



# An industrial strategy for EU cohesion in an era of transformation

Lisa De Propriis & Sandrine Labory

To cite this article: Lisa De Propriis & Sandrine Labory (2025) An industrial strategy for EU cohesion in an era of transformation, Contemporary Social Science, 20:2-3, 249-271, DOI: 10.1080/21582041.2025.2590108

To link to this article: <https://doi.org/10.1080/21582041.2025.2590108>



© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 26 Nov 2025.



Submit your article to this journal [↗](#)



Article views: 276



View related articles [↗](#)



View Crossmark data [↗](#)

# An industrial strategy for EU cohesion in an era of transformation

Lisa De Propriis<sup>a</sup> and Sandrine Labory<sup>b</sup>

<sup>a</sup>Birmingham Business School, The University of Birmingham, Birmingham, UK; <sup>b</sup>University of Ferrara, Ferrara, Italy

## ABSTRACT

The current disruptive and systemic technological shift is posing a significant threat to persistent European Union socio-economic disparities due to path dependency forces, resistance and lock-in. The technological upgrading that is embodied in EU cohesion policies and the smart specialisation strategies has been an effective approach to allow low performing regions ‘to keep-up’ with higher performing regions, without, however, enabling actual convergence. We suggest that European cohesion would be better achieved with a transformative industrial strategy focused on national-level investment in productive activities that addresses the current technological transitions in digital and green in terms of both physical and human capital. Such investment can target new technologies and new industries adopting an approach that sees the techno-economic paradigm as a system of systems (sector innovation systems and technology innovation systems) nested in multi-territorial infrastructural investment. We discuss three case studies that have been chosen to portray the three tenets of transformative industrial strategy, namely: the relevance of triangulating digital, green and skills transitions; the strategic necessity to connect technology, sector and finally, coordinate multi-scale interventions and investment.

## ARTICLE HISTORY

Received 6 October 2025

Accepted 10 November 2025

## KEYWORDS

Industrial strategy; EU cohesion; green transition; digital transition; just transitions; skills

## 1. Introduction

With industrial policy back on the agenda in western economies (Aiginger & Rodrik, 2020), we would argue that the European Union (EU) has accelerated its effort to sharpen its role and available instruments to inspire, guide and support EU industries in a more transformative and consequential way. Of course, the EU has been pro-active in supporting socio-economic growth since the launch of the Single Market in 1990s, which coincided with the Reform of the Structural Funds. The latter marked the beginning of three decades of pro-active policy engagement aimed at reducing intra-EU regional income disparities. Indeed, drawing on the scientific debate on the drivers and barriers of regional growth in

**CONTACT** Lisa De Propriis  [l.depropriis@bham.ac.uk](mailto:l.depropriis@bham.ac.uk)

© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

economic geography, EU Cohesion Policy has shaped our understanding of why regional growth matters and how to achieve it.

Contrary to the general *lassaiz-faire* policy approach to government intervention that dominated western economies since the 1980s, EU Cohesion Policy has asserted the positive role that policymaking could have in steering socio-economic growth (Bailey & De Propriis, 2007). It was designed as a *regional* policy with great flexibility and powers delegated to regional governments to decide on the aims, objectives and instruments of intervention. The allocation of funds signalled the pro-equity spirit of the policy vision to enhance intra-regional cohesion, with most of the funding allocated to low GDP regions (Bailey & De Propriis, 2007). It is beyond the scope of this paper to judge whether Cohesion Policy achieved its objectives, but it is well documented that whilst regional disparities persist, regions have progressively and in aggregate terms been better off (European Commission, 2024).

A step change in the EU policy mindset occurred following the 2008 Great Financial Crisis (GFC); however, it remained fundamentally anchored around motivations linked to regional cohesion. The 2008 GFC showed the fault lines in the EU economic model based on globalisation, openness and interconnectedness. With European industries stretching their value chains across continents, the European industrial system appeared exposed as being dependent for critical production factors on foreign suppliers as it had sleepwalked into profound de-industrialisation with a loss of manufacturing capacity and related skills. In the midst of the de-globalisation narrative that followed, a wave of new digital and green technologies started to emerge. Referred to as the Fourth Industrial Revolution (Schwab, 2018), the adoption of digital technologies from robotisation to AI was labelled as 'Industry 4.0' (GTAI, 2014) and visualised a disruptive change that altered the factors of production, the nature of capital, as well as redesigned the organisation of production inside and between firms. At the same time, climate change concerns accelerated the development and adoption of climate neutral technologies linked to alternative energies and green products and processes. The nature and pace of the digital and green transitions highlighted their disruptive and pervasive power in what is seen as a socio-economic-institutional system change. Yet the EU policy response was simply to tweak the Smart Specialisation Strategy to include sustainability priorities, by moving from Smart Specialisation (S3) to 'smart specialisation strategies for sustainable and inclusive growth' (S4+) (McCann & Soete, 2020, p. 19).

However, such technological disruptions together with the geopolitical shocks in the 2020s brought home for EU policymakers key concerns that required more drastic actions. The Covid pandemic and the war in Ukraine added to the realisation that the modest adjustments advocated by Smart Specialisation Strategies did not suffice. The pivoting of EU policy from reducing regional income disparities to attempting to build the capacity of the productive factors fundamental for the European economy, marked in our view the launch of a European industrial policy.

The objective of this paper is to discuss the future of EU policy as it grapples with the challenges of reconciling the expectations of maintaining an equity priority with the necessity of delivering a smart, green, inclusive, but above all, resilient growth across the EU. We will propose framing EU cohesion priorities in the context of embracing a transformational industrial policy with a triple (green, digital and skill) transition (Bianchi et al., 2024), as a pathway to socio-economic resilience and strategic autonomy.<sup>1</sup>

The debate on whether EU Smart Specialisation Strategies have been sufficiently redesigned to address triple transitions, related to what one might define as more top-down EU policy initiatives, is at a very infant stage. In this space, the paper's main novelty is to suggest the need to shift the EU policy narrative from a purely regional policy approach to a transformational industrial policy able to support and promote regions' industrial transformation, rather than upgrading. We draw on the concept of triple transition to underline the interconnectedness of green and digital transitions with a shift in the productive factors and in particular human capital. There is a strong argument in favour of green and digital technologies delivering expected productivity gains in a socially uneven way unless all productive factors are equally invested in, including skills. This paper portrays three case studies that have been carefully selected to illustrate the key tenets of the proposed transformational industrial strategy, these are (a) the importance of designing a regional industrial policy that triangulates digital, green and skills transitions in the Emilia Romagna region, (b) the strategic importance of connecting technology, sector, place and national levels in the case of Sweden and (c) the transformational vision of coordinating an energy shift that requires investment, scale and multi-territory integration in case of the EU battery technology strategy.

This paper will proceed as follows. Section 2 will review the current debate on green and digital transitions and introduce the concept of a triple transition. Section 3 will present the conceptual framework that spells out the key tenets of a transformative industrial strategy. Section 4 will discuss the case studies. Some remarks will conclude this paper in Section 5, suggesting ways forward to both policy and research.

## 2. Triple transition: green, digital and skills

### *The digital and green transitions*

The nature and implications of the Fourth Industrial Revolution are associated with a wave of new digital and green technologies that are often referred to as Industry 4.0 technologies. There is already a growing policy and scholarly literature on the emergence of new digitally enabled services and devices (Brynjolfsson & McAfee, 2014; Goodwin, 2018; McQuivey, 2013): these include cyber-physical systems, the internet of things, big data, data analytics, data science, cloud technology, artificial intelligence, blockchain, simulation and modelling, visualisation technology, automation and robotics, additive manufacturing, mobile tech, sensoring, space technology and drones (Benassi et al., 2020; Capello & Lenzi, 2021; De Propriis & Bailey, 2021; EC, 2016, 2021; European Parliament, 2015; OECD, 2017; Zheng et al., 2021). The digital transition (OECD, 2022) here refers to the penetration of digital technologies into all aspects of economic activities, from manufacturing industries to services. Critical technologies are also in our grasp to pursue decarbonisation and climate neutral solutions to a point where they can trigger a socio-economic discontinuity. These green technologies include carbon capture and removal, hydrogen technology, green chemistry and materials, green building technology, sustainable agriculture, circular economy, green transport, and alternative energy and storage. They power a system change that is referred to as a green transition (OECD, 2025).

