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New Manufacturing Trends in Developed Regions. Three Delineations of New Industrial Policies: 'Phoenix Industry', 'Industry 4.0', and 'Smart Specialisation'

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ABSTRACT

This chapter addresses new industrial policies in the context of advanced regions in England, southern Germany and northern Italy. Manufacturing activities are of the utmost importance for preserving innovative capabilities, ensuring value added and retaining skilled jobs.

The challenge that strong manufacturing regions face lies in upgrading their innovation strategies to emphasise the new *system nature* of manufacturing. The chapter highlights three ways regions may choose to address the challenges of global competition and sustainable growth.

The birth of a 'Phoenix Industry' in the West Midlands (UK), the 'Industry 4.0' programme in the southern *Länd* of Baden-Württemberg (D) and the 'Smart Specialisation' strategy in the Lombardy region (IT) represent three different but converging ways of reinterpreting the innovation vocation of these core regions.

Two policy implications are discussed: the place-based dimension of new industrial policies, and the attention paid to the labour market and the emerging need for new skills. Both of these policy implications highlight a need for multi-actor, multi-level governance structures, which make them some of the greatest challenges in all of the considered regions.

Keywords: NEW INDUSTRIAL POLICIES, INNOVATION, MULTI-LEVEL GOVERNANCE

JEL classification: O30, O38, R50

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Introduction

In the aftermath of the financial crisis, a resurgence of interest in the manufacturing sector and in industrial policy has spread throughout Europe (Dhéret *et al.*, 2014; EC, 2014; Bailey *et al.*, 2015). The recent success of the BRIC countries, and the less recent but still prominent policies of Japan, South Korea, Germany and the US suggest that a pro-active state can play a positive role in facilitating economic growth (Pisano and Shih, 2009; 2012; Mazzucato, 2013).

There are good reasons for this revival and for the rising interest within the European Union in maintaining a strong industrial base and a competitive position at the international level. The most striking figures in this regard are related to exports. EU exports consist mainly of manufactured products, which represent more than 80 percent of all EU exports. Small and medium-sized enterprises (SMEs) are the backbone of the manufacturing industry in the EU, as they provide around 45 percent of the industry's total value added and 51 percent of manufacturing employment. In this respect, they make a significant contribution to retaining jobs in European regions instead of offshoring them to distant, low-cost locations, a trend common among multinationals. Another key reason to look at this industry as a powerful engine of contemporary development is related to R&D investments and innovation processes. In the mechanical engineering sector, for instance, R&D expenditures totalled around EUR 8.3 billion in the EU-10 just before the 2008 crisis. Notably, this covers just one of the core sectors of European industry. A major consequence is that, in the long term, regions lacking the infrastructure necessary for advances in processes, engineering and manufacturing will

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lose their ability to innovate. This is because firms without process-engineering capabilities find it increasingly difficult to conduct advanced research on next-generation process technologies. Finally, a strong and innovative manufacturing sector is able to address major societal challenges, such as climate change, energy and food security, and health and the ageing population (Aghion *et al.*, 2011; EC, 2014).

This chapter addresses the evolving paths of *advanced manufacturing industries*[1] in strong regions that are passing through a turbulent phase characterized not only by significant uncertainties but also by meaningful opportunities and great challenges. One of the main changes affecting advanced manufacturing industries is related to a shift in their positioning within global value chains (GVCs). Moreover, the metric of GVCs is changing owing to stronger competition on three main dimensions (WEF-UNIDO, 2014): competition over concepts (i.e., creating new products),[2] competition over processes (i.e., manufacturing new products) and competition over markets (i.e., delivering new products).

The real challenge for strong manufacturing regions is the need to upgrade their value chains by enhancing their capabilities (Timmer, *et al.*, 2010) and emphasising the new *systems nature* of manufacturing (O'Sullivan and Mitchell, 2013). Core manufacturing regions are well positioned to face this challenge, as they nearly always share some winning common features (Bramanti, 2016), including:

— A close relationship between leading-edge research and applications in more mature industries (e.g., mechanical engineering, precision engineering, medical instruments, apparatus building);
— A well-trained (blue collar) labour force as well as a university-educated labour force, with high average incomes; and
— Embeddedness in international networks.

In addition, most of these regions are relatively well positioned on the governance side (Hilpert, 2016). They are endowed with capable sub-national governments, which can help them along their development paths. Moreover, they are highly responsive to change. In addition, they tend to

[1]The Global Agenda Council on the *Future of Manufacturing* (WEF-UNIDO, 2014: 7) states: "*Advanced manufacturing is defined as the technological, organizational, social and environmental strategies that improve manufacturing so that it can meet the goals of enterprises, society and governments, and adapt to change. This definition reflects the growing level of integration across the value chains of the functions of production, distribution and consumption*".

[2]Products are not necessarily physical objects. Increasingly, they are platforms for new services and complex systems that address new needs and/or offer new answers to old ones. For example, in the case of the UK manufacturer Rolls-Royce: "*Over 50 percent of its revenues are now accounted for by their servicing of aircraft engines, while engines themselves are sold at near cost, to create lock-in and quasi-captive service recipients-customers. Important in such cases is that servicing requires manufacturing skills, knowledge, and capabilities to start with – this renders the two inseparable in a fundamental, even definitional, manner, hence the emergence of terms such as 'manuservices'*" (Pitelis, 2015: 26).

look to their traditional industrial apparatus for opportunities for innovation-oriented restructuring.

The goals for a new industrial policy are quite clear – to keep advanced regions on a sustainable development path while ensuring international competitiveness and local well-being without major imbalances related to social or environmental issues. However, the possible solutions are widely diversified, and they are deeply marked by the (sometimes divergent) national and regional frames, and rooted in innovative processes that are by no means the 'one-best way' of the Fordist paradigm.

The chapter is structured in the following way. It starts by focusing on the new role of manufacturing in European developed regions (§ 1). Many territories are at a low point in their historical industrial cycles. However, they are showing reliable prospects for a resurgence in manufacturing sectors in terms of offering a positive contribution to their regions through value added, investments, high-quality job creation, environmental sustainability and enhanced quality of life.

This positive role is largely the result of the dramatic changes that manufacturing sectors have undergone over the years (§ 2). The future of manufacturing will be very different from its history, and it is probably best captured by the label 'Industry 4.0', which refers to the fourth technological, industrial and societal revolution, which is slowly but steadily spreading across the globe. The trigger of and engine behind this fourth revolution is innovation. Moreover, the linkages between industry and open innovation (Chesbrough and Appleyard, 2007) are now stronger, more powerful and more pervasive than in the past (Cooke, 2012; Bailey *et al.*, 2015).

The core of the chapter is developed in the next section (§ 3), where three national/regional answers to the same meta-goals are discussed. First, the UK case is captured in terms of the emerging need for 'related variety' (Frenken *et al.*, 2007). This concept refers to the path towards smart diversification, which has emerged partly in response to the tyrannical predominance of the financial services economy. The urgency of the issue is even greater given the UK's vote in favour of exiting the European Union (Bailey *et al.*, 2015) (§ 3.1). Second, the German case is depicted in relation to the developing trend of 'Industry 4.0', which characterizes the major and deep transformation of the 'joyful war machine' that is the German manufacturing industry (Deloitte, 2014; Heng, 2014) (§ 3.2). Third, the Italian case is viewed through the lens of the new European policy of 'smart specialization' (Foray and Goenaga, 2013; Foray, 2015). The reasons for this choice are twofold. First, the new model of open innovation is gaining momentum (at least in the country's northern regions). Second, Italy has to recover from its poor productivity growth from 1999 to 2013, which requires new alliances between public institutions and private actors (Bramanti and Lazzeri, 2016) (§ 3.3).

The conclusion of this section is that the three paths – the renewal of manufacturing sectors through related variety diversification, the strengthening of competitiveness by moving towards Industry 4.0 and the regaining of productivity through smart specialization – are unified by the role of innovation and by their attention to human capital. These are the two major, intertwined challenges developed regions face in their attempts to reach their planned future (§ 3.4). Different innovation processes are at work in each of the regions, each of which represents a special combination of a specific Regional Innovation System (RIS), a particular industrial mix, a distinct skilled workforce, and a precise form of governance. The outcomes of these combinations of multiple alternatives determine the level of innovativeness found in each territory. At times, this level of innovativeness is imitable (i.e., we can learn from best practices) but it can never be duplicated, as attested to by the numerous abortive attempts to replicate Silicon Valley around the world.

The next section (§ 4) highlights some policy implications arising from the strategies pursued in the three cases. The analysed implications are the place-based character of new industrial policies (§ 4.1), and the impact on job markets and the workforce (§ 4.2).

The final section (§ 5) offers a summary of the main findings on the centrality of innovation that underlie the spatial concentration of innovative efforts, which frequently takes the form of clusterisation. The emerging diversities that are a positive feature of core developed regions in Europe are determined by the quality of institutional endowments and human capital. This suggests that governance structures are vital for the future competitiveness of any region. This is an area that is open to future research.

1. The role of manufacturing[3]

The manufacturing sector has one of the highest multiplier effects on the economy, as it is a major driver of knowledge building and job creation (Farshchi *et al.*, 2009). Despite the fact that the share of manufacturing activities as a percentage of GDP continues to fall globally, manufacturing still plays a central role in forging capabilities and disseminating knowledge across GVCs (EC, 2014).

