Broad-based Innovation Policy for All Regions and Cities

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Foreword

To deepen the understanding of how OECD countries can move towards a broad-based form of innovation policy, the OECD worked with the European Commission's Directorate-General for Regional and Urban Policy in bringing together academic and policy experts in a series of five high-level expert workshops on "Broadening innovation policy – New insights for regions and cities". This publication provides a summary of the discussion, building on background papers prepared by academic and policy experts.

This report highlights the need for a broad-based approach to innovation policy to unlock the innovation potential of all types of regions and cities. A broad-based approach requires taking capacity of the regional innovation system into account and adapting efforts across all levels of government to work with and upgrade that capacity. As regions and cities across the OECD have to face today's grand societal challenges, such as demographic transitions, climate change, digitalisation and automation, innovation needs to take centre stage in the thinking of local, regional and national policymakers.

There is an increasing body of evidence suggesting that weaknesses in technology and knowledge diffusion in OECD countries are weighing on productivity growth and innovation, particularly among firms that are distant from the technological frontier (whether global or national). This weakens the capacity of OECD countries to adapt to meet future challenges and undermines inclusive growth. It is, therefore, necessary to examine whether current tools for innovation policy are too narrowly focused, targeting mainly research and development as well as science- and technology-based interventions. To empower firms in all types of regions to benefit from global trends and technological change, a broad-based innovation policy also needs to be flexible enough to adapt to the different capacity and innovation ecosystems in different regions and cities.

Strengthening and upgrading innovation capacity requires that policy efforts engage and leverage the local and regional innovation systems. In some places, strong systems are already in place with links between the stakeholders of the quadruple helix formed by the public sector, the education system, the private sector and civil society, that support creation, uptake and diffusion of innovation. In others, the historic achievements of the region have not translated into a successful transition of the local economy during the third or – ongoing – fourth industrial revolution. For some, there is a need to develop initial links and build on niches of strengths. The capacity of the public sector and its ability to learn and transform its processes are critical elements for the continued success of innovation policy.

The workshops' lessons summarised in this report provide no easy solution for policymakers to prepare their regions and cities to navigate the current wave of radical innovations and digital disruptions. The knowledge frontier on what works and what does not (and under which circumstances) is constantly changing, while the complexity of innovation and the global technological context continues to evolve. Instead, the lessons show the need to think beyond innovation policy and integrate it with other policy fields when it comes to the uptake of innovation in regions. Knowledge can flow through the academic or education and training system or through foreign direct investment and firms engaged in production within global value chains.

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The workshops and final publication were co-ordinated by Alexander C. Lembcke under the supervision of Rudiger Ahrend, Head of Division, Economic Analysis, Statistics and Multi-level Governance in CFE. The chapters build on the background papers prepared by experts as well as on the workshop discussions. The chapters were finalised by Alexander C. Lembcke (Chapters 1-4) and Sandra Hannig (Chapter 5) based on initial drafts by Diogo Machado. Nikolina Jonsson, Talia Kaufmann, Diogo Machado, Spencer McMurray and Charles Victor supported the organisation of the 5 workshops for which Enrique Garcilazo (Workshop 1), Alexander C. Lembcke (Workshop 2), Abel Schumann (Workshops 3 and 4) and Dorothée Allain-Dupré (Workshop 5) were responsible.

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Abbreviations and acronyms

AI	Artificial intelligence
AMP	Advanced Manufacturing Partnerships (United States)
ART-ER	Attrattività Ricerca Territorio (Emilia Romagna, Italy)
ASTER	Agenzia per lo Sviluppo Tecnologico dell'Emilia Romagna (Italy)
BCIP	Biotechnology Cluster Program (Canada)
BDC	Business Development Bank of Canada
CCEIs	Centers for Creative Economy and Innovation (Korea)
CEG	Center for Economic Growth (New York, United States)
CFA	Centre for Technological Innovation and Advanced Aeronautical and Naval Manufacturing (Andalusia, Spain)
CNSE	College of Nano Scale Science & Engineering (United States)
DARPA	Defense Advanced Research Projects Agency (United States)
DEPA	Digital Economy Promotion Agency (Thailand)
EC	European Commission
EDP	Entrepreneurial discovery process
EEC	Eastern Economic Corridor (Thailand)
ERDF	European Regional Development Fund
EU	European Union
FDI	Foreign direct investment
GDP	Gross domestic product
GVA	Gross value added
GVCs	Global value chains
HEIs	Higher education institutions
ICT	Information and communication technology
IDEA	Innovation and Development Agency (Andalusia, Spain)
IoT	Internet of things
IPAs	Investment Promotion Agencies
ISI	Innovation Superclusters Initiative
ITI	InterTrade Ireland
LCUs	Local content units
LPWAN	Low Power Wide Area Network
M2M	Machine-to-machine communication
MMIs	Manufacturing innovation institutes (United States)
MNEs	Multinational enterprises
NCR	National Cash Register (United States)
NGOs	Non-governments organisations
NNMI	National Network of Manufacturing Institutes (United States)
OCN	Ontario Commercialization Network (Canada(
OEMs	Original equipment manufacturers
ONE	Ontario Network of Entrepreneurs (Canada)
PARC	Palo Alto Research Centre (United States).
PSI	Public sector innovation

R&D	Research and development
RAI	Regional Authority Index
RCTs	Randomised controlled trials
RDAs	Regional development agencies
RICs	Regional Innovation Centres (Canada)
RIS	Regional Innovation Scoreboard / Regional Innovation System
S3	Smart Specialisation Strategies
SDA	Schumpeterian development agency
SDGs	Sustainable Development Goals
SEZ	Steinbeis-Europa Zentrum (Germany)
SMEs	Small- and medium-sized enterprises
SOSCIP	Southern Ontario Smart Computing Innovation Platform (Canada)
STEM	Science, technology, engineering, and mathematics
SWOT	Strengths, weaknesses, opportunities and threats
TL2 / TL3	Territorial level 2 / Territorial level 3, i.e. large / small regions
VC	Venture Capital
VCR	Video cassette recording

Executive summary

Broadening innovation policy for all regions and cities

There is an increasing awareness that a narrow – purely excellence-oriented – approach to innovation policy misses the opportunities that innovation diffusion and upgrading of regional innovation systems provide to support regional and national growth. A broad-based approach can help unlock this potential. Taking the capacity of the regional innovation system into account, it aims to improve and grow the innovation system through learning and by leveraging opportunities that other policy areas provide. A broad-based approach is not meant to forego the support of excellence in innovation policy but rather acknowledges that different places have different needs to fully unlock their potential. This report establishes six principles that help broaden innovation policy to benefit all types of regions and cities.

Build on your regional innovation system, involving everyone

There is no single "best practice" in policy to ensure that all types of regions fully leverage their innovation potential. Instead, policy needs a tailored approach that considers and adapts to local assets. This approach should not be purely driven by the public sector but should also engage the local actors that create, share and distribute knowledge. Many if not most regions already have bodies with a "quadruple helix" structure of academia, public and private sectors and civil society. The success of these bodies varies, however. Successful engagement requires incentives (e.g. regulatory or fiscal) aligned with the aim to support regional innovation, or at least incentives that do not actively discourage collaboration between actors in the innovation system. It also requires actors to see their input and investment as having value, i.e. their participation is more than "window dressing".

Ensure your regional innovation system is adaptive

Even in regions with established economic strengths, there is a risk that economies become stuck during industrial, digital or green transitions, failing to adapt to changing times. To ensure that regions continue to upgrade their economies, the regional innovation system needs to be suitably adaptive. Historically, a closed innovation system that aims to internalise competencies and returns from innovation has supported the development of many regions in the OECD. However, as innovations increasingly arise at the intersection of existing technologies and knowledge areas, a closed system might no longer be the most effective approach to regional innovation.

Integrate mechanisms that support learning into policy development

Evaluation and learning how to improve the regional innovation system needs to be an integral part of the policy process. A region's own policies can be a source for learning; another source lies in ideas, innovations and discoveries produced in other places. Regional and national policymakers can adapt the tools and programmes that worked in other regions and study their development to avoid the pitfalls they experienced. Learning is crucial at different stages of the policy process and can be supported through

different means. Knowledge sharing networks can help disseminate practices that worked in other places, and mapping and foresight exercises can help learn about the strengths and weaknesses of the regional innovation system. The process of developing an innovation strategy, a policy or a programme often helps facilitate learning, as it builds capacity in the public sector and helps forge links between the members of the quadruple helix. Governance mechanisms, such as experimental governance, can institutionalise the learning process and make it an integral part of the policy cycle. A fundamental challenge in policy learning and experimentation, however, lies in determining the underlying social and institutional criteria necessary to make them successful.

Seek opportunities for local innovation along global value chains

Many different channels support the flow of knowledge to regions that are not themselves at the technological frontier. Foreign direct investment can bring new ideas and competencies to a region if the incentives are such that multinational enterprises are willing to engage locally. Firms can draw on knowledge within their supply chains, which can be particularly valuable if these supply chains cross borders, e.g. as part of global value chains. Ensuring spillovers to the region often requires a proactive role by regional or local governments that have to think beyond simply attracting economic activity and instead focus on embedding it.

Embrace disruption rather than fight it

Disruptive innovations can lead to the displacement of existing industries and job losses. The severity of the shock varies across regions. The first reflex by local or national policymakers is often to try to stymy new technologies but this approach does not solve the underlying problem. Rather than trying to avoid disruption, policy responses need to prepare and steer disruptive progress towards growth that is inclusive, e.g. through aligning training efforts with expected innovations. Disruption to the way economies function might even be necessary. Without disruptive innovations in transport, energy production and a move towards less wasteful consumption, efforts to mitigate climate change and to transition towards carbon-neutral economies will fail.

Foster links between policy domains and its intermediaries

An innovation system is only as strong as the links that connect the actors in the system. Regions have the potential to foster the strongest possible links through which actors can engage regularly, build trust and ideally a common vision in the area where they live and work. Many of the policies that can foster stronger innovation systems are outside the scope of innovation policy, e.g. training and skills development, business promotion or attraction of foreign direct investment. All of these fields can provide a critical impetus for the upgrading of the regional capacity for innovation, in particular if they embrace innovation as an additional objective.