The double transition of digital and green will arguably change the nature of capital, as well as the capital-labour ratio by redesigning the organisation of production inside and

between firms. Value creation parameters in firms' business models are being redefined not just in terms of market presence, but crucially in terms of their environmental and social impacts (Kaplinski, 2021). Whilst some existing industries will disappear, and others are transitioning onto the 4.0 model, new sectors and markets will be created either pushed by new technologies or pulled by new demand and consumer needs (De Propriis & Bailey, 2020). The global organisation of production will be re-drawn both in terms of value creation functions and geographical presence. Indeed, the location of production is starting to matter again but not in terms of cost-saving, but in view of the knowledge appropriation of its embedded technology (Baldwin, 2019; Coe & Yeung, 2015). The development and availability of technologies for green and renewable energy are also shifting the balance of power in the geopolitical order, given that alternative energies can be distributed and available at the point of consumption (i.e. region, locality or household).

The pervasive and disruptive nature of digital and green technologies coincides indeed with an *inflection point* (Brynjolfsson & McAfee, 2014) due to their nature: they are exponential and combinatorial (in adoption and diffusion) and make pre-existing knowledge less critical (Brynjolfsson & McAfee, 2014). The literature on systems change explains technological change as shifts in the dominant technological paradigm (Dosi, 1982) driven by scientific discovery. Although inventions (Schumpeter, 1942) might trickle through over time, they tend to cumulate and tip over in discontinuous technological jumps that disrupt the socio-economic system only at discrete intervals (Kondratieff, 1984; Perez, 2010). The Fourth Industrial Revolution marks such a technological break point and introduces a new socio-techno-economic paradigm that will dominate for the next 30–50 years. Indeed Industry 4.0 technologies are expected to replace and displace obsolete 3.0 technologies at an increasingly faster pace.

The transition (OECD, 2019) from 3.0 technologies to 4.0 technologies has been introduced by a thread of continuous and incremental science-pushed innovations that has entered the economy through experimentation and exploration. The drivers and dynamics of technological transitions across technological paradigms have been explored by the Multi-Level Perspective (MLP) framework (Geels, 2002; Geels & Schot, 2007) which argues that system change occurs when a set of new technologies challenges existing ones by moving in from being marginal (niche) to the technological system to becoming mainstream. This occurs when new technologies start outperforming established ones which are thereby gradually set aside. The transition literature suggests therefore a phase where old and new technologies co-exist and where experimentation and discovery run in parallel with resistance. To understand the complex interplay and trade-offs between radically different technological regimes, the evolutionary economic geography literature contends that technological change has a spatial dimension and that regional technological evolution is path dependent (Hassink et al., 2019; Isaksen et al., 2018) and determines regional development trajectories. A fast-growing literature has indeed looked at ecological or green transitions (Hansen & Coenen, 2015; Ramirez, 2021; Truffer & Coenen, 2012) through national and regional case studies.

### **To triple transition**

Digital and green transitions are being increasingly praised in terms of efficiency and productivity gains, but not without an apprehension for the real threats and possible dangers

associated with them. Theory suggests therefore that EU regions will face the current technological change from very different positions depending on their stratified industrial specialisations, technological capabilities, innovation system maturity, policy governance and quality of endogenous resources. Early contributions suggest that innovation in and adoption of digital technologies occur in regions with an existing strength in 3.0 technologies (electronics and computers, petrochemicals and aerospace) (Corradini et al., 2021; Crespo Cuaresma & Lutz, 2021). There is a body of literature that has looked at the adoption of digitally enabled automation (including AI) in the workplace has been found to create an income divide that has widened over time (Autor & Dorn, 2013). As widely documented, skill-biased technological change has indeed redefined the labour market with persistent and widening job and wage polarisation (Autor et al., 2003, 2013; Baldwin, 2019; Harari, 2019; McChesney & Nichols, 2016; OECD, 2021). We know that climate change impacts differently on regions and localities and at the same time, like automation, digitalisation is expected to exacerbate socio-economic divergence.

We draw on the concept of triple transition introduced by Bianchi et al. (2024) and argue that an equitable and fair transition<sup>2</sup> would require investment in human capital similar to those in digital and green technologies. This would allow, on the one side, the availability of competences and skills to industries to power the double transition, and on the other side, it would guarantee the inclusiveness, welfare and wellbeing of as many people as possible. An equitable and fair transition is not primarily about jobs, but about knowledge. Paraphrasing a very famous line, we would argue that social equality is ultimately determined by the race between technology and education (Goldin & Katz, 2009), or more broadly, between technology and competence capability building. However, if investment in digital and green technologies outpaces investment in human capital, we fail to mark a path leading to a triple transition able to deliver an equitable and fair transition (De Propriis & Bailey, 2021).

### 3. From cohesion policy to an industrial strategy

EU Cohesion Policy has been one of the cornerstones of European integration since its reform in the 1990s in concomitance with the creation of the EU Single Market. It was launched in the 1990s with the Reform of the Structural Funds and shaped not only the type of socio-economic development EU believed in and aimed to achieve, but it also revolutionised the nature, objectives and processes of EU socio-economic support. A model based on inter-country fiscal transfers to be managed nationally would have cemented a Union formed by a patchwork of member states denying the opportunity for larger scale ambitions and synergetic cross-countries coordination. Instead, the Reform of EU Cohesion policy introduced the vision of a European Union locked along a path of deeper integration between committed and similar-minded countries sharing the same *European* dream (Rifkin, 2013). It also pivoted EU integration towards the centrality of socio-economic cohesion, namely GDP convergence. A European model of socio-economic development required a governance mechanism that had to strike a difficult balance between supra-national orchestrated endeavours and the recognition of national and regional identities. The design and delivery of EU regional policy have been characterised by subsidiarity (multi-scale), partnership (multi-stakeholder) and evolutionary adjustments.

EU Cohesion Policy was designed and has remained anchored to a policy vision that aimed at sustaining and supporting regional growth as advocated by the convergence of three strands of literature: regional path evolution, spatial agglomeration, external economies, industrial districts and clusters, and forms and processes of learning. Scholarly contributions in the Evolutionary Economic Geography literature have placed great importance on the knowledge base of sectors and innovation for regional growth and resilience (Boschma, 2015; Bristow & Healy, 2014). A sector-based understanding of the forms and direction of regional paths evolution is underpinned by the key concepts of related variety, unrelated variety (Boschma & Iammarino, 2009) and related diversification (Martin et al., 2019). Whilst related variety (Frenken et al., 2007) allows sectors to benefit from each other if they share cognitive proximity (augmenting agglomeration economies), the presence of sectors in a region that present unrelated variety allows for better risk spreading and reduce the possible exposure to asymmetric shocks (Boschma & Iammarino, 2009). Empirical studies have also established with ample evidence that regional economic development and regional technological evolution proceed through incremental adjustments that are path dependent (Martin & Sunley, 2006). Indeed, Balland et al. (2019) find evidence that 'regions are more likely to develop new specialisations in complex technological activities when related to their knowledge bases' (p. 1255). More recently, unrelated and related diversification have underpinned a debate on the processes of regional technological upgrading through path creation (Uyarra et al., 2020; MacKinnon et al., 2019), path branching (Frenken and Boschma 2007), path saltation (Boschma et al., 2016), regional diversification (Boschma, 2017) or technological diversification (Rigby, 2015). All of the above suggest trajectories where new regional path development occurs with changes in a context of continuity (Hassink et al., 2019; Isaksen et al., 2018). It is our consolidated understanding of regional growth that the knowledge bases of regions' industrial specialisations, therefore, matter. We also know that whilst regions are connected internally through agglomeration and external economies (see all the literature on clusters and industrial districts), they are also connected outward through extra-regional linkages (Barzotto et al., 2019) which really affect regional growth if characterised by related variety. Regions' absorptive capacity (Cohen & Levinthal, 1990) here becomes the key factor.

The two decades that followed coincided with a period of relative technological stability and oversaw an aggressive and fast-moving globalisation that shifted the needle of economic activities towards the Asian economies. Efficiency seeking strategies by European MNEs drove the relocation of a large and important part of the EU industrial complex to Southeast Asia. What was indeed described as a 'global shift' (Dicken, 2007) in the international organisation of production to enhance the competitiveness of EU manufacturing industries, turned out to be a lethal process of de-industrialisation, deskilling and socio-economic polarisation. The 2008 Global Financial Crisis marked a sharp watershed. Globalisation turned out not to benefit everyone and in fact, it exposed the fragility and captivity of EU economies to global trends. The post-crisis growth was, however, slow to come due to a long period of fiscal austerity during which debt reduction strategies were preferred over pro-growth investment. Notwithstanding that, the EU commitment to regional policy and cohesion did not falter even in the face of such budget reductions (EC, 2010).

Rather it was reinvigorated by the launch of the Smart Specialisation Strategy (S3) (Foray, 2015; Foray et al., 2012) in the planning round 2014–20, and it has defined EU Cohesion Policy since (McCann & Ortega-Argilés, 2011).