Notably, de-industrialization is no longer perceived as a natural process of economic development. After decades of delocalization, a change is underway in the European industrial panorama. The assumption that developed regions should (mainly) focus on knowledge-intensive

[3]According to Eurostat classifications, manufacturing includes all activities in section C of the NACE (rev 2). This section encompasses industries involving the physical or chemical transformation of materials, substances or components into new products.

services has been questioned in the light of the Great Recession (2008-2009). The evidence that developed regions have become too unbalanced and heavily dependent on a small number of business and financial services is widespread (Christophenson *et al.*, 2014). Some are wondering if a new trend of onshoring could soon replace the offshoring trend, thereby reinforcing domestic employment, even if this move may be extremely difficult to achieve (Pisano and Shih, 2012; Bailey and de Propis, 2014). The trend of moving a significant portion of domestic production abroad has been taken to a dangerous extreme. The persistent trend of exacerbating outsourcing decisions within large firms has caused lasting damage not only to the firms' own capabilities but also to the entire domestic value chain, which encompasses suppliers of materials, tools, production equipment and components. All of these collective capabilities are referred to as the 'industrial commons' (Pisano and Shih, 2009).

In recent decades, many European regions have moved beyond the comparative advantage phase, which centred on factor endowments and cheap costs, into the 'competitiveness phase', which is focused on such elements as standards, infrastructure, education and finance (WEF-UNIDO, 2014). However, the shift from competitiveness to global competition is shifting the focus toward a new capabilities phase in which firms attempt to maintain and improve competitiveness in light of declining comparative advantages (Dettori *et al.*, 2013). As this stage tends to be innovation driven, 'talent' and creative skills are what most matters. It is precisely the role played by innovative workers that changes the economy of cities and regions, and enables them to attract other skilled workers up to the point at which these cities and regions leap into the knowledge-based world and become 'winners' (Moretti, 2012).

Given these factors, manufacturing is of exceptional importance in this era of globalisation. Today's technological innovations will lead to a massive increase in manufacturing productivity on both the micro and macro scales. Manufacturing is still the second largest of the NACE sections within the EU-28 non-financial business economy in terms of its contribution to employment (30 million employees in 2012, or 22.4% of the total) and the largest contributor to value added by the non-financial business economy (EUR 1,620 billion in 2012, 26.2% of the total). If we look closely at the industrial sector, we find that the EU is the world's largest producer of mechanical engineering equipment, surpassing the US and Japan by far. Total exports of machinery from the EU represent 42% of total mechanical engineering production within the Union, and this share has increased in the last three years.

In addition, the European manufacturing sector is highly active in R&D and innovation. In 2011, the share of gross domestic expenditure on R&D (GERD) relative to GDP was 2.03%. The R&D intensity of mechanical engineering is as high as 3.6% of GDP, having passed well beyond the EU's

target of 3% by 2020, and having achieved a higher importance for overall technological performance than in the US and Japan (EC, 2013).

Even though the EU sometimes struggles to maintain a strong industrial base and a competitive position on the international level, a need to renew coordinated policies at the European level has emerged, as has a need for the implementation of genuine multi-level governance[4] (Hooghe and Marks, 2001; Kaiser and Prange, 2004; Faludi, 2012). "Multi-level governance" has been used as a simplified notion of pluralistic and highly dispersed policy-making activities in which multiple actors (individuals and institutions) participate at different political levels, as if the use of this buzzword will help simplify a rather intricate and difficult-to-manage reality. The focus is on co-ordination and partnership at various stages of the policy-making process.

2. Manufacturing is changing

A key feature of recent international analyses of the future of manufacturing is the emphasis on the *systems nature* of the industry. Modern manufacturing systems are constructed around supply chains, which may interact in highly complex ways. A number of major changes are underway: the blurring of traditional sector boundaries; the emergence of complex interdependencies between manufacturing systems and national innovation systems; and a shift towards highly complex products, which are the final point in a range of industries.

Research, development, design and production are closely intertwined, with complex interdependencies emerging among system elements. In particular, the US Institute for Defence Analysis (IDA, 2012) points to a set of converging trends associated with the transition from labour-intensive production to high-value production based on advanced technologies. Among these trends, certain factors are particularly relevant: i) the ubiquitous role of IT, ii) the increasing reliance on modelling and simulation in the manufacturing process and iii) the acceleration of innovation in global supply-chain management, which implies that separating R&D, design and production is impossible.

Over the past decade, a number of analyses have stressed the main features of manufacturing in advanced countries (e.g., O'Sullivan and Mitchell, 2013; Dhéret *et al.*, 2014; Dolphin, 2015). Some common elements emerging from those surveys include sustainable manufacturing; production technologies and bio-manufacturing; simulation and

[4]Multi-level governance requires a system of continuous negotiations among nested governments at different territorial tiers as a result of the broad process of institutional creation and decisional reallocation that had affected some previously centralized functions of the state (Marks, 1993).

modelling; additive manufacturing; and responsive production networks. Moreover, in almost all core regions in advanced economies, producers are seeking out ways to achieve greater product flexibility and to manufacture them at a cost level close to that associated with mass production. This effort calls for a system-thinking approach (Fujimoto, 2011), which requires sophisticated levels of coordination in terms of production engineering, design and technology.

In addition to technological improvements and the ability to answer to new, emerging needs, manufacturing systems are on the front line in terms of capturing significant value for the territories in which they are rooted. This entails translating innovations into new products and services, and then scaling them up in a way that creates jobs and opportunities for the entire population. A twin area of attention places emphasis on addressing 'demand-pull' social and economic challenges, with specific attention paid to green innovation and life innovation.

In the light of the above-mentioned changes, a key question arises in the debate on new industrial policies: How do manufacturing systems need to be configured to support economic value creation and value capture? Policy makers, mainly at the regional level, pay significant amounts of attention to the potential to retain and create jobs, and the potential to retain and attract investments. There is a growing awareness that a knowledge economy that fails to interact with its production base may lose the ability to innovate next-generation technologies and, as such, compromise its potential to participate in important emerging industries. This is exactly what has happened to the US manufacturing system, which is threatened by the loss of a great part of the assets – skilled labour and specialised suppliers – required to manufacture many of the cutting-edge products it invented (Pisano and Shih, 2009). Therefore, major efforts in national/regional industrial policies are understandably devoted to guiding regional manufacturing systems towards a new path of renewal and innovation.

3. The uniqueness of innovation regional paths within a converging frame

This section, which is at the heart of this chapter, is related to three territorial approaches to innovation. It focuses on new industrial policies that are emerging in the UK (West Midlands), Germany (Baden-Württemberg) and Italy (the Lombardy region). Despite significant differences in the macro-frameworks of the three countries, the challenges that European core regions face seem quite similar (Tomaney, 2009).

Of the different composite indicators covering innovation activities, the Ambrosetti Innosystem Index has two notable merits (Ambrosetti, 2016): it

looks at integrated innovation ecosystems in which the results of innovation are determined by interactions among key players (e.g., academia, government and business), and it is up to date, as the 2016 edition has just been released. The leaders in this ranking are Switzerland (6.80 in the range of 0-10) and South Korea (6.47). Germany ranks fifth, with a rating of 5.67. The UK ranks seventh (5.16), while Italy is next-to-last with a rating of 3.36. A comparison of country innovative performance to performance on the regional level highlights the tremendous differences in the performance of local ecosystems. If we examine the 89 Nuts-2 regions of EU-15, the ratings of our regions are as follows (on a 100-point scale): Baden-Württemberg ranks first with a rating of 85.2, Lombardy is 18th with a rating of 44.3, while East Midlands is 31st (35.5) and West Midlands is 44th (28.0).

Even though a great deal of distance remains among the regions in terms of quantitative indicators of innovativeness, many of them have struggled to maintain their economic dynamism, which sometimes seems to be locked into sectoral profiles reflecting a long-standing over-reliance on existing path dependencies (Bailey *et al.*, 2015). In all of these territories, new industrial-strategy policies are focusing on activity-based, technology-intensive sectors able to produce tradable and exportable goods and services with the potential to enhance national/regional competitiveness. These policies relate to the different needs and capabilities of the various regions, and they affect how and why the individual areas might win or lose (Boschma, 2008; Bramanti, 2016; Hilpert, 2016).

The common denominator in the different strategies pursued by core regions is a shared vision on the future of industry in which manufacturing is (IDA, 2012; EC, 2013):

— An 'ecosystem' in which a variety of components, materials, production systems and sub-systems, and producer services work together;
— A productive field that prioritizes emerging technologies and new research domains;
— A preferential field in which public-private partnerships are developed in areas ranging from pre-competitive consortia to public procurement policy, and in which the role of technical standards in supporting future manufacturing competitiveness emerges and needs to be managed;
— A powerful instrument useful for addressing societal challenges and an instrument that can benefit from a demand-side approach to the market in terms of learning to detect and master the new needs of an increasingly urbanized population.

Cities and metropolitan areas within core regions are increasingly recognized as potential environments for creativity (Hilpert, 2016) and as possible drivers of economic growth (Moretti, 2012). In fact, cities represent emerging markets for a number of new needs that require prompt answers.

When manufacturing sectors learn to serve these new needs (Cappellin, 2016), they can exploit the specific, idiosyncratic 'territorial capital' (OECD, 2001) present within the cities (and the regions). This capital encompasses a wide set of skills, knowledge and competences. This is the prerequisite for the development of diversity and technological heterogeneity, which offer uniqueness and distinction within global markets (Boschma, 2008). Clearly, region-specific characteristics have a strong influence on innovative output and give rise to different RISs (Braczyk *et al.*, 1998; de la Mothe and Paquet, 1998; Niosi, 2010; Isaksen and Trippl, 2014). These RIS are determined by the innovative environment and research institutions; by the specific industry mix, as characterised by related and unrelated variety (which, in turn, depends on the competences accumulated at the local level); and the workforce and labour-market dynamics, which influence the degree of technological relatedness among different activities (Quatraro, 2016).