1 Lessons learned

The need for innovative regions and cities

Innovation is key for growth in all types of regions but many regions are struggling to transition towards new growth opportunities and reap the benefits that a constantly expanding global pool of knowledge offers. Traditionally, "innovation" carries the notion of scientific and technological breakthroughs and this aspect remains a crucial component of most innovation policy. Patenting activity and research and development (R&D) spending are, however, highly concentrated. Ten large (Territorial Level 2, TL2) regions account for about 45% of global patents and private sector spending on R&D among 34 OECD countries with available data. The same 10 regions produce a sizeable share (approximately 18%) of OECD-wide gross domestic product (GDP) but far less than their contribution to frontier innovation. This does not mean there is no frontier research activity elsewhere: many regions have frontier activities in certain sectors or academic disciplines. It does, however, mean that a purely frontier-focused approach to innovation policy will exclude a large number of places, firms and people and will miss out on their potential.

Innovation for many firms and regions is less about expanding the frontier and more about "catching up", i.e. adopting ideas, inventions and innovations from other parts of the country or even other parts of the world. Capturing these dynamics requires a broad notion of "innovation" that includes all types of novel processes, products or activities that come through knowledge creation in a firm, the public sector or any other innovating unit. It also requires acknowledging that the tools to unlock innovation potential differ and depend on the capacity of the different actors in the region. The opportunity to upgrade exists everywhere but R&D incentives, support for patent commercialisation and rewards for academic excellence might not be the right tools to unlock them in every region. What is required are programmes adapted to the local context, in particular the capacity of the "regional innovation system", i.e. the network of relevant innovation actors and the formal or informal links between them.

The need to improve the innovation performance of regions is mounting. Economically, weak productivity growth across most OECD regions is weighing on aggregate growth. In one-third of OECD countries, productivity growth has been concentrated in a single and already highly productive region. In some countries, the productivity gap between the top region and others is closing but in 14 out of 31 OECD countries, regions at the productivity frontier contributed more than 50% to the overall productivity growth in the country between 2000 and 2016. Beyond the slowdown in productivity growth, OECD countries will have to leverage regional innovation to support mitigation and adaption measures to combat climate change. They will need innovation to ensure functioning and sustainable economies in the face of rapid ageing and look outward to ensure that globalisation and the growing role of emerging economies create benefits for all and not just a select few firms or individuals.

The choices regions make will determine how successfully they navigate the ongoing fourth industrial revolution. The fourth industrial revolution is characterised by the integration of the physical and digital worlds, enabled by improved monitoring through sensors, connected devices and advances in machine learning and artificial intelligence that open new routes for automation of tasks. Without intervention, interpersonal and interregional inequality is likely to continue to rise. Technological improvements often substitute routine cognitive and manual skills, which means that the wages of workers that rely on these

skills will fall or even that their jobs become obsolete. This will affect workers in manufacturing but also in services. Trying to avoid change is not the solution but innovation policy can help steer the direction to ensure that progress creates jobs and makes workers more productive, rather than replace them, and that the local workforce is prepared to use new tools.

Building on regional innovation systems…

There is no single "best practice" to follow to ensure that all types of regions fully leverage their innovation potential. Instead, policy needs a tailored approach that considers and adapts to local assets, including the region's economic foundations, good transport accessibility, availability of talent, investors, incubators or urban-cultural and other amenities for example. This approach should not be purely driven by the public sector but engage the local actors that create, share and distribute knowledge. These actors come from different parts of the regional fabric: they are firms in the private sector, academics at local universities, policymakers in the public sector or civil society organisations (including business networks and industry associations). Together with the formal and informal links between these actors, they form the regional innovation system.

The importance of regional innovation systems for policy purposes is growing. Regions and their specific assets are increasingly finding their way into national innovation policy, supported by a paradigm shift in regional development policy from a subsidy-oriented model to policies that invest in local assets and unlock growth potential – including innovation assets. There is also a move towards less direct interventions at the national level. National innovation policy shifting towards framework setting and regulation has also provided more space for regions and cities to develop their own policies.

The ambition to achieve a particular type of economic growth (e.g. smart, inclusive or sustainable) embraces the idea that economic growth has not only a rate but a direction. Innovation and the current growth model may be having negative impacts in terms of job destruction and environmental degradation – elements with important local dimensions. There are often clear synergies between economic growth and other objectives, e.g. developing workforce skills contribute to productivity gains for firms, wage gains for workers and can raise the capacity for the adoption of innovation in firms and the region as a whole. Green public procurement can stimulate innovation in providing firms with incentives for developing environmentally friendly products and services, ideally supported by market consultation and involvement of suppliers in the development of feasibility studies and procurement strategies. Regions, cities and rural areas are well-placed to enable these synergies and to make the most of their potential through local networks and actions that complement national frameworks. They are also the places where trade-offs between different objectives are felt the strongest. This can be an opportunity in the pursuit of policy objectives as residents can experience local benefits directly, making them potentially more amenable to accepting their costs.

Mission-oriented innovation policy – i.e. policy that targets a specific outcome rather than steps in the innovation process – aligns well with grand but concrete challenges. "Missions" can be driven by national or global agendas, e.g. the United States' "man on the moon" mission in the 1960s. They can also be set by subnational actors, e.g. Stockholm's strategy for a fossil-fuel-free city by 2040 or Daegu's transition of their traditional vehicle manufacturing sector to a leading sector for future vehicles. The mission statement itself can be key to ensuring that innovation in line with the mission is activated across sectors, actors, disciplines and regions. Successful mission-oriented innovation policy must acknowledge that there is not necessarily a single – best – path to achieving the mission. It, therefore, pays to enable bottom-up solutions and experimentation in the process.

Innovation policy challenges are often dispersed among networks formed by governments, innovators, private platforms and users. This may mean leaving space for people to experiment and test new solutions by themselves and to find ways of exchange and collaboration that help governments make use of them.

Experimental governance is an example of an explicit mechanism that enables a multi-level architecture to address challenges but also leverage the opportunities from a distributed approach to innovation. Responsibility for policy design and implementation is distributed between different levels of government and special-purpose local institutions. In this architecture, it is up to the higher levels of government to set general goals and performance standards and to establish and enforce the "rules of the game". It is up to the lower levels to have "the freedom to advance the ends as they see fit". It involves a multi-level process in which four elements are linked in an iterative cycle: i) broad framework goals and metrics are provisionally established by central and local authorities; ii) local authorities are given broad discretion to pursue these goals in their own way; iii) as a condition for this autonomy, local agents must report regularly on their performance and participate in a peer review in which their results are compared to others who are using different means to the same ends; and iv) the goals, metrics and decision-making procedures are revised by a widening circle of actors in response to the problems and possibilities revealed by the peer review process; and the cycle repeats.

… to support catching up

Diffusion of knowledge and uptake of new ideas across regions is by no means automatic. Many regions are struggling as firms' fail to adopt new technologies and fall behind in the global economy. Simply adopting a regional innovation systems approach will not solve these challenges on its own. To be successful, regions need to address the systemic challenges that hold back the development of their local innovation system. A clear understanding of the capacity and the bottlenecks in the regional innovation system is the first step in this direction. The second is to tailor the system to the regional or local characteristics. The third is to ensure that the system is adaptive and can grow as the local and regional capacities improve or shift to a different growth path as technologies and the global context evolve. Without such a place-based approach, innovation policy might inadvertently accentuate inequality and regional disparities as local pockets of excellence (e.g. in research) fail to create benefits for the wider region and the lack of prerequisites in non-frontier regions limits the capacity of firms to benefit from innovation diffusion. A key challenge is that upgrading the regional innovation system often requires a very broad view of the local ecosystem and more than simply adjusting one element. It is less about what matters most than about setting a path to develop all elements of the innovation system. As there is no capacity to adjust all elements at once, it is important that regions not only set a path but also remain on it.

Innovation policy needs to reflect heterogeneity in terms of innovation capacity in regional innovation systems. In practice, highly heterogeneous regions or even countries are using very similar policy mixes, i.e. follow a "cookie cutter" approach without adapting to the different local capacities and opportunities. Instead, true policy learning and experimentation adopts the policy mix through monitoring and evaluation, which need to be embodied in programmes and policies from the outset. Policy learning includes provisional goal setting and revisions based on lessons drawn from experiences and from "learning by doing".

Learning is crucial for catching up. A region that is not at the innovation frontier can copy, imitate or import many of the ideas, innovations and discoveries produced in other places and thereby boost local productivity and increase growth. The same applies to policies that support innovation and innovation diffusion. Regional and national policymakers can learn from the experience in other places, find the tools and programmes that work and avoid the pitfalls that others have experienced. This approach requires careful identification of suitable examples that fit the local context. Learning through processes is another important path. Developing an innovation strategy that fits the local or regional needs is important. In some places, its greatest value lies, however, in the process of developing the strategy as governments develop internal capacity, external links with local firms, academics or civil society and find a platform that helps align interests and narratives within the region.

Learning requires investment. The learning process itself requires resources but investment needs go beyond the direct time and money put towards learning. Institutional and administrative capacity for collaboration and exchange are critical for policy learning. They underpin the ability to adapt external solutions to local and regional bottlenecks. Building up such capacity requires investments in knowledge, skills, and the education and training system. Regions differ widely in their adoption capacity and the cumulative benefits that accrue from investment. National governments can support regions through dedicated capacity building as well as setting up platforms of exchange between regions.

A fundamental challenge in policy learning and experimentation is determining the underlying social and institutional criteria necessary to make policy learning successful. A second related challenge is whether and how policy learning and experimentalist approaches are applicable across different types of regions. Not all learning mechanisms are applicable to all regional contexts. In particular, regions with weak institutional capacity – paradoxically those most in need of learning – face a range of barriers to learning because of their institutional weaknesses in terms of governance and capacity. A third is the true engagement of all actors in the innovation system. Simply adopting a tool, such as experimental governance, as a policy approach will not induce greater involvement by firms, citizens and civil society on its own. Rather, it depends on the ability of those regions and localities to foster the creation of more networked and collaborative forms of governance in order to succeed.

One way to support regions with less developed innovation systems is through specific learning mechanisms, such as learning networks. Learning networks are formally established mechanisms meant to support the practical learning of its members. Learning networks provide the flexibility to find concrete solutions to the challenges that are specific to each region's innovation system. Typical challenges in less developed innovation systems include low levels of co-operation, weak administrative and governance capacity, lack of critical mass or a lack of systemic support for entrepreneurs. A second mechanism is to carefully balance top-down policies with locally led policy efforts and to experiment with existing governance arrangements to allow actors at the margin to be part of the policy process. Success might depend on the ability of local leaders to form collaborative arrangements allowing public sector institutions to work with the private sector in devising experimental approaches. The ability to do so often depends on the willingness of policymakers to enhance their capacity to lead and work with change.

