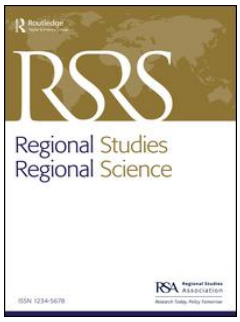

Regional Studies, Regional Science

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rsrs20

Smart specialisation, Industry 4.0 and lagging regions: some directions for policy

Mariachiara Barzotto , Carlo Corradini , Felicia Fai , Sandrine Labory & Philip R. Tomlinson

To cite this article: Mariachiara Barzotto , Carlo Corradini , Felicia Fai , Sandrine Labory & Philip R. Tomlinson (2020) Smart specialisation, Industry 4.0 and lagging regions: some directions for policy, Regional Studies, Regional Science, 7:1, 318-332, DOI: 10.1080/21681376.2020.1803124

To link to this article: https://doi.org/10.1080/21681376.2020.1803124

Published online: 25 Aug 2020.

REGIONAL STUDIES, REGIONAL SCIENCE
2020, VOL. 7, NO. 1, 318–332
https://doi.org/10.1080/21681376.2020.1803124

Smart specialisation, Industry 4.0 and lagging regions: some directions for policy

Mariachiara Barzotto[a], Carlo Corradini [b], Felicia Fai[c], Sandrine Labory[d] and Philip R. Tomlinson [e]

ABSTRACT

At the heart of the European Union's innovation policy is Smart Specialisation Strategy (S3) as embodied in the Research and Innovation Strategies for Smart Specialisation (RIS3) programme. So far, RIS3's efficacy on the revival of so-called lagging regions has been weak. This is in large part due to the weak initial endowments of technology, social/business networks, poor governance and institutional failures that typify lagging regions. This combination inhibits both the effectiveness of the programme and the ability of lagging regions to take advantage of the new opportunities proffered by Industry 4.0. This paper highlights some of these challenges and presents some policy directions for S3 and Industry 4.0 to deliver better regional cohesion and enhance inclusive growth.

ARTICLE HISTORY

Received 28 April 2020; Accepted 24 July 2020

KEYWORDS

lagging regions; Smart Specialisation; RIS3; Industry 4.0; place-based policy

JEL CLASSIFICATIONS

N94; O25; R10

INTRODUCTION

For the past 10 years, the Smart Specialisation Strategy (S3) has been the fulcrum of the European Union's (EU) Research and Innovation Strategies for Smart Specialisation Programme (RIS3). S3 aims to target public funding for innovation towards selected 'activities' within specific technological fields – critically where there is realizable potential for innovation, knowledge spillovers and market opportunities. These 'activities' are identified through 'entrepreneurial discovery' – a 'bottom-up' collaborative process involving public and private sector stakeholders. This collaboration should exploit a region's existing and historic advantages and capabilities, with particularly rich opportunities to be grasped at the technological intersections of industrial sectors. Consequently, S3 is considered to be a 'place-based' and vertical approach to industrial policy (Barca et al., 2012; Foray, 2013).

CONTACT

[a] Centre for Governance, Regulation & Industrial Strategy, School of Management, University of Bath, Bath, UK.
[b] Birmingham Business School, University of Birmingham, Birmingham, UK.
[c] Centre for Governance, Regulation & Industrial Strategy, School of Management, University of Bath, Bath, UK.
[d] Department of Economics, University of Ferrara, Ferrara, Italy.
(Corresponding author) P.R.Tomlinson@bath.ac.uk
[e] Centre for Governance, Regulation & Industrial Strategy, School of Management, University of Bath, Bath, UK.

In part, RIS3 was an EU policy response to the Global Financial Crisis (GFC) and some have even pronounced it as 'the biggest and boldest experiment' in regional industrial policy that has ever been undertaken (Morgan & Marques, 2019, p. 180). Whilst RIS3 generated much excitement in its perceived potential to revive so-called lagging regions (Barca et al., 2012),[1] strong evidence of its efficacy in those regions has yet to emerge. Indeed, since the GFC, the trend towards interregional convergence (across the EU) has been reversed, with widening interregional divergence (EU, 2014). In part, these widening regional inequities have contributed to rising populism and discontent with the European project (Rodríguez-Pose, 2018).

Accordingly, a growing debate on the potential limitations of S3 is emerging in the literature. Scholars have stressed Smart Specialisation remains largely based on a conventional science and technology model of innovation, while socio-ecological and social innovation are only implicitly considered. Also, S3 does not clearly outline the role of diversification or the importance of the territorial context (Benner, 2020; Hassink & Gong, 2019). Moreover, the limitations of Smart Specialisation may be especially pronounced within the context of lagging regions (Capello & Kroll, 2016; Hassink & Gong, 2019; Marques & Morgan, 2018). A region's initial endowments often predicts successful RIS3 outcomes. Indeed, the inherent logic of S3 may induce a 'Matthew effect'[2] in which the greater entrepreneurial/technological capabilities and business networks of dynamic and leading regions better position these areas to exploit the opportunities of the RIS3 programme. Meanwhile, in lagging regions, such opportunities are much diminished, since they are typically blighted by low technological bases and weak social/business networks (Hassink & Gong, 2019; Rodríguez-Pose, 2013). Limited governance capacity and institutional failures may further exacerbate the transformative ambition of RIS3 in those regions where it is needed the most (Marques & Morgan, 2018; Uyarra et al., 2018).

These issues may similarly hamper the opportunities offered by new general-purpose technologies (GPTs) such as digitalization, the Internet of Things, robotics and artificial intelligence, and data exchange in manufacturing technologies collectively known as Industry 4.0 (I4.0). A real concern is that the displacement of labour caused by the distribution of capital-intensive I4.0 manufacturing will be spatially uneven yet again, unduly favouring more dynamic regions over peripheral ones, further amplifying regional socioeconomic divisions (Bailey & De Propris, 2019). This inhibits lagging regions from exploiting the new opportunities that these technologies provide, both within the context of their own regional capabilities and, indeed, within the RIS3 framework.

From the perspective of lagging regions, both the implementation of S3 and the adoption of I4.0 technologies present significant policy challenges. In a recent Regional Studies Association (RSA) Expo book, leading academic and policy-maker experts contemplate, deliberate, and discuss the impact of S3 and I4.0 on lagging regions, and explore how future EU innovation policy could be better tailored to address these twin challenges (Barzotto et al., 2019a). These policy debates are particularly pertinent for the EU since it will shortly embark upon a €100 billion research and innovation programme for 2021–27 called Horizon Europe, and the next round of EU Cohesion Policy. Hence, it is important to further reflect on RIS3's socioeconomic impact, expressly in the context of the potential negative effects it can have, and in the wider context of EU Cohesion Policy aims around balanced regional growth and the promotion of 'inclusive, innovative and reflective societies' (EU, 2017b, p. 13). The remainder of this paper offers a synopsis of the key points explored in this RSA Expo book (Barzotto et al., 2019a) and, in doing so, outlines directions for S3 policy and suggests ways in which lagging regions can overcome their weak initial endowments and benefit from both S3 and I4.0.