Two key aspects have characterised so far S3. First, S3 has been largely focused on upgrading regional economies given the regional assets and capabilities they had. These determined their specialised knowledge bases and namely their absorptive capacity. On the one hand, as an upgrading strategy, S3 foresaw access to new technologies, mostly key enabling technologies and general-purpose technologies (Bresnahan & Trajtenberg, 1995), to be adopted in already existing industrial sectors to engender an adaptation to market changes. This focus on innovation and technological adoption was criticised as being unfit especially for less developed regions (Barzotto et al., 2020) and argued that the S3 should be interpreted as a choice of priorities between regional sectors rather than focus only on technology development. In other words, it should be conceived as an *industrial policy* rather than an innovation policy only. In this view, the analysis of production processes in relation to the market is key, together with the learning processes implied by the associated structural changes of production structures (Bianchi & Labory, 2019). Innovation processes analysed without considering the necessary transformation in production systems therefore miss an important part of industrial development processes and their impact on the wider socio-economic systems. Similarly, innovation policy designed without considering productive transformations is likely to have limited impact, leading to a lack of industrial application of research.

This leads us to the second aspect, that is the fixation with and reliance of S3 on the entrepreneurial discovery process. This envisages a bottom-up mechanism that allows entrepreneurial forces (with wide stakeholders' involvement) to match new technologies with existing productive activities that are market-ready. The assumption is that the technologies to be adopted are somehow fixed and that once integrated with existing production capabilities will deliver a regional growth based on the regional upgrading (on the concept of upgrading, see Coe & Yeung, 2015) of its existing assets. Although slowly shifting, the technological paradigm was sufficiently stable during the first S3 round (2014–20) especially given that the planning was designed prior to that. More challenging has been the pace and disruption of the technological advancements that are more clearly unfolding at present.

Over three decades, EU Cohesion Policies have been the main channel to deliver innovation, cluster, and competitiveness 'policies', in view of enabling the catching up of low performing regions whilst supporting the global competitiveness of the best performers. Despite the *7th Report on Economic, Social and Territorial Cohesion* (2017) concluded that high GDP regions performed better than low performing ones, with those in the middle stuck in the so-called middle-income trap (Diemer et al., 2022), EU exited the post GFC recession with a sense of optimism thanks to the anticipation of the benefits of the technological shift that was about to unfold (EC, 2014, 2016; EU Parliament, 2015). A greater understanding of the nature, forces and implications of the Fourth Industrial Revolution started to emerge within the business and policy communities (Bianchi & Labory, 2018; De Propriis & Bailey, 2020; EC, 2016; OECD, 2017; Schwab, 2018). It became increasingly clear that the wave of new digital and green technologies was going to redefine products, markets and industries, challenging any socio-economic convergence the EU had pursued until then. In this context, the EU renewed its policy commitment to guarantee

inter-regional economic cohesion. The Europe 2020 Strategy embodied a pivot in EU policy towards a smarter, greener, better connected, more inclusive and spatially aware growth for European regions (EC, 2020). The urgency to support and promote digital and green transitions was, however, weaved in the existing Cohesion Policy framework, with the evolution of S3 into 'Smart Specialisation Strategies for Sustainable and Inclusive Growth' (S4+) (McCann & Soete, 2020). In the 2022 Strategic Foresight Report, the Commission makes a strong argument in favour of social and economic cohesion to be strengthened thanks to twin transitions (European Commission, 2022). The commitment of the EU in this respect was revealed in the political and financial investment that sealed the EU Green Deal and the EU Digital Agenda.

The geopolitical shocks of the 2020s (covid pandemic in 2020–2022, oil shock due to Russia's invasion of Ukraine in 2022) turned the attention to the crucial leadership of governments which had to take unprecedented decisions on the economy: first they forced governments to set aside fiscal responsibility to guarantee people's right to minimum living standards, then it raised the spectre of austerity. Overall, EU policy priorities were reset and renewed with a sense of responsibility and urgency to pursue socio-economic resilience and reimagine growth and prosperity: digital and green transitions started to enthuse EU economies looking forward.

The current debate on the future of EU Cohesion Policy post-2027 raises several issues related to the optimal scale of intervention to respond to societal and technological challenges. Are regions capable of activating the necessary interventions for the triple transition? European regions enter this phase as regional income gaps persist due to path dependent trajectories. Evidence also shows that green and digital transitions are likely to exacerbate existing spatial divides. Therefore, the challenge for EU Cohesion Policy post-2027 is to remain place-based to maintain the agency of regional governments, whilst presiding over the complete transformation of regions' factors of production in ways that require the scale, complexity and vision that national and EU levels policies can deliver.

The technological disruption of the triple transition has renewed great interest in science and technology policies reflected in EU initiatives with a Mission-Oriented approach (Mazzucato, 2021) and in industrial policies targeted at building industrial capacity and championing securing key segments in strategic value chains (Bailey et al., 2023). In this context, we believe key questions are: what does *cohesion* mean? What can the aim of Cohesion Policies be? Can regions just upgrade to deliver the regional transformation 4.0 technologies require?

We would argue that EU Cohesion policy can enable all regions to benefit from a triple transition only to the extent that it supports regions to transition onto the new techno-socio-economic model with a combination of industrial, innovation and labour market policies, namely a transformative industrial strategy. We consider here three key components: (1) investing in productive activities for the *triple transition*; (2) adopting an approach that sees the techno-economic paradigm as a *system of systems* and (3) nesting *multi-territorial* infrastructural investment.

To benefit from the productivity gains of 4.0 technologies, the first priority is to invest in all productive activities for the triple transition, in other words in physical and human capital. Industrial policies have in the last decades tended to focus on innovation and technological change (Bailey et al., 2023), assuming that what mattered was control

over the innovation process leading to the industrial applications of new technologies and the creation of new products. This led to underestimate the dovetailing between innovation and production and the strategic importance of controlling the value chain. However, the recent literature on industrial policy has stressed the importance of more holistic approaches that also considers social, labour, trade and competition policy instruments (Bailey et al., 2015; Bailey et al., 2023; Bianchi & Labory, 2018). Regional economies have embedded, stratified, historically cumulated assets (tangible and intangible) in specific industrial productions. Path dependency theory shows that such legacy locks regions' trajectory on fixed rails with limited opportunities for divergence, renewal or branching. As 4.0 technologies are changing the nature of existing industries and creating new ones, regions could look not just for what is possible but also for what might be desirable: regional transformation might indeed entail forms of knowledge unlearning (Bellandi et al., 2018) as well as capital retiring, overall it requires equal investment in all productive activities: both physical capital and human capital. Goldin and Katz (2008) argue that investment in new technologies will not bring social growth unless it is matched by an equal investment in skills, competences, people. Only investment dedicated to the triple transition (digital, green and skills formation) can enable regions to identify possible 'windows of growth opportunities' in the region and for the region so as to build, anchor and capture the value of their productive capacity (Bailey et al., 2020).

Transformative industrial policies should therefore entail the research, development, adoption and diffusion of 4.0 technologies that require more far-sighted, imaginative, interventionist and game-changing policies that are prepared to commit political capital and resources to *triple* infrastructural investment. Only the latter has the potentials to close the loop and deliver a system change that equalises the opportunities for regions to open up new avenues of regional development. Digital, green and education investment will scaffold the ability of all regions to create new productive activities and retain their value.

Second, the triple transition entails policy design that adopts an approach that sees the techno-economic paradigm as a *system of systems* (Bellandi et al., 2025). Too often innovation and technology policies have focused on research and innovation; industrial policy on sectors and regional policy on place-based interventions, with the national level concerned with macro policies, i.e. fiscal and monetary policies. Such segmentation would fail to deliver *system* change. Bellandi et al. (2025) argue that a transformative strategy works through four nested and interconnected systems: the regional and national innovation systems, the sector innovation system and finally the technological innovation system. These need to be understood as eco-systems that reinforce, complement and overlap with each other as individual actors are in reality operating in all of them at the very same time.

Finally, despite the founding principle of subsidiarity, Cohesion Policies have primarily been bottom-up and place-based in the design and implementation. This has allowed for tailored and dedicated interventions fitting the needs of regions within some broad parameters matching EU priorities. Whilst, this has been successful in supporting regional incremental upgrading, the full benefits of the system change that is unfolding demands the EU, national and regional governments to assume *nested critical roles* (Bellandi & De Propriis, 2023). The literature on mission-oriented policies (Mazzucato, 2018, 2021, 2024) has advocated for a policy design that addresses grand challenges – such

as climate change or aging – thanks to the coordination of diverse stakeholders at the national and regional levels. The mission-oriented approach started shifting our fixation with the dichotomy top-down versus bottom-by, by suggesting that societal or technological challenges that impact on the whole society or economy require system-level interventions.