Innovation in non-frontier regions relies more on imitation and adoption than the development of own innovations. It includes, for example, incremental changes to production processes, local adaptations of established technologies by importing capital and knowledge, and local institutional capacity building to manage innovation policies. This is also reflected in the type of skills and supportive infrastructure firms in non-frontier regions need. Vocational and engineering skills rather than scientific capacity are more important for upgrading in regions that are lagging behind the innovation frontier. Knowledge is often implicitly imported (e.g. in the tools and machinery that firms purchase from elsewhere) or flows through supply chain linkages including global value chains (GVCs).

Understanding the local strengths and weaknesses…

Nurturing local innovation and innovation policy is central to ensuring that regions transition from their current economic structure towards new opportunities. Relying on past and current industrial strengths is tempting but the lessons from past industrial revolutions show that transitions are crucial for regions to remain economically strong. Past industrial revolutions also show that industrial transition is no mean feat. Even today, many European and OECD regions appear to be stuck in a "middle-income trap", i.e. a loss of growth momentum as they reach middle-income levels. Managing transitions requires identifying and exploring areas of economic potential to generate new sources of regional growth. The identification of domains of competitive advantage should not be limited to the public sector. It requires engaging with the private sector, academia, as well as relevant actors from civil society.

The core questions centre on whether it is better to specialise in those areas where the region is already strong or whether it is better to diversify. More specialised regions were richer (in term of per capita GDP) but more diversified regions grew faster over the 2008-14 period. What further complicates the challenge is that there is no unique path to upgrading the local economy. Three common pathways for regions' innovation development include: i) regional specialisation in a particular technology domain; ii) regional diversification in related technological domains; or iii) regional diversification in unrelated technological domains. Specialisation might be the most beneficial path if a region has a strong comparative advantage and assets that are hard to replicate. Excessive concentration on specific sectors does come with risks, as exposure to shocks is very concentrated or the sector might reach maturity or even decline. Instead of further specialising within existing sectors, regions can aim to diversify their economies and thereby "branch" onto new development paths.

Different tools are available to help regions identify their strengths and weaknesses. Regional benchmarking can be of great value for identifying best policy matches in the design and implementation processes of regional innovation policies. Policies in the context of European Union (EU) Cohesion Policy and related Smart Specialisation Strategies present much space for improvement in enabling differentiated policy strategies based on regional assets. Regional mapping should consider a wider range of assets. For example, mapping local opportunities and key actors for engagement with GVCs is an important tool to inform regional innovation policies. For some regions, mapping is a critical tool to identify current barriers to progress; in others it is important as a foresight tool to avoid getting "stuck" on their current development path. Diagnosing the characteristics of regions that support integration in GVCs, such as geographical influence and stakeholder activities, is extremely useful to ensure regions can leverage their engagement with multinational enterprises on a path to regional innovative upgrading.

For future development under uncertainty, the combination of machine learning techniques and "big data" opens up new avenues for such forecasting exercises, in particular in new technology domains. Patent and trademark data have been used in some recent applications and can complement more traditional foresight methods. Technological foresight exercises can be an important help to assess how different technologies will affect a region, thus equipping local agents with the tools that help them identify needs for regulation or policy to intervene. Previous waves of technological breakthroughs have shown that new technologies do not spread evenly across space and results in a variety of outcomes across regions. Preparations to benefit from new trends need to start early as a common lesson from past industrial revolutions is that regions with a more educated and skilled workforce are those best placed to reap the benefits of new opportunities.

Despite significant progress, improving the measurement of innovation capability remains a key challenge. Especially, evidence on hard-to-quantify factors in innovation, such as links between actors or the role of (local) leadership, often remains in the realm of case studies. More can be done by improving access to available administrative data for research purposes but a large, untapped wealth of information lies in the hands of the private sector. Significant progress can be achieved by combining different data sources and finding ways to harness the potential of data in the private sector without threatening business models or the confidentiality of sensitive business data or personal data (e.g. of entrepreneurs).

… to make regional innovation systems fit for the future

A static regional innovation system will become obsolete; a learning innovation system can persist. A regional innovation system that is fit for the future is able to reconfigure and adapt. Such a forward-looking view is for example reflected in the guiding principles for smart specialisation strategies that European regions develop as part of the EU Cohesion Policy. A closed innovation system that aims to internalise benefits is most successful in settings with stable actors and has supported the development of many regions in the OECD. In a rapidly changing world, with disruptive technologies challenging incumbents'

products and even their whole business model, the question is whether such systems are suitably adaptive. Disruptive technologies are not necessarily radical but can come out of the recombination of existing technologies or competencies. This poses the question of whether the closed approach that relies on internal knowledge across those fields is light-footed enough to keep pace with change. Moving to a more open mode of innovation is difficult as there is no ideal model that can guide the process. For policymakers, it is often easier to rely on "tried and tested" approaches rather than take a risk with new approaches.

Whether through the effect of a combination of different innovations, or individual disruptive innovations, new opportunities come along with the displacement of existing industries, workers and respective institutions. Innovation can have very different regional impacts. Innovation can disrupt incumbent industries in all types of regions but the most developed regions in the innovation frontier are more likely to create (and benefit the most from) disruptive technologies, creating new sources of jobs and finding new growth paths. If regions cannot transition their economies to reap the benefit from new opportunities related to industrial transitions and disruptive technologies, they face the risk of periods of prolonged decline and rising unemployment. Rather than trying to avoid disruption, policy responses need to prepare and steer progress towards growth that is sustainable and inclusive.

More fundamentally, disrupting the way economies function might be more important now than it has ever been before. Disruptive innovations might be the only way to tackle "grand" societal challenges OECD countries are facing. Without significant changes to transport, energy production and a move towards less wasteful consumption, climate mitigation efforts and the transition towards carbon-neutral economies will fail. In many areas, innovations are becoming increasingly disruptive, completely moving markets away from existing practices, introducing new paradigms and opening up avenues for further developments.

For policymakers, the challenges that need to be overcome to increase experimentation are multi-faceted, ranging from questions of commitment to learning by monitoring on the part of ruling politicians and their public sector managers and an organisation's technical capacity for learning by monitoring. To adopt and adapt to the learning mechanisms described in this report – collaboration and exchange, as well as greater experimentation –, policymakers need different types and combinations of skills, which might not always be easy to acquire.

2 Broadening innovation policy for regions and cities

This chapter discusses the need to move from a narrow focus in innovation policy to a broad-based approach that adapts to the needs of different regions and cities. A broad-based approach requires taking capacity of the regional innovation system into account and adapting efforts of all levels of government to working with and upgrading that capacity. As regions and cities across the OECD have to face today's grand societal challenges, business-as-usual approaches are unlikely to deliver innovation in all places.

Introduction

Weaknesses in technology and knowledge diffusion are weighing on regional innovation and productivity growth, particularly for firms in regions distant from the innovation frontier. A few regions lead innovation in a progressively more complex environment. They expand the global knowledge frontier and thrive as innovation supports the creation of new jobs and productivity growth. Other regions are struggling to adapt their economies and are increasingly at risk of facing prolonged increases in unemployment due to automation (OECD, 2018[1]; 2015[2]) or to job losses in traditional industries.

In one-third of OECD countries, productivity growth has been concentrated in a single, already highly productive region that usually includes the country's largest city. On average, productivity in the least productive region in a country is 46% lower than in its most productive region (OECD, 2019[3]). Between 1995 and 2013, the gap between the top 10% OECD regions with the highest productivity and the bottom 75% has grown on average by almost 50% (OECD, 2016[4]) and between 2000 and 2016, 14 out of 31 OECD countries had more than half of their productivity growth coming from the already most productive "frontier" regions (OECD, 2019[3]). While innovation is essential for productivity growth and sustained economic development, pursuing innovation activities is becoming increasingly complex and costly (Bloom et al., 2017[5]; Gordon, 2017[6]).

At the same time as innovation and technological progress seem to slow, disruptive innovations are fundamentally changing how OECD economies function. Shared mobility, the rise of micromobility solutions and platform-based short-term rental have already changed the inner cities of many OECD metropolitan areas. Free-floating bicycles and e-scooters line the sidewalks and trial runs of autonomous drones delivering parcels or take-out have started.[1] Private-to-private rentals via online platforms challenge the hotel industry, the same as ride-sharing applications challenge the traditional taxi market, both also affecting prices in the rental market.[2] Digitalisation and the growth of "big" data, as well as the tools available to analyse it, open new opportunities to all types of firms to gain a competitive edge.[3]

Disruptive innovations might be a challenge for regulators and planners but they might also be necessary to address the grand societal challenges that OECD economies are facing. Beyond the slowdown in productivity growth, OECD countries will have to take strong mitigation and adaptation measures to combat climate change, will have to ensure functioning and sustainable economies in the face of rapid ageing and look outward to ensure that globalisation and the growing role of emerging economies create benefits for all and not just a select few firms or individuals (OECD, 2018[7]; 2019[3]).

As the nature of innovation in regions and its underlying factors change, traditional innovation policies may be too rigid and narrowly focused. Innovation policies systematically aim to stimulate firms' research and development (R&D) activities while overlooking that R&D and technological development are not the only sources of innovation. In the context of the Smart Specialisation Strategies (S3) framework, additional factors should feed into "entrepreneurial discovery" strategies in order to identify key opportunities and bottlenecks to regional innovation. To ensure that all regions benefit from innovation, regional policies need to be broadened, taking into account additional drivers of innovation, such as embedded R&D or management and production capabilities.

Simply copying and applying policies locally because they were successful elsewhere can have serious drawbacks. If the underlying conditions that led to policy success elsewhere are not present locally, such policy is likely to fail, or not even progress from the design to the implementation phase. Moreover, some regions were successful in the past but are now facing difficulties in adapting to the latest industrial transitions. Therefore, if less-developed regions copy policies that were successful in the past for regions currently in industrial transition, the former can also end up struggling to manage the latest or future industrial transitions. Ultimately, well-design policies require learning from best practices and finding how to match or adapt such practices to local contexts.