In line with the issues surrounding S3 that are discussed in the literature and reflecting the structure of the book (Barzotto et al., 2019a),[3] the next section shows that there is scope for improving the specificity of RIS3 in each region, away from one-size-fits-all approaches by focusing upon addressing structural weaknesses. In the third section, the discussion argues that

strategies used to address these systemic weaknesses must be comprehensive, focused not only on innovation but also on improving institutional capacity, as well as other enabling conditions such as the availability of skills and networking capacity. We review issues related to low regional endowments and weak business networks in the fourth and fifth sections. Networking must be not only within the region but also outside the region, by developing multidimensional external links (the fourth section). Even the adoption of the new I4.0 technologies – which have applications in all sectors (even agriculture) – requires a holistic industrial policy that supports the social transformation processes that constitute the basis for industrial transformation (the fifth section). Finally, the need to take a broader perspective beyond technology and innovation policy is further explored in the sixth section, offering arguments in support of more comprehensive regional development trajectories by embracing new models grounded on social innovation and the foundational economy.

BUILDING UPON PLACE-SPECIFIC ASSETS

Before S3, regional development policies were largely based upon importing external industrial capacity and/or new technologies through using, for example, the state apparatus (e.g., via tax incentives/subsidies/relaxed planning restrictions) to encourage foreign direct investment (FDI) and/or domestic large private firms to relocate/set-up new divisions within a lagging region. In some cases, such investments may have come from public sector/public anchors – for example, the British Broadcasting Corporation's (BBC) relocation to Salford being the catalyst for its successful Media City. However, in most cases, as McCann and Raquel Ortega-Argilés (2019) point out, this approach was blighted by the misalignment between the new imported technologies and the region's existing industrial capabilities; skills and supply chain incongruities; and technological synergies between new and existing capital. Thus, while the policy may have generated short-term political gains in terms of higher employment, these types of activities were quite circumscribed in terms of reshaping regional trajectories, while the lack of local regional embeddedness of foreign firms also undermined the approach (McCann & Raquel Ortega-Argilés, 2019).

RIS3 offers a completely different approach by favouring Rodrik's (2004) notion of 'entrepreneurial discovery' at the local level, and endogenous development by building upon existing place specific assets, with the intention of forging new regional specialisms (Foray, 2015). 'Entrepreneurial discovery' is an interactive process involving public and private actors sharing information about possible future technological and commercial opportunities. It is regarded as the key facet of S3 since it facilitates – at the granular level – the identification and prioritization of 'activities' for state funding (Foray, 2013). These 'activities' are not clearly explained within the S3 literature, although it is noted that they typically arise at the intersections of sectors – an example may be the activity of processing/analysing big data in the context of the energy sector (but the activity itself could have multiple applications across a wide set of sectors beyond that of energy). Critically, this policy prioritization process ought to be both specifically tailored to the region, and future-oriented with resources targeted at those sectors, technologies and activities which offer the region the best or most realistic opportunity to shape a new trajectory for its economic and industrial development. Instead of replicating and applying policies that may have been successful in different socioeconomic settings, policy-makers ought to grasp this regionally specific approach. Indeed, there is now substantive evidence that regions best prosper by building on their existing capabilities and expertise, 'branching' into new technologies, skillsets and activities (Kogler et al., 2017) through a process of related diversification.

Yet, for lagging regions the 'entrepreneurial discovery process' and identifying 'new activities' may be especially challenging due to inherent underlying structural weaknesses, including poor skillsets and weak social/business networks that limit synergies, the exchange of ideas and the

identification of emerging commercial opportunities (Benner, 2020; Capello & Kroll, 2016; Hassink & Gong, 2019). If lagging regions are to benefit from the S3 approach, then industrial policy also needs to address these deficiencies. For instance, a place-based based skills policy framework, which is tailored towards a region's existing sectoral strengths but also covers a wider skillset for potential new and emerging sectors, may be useful. Such programmes can build in flexibility to account for structural and technological changes in markets to support dynamic competitiveness (Bailey et al., 2018). Similarly, strategies to build local institutional capacity, new infrastructure and the regional ecosystem will also be important (see the third section).

In terms of building upon place-specific assets, Potter and Lawton Smith (2019) put forward the Polish region of Pomorskie as a useful example of a region successfully utilizing the S3 approach.[4] Following the European Commission's S3 guidance, the Pomorskie regional government – in concert with science and industry stakeholders – activated a 'bottom-up' process for identifying its S3 priorities. Pomorskie conducted a regional diagnostic analysis of both its innovative capabilities and its challenges, assessing: current and emergent sectoral strengths/weaknesses, research and innovation capabilities, skills levels and labour market participation. It was accompanied by a public consultation with key stakeholders considering 'global trends, market and technological potential, domestic and international benchmarking, the formation of partnerships/networks, and deliberations over a proposed strategy and action plan' (Potter & Lawton Smith, 2019, pp. 46–47).

According to Potter and Lawton Smith (2019), this process led to an S3 strategy focused on two broad traditional sectors (offshore, port and logistic technologies; and eco-effective technologies in the generation, transmission, distribution and consumption of energy and fuel, and in construction) and two new sectors (interactive technologies in an information-saturated environment; and medical technologies in the area of civilisation- and ageing-associated diseases). Pomorskie's regional government also adopted a broadly defined information and communication specialization as a GPT input with cross-sectoral relevance. Moreover, the authors report Pomorskie defined an implementation programme for each type of specialization, which includes 'its scope, aims, and priority research directions' as well as partnership agreements with priority access to EU funding established for each specialization (p. 46). To enhance this process, Pomorskie has sought to engage businesses and higher education institutes (HEIs) in developing and implementing its S3 strategy. The co-involvement of various actors/stakeholders in developing these specific Smart Specialisation projects has promoted a sense of inclusivity and is generally regarded as having been effective in implementing the region's S3 strategy (for further details, see Potter & Lawton Smith, 2019).