We look at some successful strategies that are deeply rooted in innovation based on in its broader definition,[5] and that target some of the main challenges that the English, German and Italian regions are facing.

3.1 The emergence of a 'Phoenix Industry' in the Midlands

In the UK case, it is widely accepted that manufacturing could serve as a rebalancing force that could help the region move from an over-reliance upon consumerism and the financial sector towards more sustainable production activities (Christophenson *et al.*, 2014; Bailey *et al.*, 2015). Even in the heartland of Anglo-American orthodoxy, there is a growing recognition of the need to rebalance economies that are overly focused on service employment and unregulated financial markets. We refer to this trend as the exploitation of 'related variety' (Frenken *et al.*, 2007; Boschma, 2008). The idea is simple but effective. Neither regional diversity nor regional specialisation per se may have a significant impact on innovation and change. Rather, regional related variety is more likely to generate effective interactive learning and innovation. This is linked to diversification which, in turn, is rooted in the existing regional knowledge base. As such, related variety encompasses the two complementary dimensions of external knowledge flows – 'cognitive proximity' (which matters most in this discussion; Boschma, 2005; Torre and Rallet, 2005) and local 'absorptive capacity' (Cohen and Levinthal, 1990; Caragliu and Nijkamp, 2008), which is necessary for understanding external knowledge and transforming it into economic growth.

[5]Here, the 'broader definition' refers to all that exceeds technological progress. Cultural, societal and aesthetic innovations – sometimes referred as 'soft innovation' (Stoneman, 2009) – are key for shaping the developing paths of advanced regions.

The challenge for industrial strategy in relation to older cities lies in widening their economic diversity, possibly by unlocking their existing expertise, competencies and knowledge bases, and combining them with new, complementary ideas and technologies in adjacent, related sectors (Moretti, 2012). If industries downsize or disappear completely, their resources (including their skilled employees) are released. Intra-industry networks play an important role in enabling job seekers to find a job in the same or a related industry. Therefore, the competencies accumulated at the local level are important for shaping the process of industrial diversification – a change in the allocation of employees across sectors is influenced by the degree of technological relatedness among the involved activities (Cooke, 2012; Morkuté *et al.*, 2016).

Another benefit of labour pooling is that fluctuations in a firm's labour demand can be more easily accommodated. Consequently, all else equal, the unemployment rate in this situation will be lower than the rate achieved in any other way.

The problem in this regard is the need to increase exports of cutting-edge, high-quality manufactured products (Dolphin, 2014). Frequently, old industrial cities seem to be locked into old ways of doing things. Moreover, although they have some key assets that can support process and product innovations, those assets may be difficult to move. This phenomenon has been described as the emergence of 'phoenix industries'[6] (Christophenson, 2009; Tomaney, 2009), which are clusters of SMEs that are born of the ashes of pre-existing large firms and share similar technologies. They benefit from the firms' sunken investments, including the accumulation of technical knowledge and workforce skills over the years. They add new R&D and, as a result, are able to produce sophisticated components for different industries. As such, they take on the role of 'enabling industries' (Amison and Bailey, 2014).

In the UK, just as in the US,[7] several phoenix industries have developed in the last decade. Sheffield (UK), for instance, has moved from production

[6]In Greek mythology, a phoenix is a long-lived bird that is cyclically regenerated or reborn. A phoenix rises to life from the ashes of its predecessor. A 'phoenix industry' is a new productive activity born from the ashes of a previous producer (frequently a large firm) that maintains some elements of its predecessor and adds new lifeblood.

[7]The story of photonics in Rochester (NY) is particularly instructive. Photonics – the science of using light in processes from advanced manufacturing to data transmission – has a strong footprint in Rochester. It emerged from the old photographic equipment and supply industry (Kodak's sector), and resulted in a hub focused on the design, manufacturing and packaging of circuits that combine photonic and electronic components. Integrated photonics have the potential to revolutionize the carrying capacity of Internet networks, improve performance in biological research, and they have applications in such areas as cyber defence, banking, investing, video conferencing and weather modelling. This sector accounts for an estimated 17,000 jobs in the region. In 2014, Rochester was chosen as the headquarters of the American Institute for Manufacturing

of routine steel products to production of high-quality products for specialised markets, such as surgical instruments (Christophenson, 2009). The implementation of this kind of industrial rejuvenation requires working closely with SMEs, which are frequently the main actor in the downstream processes associated with new products.

One success story has emerged in the West Midlands,[8] where small, niche firms have developed an important presence in automotive design and engineering out of the disappearance of UK vehicle producers. Significant investments were made in the automotive sector over an extended period of time, allowing for the accumulation of territorial capital (OECD, 2001) and the creation of 'industrial commons' (Pisano and Shih, 2012), which are innovation-prone environments in which knowledge and skills related to old technologies and emerging ones are combined.

According to the literature (Christophenson, 2009; Amison and Bailey, 2013; 2014), the necessary (but not necessarily sufficient) conditions for the birth of phoenix industries are the following: i) the presence of relevant skills in the workforce and among potential suppliers, ii) technical skills and expertise in nearby universities and research facilities, iii) personal networks and market knowledge related to the focal industries, iv) reputational factors, and v) capital for investments. Apart from capital availability,[9] all of these conditions are present in the Midlands case. The skills necessary to manufacture innovative products or components are embedded within local firms' workforces, even though some of these skills may be lost as the workforce ages. Expertise and specialisations are retained within local universities (e.g., Coventry, Warwick, Oxford, Birmingham). If we take SMEs and local academia together, we have an impressive pool of automotive- and engineering-related expertise. Furthermore, the area has been able to attract suppliers of vehicle-design and engineering services despite the loss of major big car manufacturers (e.g., the closure of MG Rover in 2005).

In the Midlands, SMEs play a central role in providing the more radical innovation needed for systemic change in the automotive sectors. In addition, and even more interestingly, many SMEs are serving industries beyond the automotive sector. Their innovation efforts are oriented

Integrated Photonics (AIM Photonics), a first-class national institution. This is likely to boost the visibility and the attractiveness of the region.

[8] Much of this case on the automotive industry in the West Midlands is based on Amison and Bailey (2014). Further information on the case is available in a detailed research report by the same authors (Amison and Bailey, 2013).

[9] "*In the Midlands case, rather than being a supporting factor, lack of access to capital has been a drag on the sector (…). Domestic finance for investment in manufacturing has been a problem for British industry, stretching as far back as to late XIX Century. Several interviews expressed the belief that 'there is no finance available in the UK for manufacturing'*" (Amison and Bailey, 2014: 403-404).

towards aerospace, defence and motorsports, as well as renewable energy and medical technology.

Given the reasoning developed in this chapter, a question emerges: Did industrial policy play a proactive role in triggering and/or sustaining this structural change? The answer is, at least to some degree, affirmative. For instance, the extent of collaboration among firms, and between firms and research institutions has been strongly supported by public programmes and R&D funds. In addition, regional policies have to play a positive role. They should address industry partnerships in terms of enhancing productivity and making room for innovation; bringing SMEs together and enabling them to act as more powerful networks; and directing public investments in a way that strengthens the linkages among the university system, local development agents and manufacturing firms (as in the case of the Marine Design Centre established in Newcastle to create a new industry from the old shipbuilding manufacturers).

In summary, new industrial policies aimed at promoting diversification through related variety must support industrial clusters. These clusters exert a number of positive impacts in the field of innovation, lead to productivity gains that enhance entrepreneurialism, and support economic diversification. In developed regions around the world, clusters represent proven areas of competitive advantage that also support high wages and high skill levels (Dolphin, 2014).

Two policy interventions are probably essential for the Midlands clusters. First, some form of support is needed to move from the prototype stage to the production stage, as the process of scaling up production of a new product to the point of full commercialisation is often difficult for SMEs to carry out on their own. One way to achieve this goal may be to create projects, such as joint procurement bids, that can support regional/national demand (we will see a similar challenge in the Lombardy case).

The second area of intervention is in the Vocational Education and Training (VET) system. The aims in this regard should be to provide the skills needed by firms, to address the skill gaps in the science, technology, engineering and math (STEM) subjects and to address the need for people with vocational skills (i.e., a number of firms in the area note that the younger generation of workers does not have the same practical skills as the older generation). The market for skilled labour is rapidly growing, as a significant number of global players have located their research facilities in the West Midlands (e.g., Jaguar-Land Rover, Tata Motors, MIRA, Ricardo UK). Their investment choices have opened the local labour market up to a more national and global dimension. Many firms have declared that they have exhausted the local supply of required specialized skills and are therefore recruiting internationally.

On these grounds, employers within clusters need to work together to identify future skills needs, and to coordinate, plan and purchase skills training. They need to develop transversal competencies within their workforces – such as problem solving, critical thinking, initiative, risk-taking and collaboration. This implies that VET curricula should be transformed. This change will be better planned at the cluster level, working together with training suppliers.

3.2 The German 'Industry 4.0' approach in Baden-Württemberg

Baden-Württemberg is one of the leading regions for research, not only in Germany but also in Europe. This German *Länd* has the highest share of GDP spent on R&D as well as the highest number of patent applications per million inhabitants.

