wrocław (co-organised by Wrocław University of Science and Technology). Polish-Saxon Economic Forum (dedicated to key industrial sectors, including automotive).	◦ Strengthening interregional knowledge exchange and technology transfer between Saxony and Dolnośląskie. ◦ Greater access to Saxon automotive and hydrogen technology expertise. ◦ Establishment of long-term institutional partnerships for joint research, business networking, and industrial collaboration.	Marshal's Office of Lower Silesia (in cooperation with universities and clusters)
Trade Missions and "Going Global" (International)	◦ Organisation of business trips to trade fairs and meetings with international partners. ◦ Financial and logistical support for automotive sector companies seeking new markets. ◦ Promotion of regional enterprises in the international arena.	◦ Acquisition of new foreign business partners, strengthening Dolnośląskie's global market position. ◦ Enhancing the visibility of the regional automotive sector at key industry events (e.g., automotive fairs in Germany). ◦ Gaining insights into market trends and technological developments in other countries.	Marshal's Office of Lower Silesia
Study Visits to Automotive Plants (Mercedes, Toyota) (National)	◦ Presentation of modern production solutions (automation, robotics, Industry 4.0) in major automotive plants located in the region. ◦ Direct contact between SMEs and global automotive corporations (e.g., Mercedes, Toyota).	◦ Skill enhancement for smaller firms through observation and benchmarking of best industry practices. ◦ Potential integration of local companies into large	Marshal's Office of Lower Silesia

		manufacturers' supply chains. ◦ Development of capabilities to adapt innovative technologies and establish joint R&D projects.	
Membership in Regional Innovation Valleys (RIV) (International)	◦ Recognition of Dolnośląskie as a "Regional Innovation Valley" by the European Commission (June 9). ◦ The program supports the region in implementing EU priorities, including: reducing dependence on fossil fuels, Enhancing global food security, Digital transformation (e.g., cybersecurity), Improving healthcare, Building a circular economy ◦ Not directly related to automotive sector and not supported by specific projects yet, thus the impact is only potential.	◦ Potential funding opportunities and international partnerships in innovation projects (Horizon Europe, Interreg). ◦ Potential focus on e-mobility and alternative energy sources (e.g., hydrogen fuel cells) in the automotive sector. ◦ Potential impact on competitiveness of Dolnośląskie companies.	Marshal's Office of Lower Silesia
Triangular Partnership: Dolnośląskie – Saxony – Coventry (International)	◦ Establishing a "triangle" of cooperation among regions with developed automotive and aerospace industries (e.g., Jaguar Land Rover in Coventry). ◦ Official partnerships between cities, regions, and universities (e.g., academic exchange, innovation projects). ◦ Joint meetings and study visits at automotive hubs (Saxony, UK).	◦ Multilateral knowledge exchange with key global players (JLR, German manufacturers). ◦ Greater opportunities for participation in research and development projects and skill development (Industry 4.0, e-mobility). ◦ Strengthening Dolnośląskie's position in international value chains.	Dolnośląskie Automotive Cluster, supported by Marshal's Office of Lower Silesia
Agreement of Four Automotive Clusters (National)	◦ Strategic partnership between four major regional automotive clusters: Dolnośląskie Automotive Cluster, Silesian Automotive & Advanced Manufacturing Cluster, Eastern Automotive Alliance, and Polish Automotive Group-a national association focused on Polish-owned automotive suppliers. ◦ Joint representation of the industry (e.g., at the ministerial level). ◦ Organization of industry events. ◦ Knowledge and experience exchange within the automotive sector.	◦ Expanded network of contacts across the country. ◦ More effective promotion of automotive sector interests. ◦ Easier access to information on cooperation opportunities (e.g., joint projects).	Dolnośląskie Automotive Cluster in cooperation with other clusters

Membership in the European Automotive Network (International)	◦ Participation in international events and networking meetings for the automotive sector. ◦ Support for SMEs in establishing contacts with potential partners (e.g., Lithuania, Slovakia).	◦ Easier entry into foreign markets (exports, B2B cooperation). ◦ Broad exchange of experiences with companies from other EU countries. ◦ Expansion of research and development cooperation and increased participation of Dolnośląskie enterprises in global value chains.	Dolnośląskie Automotive Cluster
Collaboration with the "Western Electromobility Cluster" (National)	◦ Integration of companies from Dolnośląskie and Lubuskie, mainly around electromobility development. ◦ Joint initiatives within the Legnica Special Economic Zone (LSE).	◦ Expansion of competencies in e-mobility. ◦ Strengthened B2B connections between enterprises from both regions. ◦ Accelerated knowledge transfer in the field of new propulsion systems (e.g., electric vehicles).	Dolnośląskie Automotive Cluster

Source: own compilation based on the interviews and https://pwr.edu.pl/uczelnia/przed-nami/iv-saksonsko-polski-dni-innowacji-1488.html; https://innowacje.dolnyslask.pl/pl/node/560; https://innowacje.dolnyslask.pl/pl/node/673