Along these lines, we would argue that the current technological paradigm shift requires infrastructural investment that requires scale, integrability and connectivity in a way that can only work if designed and coordinated at the national level. Investment in energy, transport and communications will set the foundation for the technological shift that will unfold in all other industries, in the public sector and in the civic society. New rules, regulations, guidance and code of conducts will have to be drafted, and this can only occur at the national and EU levels to guarantee coherence and consistence.

#### 4. Three case studies

We present three case studies to illustrate respectively: (a) the relevance to design a regional industrial policy that triangulates digital, green and skills transitions in the Emilia Romagna region, (b) the strategic importance of connecting technology, sector, place and national levels in the case of Sweden and (c) the transformational vision of coordinating an energy shift that requires investment, scale and multi-level coordination.

##### *Case 1: Emilia Romagna, Italy*

The implementation of EU Cohesion Policy in the Emilia Romagna (ER) region provides an insightful case study of how far beyond the Smart Specialisation Strategy policy design can be stretched to pivot towards a regional industrial policy that triangulates digital, green and skills transitions.

The ER region is part of the well-known Third Italy where industrial districts formed the backbone of the industrial miracle of the 1970s and 1980s, and that laid the foundation for the regional competitiveness of these regions since. ER is a highly competitive region with one-third of employment in manufacturing SMEs; regional GDP is about 20% higher than the EU average, and it is ranked as a ‘strong innovator’ in the EU Regional Innovation Scoreboard. Thanks to devolved powers, the regional government has a degree of freedom to shape the vision of its regional growth, and this has been strengthened since the 1990s with EU Cohesion Policies directly involving regional actors in the design and implementation of initiatives. Regional industrial policies have been implemented since the 1980s and allowed the regional industrial system, primarily based on industrial districts in traditional sectors, to transform into a regional innovation system with manufacturing specialisations that have become increasingly more high-tech (Bianchi and Labory 2019). Since the launch of EU Cohesion Policies, innovation has become an important focus of industrial policy throughout the 1990s, while strongly connected to the regional industrial base (Bianchi & Labory, 2021).

In 2014–20 round of S3, the ER region launched a transitioning *industrial strategy* through a new policy instrument called Clust-ER (ClustER in what follows) in critically important sectors of the region: (1) MECH, regards mechanical engineering and mechatronics; (2) AGRIFOOD, agriculture and the food-processing industries; (3) BUILD,

construction and building industries; (4) HEALTH, health and wellbeing industries, and (5) CREATE, cultural and creative industries. Six more were added in the 2021–27: (6) GREENTECH, energy and sustainable development industries; (7) INNOVATE, digital services; Big data and AI; and logistics; (8) TOURISM; (9) URBAN ECONOMY, smart and sustainable cities; (10) BIG DATA Association, created together with the infrastructural hub in the capital city of the region, Bologna, and (11) MUNER, the university of the Motor Valley.

There are three aspects of ClustER that we highlight. First, the realisation that the digital and green transitions had disruptive effects on all productive activities alerted policymakers to need to strengthen the innovation capacity especially of SMEs by connecting the latter with the regional innovation infrastructure (universities and research centres). Indeed, technological change shifted the attention from incremental innovation based on DUI models of production familiar to small firms to more radical innovations that required access to technologies distant from firms' core competencies. For this, each ClustER was defined in broad terms to capture and anchor higher value added parts of the regional value chain, and it connected the relevant regional nodes of the regional innovative and productive systems to increase their capabilities to innovate, to produce both new products and new production processes for the transition, and to exploit complementarities and cross-fertilisations among the different productive activities in the region.

Second, the vision of the policy was to create a network of ClustERs whereby, the object of the policy was not limited to selected sectors associated to digital or green. More crucially, a transversal approach was adopted to transform all the regional productive activities from food/tourism to AI/mechatronics. The inter-sectoral synergies that connecting these ClustERs could generate showed an understanding of the opportunities of a twin transition (Faggian et al., 2024). In other words, the policy reveals the opportunity for an industrial strategy that encourages firms to innovate by exploiting synergies either with research organisations or with other firms in value chain based on unrelated technologies, allowing a transitioning trajectory through branching, diversification or saltation openings. Examples of this are specifically two ClustERs which are inherently transversal: GREENTECH and INNOVATE, enabling both the green and digital transition in all other sectors of the region.

Finally, the ClustER policy placed a strong emphasis not only on green and digital transitions but also on a commitment to 'justice and inclusivity' (Bianchi & Labory, 2019). The latter translates in a focus on building critical skills for the future. Indeed the policy has been part of a bigger regional framework called The Labour and Climate Pact which aimed for the region to become a place '*where research, innovation and skills are the strategic levers of change, for sustainable and inclusive development*'.<sup>3</sup> In other words, the ambition is for 'transitions to be able to ensure decent jobs and living conditions' (Bianchi & Labory, 2019) in line with concepts of a just transition. The idea of social inclusiveness and equality to be tied together with green and digital transitioning allows policy instruments to connect them society and in particular to labour. As new technologies require new competences, the labour force needs to be invested in to acquire new skills to carry out new jobs or to carry out tasks in existing jobs. A triple transition therefore enables a form of industrial development that respects and is inevitably linked to people and to the society. This is why the ClustER policy echoes the first tenet of this paper that a triple transition requires creating and developing the skills that will underpin the jobs of the future.

Examples of this are the instruments the policy deploys: the promotion of ClustERs is activated with new research activities and cross-sector collaborations, strategic innovation projects, systemic actions, skills and competencies boosting, firm creation and startups, as well as practical actions to digitally upgrade the private and public sectors in line with the EU Digital Agenda.

Other examples are MUNER and the BIG DATA Association. MUNER is ERa Motor Valley, comprising the main automotive companies and the universities of the region, and it trains engineers to develop frontier technologies for this sector. MUNER and the Big Data Association are primarily aimed respectively at education and research. MUNER aims at providing the human capital for the automotive companies located in the region; it could have been included in the MECH ClustER, to which it could have added a skills dimension. However, it is an additional strategic node of the region, since regional firms of the Motor Valley have many international links and together aim to become a centre of excellence for the production of high-end vehicles in the luxury cars market segment, and crucially transitioning to electric cars in particular.

### **Case 2: Sweden: a system of systems**

Sweden is a small high income open economy. In the 1980s and 1990s, Swedish pursued an industrial policy aimed at creating a favourable macro environment for businesses with an internal resource redistribution mechanism that gave the policy a regional dimension. This period saw Sweden underperforming against its inputs, especially the high quality of human capital and the presence of large enterprises. This Swedish paradox was blamed on poor the research system, including inadequate university sector, and resulted in relative low performance in terms of export of innovative products, slow growth and low innovation intensity (Swedish Agency for Growth Policy Analysis, 2011). The protectionist policies characterising the 1980s (blocking foreign ownership to reduce domestic competition) were relaxed in the 1990s in preparation to EU membership. Evidence shows a sharp increase in the MNEs' entries and therefore a rise of foreign ownership in the 1990s which allowed Swedish MNEs to be plugged into global value chains by moving low skill manufacturing jobs to emerging markets leaving in Sweden high productivity jobs only, as an increase in domestic wages shows (Bandick & Hansson, 2009). In this phase, the focus turned to high productivity and high wages as the only sustainable pathways to Swedish prosperity, kickstarting an obsession with innovation as engine of economic competitiveness. This model was also able to sustain a model of high tax and diffused public services needed to compensate for its peripherality and uneven population density. Consequently, in the early 2000s Swedish policy pivoted away from an industrial policy aimed at shaping the business environment to a policy focused on investing in innovation capabilities and supporting innovative activities. Sweden joined the EU, and conjunctly the Single Market in 1995. The entry of the Scandinavian economies in the EU coincided with the set-up of a special fund for 'sparsely populated regions,' signalling the EU commitment to new members and the emphasis of EU regional policy's concern with its geographical periphery.

Innovation has been a clear and declared objective of Swedish government since the 2000s. The starting point was the construction of an advanced, pro-active, cutting-edge National Innovation System. The introduction in 2002 of a separate chapter on innovation

in the Central Government Budget Bill Under the title 'R&D and Collaboration in the Innovation System', and updated over a four-year cycle (Swedish Agency for Growth Policy Analysis, 2011), sealed the complete change of approach towards promoting Swedish competitiveness, no longer by creating a favourable macro-economic environment for businesses, but focusing on unlocking innovation dynamics in sectors, in firms and more crucially at the system level both nationally and locally (Swedish Government, 2011). The vision and the ambitious objectives of the Innovation Bill were meant to be delivered by what we would describe as a system of systems: namely, the nesting of national and regional innovation systems was complemented by initiatives aims at sectors and, transversally, at technologies.