ENHANCING THE REGIONAL INNOVATION ECOSYSTEM (RIE)

The successful implementation of S3 relies upon the systemic nature of innovation embodied within an efficient and effective regional innovation ecosystem (RIE)[5] of local knowledge generation, exchange and dissemination. If policy is to be effective in lagging regions, it will therefore be important to strengthen indigenous firms' and actors' capabilities and to enhance collaborative networking both within the region and with actors elsewhere (see the fourth section). However, the potential benefits of RIS3 should not just be confined to focusing on technological and commercial facets. Institutional capacity, good governance (including active participation between private, public and civil society stakeholders), and policy coherence are also essential ingredients for a successful S3 strategy (Morgan, 2018; Morgan & Marques, 2019).

It is therefore critical that policy seeks to support the RIE in lagging regions by developing and enhancing business and knowledge networks across the locality (including local government, firms, public research centres, HEIs and the third sector). In this way, social/cultural capital can be nurtured, reciprocal investments and collaborative activities promoted. Moreover, policy

might also foster and leverage the presence of regional anchors – such as large public and/or private firms based in the RIE – that can act as catalysts for local entrepreneurship and innovation (Bailey et al., 2018).

Andreoni (2016), for instance, argues the German Fraunhofer institutes are a European exemplar in encouraging public–private partnerships for open innovation, especially in leading 'in joint pre-competitive research, prototyping and manufacturing scale-up, as well as product-ideas, commercialization, bilateral applied research with individual firms, and technology transfer schemes' (p. 274) (see also MIT, 2015). Similarly, in Ireland, during the 1990s/early 2000s, regional public agencies (such as HEI labs) played a key role in supporting small and medium-sized enterprise (SME) collaboration in innovative activities and bringing new products to market in the country's high-tech sector (Ó Riain, 2011). Such initiatives by public bodies in forging cooperation and network building with the private sector are critical in the development of the RIE, and in ensuring the successful development and adoption of new enabling and cutting-edge technologies (see also Tassey, 2007).

EU funding streams have increasingly sought to enhance RIEs within lagging regions in line with the priorities of the S3 approach. For instance, McCann and Raquel Ortega-Argilés (2019, p. 22) note Gianelle et al.'s (2016) analysis of 46 EU operational programmes, which finds that S3 initiatives form a growing share of European Regional Development Funding (ERDF) projects. These include projects geared towards 'supporting the creation and strengthening of innovative SMEs via innovation support services, the public procurement of R&D and innovation, innovation prizes, support for research infrastructures, support for business-support organizations, innovation networks and platforms' (McCann & Raquel Ortega-Argilés, 2019, p. 22). Such interventions not only focus on high-tech sectors but also include support for more traditional sectors, including tourism, agri-food, textiles and forestry. This offers opportunities for these lower tech sectors to focus on incremental innovation and more gradual and tailored evolution of their RIE (McCann & Raquel Ortega-Argilés, 2019).

SUPPORTING EXTRA-REGIONAL COLLABORATION

It is widely accepted that collaboration facilitates interactive learning, knowledge transfer, and innovation between firms and across regions (Tomlinson & Fai, 2013, 2016; Tödtling et al., 2006; Trippl et al., 2009). Hence, it follows S3 should also seek to enhance collaboration between actors to facilitate the cross-fertilization of ideas and technological upgrading. Extra-regional collaboration between firms in lagging regions and partner firms (and/or HEIs) in more technologically orientated/advanced regions can bring benefits – especially if it facilitates knowledge exchange, enhances technical and managerial capabilities, and also the earlier adoption of new technologies emerging in the I4.0 paradigm. Such extra-regional collaboration may also support business, knowledge and social networks and allow firms homed in lagging regions to be exposed to new domestic and/or international market opportunities (Barzotto et al., 2019a). In such cases, engaging in extra-regional networks can allow firms (in lagging regions) to compensate for a weak RIE, a deficient local knowledge base and a lack of local synergies (Johansson & Quigley, 2004). Indeed, De Noni et al. (2018) find that across the EU, firms based in lagging regions have significantly higher levels of innovation when they work closely with prolific inventors located in knowledge-intensive regions. Similarly, using patent data, Barzotto et al. (2019a) show that, in lagging regions, extra-regional collaborations are positively correlated with higher levels of innovation.

Radosevic and Ciampi Stancova (2018) discuss how extra-regional links could be supported through RIS3 initiatives. They argue that in the case of new EU member states (EU-13), the integration of FDI and S3 type innovation policies could be usefully employed to derive benefits from foreign knowledge. EU-13 countries and their regions therein are indeed characterized by

their participation in global value chains, thanks to a long-term policy of attracting FDI, and simultaneously a public R&D system that has been promoted through investment in universities and public research agencies. However, the two systems do not – at present – sufficiently overlap, and a more strategically applied RIS3 approach could support better integration. In this regard, Uyarra et al. (2018) report the results of a survey of regional policy-makers – from a representative sample of EU regions and two associated countries – to outline the barriers to extra-regional collaboration and start exploring possible solutions. They find that lack of political commitment, relational inertia and the difficulty in adapting EU funding rules and procedures for this type of collaboration are the main barriers encountered. It is these barriers which should be addressed in order to improve the capacity of RIS3 to promote better and more fruitful extra-regional connectedness.

Within this context, established EU programmes – for example, H2020 and INTERREG – are important conduits for a wide set of extra-regional collaborations. These types of programmes deliberately connect actors from dissimilar regions and offer the opportunity to widen scientific, technological and organizational learning. This can enhance innovative activity and revive faltering industrial bases, whilst stimulating a higher level of cohesion. Extra-regional collaborations may also contribute to overcome over-embeddedness issues and 'closed thinking'/network biases among similarly minded actors (across regions) with regard to cooperation. Moreover, the networks springing from these type of projects can last beyond the EU funding cycle, and thus build longevity into the trajectory of development that is co-created.

One example of EU project supported by the H2020 to nourish extra-regional collaborations is, as highlighted by Barzotto et al. (2019b), the ¡VAMOS! Project. It was funded to create a new underwater, remotely controlled, environmentally viable mining system that would facilitate new mining possibilities, particularly with regard to exploiting discarded European deposits of high-grade minerals, so as to ensure the EU can secure a sustainable source of minerals.[6] The project involves several partners from science, industry and academia based in nine EU countries and brings together expertise from a range of fields (including robotics, geology and mining technologies). Partners located in the UK lagging regions, such as Cornwall, have benefit from being part of ¡VAMOS! Indeed, it has opened up a new set of opportunities that build upon Cornwall's traditional mining expertise. These largely revolve around developing new specializations in environmental marine mining techniques and technologies, which have a potential global market. This, in turn, could bring in new jobs and investment opportunities to the region (Barzotto et al., 2019a).