In 2013, the proportion of R&D expenditure in relation to GDP in Baden-Württemberg was 4.8% (corresponding figure for all of Germany: 2.8%). Baden-Württemberg is therefore one of the leading regions in an international comparison, as the region's research intensity rate of 4.8% is the highest in the European Union. It is clearly in the lead when compared to other top-spending countries, such as Finland and Sweden (both at 3.3%). The predominant investor in R&D in Baden-Württemberg is the industrial sector, which has numerous in-house research facilities. In 2013, the industrial sector alone contributed almost 81% of total R&D investments in the *Länd*, while the university sector was responsible for 8.7% and the public sector for 8.7%. With more than 100 R&D institutions, the public sector offers a broad spectrum of non-university research institutions. 13 of the 83 Max Planck institutes and 15 of the 67 Fraunhofer institutes, as well as 25% of the Helmholtz Association of German Research Centres' research facilities are based in this region. In addition, more than 70 universities are located in Baden-Württemberg, including three of Germany's eleven elite universities. In addition to this strong and rich RIS, other key points are the cooperative industrial relations, and the close, long-term relations between banks and firms.

This region is therefore extremely well positioned to meet the potential of the new 'Industry 4.0' trend. [10] The German government is wholeheartedly sponsoring Industry 4.0, a multi-year strategic initiative that brings together leaders from the public sector, the private sectors and academia to create a comprehensive vision and action plan for applying digital technologies to the industrial sector.

[10] *"In essence, Industry 4.0 will involve the technical integration of Cyber-Physical Systems (CPS) into manufacturing and logistics, and the use of the Internet of things and services in industrial processes. This will have implication for value creation, business models, downstream services and work organisation"* (Industrie-Science Research Alliance, 2013: 14).

In essence, Industry 4.0 involves deep and useful exchanges among actors operating in the fields of electronics, electrical engineering, mechanical engineering and IT. Such networks are particularly well developed and functional in the southern *Länd* of Baden-Württemberg, which can also count on such elements of as a good educational system, established development partnerships between suppliers and users, market leadership in plant and mechanical engineering, strong and dynamic SMEs, and a position as the leading innovator in automatic methods (Heng, 2014).

The role that Germany can play in Europe and that Baden-Württemberg can play in Germany is to lead the fourth industrial revolution, thereby enhancing EU competitiveness and offering an answer to some grand societal challenges (e.g., renewable resources, quality of life, active aging). Without overemphasizing the role of interregional innovation spillovers, the southern *Länd* is well positioned to ensure widespread innovation throughout Europe.

It has a strong, well-established research network with many external linkages. To name but a few, this network includes the Heidelberg Academy of Sciences and Humanities, two Helmholtz Centres, six institutes of the German Aeronautics and Space Research Centre DLR, 12 institutes of the Baden-Württemberg Innovation Alliance, the Centre for European Economic Research (ZEW), the Max Rubner Institute, and the Federal Waterways Engineering and Research Institute[11].

It is endowed with a number of large, multinational enterprises that weave a network of direct and indirect relationships. 2,000 companies have 250 employees or more. Of these, the 10 biggest companies include four automotive multinationals (Dailmler AG, Robert Bosch GmbH, ZF Friedrichshafen AG and Porsche AG), two wholesale pharma companies (Phoenix Group and Celesio AG), and companies belonging to the following industries: retail (Schwartz-Gruppe), energy (EnBW AG), software (SAP AG) and construction material (Heidelberg Cement AG).

It operates as the leading partner in articulated value chains, which gives rise to trust and a shared identity. This, in turn, facilitates collaboration with both firms and suppliers, as well as among personnel employed in partnered firms. According to the 'Competence Atlas' (Ministry of Finance and Economic Affairs B-W, 2014) there are around 400 actors with industry 4.0 competencies, with specialisation in niche markets with the presence of global leaders in their particular fields. They include Trumpf in laser technology, Festo in automatisation technology, Alfred

[11] All of the information reported here is extracted from the rich and up-to-date 'Regional Innovation Monitor' developed by Technopolis in partnership with the Fraunhofer Institute for Systems and Innovation Research ISI on behalf of the European Commission (Zenler and Schnabl, 2016).

Karcher in cleaning systems, ebm-papst in ventilation and drive engineering, Homag in woodworking machinery and Fischerwerke in fixing.

One of the most interesting lessons from the Industry 4.0 process in Baden-Württemberg is that regional capabilities[12] are more than just competences. In regional development, the combination and creative interaction of existing assets are key. Within this region, a production system, a set of actors, a system of representation and an industrial culture have given rise to a dynamic, localised process of collective learning, which serves to reduce uncertainty in innovative processes (Ratti *et al.*, 1997).

Many regions around Europe compete on some single component of the complex puzzle. However, to enable the discontinuity leap that will lead to the breakthrough of the fourth industrial revolution, a fully integrated, intelligent environment is needed, an environment in which the boundaries between industry and services, and among the different sectors become increasingly blurred. The impact on the economy should be highly pervasive, allowing for greater efficiency, increased flexibility, lower costs, reduced time requirements, and easier adaptations to customer requirements.

Obviously, this complex and ambitious outcome cannot occur without specific effort. In fact, it will entail addressing technical, economic, organisational and legal challenges, which is exactly where the 'German system' can make a difference (Industry-Science Research Alliance, 2013; PwC and Strategy&, 2014) by enabling the numerous actors along the value chain to work together; coordinating public and private investments, and properly subsidising the latter; offering legal protection and addressing those risks arising from the imperfect appropriability of knowledge; providing suitable financing for the investments required; and ensuring job training and re-training for all workers affected by the radical changes occurring within organizations and on the job market.

Regions that have activated the positive cycle of innovation-productivity-growth are those that seem best positioned in terms of long-term systemic competitiveness. They also experienced greater resilience in the current crisis (Sedita et al., 2015; Fratesi and Rogriguez-Pose, 2016). The uniqueness of the RIS functioning in the *Länd* under analysis consists of the idiosyncratic elements and relationships that interact in the production, accumulation, diffusion and exchange of new, economically useful knowledge. The *Länd* is endowed with an economic community with robust system characteristics of mutual understanding, trust and reciprocity. This community, in turn, can channel flows of information to

[12]Different labels are used in the literature to indicate the pool of idiosyncratic regional assets enabling innovation processes and enhancing development paths. They include 'territorial capital' (OECD, 2001), 'industrial commons' (Pisano and Shih, 2012) and 'innovative milieu' (Ratti *et al.*, 1997).

its members. The region has its own social filter in which innovative and conservative components are combined. This social filter is highly influenced and shaped by local innovation institutions (Ratti *et al.*, 1997).

However, the vision sometimes precedes reality. Due to the radical changes involved in the building of the new market scenario, a variety of opposing forces are at work (Heng, 2014). They are mainly related to the marked changes in value chains and in generated margins; the wide-ranging fears about losing jobs or having one's responsibilities curtailed; uncertainties linked to the lack of generally applicable standards; and bottlenecks that may arise in communication networks in relation to availability and speed.

The economy of Baden-Württemberg appears well positioned to drive this complex upgrading process, as it is strong enough in terms of technologies and competences, and inclusive enough in the labour market and in terms of societal-participation processes. Nevertheless, the region needs to further strengthen industrial co-operation (i.e., ensure a true coalescence) among the fields of electrical engineering, mechanical engineering, electronics and IT. In other words, it must work toward fully integrating the regional innovation system with the production system while applying even greater efforts in relation to the VET and education systems.

The likely rewards of such an effort are significant. The impact of Industry 4.0 on the Germany economy is expected to be strongly positive and sizable in three different respects over a time horizon of only five years (Heng, 2014; PwC and Strategy&, 2014):

— Productivity should increase via diminishing costs, and better management of both horizontal and vertical value chains. Companies directly involved in the process expect productivity to rise by more than 18 percent over the next five years.
— Average revenue growth related to the Internet of things and services is estimated at 2-3 percent per year.
— Investments in Industry 4.0 solutions should account for more than 50 percent of planned capital investment for the next five years, reaching the threshold of EUR 200 billion by 2020.

A relevant issue is related to the impact of the fourth industrial revolution on the labour market, as the revolution will entail a radical reshuffling within the workforce. The technological progress will deeply change the workforce from both a quantitative and qualitative point of view. In the coming decades, 45 percent to well over 60 percent of workers from EU-28 countries could see themselves displaced due to computerisation. At the same time, digital literacy will become critically important

> *Jobs that are not at risk of computerisation have something in common: they require and understanding of human heuristics or involve the creation of a novel*

> *idea – that is, they require social or creative skills. Many jobs in management, education or healthcare that involve social interaction, therefore, are unlikely to be automated. Similarly, science or engineering jobs that require creative skills will probably not see substantial job losses due to technological advances in the near future.* (Dolphin, 2015: 77)

However, there are also reasons to be optimistic about the future demand for employees. The loss of manufacturing jobs in the EU appears to have stopped. At the same time, a skill shortage exists and will probably increase in the medium term. According to CEDEFOP (2013), in a baseline scenario, EU-27 employment should return to its pre-crisis level between 2017 and 2018, after which it should steadily increase. Job opportunities will be associated with responding to expansion demand and replacement demand. As the replacement component is almost the same in various scenarios, the differences in terms of forecasting mainly relate to how well the economy generates new jobs (around 114 million job opportunities in Europe between 2012 and 2025). Most newly created jobs will require a higher skills level (e.g., technicians and associate professionals).