Decentralising policymaking to local actors can contribute to better adapt policies to regional characteristics. Decentralisation is an increasing trend across OECD countries that will require breaking silos across different layers of government and policy areas. National governments remain leading players in designing and implementing innovation strategies, thus the decentralisation trend will require strengthening policy coherence across different layers of government to enable complementarities and avoid inconsistencies. Furthermore, as the factors and nature of innovation become more multidisciplinary and complex, policy co-ordination is also required across different policy areas such as education and skills, or global value chain (GVC) participation. An additional level of complexity is that some policy areas can be managed locally, such as incentives for innovative collaborations and training, while others will remain managed nationally, such as intellectual property rights, competition policy or education policy (with exceptions in some OECD countries).

Addressing potential adverse social impacts of technological breakthroughs without jeopardising the pace of technological development itself, will require policy coherence between innovation and other policy areas such as social policies. With fast-paced technological innovations, for example, in robotics and artificial intelligence, an increasing number of tasks are becoming automated. This enables productivity growth but also poses the risk of displacing several human jobs, which can increase unemployment and amplify inequalities. Innovation policies may need co-ordination with social policies to address these concerns, for example, fostering skills' upgrading through specialised training programmes and mobilising "left-behind" populations to participate in regional innovation policymaking (Pyke, 2018[8]).

This chapter and the whole report draw from a series of expert workshops on "What works in innovation policy? New insights for regions and cities" organised by the OECD and the European Commission (EC). For each workshop, experts provided background papers that, together with the discussion during the workshop, form the basis for this report:

- Fostering innovation in less-developed regions, with papers by Slavo Radošević (2018[9]) and Lena Tsipouri (2018[10]).
- Building, embedding and reshaping GVCs, with papers by Riccardo Crescenzi and Oliver Harman (2018[11]), and Sandrine Labory and Patrizio Bianchi (2018[12]).
- Developing strategies for industrial transition, with papers by David Audretsch (2018[13]) and Charles Wessner and Thomas Howell (2018[14]).
- Managing disruptive technologies, with papers by Pantelis Koutroumpis and François Lafond (2018[15]) and Jennifer Clark (2018[16]).
- Experimental governance, with papers by Kevin Morgan (2018[17]) and David Wolfe (2018[18]).

Innovation policy and innovation systems

Traditionally, innovation policy is often part of a science, technology and innovation package. This combination can miss the distinctive features of innovation that go well beyond progress in the important field of science and technology. In particular, to support "catching up" of places that are lagging within a country, it is often more effective to focus on adopting ideas, inventions or even innovations developed in other parts of the country or even outside the country rather than trying to directly move towards the innovation frontier.

What is innovation (policy)?

The *Oslo Manual*, published jointly by the OECD and Eurostat, provides guidelines on how innovation can be measured. The 4th edition of the OECD/Eurostat manual (2018, p. 60[19]) defines "innovation" as:

> *An **innovation** is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).*

The definition sets out a broad notion of "innovation". It goes beyond a sole focus on business sector innovation by using the term "unit", which can cover private individuals or public sector agencies. An essential element for innovation is that it derives from knowledge-based activities and that it is novel. Underpinning the innovation activity is the goal of value creation or value preservation (albeit the actual realisation of economic or social value might not arise as innovation outcomes are uncertain). Innovation distinguishes itself from other concepts (such as inventions) as innovations need to be implementable, i.e. an innovation needs to be put into use or made available for others to use (OECD/Eurostat, 2018[19]).

The activities in which firms engage in order to develop innovations are as broad as the definition of innovation. They include R&D and engineering, but also design and other creative activities. Beyond the activities directly involved in the development of products, services or processes, innovation activities also include marketing and brand equity activities (i.e. those activities that raise the public value of a brand), as well as activities related to firms' intellectual property (protection and exploitation). Firms also conduct activities that support innovation, such as employee training, software development or database-related activities (including data analysis) and the purchase (or lease) of tangible assets. Finally, innovation itself can require direct formal management arrangement or informal setups (OECD/Eurostat, 2018[19]).

Innovation policy has continuously evolved, as the focus on "innovation" as a standalone concept increased. Traditional policy efforts affecting innovation would not necessarily fall under the heading of innovation policy. Since the 1990s, the concept of "innovation policy" has become increasingly used as a separate moniker (Edler and Fagerberg, 2017[20]). The lines between science, technology and innovation policy for example remain and are often blurred. The renewed interest in industrial policies in Europe often includes a strong focus on innovation, e.g. the United Kingdom's Industrial Strategy set out to invest GBP 725 million through its Industrial Strategy Challenge Fund to "capture the value of innovation" (BEIS, 2017[21]).

The classic approach to innovation policy is "invention-oriented" but this approach has increasingly been complemented with system- and mission-oriented innovation policies. Invention-oriented innovation policy tends to focus on the R&D and invention-related aspect of innovation often supported by dedicated public bodies (e.g. research councils). Mission-oriented innovation policies set out specific goals that innovation is meant to achieve, which means that policy does not target an individual step in the innovation process but the whole process to ensure that progress leads towards a path in line with the mission statement or towards achieving the goal. System-oriented innovation policy stresses the importance of links between different actors and focuses on the innovation system as a whole. Among OECD countries and in OECD reviews of innovation policy, this approach has been popularised since the 1990s (Edler and Fagerberg, 2017[20]).

The different types of innovation policy reflect the evolution of the rationale for public intervention. Market failures are at the heart of traditional innovation policy. Benefits from basic research, for example, tend to be universal and difficult to commercialise, which means that firms underinvest. Certain firms might not have the (*ex ante*) financial capacity to invest in R&D or acquiring knowledge or information might be too costly to the individual firm, but worthwhile when firms share the effort. Invention-oriented policies address such market failures. However, they do not address systemic failures of the innovation system as a whole. This is the view in the innovation systems approach, which also puts a greater emphasis on the public sector as a key actor (and facilitator), as well as acknowledging the role of other non-market actors (e.g. foundations or private individuals) rather than relying on the market to produce innovation.

The need to address grand social challenges is a rationale for a mission-oriented innovation policy approach. The aim of mission-oriented innovation policy is to redirect technological change from existing trajectories towards more economically, socially and environmentally beneficial paths. It thereby moves

beyond trying to fix market failures but aims to solve broader "grand challenges" or achieve ambitious global projects, such as the sustainable development goals (SDGs). In pursuing "mission-oriented" innovation policy, governments are also aiming to work more closely with the business sector and civil society to ensure that technological progress moves in the direction of shared goals (OECD, 2018[7]). For example, creating incentives to align innovation efforts with SDGs has the potential to enable new forms of technological development that address grand societal challenges, such as poverty, ageing or climate change.

The concrete instruments used in innovation policy are not bound to a specific type of innovation policy. Instruments fall into two major groups, those that target the supply of innovation and those that target demand for innovation. Supply-side instruments are more traditional measures and include direct (fiscal) incentives and support, for example, training and skills development, provision of innovation infrastructures or advice services. Demand-side measures have increased in popularity in recent years. Demand-side instruments stimulate innovation through "pull" factors that take different forms. Regulation or standards can create framework conditions that induce firms to innovate. Another tool is the strategic use of public procurement to foster innovation. However, with few exceptions, experience in OECD member countries shows that the use of such policies remains limited to areas in which societal needs are not met by market mechanisms alone, e.g. health, environment, or in which private and public markets intersect, e.g. energy supply and transport (OECD, 2011[22]).

National and regional innovation systems

The focus on innovation policy is increasingly turning towards creating and nurturing support systems and infrastructures that help increase technological absorptive capacities. The emphasis moved from disseminating advanced manufacturing technologies and addressing internal obstacles to technology diffusion at the firm level, to supporting system-oriented and integrated approaches in innovation.

Three elements underpin most definitions of "innovation systems", the actors within the system, the networks that connect them and the institutions integrated within the system. Actors are firms in the private and public sector and the supporting infrastructure that includes educational institutions, research centres, public bodies and other agencies. The network between those actors facilitates the flow of knowledge that can be facilitated (or hindered) by the institutional framework, which includes formal rules and informal norms within the network (Isaksen, Martin and Trippl, 2018[23]). Earlier definitions of (national) innovation systems included the general elements but often used the term "institutions" as a catch-all replacement for "actors" (Box 2.1).

Box 2.1. Early definitions of national innovation systems

The concept of national innovation systems rests on the premise that understanding the linkages among the actors involved in innovation is key to improving technology performance. There is no single accepted definition of a national system of innovation. What is important is the web of interaction or the system, as reflected in the definitions used in the academic literature.

A national system of innovation is…:

- "... the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987[24]).
- "... the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge [...] and are either located within or rooted inside the borders of a nation-state" (Lundvall, 1992[25]).

- "... a set of institutions whose interactions determine the innovative performance [...] of national firms" (Nelson, 1993[26]).
- "... the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country" (Patel and Pavitt, 1994[27]).
- "... that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies" (Metcalfe, 1995[28]).

Source: OECD (1997[29]), *National Innovation Systems*, https://www.oecd.org/science/inno/2101733.pdf.