An additional benefit for lagging regions is that participation in these types of EU programmes raises the region's international profile. It can also help these areas to improve policy learning at industry as well as administrative levels, while also building institutional capacity, especially in local and regional governments. For instance, many lagging regions have benefitted from administrative collaboration organized within INTERREG programmes, aimed at improving the efficiency of administrative and government processes, through different means, including the adoption of I4.0 technologies in order to digitize processes. This is a critical element in designing and implementing S3 (Barzotto et al., 2019a).

Apuglia – one of Italy's poorest regions – offers a useful example of the wider benefits of participation in EU initiatives. The region has long been blighted by poor governance, weak social capital and the presence of criminal organizations, and consequently poor economic performance. In recent years, Apuglia has sought to promote the development of both teaching and research capacity in aerospace and smart manufacturing technologies (in particular, information and communication technologies (ICTs) and digitalization). In order to achieve this, there has been a concerted effort by the regional government and local stakeholders to promote greater intra-regional networking, especially between educational/research institutions and businesses. However, critical to this process has been Apuglia's new willingness to engage in a range of

EU extra-regional collaborative projects. Among these projects, there are: (1) NEREUS – a European interregional space industry initiative that includes the European Space Agency along with business and local governments; and (2) ADRION – gathering regions bordering the Adriatic and Ionian seas, covering eight partner states, of which four are EU member states (Croatia, Greece, Italy and Slovenia), three are candidate countries (Albania, Montenegro and Serbia) and one is a potential candidate country (Bosnia and Herzegovina). For instance, within ADRION, Apuglia is engaged in the Blue-Boost project (receiving €1.5 million for 2 years), which seeks to promote innovation and knowledge exchange in the maritime economy. This project includes fisheries, shipbuilding and so-called blue technologies (i.e., new materials, green shipbuilding and robotics). The emphasis here is upon exploiting related technological diversification at the regional and extra-regional levels through a range of cross-sectoral networking mediums including innovation hubs, fablabs and co-working spaces. These types of initiatives have also facilitated improvements in Apuglia's local governance processes, especially with regards to reducing levels of local corruption and promoting greater trust among local actors. In turn, these local networks have been strengthened and regional growth has improved (for further details, see Barzotto et al., 2019b).

Nevertheless, generally, existing policy frameworks have tended to adopt a cookie-cutter *modus operandi* to S3 and RIS3, in that they typically ignore the socioeconomic heterogeneity between lagging and leading regions. Indeed, Barzotto et al. (2019c) argue the incentives to take part in extra-regional collaboration are likely to be different, depending upon the actors, their location and their underlying capabilities. It is often the case that firms based in lagging regions tend to benefit more from extra-regional collaborations vis-à-vis those firms located in more advanced regions. For firms in lagging regions, extra-regional collaboration offsets weak local knowledge bases (Barzotto et al., 2019a). Yet, in leading regions, extra-regional links are less significant, as these firms tend to benefit from their embeddedness in strong intra-regional innovation systems (Tödtling et al., 2012; Grillitsch & Nilsson, 2015) in which greater technological complexity, knowledge interactions and learning processes tend to occur (Fritsch & Franke, 2004). Moreover, where companies in leading regions do participate in extra-regional collaboration, such collaborations tend to be with like-minded actors located in other leading regions. In contrast, collaborations between actors in leading and lagging regions tends to gravitate around the lower value-added activities, around manufacture and commercialization of existing products (Bianchi & Labory, 2018).

Policy therefore should be supple to deal with these differences. In particular, EU frameworks for stimulating extra-regional collaborations ought to be bespoken more tightly to distinct regional RIS3 objectives. For instance, it may mean providing advanced regions with different incentive packages to encourage them to engage with lagging regions. It may also mean favouring extra-regional collaborations between low and medium value-added sectors to allow lagging regions to better search for new technological specialisms. The lower technological gap may better facilitate new synergies and innovation (see also Grillitsch et al., 2018).

I4.0 AND TECHNOLOGICAL UPGRADING

Critical to revitalizing lagging regions will be the adoption and application of I4.0 cross-cutting and platform technologies (e.g., the internet of things, digitalization, artificial intelligence and robotics) which play an enabling role across services and manufacturing. Digitalization, for instance, can improve efficiency across the private and public sectors, with digital platforms and high-speed communication/enhanced data exchange having the potential to reduce some of the disadvantages associated with being located in remote and lagging regions. It may also offer new conduits for producer–consumer collaboration, which may create entirely new business opportunities or transform existing ones via big data analytics and the new platforms. For lagging

regions, Bailey and De Propris (2019) suggest this opens the possibility of revitalizing traditional industrial bases by focusing upon better product customization and forging new synergies between manufacturing and R&D – this in turn may facilitate a reshoring of manufacturing activities.

However, Bailey and De Propris (2019) also raise serious concerns about the emergence of 'digital divides', especially with regards to capacity, digital capabilities and skills, broadband speeds and coverage. These 'divides' have arisen across Europe both interregionally and between different income bands (within the same country) and present a major constraint to balanced, cohesive, inclusive growth (Bailey & De Propris, 2019). Moreover, in a significant number of lagging regions, knowledge and application of new I4.0 technologies are so far relatively limited. I4.0 is a transformative process, not only for the economy but also for culture and wider society. Not being able to embark upon the transformations required will mean lagging regions will remain trapped in a downward cycle. Yet, if such transformations are pursued, then they may offer a great opportunity to eliminate some of the old dynamics that impede regional development (Bailey & De Propris, 2019). EU innovation programmes should acknowledge these deficiencies and heighten awareness of I4.0 technologies in lagging regions and ensure they are more widely accessible to businesses in different regions.

To facilitate knowledge transfer mechanisms between firms from related and unrelated sectors, policies which encourage crossovers between manufacturing and service sectors, and between industries using traditional techniques and new I4.0 technologies, should be established. In the literature, scholars have pointed to the effectiveness of policy platforms for enabling learning across different sectors and knowledge bases (Asheim et al., 2011; Cooke, 2007). Similarly, as discussed with respect to the transformative potential of I4.0 (Bailey & De Propris, 2019) the application of enabling technologies offering a bridging effect across sectors may provide opportunities for regional change (Foray et al., 2009; Montresor & Quatraro, 2017). These perspectives may support cross-specialization policies where the focus is not based solely on related variety; instead, by supporting strong (yet unrelated) industries may enable new bridges between knowledge domains that reinforce existing capabilities or enable new growth paths (Janssen & Frenken, 2019). Others have indicated there may be a more prominent role of public procurement in fostering such transformations (Uyarra et al., 2020).