Competition will increasingly focus on the quality of products and services that only people with the right skills can deliver. According to CEDEFOP (2006) forecasts, jobs at all skill levels will become less routine and more demanding. Therefore, even the high-quality, above-average workforce of the southern *Länder* needs to focus on upgrading its digital skills and on continuous lifelong learning, as the digital skills of today are likely to become obsolete sooner than we may think.

In conclusion, we agree that Germany is well positioned to act as the factory outfitter of the world. It has a strong VET and educational system, which may provide the right skills in the labour market of the future. It has an imposing tradition of managing technical standards, as well as the political power and technical credibility needed to enforce those standards at the European level. It also has the core asset needed to co-ordinate a complex and difficult process – a governance structure that is up to taking on the role as well as the challenge.

3.3 The 'smart specialisation' strategy in Lombardy

The Lombardy region has used the smart specialisation strategy (S3) to escape the conventional top-down approach in which a policy is defined ex-ante, implemented mechanically and controlled ex-post. The new strategy blends the selection of some macro areas (called 'competence systems') with a bottom-up entrepreneurial process of discovery (Foray, 2015; Foray and Goenaga, 2013) that encompasses firms, higher education institutions, independent inventors and research centres. In short, all the stakeholders of the RIS are involved in S3 (Morgan, 2013).

Lombardy and other regions in northern Italy have used the European S3 approach to match the presence of rich 'territorial capital' (OECD, 2001) with a strong RIS. In so doing, Lombardy has adopted an open-innovation approach[13] (Chesbrough and Appleyard, 2007), which is matched with strong regional manufacturing clusters.

To what extent does S3 differ from the strategies in the phoenix industries and Industry 4.0 cases? At a first glance, the phoenix and Industry 4.0 cases may appear to be variations of S3 relevant for the UK and Germany. However, upon careful scrutiny, several differences emerge that enable us to consider the Lombardy case as a specific, distinct version of new industrial policies.

The pre-existence of major assemblers and the fact that the industry is limited to only one value chain (i.e., automotive) are two main features that distinguish the phoenix industries in the English case from a more generic S3 strategy. In the Lombardy experience, the focal competence systems are related to the nine pre-existing clusters, but no one sector is dominant. In the German case, Industry 4.0 is an all-encompassing strategy that goes far beyond a pure S3 strategy. That case involves numerous ingredients. An S3 strategy is by no means all-encompassing or as highly demanding as the design underlying Industry 4.0, which asks for perfect synchronization among the different components of the new industrial system, as well as full integration of technologies, organisations and people.

Moreover, there is a contingent situation that makes the Lombardy case unique: the political context in which citizens, for the first time, voted for the Council of the newly established 'Milan metropolitan area' (the election took place on June 19, 2016). In terms of governance, a new public actor will soon be at work. The S3 strategy relates to the entire region, but the metropolitan area of Milan will play a key role, as its weight, in economic terms equals approximately 50 percent of the entire region.

Finally, the availability of the site of Expo 2015 (the international exposition that closed its gates at the end of September 2015) is notable. This location, which has excellent infrastructure and is connected with the city of Milan, can be utilized as an industrial park devoted to innovative production and tertiary-level vocational training.

As mentioned above, the region can rely on a number of existing clusters. In fact, nine clusters have been officially recognised by the Italian Ministry of Industry: aerospace, agrifood, green chemistry, energy and the environment, smart plant, mobility, life sciences, living environments, and smart communities. The region can also utilise the new open-innovation

[13]In an open-innovation model, firms use external ideas and internal ideas, as well as internal and external paths to market. Firms utilise open innovation to address two growth objectives: growth in the current business (incremental change) and growth in new business areas (step change).

platform[14] as an experimental lab (Bramanti, 2015a) to mobilize SMEs and researchers. Entrepreneurial discoveries arising within the clusters may result in new value-chain strategies aimed at responding to citizens' new needs.

In the Lombardy region, a central role is played by medium-tech sectors, which combine well-made products with the trend towards incremental innovation and the recombination of different types of knowledge (Cappellin and Wink, 2009). This is a type of ongoing innovation with a strong market-pull orientation, which horizontally involves all of the different functions in the firm – managers, technicians and blue-collar workers – in a circular, ongoing accumulation of know-how that nurtures a system capability and produces industrial commons (Confindustria Lombardia, 2015).

The European S3 approach is well suited in this territorial context, as it allows for the concentration of resources in a few industrial domains. This has the valuable result of generating size and critical mass effects. In addition, regional firms have the opportunity to tackle society's problems through a new stream of broad collaboration among business, academia and the government. This process is pulled by market demand, which is closely linked to new urban needs and grand societal challenges, such as housing; mobility and logistics; energy and the environment; new urban industrial supply chains; health, welfare and education; and culture, tourism, leisure, sports, the media and the Internet (Cappellin, 2016). Moreover, the presence of established clusters supports the development of collective actors with the view to discovering, exploring and experimenting with new opportunities. All of these preconditions enable Lombardy to restore the capabilities of its enterprises in developing and manufacturing new products, thereby reversing the decline in productivity and competitiveness that has occurred over the past decade.

In addition, the Lombardy region is taking part in the international *Vanguard Initiative* [http://www.s3vanguardinitiative.eu/], a European network born in November 2013 with the aim of coordinating the efforts of 30 EU regions to better align their regional specialisation strategies. The Initiative is committed to the creation of a platform[15] designed to generate bottom-up ideas, and to support synergies and alignment on an inter-regional level. It is focused on advanced manufacturing, and it develops

[14]Lombardy has promoted an open-innovation platform to serve as a new tool for sharing and exchanging knowledge, and for defining networking activities among innovative firms. The platform aims to be a two-way communicational channel with the view to co-defining regional innovation policy and the operative tools needed to support it. See http://www.openinnovation.regione.lombardia.it/.

[15]The platform should have a strong service orientation, and focus on developing and delivering concrete services (e.g., advisory services, data and analysis services). At the same time, it should act as a vehicle to encourage and support collaboration among firms, clusters and regions.

pilot activities to foster interregional cooperation, the exchange of good practices, and the alignment of roadmaps to achieve complementarities. A specific Lombardy pilot node, which is connected to the electromechanical sector, includes the opening of a laboratory as well as the installation and integration of a reconfigurable and intelligent semi-automatic line designed to assembly different products that gather the several features on an electromechanical product. For this pilot node, which is expected to be in place by the end of 2016, the potential market – including end users, technology providers and machine providers – was clearly identified. In terms of funding opportunities, potential EU 'Horizon 2020' calls have been selected.

On a final note, the issue of the technical formation of human capital must be mentioned. Lombardy has a VET system that is better than the Italian average, but the implementation of the S3 strategy is a perfect occasion to rethink the VET curricula and training. A new, regional VET system that helps people innovate is needed. This basically implies development of transversal competences and soft skills, such as problem solving, critical thinking, creativity, initiative, learning to learn and to take risks, reflection, and collaboration. A new frontier for regional VET will be to validate non-formal and informal learning with the aim of increasing effectiveness and bringing out the on-the-job experiences of the workforce. In the Lombardy context, VET may become an innovation driver. An easy way to reach this goal is to involve a large number of firms in the process, thereby enhancing what has been called the 'educational firm' (Bramanti, 2015b).

3.4 Unifying trends towards new industrial policies

The unifying trends in these different approaches are clear and can be summarised as three main points: the existence of a well-structured RIS, which enjoys the presence of leading firms and top-rated research institutions; the ongoing switch from product/services systems to services through products (a solution-oriented approach); and the strength of regional relations (horizontal as well as vertical) together with a high degree of international connections, all of which enable the productive systems to master the state-of-the-art of their core technologies.

Some features of the three territorial experiences examined here are highlighted in **Table 1**. The shared characteristics are the high level of territorial capital and the strong RISs present in the different regions. Similarities also emerge from a comparison of phoenix industries and smart specialisation, as the concept of diversifying through related variety is shared by these two strategies. The strengths of the cases are:

— A well-educated, technically skilled workforce, and good relations between firms and research institutions in the Midlands region;

— The power of the RIS in Baden-Württemberg together with a well-performing governance structure; and
— The presence of well-established clusters with good relations between leading medium-sized firms and a diffused network of suppliers in the Lombardy region.

Table 1 — *Three delineations of new industrial policies*

Areas	**England (West Midlands)**	**Germany (Baden-Württemberg)**	**Italy (Lombardy region)**
New industrial policies: main strategies	Related variety Rise of 'Phoenix industries'	'Industry 4.0'	'Smart Specialisation Strategy' (S3)
Main actors involved	SMEs Research institutions Labour market	RIS Firms (value chains) Government	Territorial clusters Research institutions Regional government
Multi-level governance		European Commission	
	Central UK government Local authorities	Federal German government *Länder*	Central Italian government Regions
Territorial capital and industrial commons	Industrial commons		
	Sunken investments Skilled jobs Networks of suppliers	Strong networks between research institutions and firms Vocational training	Skilled jobs Network of suppliers Medium-sized firms leading the value chain Research institutions
Critical points	Integration of industrial research and production (scaling up) Availability of financial resources	Financing of new system's investments Tight coordination	Public-private co-ordination Risk sharing Vocational training Quality of government

Source: Author's own elaboration.

We must also consider the alliance networks shared by a large number of firms within each region. The extent to which a firm is indirectly connected to other firms enhances its innovativeness, while the diversity of knowledge distributed across clusters provides the variety that strengthens regional resilience (Sedita *et al.*, 2015; Fratesi and Rodriguez-Pose, 2016). In addition, the three regions share some characteristics that help retain the positive effects of knowledge creation in the region: cognitive proximity among the different actors in the RISs, strong relational capital and careful management of collective goods.