The National Innovation System was scaffolded by a policy and institutional infrastructure that included private and public actors that were well-funded, highly specialised, and smoothly integrated (OECD, 2016). The Government sets long-term vision and goals and has a hands-off political oversight; it operates through national-level public and private organisations that represent different interests and constituencies. Their involvement at the national level seems to provide accountability and endorsement. The main key national agencies include VINNOVA (Swedish Parliament, 2009), Tillväxtverket (the Swedish Agency for Economic and Regional Growth), RI.SE (Research Institutes of Sweden), Formas (Government research council for sustainable development), SP (Technical Research Institute of Sweden), and ALMI (Swedish state-owned enterprise that provide risk capital). VINNOVA was set up as the Swedish Agency for Innovation Systems with a policy and operative remit in relation to innovation (Swedish Government, 2011). VINNOVA is the government agency tasked with delivering the vision and objectives spelt out in the Government Innovation Bill.

The vision and innovation ambition of the Government have been translated in different priorities and delivered with different tools. For example, there is evidence of a shift from supporting technological diversification of traditional industries (e.g. logging, mining) to championing new industries such as ICT, with a commitment to place-based innovation systems, and to, at present, pivoting towards grand societal challenges (Vinnova, 2025).

The launch in 2001 of the Vinnväxt Programme by Vinnova showed an awareness of the benefits of pursuing a diffused and bottom-up innovation policy that started from regions. The Vinnväxt programme was designed around the theoretical concept of the Regional Innovation System and a triple helix activated, empowered, and connected critical and strategic stakeholders within the region (Eriksson et al., 2010). The Vinnväxt programme was introduced before S3 and has proved to be an effective, pro-active and transformative tool to stimulate, guide and support the industrial and economic renewal of regions. Before S3, the Vinnväxt Programme advocated for regional competitiveness to depend on place-based innovation factors and drivers, whilst aiming to compete internationally (Andersson, 2012). Vinnväxt has been an important programme aimed at supporting and championing 'growth through dynamic innovation systems' (Vinnova, 2016), and with the objective of strengthening Sweden's innovation capacity by encouraging regional renewing agendas 'to develop research and innovation milieus' that are able to catalyse key regional stakeholders applying the triple helix model. Vinnväxt was designed to allow regions to identify areas of strengths and pathways of renewal within the parameters fixed by the aims and objectives of the

national-level framework. Keywords in the Vinnväxt programme have been innovation, reviewal and sustainable growth. This explains the long-term horizon of the scheme (funding is available for up to 10 years) allowing for institutional capacity building, research and testing capability building, prototyping, and the construction of test beds and demonstrators. In addition to all this, it crucially emboldened regions to identify and test possible renewal paths by accepting some element of risk and experimentation.

Swedish innovation policy has undoubtedly had a regional dimension that has been implemented thanks to the initiatives of both Vinnova (through the Vinnväxt programme) and Tillväxtverket, which, since the introduction of the Smart Specialisation Strategy, has overseen and allocated EU regional funding to Sweden regions. One further element is the regional branching of national-level agencies and institutes. For instance, RI.SE is present across more than 30 locations in Sweden from north to south with multiple operations that include testing facilities, demonstrators, laboratories, office. This on the ground localised presence covers five priorities areas climate and environment, health and welfare, digitalisation, talent management and working life, and a strong democratic society. ALMI equally has 16 regional offices, and ALMI INVEST, which is devoted to risk capital operations has nine regional branches. Again, FORMAS fund projects that by default have regional or local dimensions whether in coastal areas or build environment.

More recently, the Swedish government has introduced programmes that have a technological priority. Strategic Innovation Programmes (SIPs) were launched in 2014 as a national-level technology focused programme aimed at creating collaboration between relevant stakeholders from academia, business and the public sector to develop radical innovation that have the potential to create cross-sector spillovers. The ambition of SIPs is to support 'collaborations for sustainable innovation'. The targeted technologies included bio-innovation, IoT, process industrial automation, graphene, med tech, etc. SIPs are not meant to be spatially aware like the Vinnväxt programme but aim to create and strengthen the technological capabilities of the country in strategic areas that have a long-term impact on the competitiveness of the country. Since the programme aims to create trans-local networks of frontier (expert) stakeholders, it tends to engage regional clusters that participate because of their expertise, and in the process, they benefit from the opportunity to access frontier knowledge in emerging technologies and to translate the applications of the relevant technology to their specific sector. SIPs have co-funded test beds, research infrastructure in key locations depending on the RIS and the sector specialisation. The more transversal (cross-sector and cross-technology) approach of the Challenge Driven Innovation Programme, that ran over 2011–23, provided funding for trans-local collaborative projects to solve societal challenges. This has been replaced by the Impact Innovation Programme (IIP, 2025; Vinnova, 2025). This is again a transversal programme [trans-local, cross-tech and cross-sector] aiming to 'identify, mobilise and fund' projects that build five critical innovation capabilities to find solutions to societal challenges specifically on green and digital transition (zero emissions from industry, sustainable metal and mineral supply, resilient management of water resources, a reformed public sector and sustainable community building and mobility). The IIP is seen as a shift towards a more top-down and challenge-driven approach that is more tightly anchored in the NIS since it encourages collaborations and networks of actors that are experts in the field.

Finally, there are programmes that Vinnova co-funds and co-designs with industry partners and business that have a sector focus such as FFI (Automotive Strategy Research and Innovation, FFI, 2025). For these programmes, the systemic nature of the policy support design is not spatial but sectoral as it looks at the industry ecosystem.

### *Case 3: EU battery technology policy*

Battery technology has become increasingly important as society uses more powerful portable electronic devices; however, its role has now become essential as we move towards a greater reliance on renewable energies requiring storage and grid balancing; similarly, the electrification of transport rests on the size and power of batteries. However, the fast pace of the digital and green transitions has left European countries exposed to depend on battery technology from mainly China. Control over the battery value chain has therefore become an existential threat for European economies' productivity growth and resilience.

To address this, the European Union adopted a comprehensive battery technology policy as part of the European Green Deal, Industrial Strategy, Critical Raw Materials Act, Fit for 55 and Circular Economy Action Plan together with the Batteries Regulation framework (Regulation (EU) 2023/1542). The objective of this policy framework was to develop a sustainable and circular battery life cycle from the sourcing of raw material to production, use and recycling. A crucial part of the battery technology policy has been to pursue EU strategic autonomy in battery production, by building more of the battery value chain within Europe (production, recycling, etc.). This ambition can be seen as a strategic industrial policy that aims at reducing EU dependency on foreign producers for a technology that is the building block of both the clean energy transition and the digital transformation. At the same time, it meets the need to create resilient jobs in emerging industries. The EU has now put in place a supra-national mesh of policy instruments with funding to be invested in member states and regions to develop battery production capacity, including the creation of a European battery Alliance, the involvement of the European Investment Bank and the alignment of the Horizon programme and the Structural Funds for the battery priority. Indeed, tight budget constraints have meant that the EU battery industrial policy has been folded into the Smart Specialisation Strategy to allow regional stakeholders to access funding.

Notwithstanding all this, the EU failed to translate its ambition into an actual success story in the Northvolt case. This begs the question: why was Northvolt a failure in EU industrial policy. The answer is threefold. First, the EU tried entering an industry whose entire value chain was already well developed in Asia, especially in China, Japan and Korea. Indeed, for instance, China started investing in battery technology in the late 1990s because it anticipated the need to shift to electric mobility due to pollution problems and to reduce its dependence on oil. To some extent, the Chinese government took the risk at first to invest in a very infant technology, but it ramped up control over the battery value chain in the last 10 years. By contrast, on the one hand, leading car European automakers dragged their feet in the shift to EVs missing the chance to be first movers and also crucially failed to understand the centrality of battery technology for the whole electrification transition. On the other hand, European governments orchestrated a battery value chain strategy only in 2017. When politically and economically,

the critical importance of battery technology became evident, it was literally too late. Second, even then, they underestimated the cost and scale of the 'mission'. The EU strategy rested on creating an EU champion, Northvolt, located in one of the member states, Sweden. This required an alignment between EU- and national-level visions that simply was not there. Sweden had had a policy stance against promoting champions for decades, that led, in this case, to the ultimate decision not to back what was meant to be an EU 'winner', simply on Swedish soil. This shows a misalignment between national and EU priorities. Besides, the vision, leadership and coordination of the EU policy need to be coupled with the need to localise battery production in specific localities hence the need to open a channel of engagement with regional actors. In the case of Northvolt, location disadvantages at the regional level in Skellefteå in terms of labour cost and availability, energy costs, and finance all proved to be a challenge given the scale of the project. More broadly, the pivot of the Smart Specialisation Strategy towards strategic priorities usually within the realm of industrial policy shows the limitations of a model to promote regional growth that remains bottom-up in name only.