These processes would benefit from support for entrepreneurship programmes, staff exchanges, research collaboration and enhanced labour mobility between sectors. Here, transformative and yet holistic industrial policies are required that address the failures and obstacles of the whole regional ecosystem (rather than specific components); such policies are typically multidimensional and not purely focused upon instruments specific to industry. Thus, social policies that favour participation in the labour market, or training and education policies, must be combined with more direct industrial policy instruments in order to induce transformation along desirable development paths (Bianchi & Labory, 2019).

In this regard, Šlander and Wostner (2019) suggest Slovenia offers an example of a vision based around an integrated and collaborative policy response at both regional and national levels in relation to I4.0 technologies. The Slovenian Industry 4.0 – or S4 – approach first identifies priorities and relevant ICT niches in which the country can acquire a long-term competitive advantage. These focal areas are signalled by emerging and existing technologies and joint research activities. This is followed by efforts both to roll out the identified I4.0 technologies to new areas of application and to encourage their convergence within, and across activities where appropriate, with the creation of a high-performing I4.0 service provider network. These supply-side initiatives are matched on the demand side. Businesses are encouraged to identify I4.0 enabled opportunities, many of which are likely to require transformative business models. Public support for the introduction of these new business models comes via appropriate voucher schemes and the provision of dedicated mentors. Within S4, the Slovenian government

also set up the Strategic Research and Innovation Partnerships (SRIPs) Factories of the Future programme to focus on the nation's ability to integrate with international technologies. Using dedicated funding, SRIP is working with the Vanguard Initiative pilots and European Smart Specialisation Thematic Platforms at regional and national levels to connect Slovenia with international partners. To facilitate Slovenia's I4.0 transformation, the workforce also needs renovation; an ambitious three-stage approach has been designed: (1) an assessment of firm-level, long-term 'needs' for I4.0 skills; (2) the translation of the identified needs into appropriate educational provision to provide the workforce of the future; and (3) the provision of (re)training programmes targeted at current employees to address more immediate needs, using human resource competence centres which should progressively evolve to meet the S4 priorities (Šlander & Wostner, 2019).

In S4, fostering the adaptation and development of the whole regional ecosystem (RIE) means supporting specific technological domains and specific institutional linkages (e.g., between university and industry) and also enhancing labour market participation through training/education and skills policy, social policy (supporting less-favoured people and addressing gender gaps) and health policy. The S4 approach is illustrative of a holistic industrial policy approach to I4.0, based upon good governance, institutional capacity and policy coherence (see also the second and third sections).

SOCIAL INNOVATION AND THE FOUNDATIONAL ECONOMY

An inclusive and holistic place-based policy should consider not only the industrial base but also the social fabric of the region. In lagging regions, this is particularly important where the local economy largely revolves around so-called 'foundational economy' (FE) activities, that is, the essential (and largely collective) goods and services that comprise everyday life (Bowman et al., 2015).[7] Focusing upon 'foundational sectors' suggests emphasizing and promoting social innovation and generating new solutions, goods and services that tackle unmet social challenges (EC, 2010). In this regard, the FE approach represents a set of new place-based perspectives, which seek to address the basic needs, concerns and general well-being of the public, particularly those groups who have been marginalized (or 'left behind') by the impact of globalization, structural/technological change and orthodox economic policy measures. Indeed, as Morgan (2019) argues, conventional science and technology (S&T) policy has tended to target public funding almost exclusively to support knowledge-generating and commercially orientated sectors to promote economic competitiveness. While such policies may generate macro-wide-level benefits, they have done little to raise welfare for those living in lagging regions (Morgan, 2019).

In fairness, the RIS3 guide does point towards a broader view of innovation policy, with calls for 'building competitiveness through design and creative industries, social and service innovation, new business models and practice-based innovation' (Foray et al., 2012, p. 9). Yet, this steer towards social innovation has largely been marginalized within RIS3 implementation – existing biases towards S&T-type initiatives still dominate. Nevertheless, some regions have begun to re-orientate and use place-based policies as a means to promote more social innovation. The Welsh government, for instance, have become the first administration to formally integrate the FE approach into its innovation programme (Morgan, 2019).

The Welsh story is particularly interesting.[8] West Wales and the Valleys have held 'less developed region' status among UK and EU bodies for a long time. During the 1980s and 1990s, policy was geared towards attracting subsidiaries of multinational firms and a drive to establish centres of technology. As purely supply-side initiatives driven without any acknowledgment of the demand or requirements of the local economy, neither delivered long-term success (Cooke & Morgan, 2000; Pugh et al., 2018). According to Morgan (2019), the creation of the Welsh Assembly in 1999 gave Wales the institutional space for experimental policy-makers to adopt

a more deep-rooted place-based policy programme – in accordance with the Barca Report (Barca, 2009) and the new World Bank (2018) approach – alongside the more traditional S&T model. In this regard, the Welsh government has moved away from its earlier state-centric strategy and instead adopted more of a custodial approach to the innovation process. This has involved building collaborative and flexible networks which embrace elements of social innovation. For example, in the SPECIFIC project (a green energy collaboration) the Welsh government has acted as a broker between firms, social enterprises and universities, and building knowledge networks while also mobilizing new finance for novel social projects (Morgan, 2019).

More generally, The Wellbeing of Future Generations (WFG) Act of 2015 and the Welsh Government (2017) are recent Welsh legislative initiatives geared towards sustaining foundational economy industries, which were not covered under innovation policy. The WFG Act requires each of the 44 public bodies in Wales to take clear action on meeting seven nationally defined well-being goals. Moreover, the Act also establishes (1) a statutory Future Generations Commissioner for Wales; and (2) local authority area public services boards (PSBs) within Wales to engage in public consultations with local citizens so as to enact a local action plans for enhancing the economic, environmental, social and cultural well-being of its area (Welsh Government, 2016). These initiatives are important since the foundational economy currently accounts for around 50% of Welsh employment, whereas the next-generation industries – which are the main focus of Wales's S&T strategy (Pugh et al., 2018) – account for a significantly lower percentage of employment. These initiatives put Wales at the forefront of nations that are beginning to place a statutory obligation on its public sector in order to integrate a range of national well-being goals (e.g., economic, environmental, social and cultural well-being) into its industrial and innovation policies, and which are in line with the United Nations' Sustainable Development Goals (SDGs) (Morgan, 2019).

Applying S3 in lagging regions does not only involve the definition of priorities for local innovation activities and the support of policy frameworks: it also entails the development and the nourishment of RIEs, enabling *all* local communities to participate in the development process, making it sustainable from both a social and an environmental perspective. For success, these initiatives must be 'bottom up' in design and implementation, with a dialogue between local stakeholders, to identify the needs, possible future development paths and make strategic choices. This can enhance inclusion and reduce social fractures, which may militate against external shocks (such as financial crises or natural/climate catastrophes). Achieving a policy transformation of this type will require a shift from conventional top-down centric policy-making to a more diffuse form of governance that redraws socioeconomic policy objectives at the regional level (Cowling & Tomlinson, 2011).