Among the critical points that may eventually evolve into weaknesses are:

— The problem of 'scaling up' good prototype solutions in the English experience;
— The need for a tight co-ordination process in the German case together with the search for adequate financial resources given the huge amount of investments needed by the innovation system; and
— The difficulties associated with developing effective public-private partnerships in the Italian case together with the continued inadequacy of the regional VET system.

A common implication for labour markets and the workforce can be derived from the structural changes underway within the regions. New industries and new specializations will generate new types of jobs requiring greater analytical abilities and skills in the use of digital technology; creative problem solving; complex forms of communication; and collaboration and the ability to adapt to unfamiliar situations (i.e., dynamic flexibility). Therefore, current producers have to enhance their workforce's competencies, identify key areas for improvement and offer the right incentives. In many sectors – even those not directly connected with new manufacturing – firms may have to adapt roles, recruitment and vocational training to provide their workforce with the additional IT skills that will be required.

When technological change is skill-based and the labour supply fails to keep up with the demand for skilled jobs, inequality tends to increase (Dolphin, 2015). On the larger scale of the European labour market, this trend is clearly emerging. A new pattern of job polarisation is evident in almost every country with an increase in low-level jobs in the social (caring) services and in personal services (more evident in the UK than in many other European countries); a declining proportion of mid-ranked jobs in such areas as administration and production; and a steady increase in highly skilled jobs resulting from task-based technological change.

Since the first study demonstrating the hollowing out of the UK labour market (Goos and Manning, 2007), a number of studies have been carried out in the UK. Similar studies have been undertaken in the US (over the period 1980-2005) (Autor and Dorn, 2009), Germany (1979-1999 and 1985-2008, including the Hartz reforms) (Kampelmann and Rycs, 2011) and Sweden (1975-2005) (Andermon and Gustavsson, 2011). Additional studies followed, using data at the European level and covering 16 countries (Goos *et al.*, 2009). The results are the same across the board – an increase in the number of jobs in the highest quantile (or decile) and a corresponding increase in the lowest-quantile jobs, regardless of differences in the degree of protection and variations among labour-market institutions. This serves as strong evidence of a 'declining middle' in each country (McIntoch, 2013).

These trends ask for renewed attention to be paid to the demand side of both the economy and the labour market in order to anticipate new societal needs related to personal services, environmental protection and quality of life. At the same time, policy is needed to provide the supply side of the labour market with answers, an effort that will involve the educational sector, the adaptation of school curricula, changes to training and tertiary education programmes, the strengthening of entrepreneurial approaches to increase IT-related skills and innovation abilities, and the expansion and upgrading of regional VET systems in order to produce a new technician class endowed with more systemic competences and soft skills.

4. Some policy implications

EU industrial policy is still far from a full-fledged and integrated strategy (EC, 2014). After decades in which industrial policy has been held in low regard, it is time for it to once again take centre stage (Bianchi and Laboury, 2016).

Governments are increasingly making innovation a key issue, recognizing its potential to promote economic growth, and its ability to address societal and environmental challenges. This is true in all advanced regions, even where diverse innovation processes have emerged. This demonstrates that geographical context matters, and that this context is understood as including social, cultural and institutional characteristics (Ratti *et al.*, 1997). We need also to consider the fact that processes of technological learning are cumulative and take time. Differences in geographical locations plus differences in the learning process require diverse policies. Therefore, it is not surprising that each region has taken its own route.

In the West Midlands (UK), the resurgence of a part of the automotive value chain has been pulled by highly specialised SMEs in niche segments of automotive design and engineering, while it has been pushed by a pool of relevant skills – technical and market knowledge – in the local workforce and among supplier firms. This creates conditions under which open innovation can be successful (Amison and Bailey, 2014; Bailey and De Propis, 2014). With the goal of strengthening the automotive cluster, the UK government has developed a GBP 245 million Advanced Manufacturing Supply Chain Initiative (2015).[16] This fund can be used for capital expenditures, skills and training, and R&D projects. The

[16]This funding scheme is designed to improve the global competition of the UK's advanced manufacturing supply chain, and to help create or safeguard 5,000 jobs over the next five years (2015-2020).

implementation of the Initiative has been supported by the Automotive Council and by the Society of Motor Manufactures and Traders, which has brought assemblers and suppliers together to determine whether more components can be sourced locally.

It is impossible to offer a full evaluation of the Initiative, especially as the overall progress is fairly limited and considerable progress is required before the programme achieves its output targets. However, the response among beneficiaries (in terms of the number of requests versus the available budget) has been positive. The projects that have been launched to date are generating a positive impact by strengthening the supply chain in manufacturing activities (BIS, 2015).

In the Southern *Länd* of Baden-Württemberg, the entire manufacturing system benefits from a strong, globally competitive position. However, the region needs to think about its future. In the automotive industry – one of the leading sectors in the German economy with revenue of EUR 357 billion in 2012 – future challenges are likely to relate to increasing the value of cars from the customer's point of view. In terms of the products, alternative drive systems are a first answer. These alternatives must match emerging needs in terms of safety, comfort and efficiency.[17] Beyond product innovation, more far-reaching changes will relate to the mobility concept and related services. By 2020, about one-fifth of the global market for mobility is expected to relate to services that exclude private car ownership (Bormann *et al.*, 2015). The idea of supplying global services as the most powerful way to increase the value of products is exactly what Industry 4.0 is prepared to deliver. 'Sharing' seems to be becoming the new philosophy of consumption, not only in the automotive sector. However, such sharing is only possible with a strict alliance between car producers and a number of other service providers, all of which must be gathered together within the framework of Industry 4.0.

Baden-Württemberg aims to become the leader in Industry 4.0 and has launched the 'Alliance Industry 4.0 Baden-Württemberg'. The region has an excellent starting position, as it is the centre of German mechanical and systems engineering, as well as home to premium enterprises active in the automotive industry and their suppliers. This, together with a leading information and communication technology cluster, means that the region covers a full range of technologies for the production of the future, and it aims to confirm itself as a leading industrial-equipment provider.

The Alliance, which is guided by a steering group of 23 high-level representatives of companies, associations, research institutions and trade unions, has been structured in different working groups (WG). For

[17]For example, 4,750 units of the model S Tesla were sold in the US in the first quarter of 2013, which was more than conventionally powered premium cars in the EUR 70,000-90,000 price range produced by Audi, BMW, Lexus and Mercedes, each of which had sales of 1,500 to 3,000 cars in the same period.

instance, the Technology and Products WG provides support for research projects that are to be implemented by research institutions in cooperation with businesses. The Transfer and Implementation in SMEs working group provides SMEs with an orientation that helps them find their own way to Industry 4.0. The Work and Organisation WG devotes itself to the support of employees and to the design of specific training projects. The fulfilment of these goals requires an excellent educational system for engineers, specialist technicians and scientists, and places requirements on the organisation and structure of regional clusters of leading firms.

In the Lombardy case (IT), the S3 strategy leverages on the existence of different clusters with good governance mechanisms. It allows for large firms to be put together with SMEs, technology providers, universities and research institutions in order to work towards strengthening the demand-side attention paid to the market in terms of new societal needs. Two clusters deserve specific attention in this regard. The first is the aerospace cluster, which is well widespread in the region and highly competitive, especially in the helicopters segment. Large system integrators are present in the region, as are equipment suppliers, engineering services and high-level design services. The productive partners match established university departments. The regional government is working to enforce research on and production of the next aeronautic platform as well as innovative electro-avionics systems, with a specific focus on the involvement of innovative SMEs in the cluster. The second cluster is related to advanced manufacturing with the aim of developing new production systems suitable for horizontal use in a number of different end-user industries (see § 3.3).

A new law ('Lombardy is research'), which is under consideration and undergoing a process of public consultation, aims to strengthen regional intervention in these fields. The law points to:

— Strengthening the governance of the RIS with a steering committee, and defining a strategic programme for search and innovation.
— Developing the operational instruments needed to implement the regional strategy. These instruments include partnership agreements, pre-commercial public tenders and contracts, co-funding schemes, and investments in digital infrastructure.
— Setting up a regional agency for the Research, Innovation and Technological Transfer (ARRITT) as an operative arm on the political level.
— Supporting and fostering a PhD programme in innovation, a higher-education programme involving firms as well as universities in the field of technology and applied sciences.

A key impact of these new industrial policies devoted to innovation is found in the job market. A new industry calls for a new workforce. However, at the same time, only the right skills can be conducive of the

structural modification of manufacturing (Beaven *et al.*, 2014; Dolphin, 2015).

Policy implications from the new emerging industrial paradigm are therefore far reaching and deeply challenging. In this section, we specifically address just two of them, both of which are widely horizontal and relatively general. As such, they are adaptable to all three territorial cases. The first policy implication is the place-based character that new industrial policies should have if they wish to contribute to regional growth through knowledge accumulation and production diversification (Barca, 2009; Garcilazo *et al.*, 2010; Bramanti and Lazzeri, 2016). The second is related to the fundamental shift in the types of jobs that will be available for workers and the skills demanded by employers across Europe (Hilpert and Lawton Smith, 2012; Beaven *et al.*, 2014).