Finally, the EU misjudged its limitations and therefore there was a mismatch between its ambition and the implementation. The difficulty of building the whole value chain was underestimated, and it proved ultimately to be impossible. Despite the fact that the EU went into this project as a latecomer, it failed to appreciate that developing and producing batteries at scale is complex, expensive and uncertain; it relies on huge upfront capital investment, it is still highly risky because the technology is still evolving and it requires control over a long and multi-located supply chain that has also to be scaled up. The limited experience in executing projects of such a large scale meant that the EU lacked cognisance of the inevitable public investment that was needed and of the risk it entailed; instead, it set rigid conditionalities which prevented even the limited committed funding to be disbursed. In summary, this case study shows that like an infrastructural project or a 'mission', the transformational ambition to control a strategic technology like batteries would have required the ambition to be matched by adequate public investment, scale and multi-level coordination at the EU, national and regional levels. However, this failed to happen.

In summary, the three cases just discussed show that, first, the current EU Cohesion Policy framework can be effective in delivering transformative change that connects digital, green and skills transitions when strong regional institutional capacity coupled with a competitive regional industrial base target-specific objectives and pathways of implementation, as in the Emilia Romagna region. At the same time, technological change requires a policy change that connects technology, sector and place in a way that moves the policy-making approach away from the dichotomy bottom-up and top-down but considers interventions that are transversal between technology and sectors and cut across multi-level geographies as in the case of Sweden. Finally, the last case presented in this paper is one of failure. The urgency to power the digital and green transition requires investment in new technologies, in this case batteries that are in terms of scale, complexity and interoperability equivalent to an infrastructural project. The failure of the Northvolt gigafactory in Northern Sweden shows that the EU and national governments have yet to fully appreciate the consequences of missing out on controlling battery technology and production for EU long-term growth and strategic autonomy.

## 5. Conclusion

The main argument presented in this paper is that the current disruptive and systemic technological shift – embodied in the digital, green and skills transitions – poses a significant threat to persistent EU socio-economic disparities due to forces of path dependence, resistance, and institutional lock-in. While Smart Specialisation Strategies have been effective to a degree in enabling low performing regions to ‘keep up’ with higher performing ones, it has not delivered convergence. Incremental upgrading within existing trajectories simply cannot ensure cohesion in a period of profound techno-economic transformation.

In this context, we argue that European cohesion would be better achieved through a transformative industrial strategy that integrates EU- and national-level investment in productive factors for the triple transition – physical, digital, and human capital – within a coordinated and multi-level governance framework. Such a strategy would move beyond the incrementalism of regional upgrading towards the creation of new capabilities, industries and infrastructures. It would also adopt an approach that understands the techno-economic paradigm as a system of systems, encompassing sectoral and technological innovation systems, nested in multi-territorial infrastructural investment.

The case studies explored in this paper illustrate the key tenets of this approach. The Emilia Romagna case demonstrates the potential of regional industrial policy that triangulates digital, green and skills transitions, while Sweden’s innovation policy highlights the importance of connecting sectoral, territorial, and national systems within a coherent framework. In contrast, the EU’s battery strategy exposes the risks associated with inadequate coordination and insufficient scale in implementing mission-oriented industrial policies. Collectively, these cases underscore that Europe’s future competitiveness and cohesion depend not on technological catching-up, but on its capacity for transformation.

From a policy perspective, several implications emerge. First, post-2027 EU Cohesion Policy should integrate industrial, innovation and skills strategies within a single transformative framework, ensuring that investment in technology is matched by equivalent investment in human capability building. Second, the subsidiarity principle should be reinterpreted to combine place-based agency with strong national- and EU-level coordination capable of steering system-wide transformation. Third, mission-oriented investment should be pursued at a scale comparable to major infrastructural programmes, capable of embedding strategic autonomy and socio-economic resilience within European production systems. Finally, social justice and inclusion must be firmly centred at the core of transformative industrial strategy, ensuring that productivity and technological gains translate into equitable and sustainable regional development.

Further research could aim to identify empirically how triple transition investments reshape regional innovation systems, labour markets, and value creation processes, and under what institutional configurations they foster both growth and equity. Comparative and longitudinal studies might usefully illuminate how different governance architectures mediate the alignment of regional-, national- and EU-level objectives. In particular, new conceptual and methodological frameworks are required to capture and measure the transformative capacity of regions and nations – that is their ability to reconfigure

productive factors, skills systems and infrastructures in a way that is in tune with the evolving techno-economic paradigm.

In conclusion, the European Union stands at a critical juncture. Persisting with a cohesion policy based primarily on upgrading risks perpetuating divergence under the guise of progress. We suggest that embracing a transformative industrial strategy that redefines cohesion as the shared capacity to navigate and shape the triple transition offers a more sustainable and inclusive pathway. In so doing Europe has a better chance of securing long-term socio-economic resilience, strategic autonomy, and a just and equitable transformation across its regions.

## Notes

1. This in turn raises issues around a 'just transition' for workers. See, for example, de Ruyter and Bentley (2024), de Ruyter et al. (2024) and Hearne et al. (2025).
2. The concept 'Just Transition' is much contested (Rainnie & Snell, 2024, Weller et al. 2024) but it has gained traction recently in policy and research debates (de Ruyter & Bentley, 2024). Recent work has for example explored impacts such as economic restructuring (Beer et al., 2024; Bianchi et al., 2024; Ding & Hirvilammi, 2024), across sectors like automotive (see de Ruyter et al., 2024 and Hancké & Mathei, 2024) and textiles (Pugh et al., 2024) and also places (Henry, 2024; Norris et al., 2024; Hearne et al., 2025).
3. From the document of the 2021–27 S3 of the ER region, translated by the author(s). See <https://fesr.regione.emilia-romagna.it/s3/2021-2027>.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

No funding was received.

## Notes on contributors

*Lisa De Propriis* is a Professor of Regional Economic Development in the Birmingham Business School (UK). She has expertise in manufacturing clusters, industrial and regional policy, innovation and technological change, industry 4.0 and twin transitions. She has published extensively in top academic journals. She sits on the Editorial Boards of *Regional Studies*, *Journal of Industrial and Business Economics* and *Progress in Economic Geography*.

*Sandrine Labory* is an Associate Professor of Economics at the University of Ferrara, Italy. Her research is focused on industrial economics and policy, including comparative analysis of national and regional industrial policies, innovative and productive processes at firm and territorial levels, structural changes and industrial development. She has been involved in research projects commissioned by the European Commission, the OECD and regional governments.

## References

- Aiginger, K., & Rodrik, D. (2020). Rebirth of industrial policy and an agenda for the twenty-first century. *Journal of Industry, Competition and Trade*, 20(2), 189–207. <https://doi.org/10.1007/s10842-019-00322-3>