Indeed, much more needs to be done in order for the foundational model to develop. Concomitant to this is a call for the formation of community-led groups of local and regional actors, and mutual recognition that the policy process itself will involve learning through experimentation and social innovation. Cooke and Morgan (2000) outline how 'smart experimentation' might be usefully employed in this respect. Local experiments should involve local businesses in the entrepreneurial discovery processes as well as universities, local community and healthcare groups that could express their own needs in a process driven by local institutional entrepreneurs that are able to mobilize political commitment and necessary resources. In other words, the idea is to build smart complementarity through the development of extra-regional links, and smart experimentation to design and deliver a smart strategy, that is also conducive to the satisfaction of social needs; this could represent two particularly important aspects for making RIS3 more effective in lagging regions. Moreover, this resonates with the call for a new paradigm that 'should be based on a holistic understanding of regional development that regards innovation not as a goal in itself but as a phenomenon that can drive the societal and economic development of a region' (Benner, 2020, p. 11).

CONCLUSIONS

The S3 approach emphasizes the place-based nature of innovation, and in doing so seeks to facilitate industrial transformation by regions building upon their existing territorial strengths and unique potentials – as opposed to replicating what other regions do or import activities and practices that might be unrelated to (or might not fit) the region's industrial base. However, in lagging regions, S3 faces significant challenges. Weak business and social networks, technological and skills gaps, and poor entrepreneurial opportunities can blunt the very best of policy initiatives. Indeed, in contravention of EU Cohesion Policy goals, S3 may widen regional imbalances. Similarly, the emergence of I4.0 technologies appears to favour more advanced regions, which can further exacerbate regional divides. Moreover, specific projects – such as the RIS3 Lagging Regions[9] – have so far offered only amount of chances for lagging regions to transition towards advanced manufacturing.

The present paper – and more fully in our recent RSA Expo book (Barzotto et al., 2019b) – has sought to highlight to policy-makers some directions for S3 and I4.0, specifically within the context of revitalizing lagging regions, delivering cohesion and growth that is more inclusive. This involves building upon place-specific assets and enhancing the regional ecosystem, but in ways that enable lagging regions to initially undertake a diverse approach in order to explore, experiment and eventually identify their own new specialization. This somewhat seems to contrast with the prevailing S3 logic, which argues for concentrated funding opportunities within specific scientific and technological fields from the outset.

Policy also should facilitate better coordinated collaboration between regions, but in ways that recognize regional differences (and the consequential differentiated incentives to participate in such projects) and which promote complementarities and the cross-fertilization of ideas. Through the vehicle of RIS3, specific public agencies could identify and initiate potential new extra-regional partnerships to bridge such gaps (Radosevic & Ciampi Stancova, 2018). Similarly, shared policy platforms, experimental labs that bring together actors from different regions (Asheim et al., 2011; Cooke, 2007) and tailoring programmes such as INTERREG also offer opportunities. Such initiatives may help to reduce technological gaps and enhance learning, especially regarding I4.0 where policy needs to be more proactive to ensure such technologies are widely accessible.

Finally, RIS3 needs to take a wider perspective on innovation which goes beyond its scientific and technological elements, and – through local institutions and coalitions of actors – embrace social innovation in the foundational economy. In this regard, the next EU funding round (2021–27) opens a new window opportunity for EU innovation frameworks to foster more actively fields that address societal challenges (e.g., healthy ageing, renewable energy, food and education) and which could involve a wider range of local actors (e.g., business, universities, healthcare and community groups) at the regional level. This would be more conduce to inclusive, regional growth.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

Research was funded by the Regional Studies Association (RSA) under the RSA Expo grant scheme (1 September 2017–28 February 2019).

NOTES

[1] The EU (EC, 2017a, p. 4) categorizes lagging regions as either: (1)'low growth regions, i.e., those NUTS2 regions that did not converge to the EU average GDP [gross domestic product] per head at [purchasing power standard] PPS between the years 2000 and 2013'; or (2) 'low income regions, i.e., NUTS2 regions with a GDP per head in PPS below 50% of the EU average in 2013'. Lagging regions typically have low innovation capabilities and may be characterized by an industrial structure predominantly based on low-tech sectors or agriculture, or difficulties related to their distance from economic, political and financial centres, leaving them on the 'periphery' as opposed to the easier conditions found by being the 'core'.

[2] 'For to everyone who has, more will be given, and he will have abundance; but from him who has not, even what he has will be taken away' (Matthew 25:29) (see Merton, 1968).

[3] McCann and Raquel Ortega-Argilés (2019) discuss perspectives on Smart Specialisation policies in lagging regions; Barzotto et al. (2019b) argue for an extra-regional collaborative approach to Smart Specialisation, Potter and Lawton Smith (2019) analyse Smart Specialisation in Eastern Europe with insights from two lagging Polish regions; Šlander and Wostner (2019) examine the Slovenian transformational approach; while Bailey and De Propris (2019) focus on Industry 4.0, regional disparities and transformative industrial policy; and Morgan (2019) concludes on the future of place-based innovation policy (as if 'lagging regions' really mattered).

[4] Although one of the more dynamic Polish regions, Pomorskie, is – under EU (2017) definitions – classified as a lagging region.

[5] The term 'regional innovation ecosystem' has become synonymous with RIS3. The EU describes it in terms of a self-organizing regional system that evolves through interaction between a range of (diverse) actors and resources from the quadruple helix of citizens, businesses, public administrations and academia, that facilitate knowledge exchange and innovation with the final purpose of boosting local economies and creating sustainable jobs (EU, 2016). For a review of innovation ecosystems, see Granstrand and Holgersson (2020).

[6] See http://vamos-project.eu/.

[7] These include 'material services through pipes and cables, networks and branches distributing water, electricity, gas, telecoms, banking services and food; and the providential services of primary and secondary education, health and care for children and adults as well as income maintenance' (Morgan, 2019, p. 83; see also Foundationaleconomy.com).

[8] For further details, see Morgan (2019).

[9] See https://s3platform.jrc.ec.europa.eu/ris3-in-lagging-regions.

ORCID

Carlo Corradini http://orcid.org/0000-0001-9164-4108
Philip R. Tomlinson http://orcid.org/0000-0001-6292-3204

REFERENCES

Andreoni, A. (2016). Varieties of industrial policy: Models, packages and transformation cycles. In A. Norman, & J. Stiglitz (Eds.), *Efficiency, finance and varieties of industrial policy* (pp. 245–305). Columbia University Press.