4.1 The place-based dimensions of new industrial policies

The foundations for new place-based approaches are rooted in the necessity of distributing policy design and implementation among different policy levels in order to tailor policy measures to local conditions. If local growth is not truly place based, then what is the alternative? We are not interested in entering the ill-fated debate on the place-based approach considered as "old regional policies in new bottle" (Gill, 2010) nor in simplifying it by setting up false dichotomies between place-based and people-centred approaches:

> *It is obvious that good economic policies should be 'people-centred', in the sense that they should maximise welfare (…). We argue that in order to maximise aggregate growth and welfare, economic policies may in some instances have to take the spatial or territorial dimensions into account.* (Garcilazo *et al.*, 2010).

A place-based approach is characterized by the production of bundles of integrated, place-tailored public goods and services, which are designed and implemented by eliciting and aggregating local preferences and knowledge through the participation of political institutions (Barca, 2009). A place-based approach looks at what Garry Pisano (Pisano and Shih, 2012) calls the 'industrial commons', which is related to the networks of jobs and knowledge, and to the pool of innovative suppliers and potential partners. Many experiences from around the world suggest that a cumulative virtuous cycle is at work in locations where industrial commons are strong. For instance, the Swiss pharmaceutical giant Novartis chose to move its research headquarters from Basel, Switzerland to Cambridge, Massachusetts to be close to universities and research institutions that are global leaders in the biosciences, and to the hundreds of biotech firms already in that area (Pisano and Shih, 2009).

All three cases described here include investments in a specific industrial commons with the support of appropriate system policies. This is exactly why the governance of the entire process is of extraordinary importance (Hooghe and Marks, 2001; Faludi, 2012; Stephenson, 2013) – a typical multi-level, multi-actor system represents the core of the process of defining objectives, setting priorities, and designing and implementing specific investments. As a consequence, policy coordination is essential for overcoming the old top-down scheme of linear innovation policies or national-champion industrial policies.

The new industrial policies exemplified here – phoenix industries, Industry 4.0, and smart specialisation – are all rooted in a mix of top-down and bottom-up approaches that typically belong to multi-level governance schemes. In this regard, it is important to note that vertical policy co-ordination tends to be very complicated because decision-making competencies are shared by actors at different territorial levels.

Even within the framework of overall policy objectives on the European level, there is room for tailored interventions at the regional level. In both Germany and Italy, priorities are to be decided in negotiations between the federal/national level and the *Länder*/regional level. Multi-level governance creates a problem of coordination and challenges the efficiency of the different administrations given the clearly defined distinctions of responsibilities.

Germany has a long tradition of co-operation between the different territorial levels, and *Länder* are involved in joint policy co-ordination processes at the federal level. However, the *Länder* have also fostered regional innovation policies which, in turn, have:

> *Gained importance as an instrument of competition and differentiation among the states, while the federal level has focused its activities either on cross-cutting infrastructural programmes or specialized priority programmes funding technologies at a pre-competitive stage.* (Kaiser and Prange, 2004: 255).

Italy has experienced some difficulties in the co-ordination phase. These difficulties led to the recent revision of the Constitution (Article 5), which reduced the power and competences of regions relative to the national level. In contrast to other European contexts, the regional resources for new industrial policies in Italy come almost entirely from the European structural funds. As such, staying within the operational programmes (ERDF) is compulsory, as is adjusting the regional priorities to fit the European guidelines, even though policy makers try to preserve some degree of flexibility (Bramanti, 2015a).

In conclusion, place-based approaches require adaptation of the governance structures in a way that allows for the formulation and implementation of regional policies. Moreover, the quality of government institutions has become a determinant factor in the improvement of

regional innovative performance (Rodríguez-Pose *et al.*, 2014). As such, good institutions seem to be a significant pre-condition for the development of regional innovative potential and for ensuring that S3 works properly.

4.2 Labour market changes and new job skills

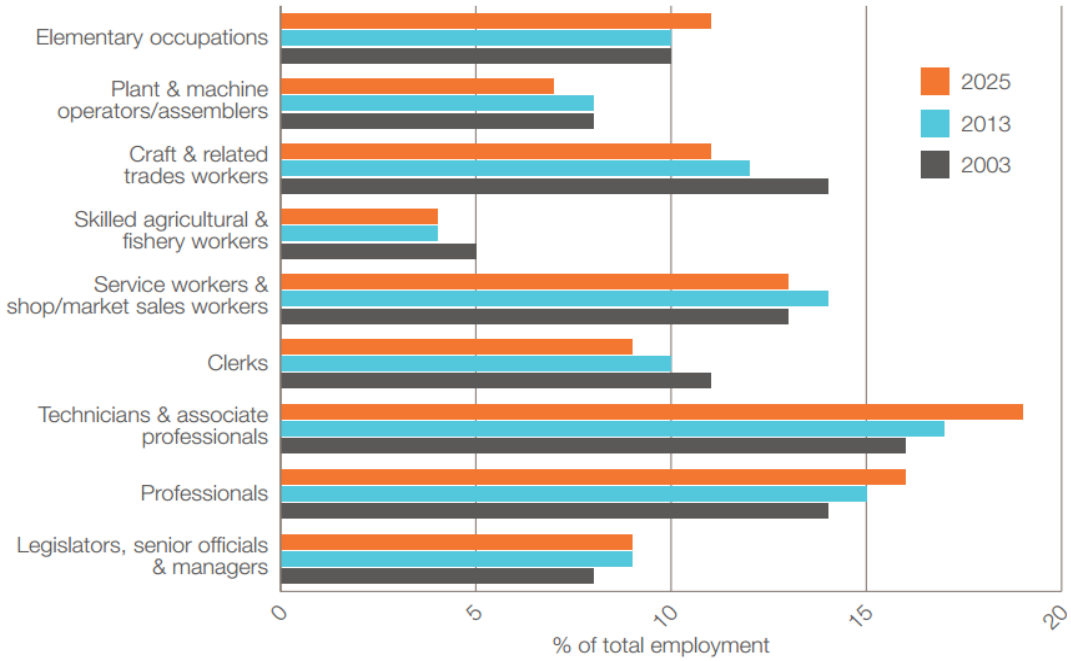
In terms of the second policy implication, we must recognise that Europe will lose many low-skilled manufacturing jobs over the next ten years (with the risk that mid-skill jobs will be also affected), while demand for workers with high-level skills able to complement the new technologies is likely to rise (McIntosh, 2013; Beaven *et al.*, 2014). In particular, technological innovation will have a significant impact on labour markets over the next decade. Up to 45 percent of jobs in the US and a similar percentage in Europe are at risk from digitalisation (Dolphin, 2015). The demand for technical talent is likely to drive a shift in job creation within the manufacturing industry toward a situation requiring more qualified personnel on the shop floor.

Productivity gains from technological innovations will increasingly accrue to the owners of technology and the relatively few workers required to operate it, while a vast majority of the workforce may face stagnant real wages at best and unemployment at worst. New jobs will require people with entrepreneurial, scientific, creative and emotional skills. Therefore, new jobs will result in demand for workers trained in cross-functional areas, and with the capabilities needed to manage new process and information systems. Thus far, these requirements are not very well developed, and some skills deficits will be a major problem over the next ten years. A new approach to skills policy will therefore be imperative, not only for the enhancement of competencies within the existing workforce but also for helping local job markets enhance employees' skills levels to match those demanded by employers.

A new industrial policy also needs to encourage higher levels of innovation among firms. It must also help a sizeable number of firms that are not currently engaged in innovation to become so. What skills do such firms need if they are to become more innovative? What changes in training policy and institutions might help develop those skills?

Figure 1 clearly shows that the share of employment concentrated in higher-level occupations is increasing. We also see some increases in lower-level occupations. The joint trend creates the well-known phenomenon of polarisation, which leaves fewer and fewer jobs and workers in the middle of the occupational distribution (Dolphin, 2015).

Figure 1 — *Proportion of EU employment by occupational category, 2003-2025 (actual and projected)*



Source: Dolphin, 2015.

However, in order to preserve a high level of regional innovation, we need numerous jobs at the top level of the workforce distribution. In fact, a recent study prepared by the OECD (2015) shows evidence of a positive association between firms' involvement in innovation and proxy measures of skills as workforce qualifications. Many of the key mechanisms through which skills influence innovative performance are connected with new technologies. In addition, skills are an essential ingredient of firms' absorptive capacity (Caragliu and Nijkamp, 2008).

New manufacturing will imply an increasing level of inter-organizational cooperation and communication, making networking and interconnectedness a focal component of Industry 4.0. As a consequence, the learning curve within production networks should steepen. At the same time, the number of external partners involved in collaborations will rise.

All of the observed regions are endowed with a relatively high skilled workforce and can count on top-rate university systems. The main issues to be addressed are therefore related to the new competences needed by already trained employees and the need to increase the average qualitative level of technical workers.

The qualifications and skills required will therefore change. We can place required skills into two broad categories: technical skills and personal qualifications. The first group includes, for instance, skills related to IT, information and data processing, organisational and process

understanding, and the working and interacting with modern interfaces. Within the personal-skills group, soft skills are the most relevant, such as social and communication skills, teamwork skills and self-management abilities.

These elements require not only a skilled workforce but also some major changes within the educational and vocational systems. As such, the transition from school to work (Bramanti, 2015b) and continuous vocational training will become more central.

Changes are also needed on the demand side of the labour market. Individuals should take personal responsibility for acquiring and constantly updating their skills in order to ensure progression. The boundaries of specialized knowledge will become blurred as technologies and disciplines converge in the constant search for innovation. Individuals should be willing to develop a blend of technical training and softer collaborative skills, while regional governments will need to help effectively align public and private investment around these new needs.