- Andersson, S., Berglund, K., Gunnarsson, E., & Sundin, E. (2012). *Promoting innovation - policies, practices and procedures*. VINNOVA -Verket för Innovationssystem / Swedish Governmental Agency for Innovation System.
- Autor, D. H., & Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review*, 103(5), 1553–1597. <https://doi.org/10.1257/aer.103.5.1553>
- Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, 118(4), 1279–1333. <https://doi.org/10.1162/003355303322552801>
- Bailey, D., Cowling, K., & Tomlinson, P. R. (2015). *New perspectives on industrial policy for a modern Britain*. Oxford University Press.
- Bailey, D., & De Propriis, L. (2007). Industrial and regional policies in an enlarging EU. *Policy Studies*, 28(4), 291–294. <https://doi.org/10.1080/01442870701640609>
- Bailey, D., Labory, S., & Tomlinson, P. R. (2023). Industrial policy beyond market failure: Structural dynamics, innovation and economic governance for industrial development. In P. Bianchi, S. Labory, & P. R. Tomlinson (Eds.), *Handbook of industrial development* (pp. 322–337).
- Bailey, D., Pitelis, C., & Tomlinson, P. R. (2020). Strategic management and regional industrial strategy: Cross-fertilization to mutual advantage. *Regional Studies*, 54(5), 647–659.
- Baldwin, R. (2019). *The globotics upheaval. Globalisation, robotics and the future of work*. Oxford University Press.
- Balland, P. A., Boschma, R., Crespo, J., & Rigby, D. L. (2019). Smart specialization policy in the European Union: Relatedness, knowledge complexity and regional diversification. *Regional studies*, 53(9), 1252–1268.
- Bandick, R., & Hansson, P. (2009). Inward FDI and demand for skills in manufacturing firms in Sweden. *Review of World Economics*, 145(1), 111–131. <https://doi.org/10.1007/s10290-009-0002-9>
- Barzotto, M., Corradini, C., Fai, F., Labory, S., & Tomlinson, P. (2019). Enhancing innovative capabilities in lagging regions: An extra-regional collaborative approach to RIS3. *Cambridge Journal of Regions, Economy and Society*, 12(2), 213–232. <https://doi.org/10.1093/cjres/rsz003>
- Beer, A., Weller, S., Dinmore, H., Ratcliffe, J., Onur, I., Bailey, D., Barnes, T., Irving, J., Horne, S., Atienza, J., & Sotarauta, M. (2024). Just transitions in the Australian automotive sector? *Contemporary Social Science*, 19(1–3), 178–198. <https://doi.org/10.1080/21582041.2024.2322132>
- Bellandi, M., & De Propriis, L. (2023). Transformative challenges, nested innovation systems, and multi-actor agency. In *RSA conference proceeding*. RSA International Conference.
- Bellandi, M., De Propriis, L., & Bailey, B. (2025). Transformative technological challenges and nested innovation systems in a multipolar world, mimeo.
- Bellandi, M., Santini, E., & Vecciolini, C. (2018). Learning, unlearning and forgetting processes in industrial districts. *Cambridge Journal of Economics*, 42(6), 1671–1685. <https://doi.org/10.1093/cje/bey032>
- Benassi, M., Grinza, E., & Rentocchini, F. (2020). The rush for patents in the fourth industrial revolution. *Journal of Industrial and Business Economics*, 47(4), 559–588. <https://doi.org/10.1007/s40812-020-00159-6>
- Bianchi, P., De Propriis, L., & Labory, S. (2024). People-centred policies for a just transition (digital, green and skills). *Contemporary Social Science*, 19(1–3), 262–282. <https://doi.org/10.1080/21582041.2024.2351479>
- Bianchi, P., & Labory, S. (2018). *Industrial policy for the manufacturing revolution. Perspectives on digital globalisation*. Edward Elgar.
- Bianchi, P., & Labory, S. (2019). Regional industrial policy for the manufacturing revolution: Enabling conditions for complex transformations. *Cambridge Journal of Regions, Economy and Society*, 12(2), 233–249. <https://doi.org/10.1093/cjres/rsz004>
- Boschma, R. (2015). Towards an evolutionary perspective on regional resilience. *Regional Studies*, 49(5), 733–751. <https://doi.org/10.1080/00343404.2014.959481>
- Boschma, R., Coenen, L., Frenken, K., & Truffer, B. (2016). Towards a theory of regional diversification. *Papers in Evolutionary Economic Geography*, 16(17), 1–23.

- Boschma, R., & Iammarino, S. (2009). Related variety, trade linkages, and regional growth in Italy. *Economic Geography*, 85(3), 289–311. <https://doi.org/10.1111/j.1944-8287.2009.01034.x>
- Bresnahan, T. F., & Trajtenberg, M. (1995). General purpose technologies 'engines of growth'? *Journal of Econometrics*, 65(1), 83–108. [https://doi.org/10.1016/0304-4076\(94\)01598-T](https://doi.org/10.1016/0304-4076(94)01598-T)
- Bristow, G., & Healy, A. (2014). Regional resilience: An agency perspective. *Regional Studies*, 48(5), 923–935. <https://doi.org/10.1080/00343404.2013.854879>
- Brynjolfsson, E., & McAfee, A. (2014). *The second machine Age: Work, progress, and prosperity in a time of brilliant technologies*. Norton and Company.
- Capello, R., & Lenzi, C. (2021). 4.0 technologies and the rise of new islands of innovation in European regions. *Regional Studies*, 55(10–11), 1724–1737. <https://doi.org/10.1080/00343404.2021.1964698>
- Coe, N. M., & Yeung, H. W. C. (2015). *Global production networks. Theorizing economic development in an interconnected world*. Oxford University Press.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152. <https://doi.org/10.2307/2393553>
- Corradini, C., Santini, E., & Vecciolini, C. (2021). The geography of industry 4.0 technologies across European regions. *Regional Studies*, 55(10–11), 1667–1680. <https://doi.org/10.1080/00343404.2021.1884216>
- Crespo Cuaresma, J., & Lutz, S. U. (2021). Modelling and projecting digital trends in European regions: An econometric framework. *Regional Studies*, 55(10–11), 1696–1710. <https://doi.org/10.1080/00343404.2021.1976746>
- De Propriis, L., & Bailey, D. (2020). *Industry 4.0 and regional transformations*, Routledge, London. (This volume is one of the outputs of the Horizon 2020 project MAKERS). Open access e-book at <https://www.taylorfrancis.com/books/e/9780429057984>.
- De Propriis, L., & Bailey, D. (2021). Pathways of regional transformation and industry 4.0. *Regional Studies*, 55(10–11), 1617–1629. <https://doi.org/10.1080/00343404.2021.1960962>
- de Ruyter, A., & Bentley, G. (2024). Enabling a just transition. *Contemporary Social Science*, 19(1–3), 1–20. <https://doi.org/10.1080/21582041.2024.2360953>
- de Ruyter, A., Bentley, G., Hearne, D., Bailey, D., & Nielsen, B. (2024). A 'just transition' for workers in the automotive sector? Survey evidence from the west midlands. *Contemporary Social Science*, 19(1–3), 199–222. <https://doi.org/10.1080/21582041.2024.2353684>
- Dicken, P. (2007). *Global shift: Mapping the changing contours of the world economy*. SAGE Publications Ltd.
- Diemer, A., Iammarino, S., Rodríguez-Pose, A., & Storper, M. (2022). The regional development trap in Europe. *Economic Geography*, 98(5), 487–509. <https://doi.org/10.1080/00130095.2022.2080655>
- Ding, J., & Hirvilammi, T. (2024). Three pillars of just transition labour market policies. *Contemporary Social Science*, 19(1–3), 244–261. <https://doi.org/10.1080/21582041.2024.2316656>
- Dosi, G. (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research Policy*, 11(3), 147–162. [https://doi.org/10.1016/0048-7333\(82\)90016-6](https://doi.org/10.1016/0048-7333(82)90016-6)
- Eriksson, A., Allee, V., Cooke, P., Harmaakorpi, V., Sotarauta, M., & Wallin, J. (2010). *The Matrix - Post cluster innovation policy. VINNOVA -Verket för Innovationssystem/Swedish Governmental Agency for Innovation System*. <https://www.vinnova.se/contentassets/b216bc6cabe548f4832715ded9302fc8/vr-10-10.pdf?cb=20170719152556>
- European Commission. (2010). Fifth report on economic, social and territorial cohesion. In *Investing in Europe's future*. Publications Office of the European Union. <https://doi:10.277629620>.
- European Commission. (2014). *Communication: Towards an industrial renaissance*. COM/2014/014 final.
- European Commission. (2016). *Industry 4.0*.
- European Commission. (2017). *My region, my future, our Europe*. Seventh report on economic, social and territorial cohesion, Luxembourg: Publications Office of the European Union.
- European Commission. (2020). *EUROPE 2020 A strategy for smart, sustainable and inclusive growth*, Communication from the Commission, Brussels, 3.3.2010 COM(2010) 2020.
- European Commission. (2021). *Industry 5.0. Towards a sustainable, human-centric and resilient European industry*. R&I Paper Series Policy Brief.