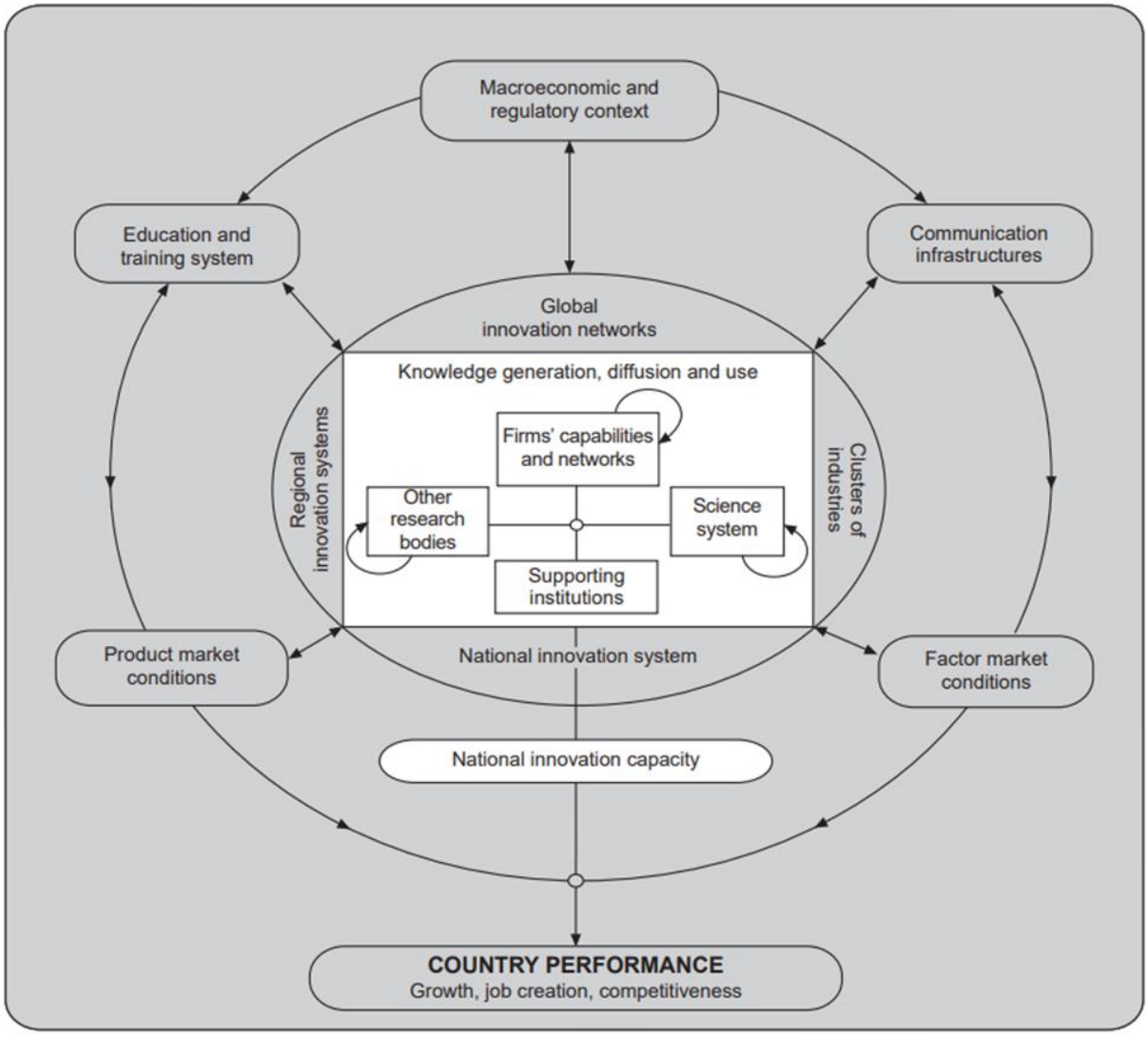
Considering the innovation system, rather than focusing on individual actors, acknowledges the importance of the links between the actors within the system. A country or region can have all the individual pieces associated with strong innovation performance, e.g. global firms, a university, technology transfer offices, research centres, etc. but progress might be slow or inexistent. From an innovation system point of view, this would be a systemic failure that traditional innovation policy does not address. Policy needs to address the capacity of individual actors (including the public sector) and assess and foster the relationships between actors. Incentives often encourage exactly the opposite behaviour. Universities target global leaders (rather than local firms) for collaborative efforts, academics' careers in some countries are solely driven by academic publications and commercialisation of research actively discouraged, subsidy schemes reward the creation of jobs rather than promoting competitiveness, etc.

OECD work has long focused on assessing innovation systems as a whole. At the heart of the (stylised) innovation system is not just a national innovation system but the combination of a country's regional innovation systems, its embeddedness in global networks and its sectoral clusters (Figure 2.1). The importance of regional or local systems is, however, not universally acknowledged (e.g. Cirera and Maloney (2017[30]) use a framework focused purely on the national level).

Two concurrent phenomena have strengthened the role of regions in the innovation system. The first is the inclusion of regions and their specific assets in national innovation policy, the second a paradigm shift in regional development policy from a subsidy-oriented model to policies that invest in local assets and unlock growth potential (OECD, 2011[31]). The move towards less direct interventions at the national level and innovation policy shifting towards framework setting and regulations has also provided more space for regional policy (Laredo, 2016[32]). Regions and cities can leverage their links with local firms to better tailor policy to local needs and capacities and support firms in leveraging the innovation framework that has been set by higher levels of government.

With large regional disparities in terms of innovation performance, local characteristics increasingly matter for policy success. Ready-made policy solutions are likely to fail in the implementation stage. Adapting to regional contexts is at the core of Smart Specialisation Strategies (S3s – see Box 2.2) that are part of the European Union's Cohesion Policy. Many factors supporting innovation have an important spatial dimension, requiring policies to avoid one-size-fits-all policy solutions and to adjust to the specific local challenges and opportunities regions face. For example, what works for low-income regions is inherently different from what works for regions at the technological frontier.

Figure 2.1. Actors and linkages in the innovation system



Source: OECD (1999[33]), *Managing National Innovation Systems*, https://dx.doi.org/10.1787/9789264189416-en.

Box 2.2. Smart Specialisation Strategy (S3)

Smart specialisation strategies are at the heart of the European Union's Cohesion Policy – this integrated, place-based approach is the main European Union (EU) policy instrument to address structural changes linked to industrial, digital and green transition. Smart specialisation plays a key role by supporting all regions and EU member states to activate their potential for innovation, competitiveness, sustainable jobs and sustainable growth through S3s.

An S3 should be designed around the following key principles:

- Smart specialisation is a **place-based approach**, meaning that it builds on the assets and resources available to regions and EU member states and on their specific socio-economic challenges in order to identify unique opportunities for development and growth.

- To have a strategy means to **make choices for investment**. EU member states and regions ought to support only a limited number of well-identified priorities for knowledge-based investments and/or clusters. Specialisation means focusing on competitive strengths and realistic growth potentials supported by a critical mass of activity and entrepreneurial resources.
- **Setting priorities** should not be a top-down, picking-the-winner process. It should be an **inclusive process of stakeholders' involvement centred on "entrepreneurial discovery"** that is an interactive process in which market forces and the private sector are discovering and producing information about new activities and the government assesses the outcomes and empowers those actors most capable of realising this potential.
- The strategy should embrace a **broad view of innovation**, supporting technological as well as practice-based and social innovation. This would allow each region and member state to shape policy choices according to their unique socio-economic conditions.
- Finally, a good strategy must **include a sound monitoring and evaluation system** as well as a revision mechanism for updating the strategic choices.

Efficient smart specialisation should prioritise domains, areas and economic activities where regions or countries have a competitive advantage or have the potential to generate knowledge-driven growth and to bring about the economic transformation needed to tackle the major and most urgent challenges for the society and the natural and built environment. The number and nature of these priorities will vary from region to region. While a first set of priorities should be identified when the S3 is designed, they can be changed or modified when new information or broader developments make it advisable.

Source: EC (2020[34]), *What is Smart Specialisation*, https://s3platform.jrc.ec.europa.eu/en/what-is-smart-specialisation- (accessed on 30 June 2020).

Broadening regional innovation policy

Regional innovation policy cannot be reduced to R&D-based interventions but in many instances, R&D is a, if not the, key focus of innovation policy. R&D accounts for only a small part of innovation activities taking place in regions. Only 2 500 companies account for about 90% of global R&D spending in the private sector in 2018. Even among the 2 500 companies, R&D spending is concentrated among the biggest investors with the top-100 companies contributing more than half of global private-sector R&D spending (Hernández et al., 2019[35]).

The relevance of private-sector R&D for innovation depends on the local industrial structure. Three sectors account for about 75% of R&D. Information and communication technology (ICT) is by far the largest industry, especially when ICT producers and service providers are considered jointly. The other two sectors are the health industry and producers of automobile and other transport equipment.[4] For regions that are specialised in other activities, R&D investment might be a less important level than investment into other innovation assets.

Elements, such as design, marketing, process and product engineering, and organisational productivity-enhancing improvements, are also key factors for innovation, which are often overlooked by policy. The excessive policy focus on R&D as an ultimate source of growth can lead to what is referred to as the "innovation paradox", where some countries perform extremely well in R&D indicators but not so well in innovation outputs or economic growth. The absence of R&D does not imply the absence of innovation, knowledge or competitive success, evidencing the need for a model that does not rely excessively on R&D as the sole driver of innovation.

A two-way R&D growth model will be explained in this section, providing a framework for the broadening of innovation policy. The mainstream view on how innovation fuels growth is primarily dominated by transitions from basic research to applied research, from basic research to exploratory development or from applied research to exploratory development or advanced development. These are areas of commercialisation of R&D, which are most often the focus of innovation policies. This intense focus on upstream parts of the innovation chain overlooks other innovation drivers, such as production capabilities and engineering improvements (incremental innovations) and the diffusion, absorption and adaptation of knowledge. These factors are especially important for less-developed regions, where the role of embedded R&D from imports and adoption of technologies and knowledge developed in frontier regions is critical.

Innovation paradox: Innovation beyond R&D expenditures

The absence of R&D does not imply the absence of innovation activities and good economic performance, nor does R&D spending necessarily imply economic dynamism. R&D is just one resource within a variety of other sources of innovation. An example of the complex relation between R&D, innovation and growth lies in debates about “innovation paradoxes”: situations where only a paucity of innovative output resulted from significant investments in R&D (Audretsch and Lehmann, 2016[36]). Other examples of so-called paradoxes include the Norwegian puzzle of good economic performance despite low R&D spending (OECD, 2007[37]) or the Scottish conundrum, with its strong higher education research but poor R&D innovation output and absence of dynamic growth (Coad and Reid, 2012[38]). The Baltimore region in the United States had robust investments in R&D and human capital but failed to provide a catalyst for commercialisation of that new knowledge in the form of innovative activity (Feldman and Desrochers, 2003[39]). These examples suggest that the links between R&D, innovation and growth are not trivial.

An excessive focus on R&D as an indicator of innovation activity overlooks the fact that a significant number of firms can be innovative without in-house R&D investments. A large share of firms innovate by developing their process, product, organisational or marketing innovations without carrying out any R&D. This holds true even for firms introducing new-to-market technologies. In nearly half of the 32 OECD countries with available data, more than one-third of the firms that introduced a product that is new to the market report to not perform in-house R&D.[5] When looking into different sectors, Som (2012[40]) finds that 17% of firms in high-tech sectors do not perform any R&D, in comparison to 27% in medium-tech and 58% in low-tech sectors.