Asheim, B. T., Boschma, R., & Cooke, P. (2011). Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases. *Regional Studies*, *45*(7), 893–904. https://doi.org/10.1080/00343404.2010.543126

Bailey, D., & De Propris, L. (2019). Industry 4.0, regional disparities and transformative industrial policy. In *Revitalising lagging regions: Smart Specialisation and Industry 4.0 (Regional Studies Policy Impact Books, Vol. 1, No. 2)* (pp. 67–78). Taylor & Francis. https://doi.org/10.1080/2578711X.2019.1621102

Bailey, D., Pitelis, C., & Tomlinson, P. R. (2018). A place-based developmental regional industrial strategy for sustainable capture of co-created value. *Cambridge Journal of Economics*, *42*(6), 1521–1542. https://doi.org/10.1093/cje/bey019

Barca, F. (2009). *An agenda for a reformed Cohesion Policy: A place-based approach to meeting European Union challenges and expectations*. European Commission.

Barca, F., McCann, P., & Rodríguez-Pose, A. (2012). The case for regional development intervention: Place based versus place-neutral approaches. *Journal of Regional Science*, *52*(1), 134–152. https://doi.org/10.1111/j.1467-9787.2011.00756.x

Barzotto, M., Corradini, C., Fai, F. M., Labory, S., & Tomlinson, P. R. (2019a). *Revitalising lagging regions: Smart Specialisation and Industry 4.0* (Regional Studies Policy Impact Books, Vol. 1, No. 2). Taylor & Francis.

Barzotto, M., Corradini, C., Fai, F. M., Labory, S., & Tomlinson, P. R. (2019b). An extra-regional collaborative approach to smart specialisation. In *Revitalising lagging regions: Smart specialisation and industry 4.0 (Regional studies policy impact books)* (Vol. 1, No. 2, pp. 29–42). Taylor & Francis.

Barzotto, M., Corradini, C., Fai, F. M., Labory, S., & Tomlinson, P. R. (2019c). 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

Benner, M. (2020). Six additional questions about Smart Specialisation: Implications for regional policies 4.0. *European Planning Studies*, https://doi.org/10.1080/09654313.2020.1764506

Bianchi, P., & Labory, S. (2018). *What policies, initiatives or programmes can support attracting, embedding and reshaping GVCs in regions? OECD Broadening innovation policy: New insights for regions and cities, Topic 2: Building, embedding and reshaping global value chains*. OECD.

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

Bowman, A., Froud, J., Johal, S., Leaver, A., & Williams, K. (2015). Reframing industrial policy. In D. Bailey, K. Cowling, & P. R. Tomlinson (Eds.), *New perspectives on industrial policy for a Modern Britain* (pp. 60–78). Oxford University Press.

Capello, R., & Kroll, H. (2016). From theory to practice in Smart Specialization Strategy: Emerging limits and possible future trajectories. *European Planning Studies*, *24*(8), 1393–1406. https://doi.org/10.1080/09654313.2016.1156058

Cooke, P. (2007). To construct regional advantage from innovation systems first build policy platforms. *European Planning Studies*, *15*(2), 179–194. https://doi.org/10.1080/09654310601078671

Cooke, P., & Morgan, K. (2000). *The associational economy: Firms, regions and innovation*. Oxford University Press.

Cowling, K., & Tomlinson, P. R. (2011). Post the 'Washington Consensus': Economic governance and industrial strategies for the twenty-first century. *Cambridge Journal of Economics*, *35*(5), 831–852. https://doi.org/10.1093/cje/ber003

De Noni, I., Orsi, L., & Belussi, F. (2018). The role of collaborative networks in supporting the innovation performances of lagging-behind European regions. *Research Policy*, *47*(1), 1–13. https://doi.org/10.1016/j.respol.2017.09.006

European Commission. (2010). *This is European social innovation*. European Commission.

European Commission. (2017a). 'Economic challenges of lagging regions. final report. Brussels. https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/challenges_lagging/econ_challenges_lagging_en.pdf.

European Commission. (2017b). Europe in a changing world – Inclusive, innovative and reflective societies. Horizon 2020 – Work Programme 2016–2017. Brussels. http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-societies_en.pdf [Accessed 27 February 2019].

European Union. (2014). Investment for jobs and growth. Promoting development and good governance in EU Regions and cities: Sixth report on economic, social and territorial cohesion. Brussels: Publications Office of the European Union. http://ec.europa.eu/regional_policy/cohesion_report [Accessed 27 February 2019].

European Union Committee of the Regions. (2016). *Regional Innovation Ecosystems: Learning from the EU's Cities and Regions*, European Union, Brussels, https://s3platform.jrc.ec.europa.eu/-/regional-innovation-ecosystems-learning-from-the-eu-s-cities-and-regions.

Foray, D. (2013). The economic fundamentals of Smart Specialisation. *EKONOMIAZ. Revista Vasca de Economía*, *83*(02|2), 55–82.

Foray, D. (2015). *Smart Specialisation: Opportunities and challenges for regional innovation policy*. Routledge.

Foray, D., David, P. A., & Hall, B. (2009). Smart specialisation – The concept. *Knowledge Economists Policy Brief*, *9*(85), 100.

Foray, D., Goddard, J., Beldarrain, X. G., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C., & Ortega-Argiles, R. (2012). *Guide to research and innovation strategies for Smart Specialisation (RIS3)*. European Commission.

Fritsch, M., & Franke, G. (2004). Innovation, regional knowledge spillovers and R&D cooperation. *Research Policy*, *33*(2), 245–255. https://doi.org/10.1016/S0048-7333(03)00123-9

Gianelle, C., Kyriakou, D., Cohen, C., & Przeor, M. (eds.). (2016). *Implementing Smart Specialisation: A handbook*. EUR 28053 EN, European Commission.

Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation*, *90–91*. https://doi.org/10.1016/j.technovation.2019.102098

Grillitsch, M., Asheim, B., & Trippl, M. (2018). Unrelated knowledge combinations: The unexplored potential for regional industrial path development. *Cambridge Journal of Regions, Economy and Society*, *11*(2), 257–274. https://doi.org/10.1093/cjres/rsy012

Grillitsch, M., & Nilsson, M. (2015). *Firm performance in the periphery: On the relation between firm-internal knowledge and local knowledge spillovers*. Papers in innovation studies (40), Working Paper, CIRCLE, Lund University.