5. Conclusions and a look ahead

There is widespread agreement in Europe that innovation (in its broader meaning) is key for achieving sustainable long-term economic development and a better quality of life. Beyond public finance control and monetary stability, sustainable growth is mainly expected from increasing productivity, which involves, first and foremost, better use of inputs thanks to the strong support offered by process and organizational innovations, and by more intense use of immaterial resources, mainly brain ware and creativity (Cooke, 2012).

Despite the impressive progress in information and communications technologies, and related areas, knowledge is not a free and costless commodity. On the contrary, knowledge is subject to path dependency. In other words, economic agents try to search close to the knowledge that they already have, which implies significant territorial variance in the capability to extract value from knowledge. As a consequence, the final result of the entire process – innovation – is spatially concentrated and strongly supported by a specific, idiosyncratic, systemic context, which scholars often call RIS (Braczyk *et al.*, 1998; de la Mothe and Paquet, 1998; Niosi, 2010). Therefore, it is not surprising that regions are becoming increasingly important nodes of economic and technological organization in the new age of global, knowledge-intensive capitalism (Rutten and Boekema, 2007).

Innovation is the outcome of an interactive process, as the three case studies show, and it appears to be a largely clustered phenomenon (Bramanti, 2016) with important regional and city poles; a clear-defined net-like structure and fundamental feedback loops; and lock-ins governing

all growth, fluctuations and decay processes. Regional clusters are therefore regarded as a tool that can be used to improve regional growth, to prevent the delocalization of production and even to ensure the re-localisation of some previously delocalised activities (Pisano and Shih, 2009; Bailey and De Propis, 2014; Christopherson *et al.*, 2014).

Governance and leadership are very important for fostering successful world-class clusters and transnational collaboration. In fact, organizations and institutions play a growing and decisive role in framing regional systems of innovation in which collective agents matter and make a difference, not only because innovation is shaped by a variety of institutional routines and social conventions, but also because these agents take on the fundamental role of gateways (Braczyk *et al.*, 1998; Niosi, 2010). They help put the RIS in contact with the global economy, and serve as a key channel for renovating and augmenting the local knowledge base, and for mitigating the potential risks of lock-ins. For instance, in the analysed cases, universities and research systems play a fundamental role in enforcing firms' regional networks.

Europe is a unique world of diversities in terms of rules, routines, habits, institutions, sectoral specialisation and innovation. However, due to the presence of more general, common elements – linked to a widespread manufacturing culture, a specialised labour market, the thickness of industrial clusters, and strong relations between machinery suppliers and end-users – different regions are able to develop strong collaborative relations, to exchange good practices and to learn from each other, as the Vanguard Initiative demonstrates. Heterogeneity is an important factor in local development and regional growth. Networks of firms and regions may gain an advantage by recombining processes. Diversity among the different European RISs (even if we only look at advanced regions) creates greater variety in the knowledge base and, thereby, serves as a greater source of cross-subsector knowledge spillovers and opportunities for new activities. Distributed networks within regional systems and among different regions transcend industries and sectors, and they sustain and enhance firms' absorptive, explorative and exploitative capacities (Asheim *et al.*, 2011). Multinational corporations have rapidly learned to leverage on national, regional and even local differences.

A great deal of research supports the idea that differences in economic performance and specialization across regions can be explained by institutional endowments. Such endowments include rules, routines, habits and traditions. Appropriate institutions are of great importance (Storz and Schäfer, 2011), as they can: i) affect and stimulate knowledge production (via R&D and via 'soft' investments); ii) facilitate the patenting process; iii) disseminate ideas and promote cooperation among researchers; iv) speed up the diffusion of scientific knowledge; and v) reduce uncertainties related to new projects. Therefore, although institutions matter, they are the result of a long, interdependent path of

accumulation that is historically embedded. Consequently, cross-country differences remain relatively stable over time, giving differences a non-temporary nature.

Even though RISs are rooted in different combinations of institutions, organizations and policies, their 'raw material' is always human capital. Human capital strengthens innovation process in numerous ways. Moreover, human capital lies at the origin of rising productivity, fosters absorptive capacity (i.e., the way in which firms take advantage of external knowledge inputs) and speeds up the adoption of innovation.

The true function of RISs, which make existing firms competitive and contributes to attracting new ones, springs from achieving the right balance between internal robustness and external openness (Bramanti and Fratesi, 2009). Territory matters, as it offers at least four core assets in the process of generating and implementing advances in technology and innovation. Territories are here viewed as:

— *"The birthplace of technology and innovation – i.e. the progress from given resource allocation processes to a collective build-up of specific resources";*
— *"A place for co-ordinating industrial activities, a link between external territorial economies and organizational and inter-organisational firm trajectories";*
— *"A political decision-making unit governing localization, able to create and redistribute resources, and expressing specific governance structures in the relations between actors"; and*
— *"A place in which untraded inter-dependencies (means through which the actors growth technologically and organisationally, and co-ordinate themselves) form, express themselves, and evolve."* (Bramanti and Fratesi, 2009: 60).

Moreover, while training and higher education can enhance labour productivity, and tend to increase individuals' income and life satisfaction, tertiary education is neither the only nor an automatic source of highly skilled workers and competitiveness. Skill upgrades and learning can play a significant role, especially when linked to labour market needs. This is particularly evident in medium-technology sectors where the regional character of the cognitive processes of interactive learning and knowledge creation is strongly developed (Cappellin and Wink, 2009).

In conclusion, there is clear evidence of the incredible resilience of RISs, which are heavily rooted in a productive manufacturing environment. Several strong, self-reinforcing mechanisms are at work in an endless spiral that brings together information, knowledge, competence and creativity, which in turn contribute to the production process, and to the accumulation and exchange of knowledge and know-how (Bramanti and Fratesi, 2009).

From a European policy perspective, the awareness of this unique and differentiated process that leads to innovative outcomes has pushed in favour of a European S3, which is convenient for different territorial contexts due to its main characteristic – flexibility. It allows for full exploitation of existing differences in territorial capital, enables regions to

root their economic activities in the local institutional fabric, and fosters the generation, acquisition and exchange of knowledge. For these reasons, the S3 approach has been diffused as a blueprint of the Commission's industrial policies, and it represents a provocative and somewhat new articulation of a place-based approach to regional development policy (Koschatzky and Stahlecker, 2010). In addition, it has been used to emphasize the need to exploit related variety (Frenken *et al.*, 2007; Boschma, 2008), to enable strategic diversification and to build regional embeddedness. New industrial policies represent a specific way of promoting innovation and of modifying existing manufacturing systems from the inside.

While the geographical centre of global manufacturing production will shift to Asia, European core regions can – and must – preserve a rich manufacturing base that is higher on the global value chain. The focus must be on deriving more systemic and articulated answers to new needs in the home market – a wealthy market encompassing around 500 million ageing consumers (Cappellin, 2016).

As this chapter has testified, manufacturing remains vital for at least four reasons: trade and global competition; productivity growth; demand for skilled employees and creativity; and quality of life and environmental sustainability. The device that will enable us to reach our goals is innovation. Moreover, spillovers between neighbouring regions make a positive contribution to regional innovation in the EU. Innovative output depends on more than just R&D. It mainly relates to region-specific characteristics, such as the industry mix, market opportunities, the innovative environment and social capital. Knowledge spillovers are also captured in social and cooperative network relationships (Guastella and van Oort, 2016).

Europe needs to ensure a future that includes new manufacturing. Consequently, it needs workable policies to support that future. However, the future will not be deterministic. Uncertainties will arise related to the market and technological environments as well as political changes and social development, which are constantly evolving (Brexit and migration flows are two major concerns in the short term). To a great extent, the future of manufacturing systems can and will be co-determined by policy packages, which will affect the business climate and the socio-economic environment in which industrial production takes place in Europe (Brandes *et al.*, 2007; Dhéret *et al.*, 2014). Even if politicians seem frightened by diversity and this feeling results in backward-oriented behaviour and nation-states with well-guarded borders, enterprises still need skilled labour and diversity, which makes them more forward oriented. They need to move, to interact, to exchange and to build together on the basis of diversity (Sedita *et al.*, 2015).

All of this will be possible if Europe delivers *systemic answers* that are all-encompassing and inclusive. European policy has to use the

complementary levers of regulation, finance, techno-infrastructures and grand societal challenges to guide and boost enterprises and private actors in their efforts to align themselves with the main drivers of the future of European manufacturing (Brandes *et al.*, 2007; EC, 2013; Dolphin, 2015). These drivers are globalisation and international competition, technological progress, socio-demographic change, energy and resource scarcity, and climate change and the environment. Europe needs a set of policies that address skills improvement, reduce the administrative burden and enhance energy efficiency. Together, these policies may provide a favourable industrial environment and lead to important results.

The most pressing questions are related to the governance issue (Kaiser and Prange, 2004; Stephenson, 2013). We cannot deny that multi-level governance represents opportunities for some and risks (of the loss of power and influence) for others, which could lead to conflicts. Due to the systemic nature of innovation, and the coordination challenges of working with different public and private actors, regions have to take on the role of 'flexible gatekeeper' within the rise of flexible 'type 2' arrangements.[18] The need to determine the best ways of governing the process, and of aligning the different, sometimes contrasting, objectives, functions and incentives is an issue that European Commission as well as regional governments will face for years to come.

[18] A 'type 2' arrangement is an alternative vision of multi-level governance. In this vision, the number of jurisdictions is vast rather than limited; jurisdictions are not aligned on just a few levels, but operate on diverse territorial scales; jurisdictions are functionally specific rather than multi-task; and jurisdictions are intended to be flexible rather than fixed (Hooghe and Marks, 2001).

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