Innovation beyond technological invention

Even 41 years after the first publication of the seminal book “Diffusion of Innovation”, the 5th edition read: “Most of the new ideas whose diffusion has been analyzed are technological innovations, and we often use the word "innovation" and "technology" as synonyms” (Rogers, 2003[41]).

Inventors may develop extraordinary technologies but often such inventors and their regions are not the ones benefitting the most from the technologies they create. For example, in the late 1980s and early 1990s, the German Fraunhofer Institute for Integrated Circuits working with academic and other partners developed the technologies that became the audio encoding format MP3. While the institute, in partnership with a German company, developed and showcased a prototype portable MP3 player in the mid-1990s, the first commercially successful MP3 players were launched from 1998 and developed in Korea by Saehan Information Systems and in the United States by Diamond Multimedia.[6] The example is similar to the development of personal computers. Although the firm MITS, in New Mexico, invented the first personal computer, it was mostly Apple in California and IBM in New York (all US Companies) who dominated the new mass market for PCs by adopting and adapting the technology to produce a leap in buyer value. Often organisations (and policymakers) mistakenly assume that innovation requires developing breakthrough technologies. An excessive focus on technology can create incentives for technological developments that

are too ahead of their time, too complicated, too costly or lacking the complementary ecosystem needed to open up a new mass market.

Many inventions fail to create and capture new markets despite developing extremely ingenious technological breakthroughs. As noted by Dean Kamen, the inventor of the Segway personal transporter:

> *"One of the hardest truths for any technologist to hear is that success or failure in business is rarely determined by the quality of the technology (…). In fact, the annals of high-tech history contain remarkably few cases in which the most innovative technology has emerged triumphant in the marketplace" (Heilemann, 2001[42]).*

The Segway is an engineering prodigy but has very high production costs and did not convince enough people to pay its high price for a product that is hard to park, hard to transport and unclear as of where it can be used (on sidewalks or roads?) – a sign of a missing enabling ecosystem. While the Segway was expected to break even six months after its launch in 2001, the business continued losing money until it was sold in 2009 (Heilemann, 2001[42]).

The focus of a successful market-creating strategy is not only on how to lay a technology per se but rather on how to ensure that the technology creates value for users assuring commercial success. When defining innovation strategies, firms and regions need to go beyond only focusing on technology. As Kim and Mauborgne (2018[43]) explain, although the firm Ampex in the United States invented video recording technology in the 1950s, companies like JVC and Sony, both Japanese, dominated the long-profitable home video cassette recording (VCR) industry by adopting the technology and making video recorders easy enough to use and affordable for the mass of buyers. Ultimately, successful innovations convert a technological invention into commercial innovation creating value for users, and the firms and regions enabling such innovations are the ones benefitting the most.

Agile innovation and user-based innovation are examples of activities that are not technology-based (even though increasingly enabled by developments in ICT) but have the potential to create new forms of value and often disrupt mature industries. See Box 2.3 for examples of agile and user-based innovation.

Box 2.3. Beyond technology: Creating value with agile and user-based innovation

Agile innovation: Fostering innovation with a flexible working environment

Agile innovation is about creating small self-managed teams without traditional managers, empowering employees to make decisions and implement new ideas. These small, entrepreneurial groups are designed to stay close to customers and adapt quickly to changing conditions. When implemented correctly, they almost always result in higher team productivity and morale, faster time to market, better quality and lower risk than traditional approaches can achieve (Rigby, Sutherland and Noble, 2018[44]).

Agile teams are small and multidisciplinary. They place more value on adapting to change than on sticking to a plan and they hold themselves accountable for outcomes (such as growth, profitability or customer loyalty), not fixed outputs such as lines of code or number of new products. Netflix is an example of a company that was born agile and has become more so as it grew. It disrupted the market not because of developing a technological breakthrough, but because of its capacity to generate ideas and rapidly explore them, while its competitors did not have a business model capable of responding (Forbes, 2014[45]).

The agile way of working has spread from software development to organisational change – for small start-ups and even large, traditional organisations. Some established firms are transforming their heavy hierarchical structures (often with rigid procedures that restrain new ideas to be implemented), such as the large banks ING and Sberbank. According to Bart Schlatmann, former chief operating officer of ING, "[…] your direct competitor is no longer the benchmark for customer satisfaction, Amazon is. The

behaviour of clients is actually set by digital innovators" (Guadalupe, 2018[46]; INSEAD, 2017[47]). Firms in mature industries are becoming increasingly aware that competition is coming from unexpected small digital start-ups, offering innovative solutions and rapidly adjusting to consumer demand due to their flexible structures.

User-based innovation: Creating value along with users

Most consumer goods innovations tend to fail but a very small percentage of new product launches end up expanding and completely revolutionising their categories, driving growth for the whole industry (Schneider and Hall, 2011[48]). Affinnova (acquired by Nielsen in 2014) helps innovators select the product features that increase the likelihood of commercial success through mathematical choice modelling enabled by user-based innovation.

When Carlsberg breweries wanted to update the bottle and label for Belgium's Grimbergen, the oldest continually produced abbey beer, the company wanted to update the brand without sacrificing its strong reputation or downplaying its 900 years of history. As explained in Brynjolfsson and McAfee (2014[49]), redesigning would mean generating many candidates for each of several attributes (e.g. bottle shape, embossments, label colour, label placement, cap design and so on) and then determining the right combination of all of these.

Defining the right combination from among the thousands of possibilities is a complex task. The standard approach in the industry is for the design team to generate a few combinations that they think are good, then use focus groups or other small-scale methods to define the best.

Affinnova offers a very different approach. It makes use of the mathematics of choice modelling, quickly identifying people's preferences, by repeatedly presenting them with a small set of options and asking them to select which they like best. Affinnova presents these options via the Web and can find the mathematically optimal set of options (or at least come close to it) after involving only a few hundred people in the evaluation process (Brynjolfsson and McAfee, 2014[49]). For Grimbergen, the design that resulted from this explicitly recombinant process had an approval rating 3.5 times greater than that of the previous bottle. The strong performance resulted in solid double-digit volume growth for the Grimbergen brand (Nielsen, 2011[50]; Brynjolfsson and McAfee, 2014[49]).

Source: Rigby, D., J. Sutherland and A. Noble (2018[44]), "Agile at scale", https://hbr.org/2018/05/agile-at-scale (accessed on 10 December 2018); Forbes (2014[45]), "A look back at why Blockbuster really failed and why it didn't have to", https://www.forbes.com/sites/gregsatell/2014/09/05/a-look-back-at-why-blockbuster-really-failed-and-why-it-didnt-have-to/#6cc0d7731d64 (accessed on 10 December 2018). Guadalupe, M. (2018[46]), "Three ways to make your organisation agile", https://knowledge.insead.edu/leadership-organisations/three-ways-to-make-your-organisation-agile-8921; INSEAD (2017[47]), "Embracing digital: ING's journey to a new way of working - ING faces digital disruption", https://cases.insead.edu/publishing/case?code=36502 (accessed on 10 December 2018); Schneider, J. and J. Hall (2011[48]), "Why most product launches fail", Harvard Business Review, https://hbr.org/2011/04/why-most-product-launches-fail (accessed on 10 December 2018); Brynjolfsson, E. and A. McAfee (2014[49]), *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W.W. Norton & Company; Nielsen (2011[50]), *Carlsberg Brewery Harnesses Design Innovation Using Nielsen*, http://innovation.nielsen.com/design-solutions/grimbergen-61HP-4991X.html? (accessed on 10 December 2018).

Aligning regional innovation with grand societal challenges

Traditional innovation policy frameworks have to be reassessed in light of the environmental and social challenges in OECD countries. A traditional innovation policy framework assumes that stimulating innovation is always positive in the long term, ignoring that innovation activities do represent a certain directionality (Schot and Steinmueller, 2018[51]). For example, despite recognising that innovation may lead to unemployment in sectors experiencing rapid technical change, the generalised view is that everyone

will benefit from new higher-quality jobs in the long term – Schumpeter's process of creative destruction. However, as Soete (2013[52]) points out, innovation may also lead to destructive creation, benefitting the few at the expense of the many, by e.g. leading to low-quality jobs. Destructive creation can also come at the expense of the environment, e.g. by being grounded on a growth model that extensively employs fossil fuels, which is resource and energy-intensive or produces a massive amount of waste.

Inequality and regional disparities may inadvertently be accentuated by traditional innovation policies. Policies that provide innovation support can entail an implicit bias against some firms or places (OECD, 2017[53]). For instance, R&D tax credits may often benefit mostly large firms already with strong R&D capacity, and public procurement requirements often tend to favour experienced incumbents instead of young firms. Policies based on excellence may also be providing opportunities mostly for individuals who are already in advantage by holding some specific skills (e.g. excellence scholarships and study grants). In terms of regional disparities, successfully expanding the knowledge frontier may require funnelling public financing to the existing top universities and laboratories located in frontier regions.

The ambition to achieve a particular type of economic growth (e.g. smart, inclusive, sustainable, etc.) embraces the idea that economic growth has not only a rate but also a direction. Innovation and the current growth models may be having negative impacts in terms of job destruction and environmental degradation – elements with important local dimensions. In this context, regional innovation policy can be a key pillar to achieve transformational change by creating the incentives to align regional innovation efforts to tackle grand societal challenges such as inequality, poverty or climate change.

Mission-oriented innovation policy aligns well with such concrete challenges. Mission-oriented innovation policy is (ideally) characterised by a bold and relevant core mission that requires activity across different disciplines, economic sectors and involves different actors of the innovation system. The mission statement itself can be key to ensuring that innovation in line with the mission is activated across sectors, actors, disciplines and regions. Successful mission-oriented innovation policy must also acknowledge that there might not be a single best path or solution but enable bottom-up solutions and experimentation, i.e. link with the systemic elements of innovation policy (Mazzucato, 2018[54]).

Some of the grand challenges, such as climate change, might require more than a shared mission, rather a transformation of the economic system. Innovation policy can be a major instrument to achieve this goal. Establishing a fair price for natural capital, e.g. using carbon taxes, can induce innovation to reduce emission (Hepburn, Pless and Popp, 2018[55]). Similarly, as environmental norms and regulation may stimulate innovation, procurement is a key tool of niche creation to help firms develop technologies and attenuate the upfront costs in the early development of products. Green public procurement – a tool that 84% of OECD countries use – can, for example, incentivise the purchase of reused or recyclable electronics or office furniture products and thereby develop recycling streams.[7] Lastly, feed-in tariffs create incentives for firms to find efficient solutions to cover not only their own energy needs but also solves the challenge of aligning firms' own demand with the time in which they can produce their own supply (Koutroumpis and Lafond, 2018[15]).