Hassink, R., & Gong, H. (2019). Six critical questions about Smart Specialization. *European Planning Studies*, *27*(10), 2049–2065. https://doi.org/10.1080/09654313.2019.1650898

Janssen, M. J., & Frenken, K. (2019). Cross-specialisation policy: Rationales and options for linking unrelated industries. *Cambridge Journal of Regions, Economy and Society*, *12*(2), 195–212. https://doi.org/10.1093/cjres/rsz001

Johansson, B., & Quigley, J. M. (2004). Agglomeration and networks in spatial economics. *Papers in Regional Science*, *83*(1), 165–176. https://doi.org/10.1007/s10110-003-0181-z

Kogler, D. F., Essletzbichler, J., & Rigby, D. L. (2017). The evolution of specialization in the EU15 knowledge space. *Journal of Economic Geography*, *17*, 345–373. https://doi.org/10.1093/jeg/lbw024

Marques, P., & Morgan, K. (2018). The heroic assumptions of Smart Specialisation: A sympathetic critique of regional innovation policy. In A. Isaksen, R. Martin, & M. Trippl (Eds.), *New avenues for regional innovation systems – Theoretical advances, empirical cases and policy lessons* (pp. 275–293). Springer.

McCann, P., & Raquel Ortega-Argilés, R. (2019). Perspectives on smart specialisation policies in lagging regions. In *Revitalising lagging regions: Smart specialisation and industry 4.0 (regional studies policy impact books)* (Vol. 1 (2), pp. 17–27). Taylor & Francis.https://doi.org/10.1080/2578711X.2019.1621098

Merton, R. K. (1968). The Matthew effect in science. *Science*, *159*(3810), 56–63. https://doi.org/10.1126/science.159.3810.56

MIT Industrial Performance Center. (2015). *Strengthening the innovation eco-system for advanced manufacturing*. MIT Industrial Performance Center. http://ipc.mit.edu/sites/default/files/images/Report.pdf

Montresor, S., & Quatraro, F. (2017). Regional branching and key enabling technologies: Evidence from European patent data. *Economic Geography*, *93*(4), 367–396. https://doi.org/10.1080/00130095.2017.1326810

Morgan, K. (2018). 'Experimental Governance and territorial development', Discussion Paper, European Commission/OCED.

Morgan, K. (2019). The future of place-based innovation policy (as if 'lagging regions' really mattered). In *Revitalising lagging regions: Smart Specialisation and Industry 4.0 (Regional Studies Policy Impact Books, Vol. 1, No. 2)* (pp. 79–89). Taylor & Francis. https://doi.org/10.1080/2578711X.2019.1621103

Morgan, K., & Marques, P. (2019). The public animateur: Mission-led innovation and the 'smart state' in Europe. *Cambridge Journal of Regions, Economy and Society*, *12*(2), 179–193. https://doi.org/10.1093/cjres/rsz002

Ó Riain, S. (2011). From developmental network state to Managerialism in Ireland. In F. Block, & M. R. Keller (Eds.), *State of innovation, the US government's role in technology development* (pp. 196–216). Paradigm.

Potter, J., & Lawton Smith, H. (2019). Smart Specialisation in Eastern Europe: Insights from two lagging Polish regions. In *Revitalising lagging regions: Smart Specialisation and Industry 4.0 (Regional Studies Policy Impact Books, Vol. 1, No. 2)* (pp. 43–53). Taylor & Francis. https://doi.org/10.1080/2578711X.2019.1621100

Pugh, R., MacKenzie, N. G., & Jones-Evans, D. (2018). From 'techniums' to 'emptiums': The failure of a flagship innovation policy in Wales. *Regional Studies*, *52*(7), 1009–1020. https://doi.org/10.1080/00343404.2018.1444272

Radosevic, S., & Ciampi Stancova, K. (2018). Internationalising Smart Specialisation: Assessment and issues in the case of EU new member states. *Journal of the Knowledge Economy*, *9*(1), 263–293. https://doi.org/10.1007/s13132-015-0339-3

Rodríguez-Pose, A. (2013). Do institutions Matter for regional development? *Regional Studies*, *47*(7), 1034–1047. https://doi.org/10.1080/00343404.2012.748978

Rodríguez-Pose, A. (2018). The revenge of the places that don't matter (and what to do about it). *Cambridge Journal of Regions of Economy and Society*, *11*(1), 189–209. https://doi.org/10.1093/cjres/rsx024

Rodrik, D. (2004). *Industrial policy for the 21st century*. John F Kennedy School of Government.

Šlander, S., & Wostner, P. (2019). Transformation and transition to Industry 4.0: The Slovenian smart transformational approach. In *Revitalising lagging regions: Smart Specialisation and Industry 4.0 (Regional Studies Policy Impact Books, Vol. 1, No. 2)* (pp. 55–66). Taylor & Francis. https://doi.org/10.1080/2578711X.2019.1621101

Tassey, G. (2007). *The technology imperative*. Edward Elgar.

Tödtling, F., Grillitsch, M., & Hoglinger, C. (2012). Knowledge sourcing and innovation in Austrian ICT companies – How does geography matter? *Industry and Innovation*, *19*(4), 327–348. https://doi.org/10.1080/13662716.2012.694678

Tödtling, F., Lehner, P., & Trippl, M. (2006). Innovation in knowledge intensive industries: The nature and geography of knowledge links. *European Planning Studies*, *14*(8), 1035–1058. https://doi.org/10.1080/09654310600852365

Tomlinson, P. R., & Fai, F. M. (2013). The nature of SME co-operation and innovation: A multi-scalar and multi-dimensional analysis. *International Journal of Production Economics*, *141*(1), 316–326. https://doi.org/10.1016/j.ijpe.2012.08.012

Tomlinson, P. R., & Fai, F. M. (2016). The impact of deep vertical supply chain relationships upon focal-firm innovation performance. *R&D Management*, *46*(S1), 277–290. https://doi.org/10.1111/radm.12181

Trippl, M., Todtling, F., & Lengauer, L. (2009). Knowledge sourcing beyond buzz and pipelines: Evidence from the Vienna software sector. *Economic Geography*, *85*(4), 443–462. https://doi.org/10.1111/j.1944-8287.2009.01047.x

Uyarra, E., Marzocchi, C., & Sorvik, J. (2018). How outward looking is Smart Specialization? Rationales, drivers and barriers. *European Planning Studies*, *26*(12), 2344–2363. https://doi.org/10.1080/09654313.2018.1529146

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

Welsh Government. (2016). *Well-being of Futures Generations (Wales) Act*. Welsh Government.

Welsh Government. (2017). *Economic action plan*. Welsh Government.

World Bank. (2018). *Rethinking lagging regions: Using Cohesion Policy to deliver on the potential of Europe's regions*. World Bank.