- European Commission. (2022). Strategic Foresight Report Twinning the green and digital transitions in the new geopolitical context, Communication from the Commission to the European Parliament and the Council 2022, COM/2022/289 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0289>.
- European Commission. (2024). Ninth report on economic, social and territorial cohesion. Publications Office of the European Union, European Union. Inforegio – Ninth report on economic, social and territorial cohesion.
- European Parliament. (2015). *Industry 4.0. Digitalisation for productivity and growth. Briefing*. EPRS, European Parliamentary Research Service.
- Faggian, A., Marzucchi, A., & Montesor, S. (2025). Regions facing the ‘twin transition’: Combining regional green and digital innovations. *Regional Studies*, 59(1), <https://doi.org/10.1080/00343404.2024.2398555>
- FFI. (2025). FFI – Strategic vehicle research and innovation, FFI – Vägtransportinnovationer för ett hållbart samhälle – Vägtransportinnovationer för ett hållbart samhälle (accessed 12/09/2025).
- Foray, D. (2015). Smart specialisation: Opportunities and challenges for regional innovation policy, regional studies association. In *Regions and cities series*. Routledge.
- Foray, D., Goddard, J., Beldarrain, X. J., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C., & Ortega-Argilés, R. (2012). *Guide on research and innovation strategies for smart specialisation (RIS3 guide)*. European Commission, Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS).
- Frenken, K., & Boschma, R. A. (2007). A theoretical framework for evolutionary economic geography: Industrial dynamics and urban growth as a branching process. *Journal of economic geography*, 7(5), 635–649.
- Frenken, K., Van Oort, F., & Verburg, T. (2007). Related variety, unrelated variety and regional economic growth. *Regional studies*, 41(5), 685–697.
- Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, 31(8–9), 1257–1274. [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8)
- Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399–417. <https://doi.org/10.1016/j.respol.2007.01.003>
- German Trade and Invest (GTAI). (2014). *Industrie 4.0. Smart manufacturing for the future*. GTAI.
- Goldin, C., & Katz, L. F. (2009). *The race between education and technology*. Harvard University Press.
- Goodwin, T. (2018). *Digital Darwinism. The survival of the fittest in the age of business disruption*. Kogan Page.
- Hancké, B., & Mathei, L. (2024). Varieties of just transitions in the European car industry. *Contemporary Social Science*, 19(1–3), 135–153. <https://doi.org/10.1080/21582041.2024.2317389>
- Hansen, T., & Coenen, L. (2015). The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environmental Innovation and Societal Transitions*, 17, 92–109. <https://doi.org/10.1016/j.eist.2014.11.001>
- Harari, Y. (2019). *21 lessons for the 21st century*. Vintage.
- Hassink, R., Isaksen, A., & Trippel, M. (2019). Towards a comprehensive understanding of new regional industrial path development. *Regional Studies*, 53(11), 1636–1645. <https://doi.org/10.1080/00343404.2019.1566704>
- Hearne, D., Bailey, D., & de Ruyter, A. (2025). Regions and just transitions: Worker perspectives on electrification in two automotive regions. *Regional Studies*, <https://www.tandfonline.com/doi/full/10.108000343404.2025.2488205>.
- Henry, M. S. (2024). Transition obstructionism and ‘embodied energy injustice.’ A Wyoming case study. *Contemporary Social Science*, 19(1–3), 337–354. <https://doi.org/10.1080/21582041.2024.2333274>
- Impact Innovation Programme. (2025). Impact Innovation – Sweden’s innovation initiative for the 2030s, accessed 06/08/2025.
- Isaksen, A., Tödting, F., & Trippel, M. (2018). Innovation policies for regional structural change: Combining actor-based and system-based strategies. In A. Isaksen, R. Martin, & M. Trippel (Eds.),

- New avenues for regional innovation systems – Theoretical advances, empirical cases and policy lessons* (pp. 221–238). Springer.
- Kaplinski, R. (2021). *Sustainable futures: An agenda for action*. Wiley.
- Kondratieff, N. D. (1984). *The long wave cycle*. Richardson and Snyder.
- Mackinnon, D., Dawley, S., Pike, A., & Cumbers, A. (2019). Rethinking path creation: A geographical political economy approach. *Economic geography*, 95(2), 113–135.
- Martin, H., Martin, R., & Zukauskaite, E. (2019). The multiple roles of demand in new regional industrial path development: A conceptual analysis. *Environment and Planning A: Economy and Space*, 51(8), 1741–1757. <https://doi.org/10.1177/0308518X19863438>
- Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. *Journal of economic geography*, 6(4), 395–437.
- Mazzucato, M. (2018). Mission-orientated innovation policies: Challenges and opportunities. *Industrial and Corporate Change*, 27(5), 803–815. <https://doi.org/10.1093/icc/dty034>
- Mazzucato, M. (2024). *The re-emergence of an industrial policy*.
- Mazzucato, M. (2021). *Mission economy: A moonshot guide to changing capitalism*. Penguin.
- McCann, P., & Ortega-Argilés, R. (2011). Smart specialisation, regional growth and applications to EU cohesion policy. *Regional Studies*, 49(8), <https://doi.org/10.1080/00343404.2013.799769>
- McCann, P., & Soete, L. (2020). *Place-based innovation for sustainability*. Publications Office of the European Union. ISBN 978-92-76-20392-6, <https://doi.org/10.2760/250023>, JRC121271.
- McChesney, R. W., & Nichols, J. (2016). *People get ready*. Nation Books.
- McQuivey, J. (2013). *Digital disruption. Unleashing the next wave of innovation*. Amazon Publishing.
- Norris, L., Bristow, G., Cotterill, E., Healy, A., & Marshall, A. P. (2024). Decarbonisation, place attachment and agency: Just transition in old industrial regions. *Contemporary Social Science*, 19(1–3), 283–302. <https://doi.org/10.1080/21582041.2024.2323106>
- OECD. (2016). *OECD reviews of innovation policy: Sweden 2016*. OECD Publishing. <https://doi.org/10.1787/9789264249998-en>.
- OECD. (2017). *The next production revolution: Implications for governments and business*. OECD Publishing. <https://doi.org/10.1787/9789264271036-en>.
- OECD. (2021). *OECD skills outlook 2021, Learning for life*, OECD. *OECD Skills Outlook 2021 (EN)*.
- OECD. (2022). *Skills for the digital transition: Assessing recent trends using big data*. OECD Publishing. <https://doi.org/10.1787/38c36777-en>.
- OECD. (2025). *Environment at a glance indicators*. OECD Publishing. <https://doi.org/10.1787/ac4b8b89-en>.
- OECD. (2019). *Regions in industrial transition: Policies for people and places*. OECD Publishing. <https://doi.org/10.1787/c76ec2a1-en>
- Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, 34(1), 185–202. <https://doi.org/10.1093/cje/bep051>
- Pugh, R., Brydges, T., Sharpe, S., Lavanga, M., & Retamal, M. (2024). The ‘wellbeing wardrobe’ as a tool to promote just transitions in the fashion and textile industry. *Contemporary Social Science*, 19(1–3), 223–243. <https://doi.org/10.1080/21582041.2024.2341143>
- Rainnie, A., & Snell, D. (2024). Just transition in Australia – Depoliticisation? *Contemporary Social Science*, 19(1–3), 21–40. <https://doi.org/10.1080/21582041.2024.2317393>
- Ramirez, P. (2021). Technological revolutions, socio-technical transitions and the role of agency: Värmland’s transition to a regional bio-economy. *Regional Studies*, 55(10–11), 1642–1651. <https://doi.org/10.1080/00343404.2021.1957810>
- Rifkin, J. (2013). *The European dream: How Europe’s vision of the future is quietly eclipsing the American dream*. John Wiley & Sons.
- Rigby, D. L. (2015). Technological relatedness and knowledge space: Entry and exit of US cities from patent classes. *Regional Studies*, 49(11), 1922–1937.
- Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. George Allen and Unwin.
- Schwab, K. (2018). *Shaping the future of the fourth industrial revolution*. Penguin Random House.
- Swedish Agency for Growth Policy Analysis. (2011). *The performance and challenges of the Swedish National Innovation system*. [https://www.tillvaxtanalys.se/download/18.62dd45451715a00666f1f94d/1586366198342/Report\\_2011\\_04.pdf](https://www.tillvaxtanalys.se/download/18.62dd45451715a00666f1f94d/1586366198342/Report_2011_04.pdf)

- Swedish Parliament. (2009). Ordinance with instructions for the Swedish Agency for Innovation Systems, The Swedish Parliament Ordinance (2009:1101) with instructions for the Swedish Agency for Innovation Systems | The Swedish Parliament.
- Truffer, B., & Coenen, L. (2012). Environmental innovation and sustainability transitions in regional studies. *Regional Studies*, 46(1), 1–21. <https://doi.org/10.1080/00343404.2012.646164>
- Uyarra, E., Zabala-Iturriagagoitia, J. M., Flanagan, K., & Magro, E. (2020). Public procurement, innovation and industrial policy: Rationales, roles, capabilities and implementation. *Research Policy*, 49(1), 103844. <https://doi.org/10.1016/j.respol.2019.103844>
- Vinnova. (2025). Impact innovation – Sweden’s innovation initiative for the 2030s.
- Vinnova. (2016). *Vinnväxt: A programme renewing and moving Sweden ahead - Regional Growth through Dynamic Innovation Systems*. Vinnova Information, VI 2016:08.
- Weller, S., Beer, A., & Porter, J. (2024). Place-based just transition: Domains, components and costs. *Contemporary Social Science*, 19(1–3), 355–374. <https://doi.org/10.1080/21582041.2024.2333272>
- Zheng, T., Ardolino, M., Bacchetti, A., & Perona, M. (2021). The applications of industry 4.0 technologies in manufacturing context: A systematic literature review. *International Journal of Production Research*, 59(6), 1922–1954. <https://doi.org/10.1080/00207543.2020.1824085>