Transformative innovation policy (or "system innovation") is a new innovation framework focusing on mobilising the power of innovation to address a wide range of societal challenges including climate change. It emphasises policies for directing socio-technical systems into socially desirable directions and embeds processes of change in society. The transformative innovation policy framework explores issues around socio-technical system change. The framework aims at: modifying governance arrangements between the state, the market, civil society and science; experimentation and societal learning; responsible research and innovation; and, finally, a more constructive role for foresight to shape innovation processes from the outset and on a continuing basis (Schot and Steinmueller, 2018[51]).

Regional innovation, job creation and job destruction

Innovation can displace jobs in the short-term, e.g. as investment into new production tools replaces manual labour. It also creates new jobs, but job creation can take longer to become reality and can take place in different regions from where jobs were initially displaced. This spatial friction can contribute to accentuate differences between non-frontier regions, where jobs are displaced due to disruptive innovations, and frontier regions, where the new jobs are created. The dilemma faced by policymakers is that fully enabling disruptive innovations can displace the current stock of jobs but enable the creation of new jobs in the future while restricting disruptive innovations to protect the current stock of jobs that can adversely affect regions' capacity to create jobs in the future.

Firms introduce process and product innovations in the hope that they will eventually enhance profits, whether by being able to sell more or by reducing the costs of current production (or a combination of both). The distinction between process and product innovations, formalised in OECD/Eurostat (2018[19]), picks up a fundamental distinction of innovative activities. Sometimes firms want to reduce cost with process innovation by altering their processes of production and sometimes want to enhance demand with product innovation by developing new products and/or improving their current ones. While process innovation tends to focus on efficiency gains, it does not automatically imply a reduction in the number of jobs used in the production process (Box 2.4).

Box 2.4. Process innovation, job creation and job destruction

The impact of process innovation on job displacement depends on the balance between how many jobs are cut due to productivity improvements and how many jobs are created due to increasing production responding to higher demand as prices drop.

By pursuing process innovation, firms aim at boosting productivity by decreasing costs, which can include reducing the required number of workers to produce a given output. Thus, productivity improvement through labour-saving innovation displaces jobs. The overall effect is less clear cut. As process innovation cuts costs that firms can translate into lower prices for their product, demand should increase. In order to meet such an increase in demand, firms increase production; hence, through that channel, firms create more jobs. The result in terms of net job creation or destruction will depend on how demand responds to price changes, i.e. on the elasticity of demand. Using firm-level data from France, Germany, Spain and the United Kingdom for 1998-2000 totalling about 20 000 companies, Harrison et al. (2014[56]) find that the effect of increased demand more than compensated the effect of cost reduction, leading to a positive net impact on employment.

This, of course, is not always the case and depends on the specific industry, production processes and demand. Crucially, the aggregate gain in the number of jobs might not be spatially neutral, e.g. as a more efficient plant is opened in another city or region, the local economy can be severely adversely affected.

Source: Harrison, R. et al. (2014[56]), "Does innovation stimulate employment? A firm-level analysis using comparable micro-data from four European countries", http://dx.doi.org/10.1016/j.ijindorg.2014.06.001.

Empirical evidence shows that innovation creates more jobs than it destroys. Harrison et al. (2014[56]) provide strong evidence that innovation stimulates employment both in the manufacturing and service sectors. However, there is still a doubt as to whether these employment creation results are idiosyncratic to the analysed period (1998-2000), whether disruptive innovations such as artificial intelligence (AI) can have a radically different impact and whether the dynamics of job creation are spatially uneven.

Innovation may have a net positive impact on job creation but job displacement is taking place mostly in regions behind the frontier, while job creation is benefitting mostly frontier regions. The resulting gap is of policy concern, as populations from non-frontier regions can be severely affected. This is likely to be the case with disruptive innovations related to AI drawing heavily on high availability of human capital, which is concentrated in frontier regions.

Regions with high levels of human capital are less affected by automation. With some exceptions, the risk of automation decreases as educational attainment required for the job increases. Around one-third of tertiary-educated workers are concentrated in the top 20% of OECD regions (Maguire and Weber, 2017[57]). The top regions that have a highly educated workforce have a low share of jobs at risk of automation, while the remaining regions face considerable threats. The OECD (2018[1]) presents evidence of a negative relationship between the risk of automation and the share of workers with tertiary education. Reducing the risk of automation in regions with a higher risk of automation will therefore require efforts in upgrading skills through training and education. The required skills for the industrial transformation are analysed in Chapter 3.

Policy responses need to be designed in a flexible manner to create bottom-up innovation. Flexibility in the management of national policies can provide local actors, such as local employment services, vocation education and training organisations, as well as city and regional authorities, with the necessary tools to tailor programmes to their unique local labour market challenges (OECD, 2018[1]). Flexibility encompasses the ability to make changes to national programme eligibility criteria, budget management, as well as accountability provisions. In general, awarding greater flexibility to local and regional stakeholders must be accompanied by guarantees regarding the accountability of decision-making and the efficiency of service delivery at the national level. In many cases, cities and regions can be viewed as “policy spaces” to test new ways of working and innovation approaches to address ongoing labour market changes resulting from automation.

Providing displaced workers with a social safety net, as disruptive technologies automate their jobs, can ensure they and their families do not fall into poverty. Social policies should be preventive, taking into account ongoing disruption trends and the likely risk of job destruction in different regional sectors. Preventive policies call for better co-ordination between innovation, training and social policies. Examples of preventive action include providing workers with adequate information, counselling and re-employment support ahead of their potential displacement during the notice period prior to a mass redundancy (OECD, 2018[58]).

Safety nets need to be combined with measures that ensure a rapid transition towards new opportunities. Such measures should target both the supply side and the demand side of local labour markets. On the supply side, anticipatory efforts at the local or regional levels help identify the gaps in the local skill base. Leadership can lie in the public, private or even non-profit sector, but necessarily needs to draw on the knowledge embedded in the network of firms in the region. For example, through upgrading an industrial district centre that has a high level of sophistication in product inspecting, testing and process certification, to also provide training for upskilling of the local workforce (Potter, Proto and Marchese, 2010[59]).

Demand-side measures help transition or rebuild the regional economic fabric. Importantly such measures need to go beyond supporting existing firms (and their efforts to transition) and focus also on firms trying to exploit new opportunities (start-ups, scale-ups, etc.). The challenge is how policy can develop the ability of regional institutions to absorb new technologies and pass those innovations through to existing and emerging networks of firms. An approach is to develop technology infrastructure in different places, i.e. provide infrastructure investments or capacity-building investments in research universities or co-operative research centres to bridge the gap between research and commercialisation of research in firms. Although the approach is necessarily competitive and thus risks reinforcing existing inequalities, examples such as the German Fraunhofer Institutes show that the approach can allow for many sites of

investment, with varied and specific portfolios based upon the embedded capacities of firms and institutions in an existing region (Clark, 2018[16]).

Using new digital technologies and statistical profiling techniques can improve the provision of tailored support based on workers' characteristics, increasing the effectiveness of preventive social policies. Overall, the provision of welfare benefits should be designed to maximise the chance of re-employment and minimise disincentives to work, including in the difficult case of mid-career workers who are displaced by structural economic change and need to switch industry or occupation (OECD, 2017[60]). As highlighted by the OECD (2015[61]), an effective framework for social safety net policies should: i) motivate job seekers to actively pursue employment; ii) improve their employability; and iii) expand the set of opportunities for them to be placed and retained in appropriate jobs.

"Smart Specialisation" strategies may be a useful policy instrument for concentrating local development activities in areas where there is a critical mass of knowledge and innovation potential (OECD, 2018[1]). In Slovenia, the Smart Specialisation Strategy has been focused on creating "factories of the future" through investments to raise the level of automation and robotics within the manufacturing sector (Slovenia Government Office for EU Cohesion Policy, 2015[62]).

Benefits from reshoring for mature industrial regions

A flurry of recent academic studies has highlighted the pressure that globalisation of production has put on regional labour markets. Local labour markets, identified by commuting patterns in the United States where manufacturers of goods that were directly competing with Chinese imports were located, experienced an increase in unemployment, lower labour force participation and a decline in wages. At the same time, benefit payments for unemployment, disability, retirement and healthcare rose sharply (Autor, Dorn and Hanson, 2013[63]). This impact had lasting effects on the local labour markets. Even a decade after the initial shock, wages and unemployment remain adversely affected (Autor, Dorn and Hanson, 2016[64]). The United States is not alone in the struggles of manufacturing sectors that experienced an adverse shock from increased import competition. Similar patterns are evident in small (TL3) German regions,[8] Norwegian local labour markets and Spanish provinces.

Institutional and sectoral differences across OECD countries do, however, highlight that globalisation can create new opportunities and adverse shocks can be buffered. For Norway, import competition from China led to a rise in unemployment among low-skilled workers but not among those with a college degree and wages do not seem to be adversely affected, which could be attributed to the Nordic labour market model with flexibility at the employment margin but less flexibility in adjusting wages (Balsvik, Jensen and Salvanes, 2015[65]). In Spain, the decline in manufacturing employment was compensated by an increase in non-manufacturing employment (Donoso, Martín and Minondo, 2015[66]).

The case of German manufacturing is particularly telling. The import competition from China was less important than the rise of Manufacturing in East European countries. As was the case in other countries, the shift of production towards (in this case) the east of Europe caused substantial job losses in German regions that were specialised in competing industries. These losses were not limited to manufacturing employment alone but affected employment in other sectors as well. At the same time, manufacturing industries that were export-oriented experienced a boom. They were able to utilise the opportunities created by having access to cheaper inputs and created a large number of new jobs. Estimates suggest that these gains exceeded the losses in import-competing sectors by as much as 442 000 jobs (Dauth, Findeisen and Suedekum, 2014[67]).

Policymakers in many regions express the hope that "reshoring" the activities that moved abroad will reinvigorate the industrial strengths of the past. For example, in the United States, General Electric moved the manufacturing of washing machines, fridges and heaters back from China to a factory in Kentucky. Whirlpool moved its mixer-making back from China to Ohio, and Otis moved its elevator production back

from Mexico to South Carolina (Mcgee, 2015[68]). Examples in Europe include companies such as Burberry that moved back production facilities from China to Leeds (United Kingdom), Safran moving back maintenance activities from Singapore to Saint-Amand-les-Eaux (France) or Sonae MC that moved production from China back to Portugal.[9]

Multinational enterprises (MNEs) can find it increasingly beneficial to move manufacturing activities from emerging countries to regions in developed economies. Reshoring allows firms to keep manufacturing closer to other business activities, such as R&D, design and sales, which tend to be in developed countries. Reducing distances between different business activities is increasingly important to speed up innovation processes. Firm performance is increasingly dependent on the speed of innovation and innovation today requires increasingly closer interaction between inventors, designers and manufacturers. For example, creating new products through R&D activities is more efficient if in direct contact with manufacturing to anticipate possible challenges concerning production capabilities for new products (Bailey and De Propris, 2014[69]).

The benefit of collocating activities raises two important caveats in the hope of creating development and innovation through reshoring. The first is that regions and cities with a strong economic base and internationalised firms will be more likely to see an increase in activity (or if not those places themselves than those who are close to them). The second is that the kind of jobs that are created in reshored plants are likely very different from those that were "lost" previously. To compensate for higher labour costs, labour productivity needs to be higher, which in turn means more skill- and capital-intensive production. In both cases, the benefits traditionally associated with manufacturing, in particular its provision of large numbers of medium- and low-skilled jobs at relatively high wages and its support of economic activity in regions that compete on cost advantage rather than productivity advantage, are unlikely to materialise. The potential of reshoring to support a reduction in interregional (as well as within regional) inequality might therefore be limited.

Innovation policies for regional inclusive growth

Economic growth is necessary but not sufficient for sustained and broad community revitalisation. Traditional indicators of growth, such as population, employment and income per capita, often fail to translate into improved opportunities for populations traditionally marginalised from the mainstream economy (Longworth, 2017[70]). Promoting inclusive growth requires taking an integrative approach to policy (see Box 2.5). Disruptive innovations can affect people at the bottom end of the income distribution the most. In places with little or no economic growth, adjusting to the impact of automation on social inclusion is extremely challenging. In regions experiencing higher growth rates, a tight labour market is an opportunity to bring marginalised populations into the labour force.

Box 2.5. An integrative approach for economic inclusion in the Midwest, Unites States

Longworth, George and O'Dell (2019[71]) examine cities in the Midwest of the United States – a region which experienced significant manufacturing job losses and has highly pronounced racial and ethnic disparities in terms of income, poverty rates, unemployment, educational attainment or homeownership for example. Fragmentation and misalignment are the factors perpetuating inequalities. At a geographic level, overlapping units of government such as school district boundaries conflicting with municipal boundaries result in disparate outcomes. A large number of social programmes are in place but often working in silos and with no evidence of impact.

Economic exclusion manifests itself in disparities – most commonly along racial lines. Other factors include age, faith, immigration status and disability. Indicators that can provide measures of exclusion include, for example, educational attainment, income, homeownership and employment. Economic

conditions for white people are consistently better: unemployment and poverty rates are lower and incomes are higher, as are homeownership rates and educational attainment levels. As general points, Longworth, George and O'Dell (2019[71]) conclude that:

- Economic growth is a necessary but not sufficient condition to foster economic inclusion.
- Economic inclusion is not about redistributing the benefits of economic growth; it is, instead, an ingredient of a more durable strategy for growth.
- Economic inclusion requires economic development strategies that break down barriers and deliver opportunities to underserved populations, placing responsibility on places and institutions rather than individuals.

Economic inclusion has become an aspirational imperative for cities, especially those that have diligently pursued strategies of economic growth only to find that economic well-being did not improve for all residents. Growth alone does not address the underlying challenges of equity and opportunity. Promoting inclusion requires polices at the local level addressing issues such as availability of public transportation, childcare, early career development or information about opportunities, and anticipating barriers (e.g. affordable housing where new firms are developing). Additionally, local public programmes need more impact measurement and to focus on outputs, for example, not only having success indicators measuring how many people have access to a given programme, for instance, but how much people actually benefit from it.

Source: Longworth, S., T. George and M. O'Dell (2019[71]), "Preliminary findings from focus groups on economic inclusion in smaller cities", *ProfitWise News and Views*, No. 2, Federal Reserve Bank of Chicago.

Innovation policies may be used to foster inclusiveness, for example, if they lead to the development of affordable goods and services tailored to the needs of the people who have been "left behind". Inclusive innovation policies aim at promoting inclusive growth and remove barriers to the participation of individuals, social groups, firms, sectors and regions that are underrepresented in innovation activities (OECD, 2017[53]). Their objective is to provide all segments of society with equal opportunities to successfully participate in and benefit from innovation, and ultimately to benefit from the forces of globalisation and technological change.

The instruments used in inclusive innovation policies are not new, mostly consisting of adaptations of traditional instruments. They include well-known traditional innovation policy instruments such as grants to fund research projects, innovation vouchers and entrepreneurship education schemes (OECD, 2017[53]). The difference consists in the new objective for which they are conceived and new directionality they aim to give innovation activities. Inclusive innovation policy instruments are designed to facilitate the participation in research, innovation and entrepreneurial activities of those groups that currently have fewer capacities or opportunities to do so.

Table 2.1 summarises the three types of inclusiveness (social inclusiveness, industrial inclusiveness and regional inclusiveness) and provides definitions and examples for each type of policy. These efforts might be perceived as foregoing efficiency considerations, i.e. it might be argued that public support should focus on top firms or frontier regions rather than on "laggards". This does not need to be the case, the returns from investment in laggards have greater growth potential through an "advantage of backwardness" (OECD, 2016[4]), investment can also lead to a different development path and endogenous accumulation of further investment (Rodríguez-Pose, 2005[72]). To unlock the benefits of investment, policy often has to address additional barriers (see Chapter 4).

Table 2.1. Innovation policies for inclusiveness

	Definition	Examples
Social inclusiveness	Policies broadening the group of innovators by including underrepresented individuals and groups in research, entrepreneurship and innovation activities. These policies can either build innovation capabilities of disadvantaged groups or facilitate their access to opportunities to participate in innovative activities.	In Israel, the Support Programmes for Companies from the Ultra-Orthodox and Arab Minority Communities, incentivise companies that have at least 33% of their share capital held by an entrepreneur of a minority group or from the ultra-Orthodox community to engage in product development projects by providing grants covering 85% of the project's budget.
Industrial inclusiveness	Policies aiming to support innovation activities in less innovative firms (including micro-entrepreneurs, SMEs and start-ups) and traditional sectors. The focus is on strengthening their innovation capacities, as well as on building an adequate business environment for innovation.	In the People's Republic of China, the Innovation Fund for SMEs provides both financial and professional advisory support for SMEs that aims at engaging in innovative activities. Professional business counselling or advice to entrepreneurs is frequently part of broader support schemes and a condition for receiving financial support. Similarly, in Israel, the programme for encouraging R&D in traditional industries provides professional counselling in addition to grants to those firms in such industries that decide to engage in an R&D project.
Territorial inclusiveness	Policies targeting lagging and less innovative regions to narrow the performance gap with leading innovation regions. They foster the innovation capacity of individuals and firms located in peripheral regions, as well as in disadvantaged neighbourhoods within large urban areas.	In Korea, technology parks have been built to address the gap between the metropolitan area of Seoul and other more peripheral regions. Technology park development includes the construction of infrastructure (e.g. common business support facilities, incubators), locating of research centres and universities to increase the pool of human capital and promote R&D, implementation of networking programmes and incentives for joint R&D projects, and the provision of finance for tech-based SMEs and start-ups, including through venture and seed capital.

Source: Adapted from OECD (2017[53]), *Making Innovation Benefit All: Policies for Inclusive Growth*, https://www.oecd.org/innovation/inno/making-innovation-benefit-all.pdf.

Innovation policies for regional sustainable growth

Innovation policies have directed innovation activities towards a growth model based on a production and consumption framework that is unsustainable. Most traditional innovation policies have been based on a 20th-century supply-driven innovation model, which takes competition between nations and support for R&D as the main entry point for policymaking (Schot and Steinmueller, 2018[51]). The current innovation framework has directed a growth path that seems unable to address the key environmental challenges we are facing, including, for example, the climate change effects of greenhouse gas emissions or the environmental effects of household and industrial waste.

The impact of the current model on climate change has strong local dimensions. For example, sea-level rise will disproportionally affect coastal areas, with average global flood losses estimated at approximately USD 6 billion per year in 2005 (OECD, 2019[3]). By 2050, these losses may potentially increase to USD 52 billion in 136 of the world's largest coastal cities, even in the absence of climate change, as projected socio-economic change (i.e. growing populations and assets) alone will lead to heightened vulnerability (Hallegatte et al., 2013[73]).

Mission-oriented policies are a potential form of applying the transformative innovation policy framework in regional innovation policymaking. Mission-oriented innovation policies aim at influencing the direction of innovation activity towards a particular type of growth model. The active role being taken by the public sector towards renewable energy investments can be seen as a new mission in relation to the green economy to promote sustainable growth. Defining a mission requires addressing a challenge instead of

focusing on the development of particular technologies (Mazzucato, 2018[74]), a "challenge" being an area identified as a priority (whether through political leadership, or the outcome of a movement in civil society). As an example of a tool to jointly and dynamically address the issue of identifying a common challenge, the EU's Smart Specialisation relies on an embedded entrepreneurial discovery process.

An example of a mission-oriented programme with important local dimensions is the Viable Cities programme in Sweden. The programme has the mission of fostering the transition to resource-efficient and fossil-free liveable smart cities in Sweden, bringing together around 50 stakeholders in various areas of research, industry, civil society and local authorities. The programme provides grants for pre-studies, research, innovation or demonstration projects for smart and sustainable cities (Viable Cities, 2018[75]). Moreover, it promotes collaborative partnerships, requiring applicants to form groups of least three independent actors, where at least two have to be from a different nature (among universities, business, local public sector organisations or non-profit organisations).

The Yokohama Smart City Project is an additional example of a mission-oriented programme in Japan, aiming to improve energy efficiency and mitigate climate change. The city of Yokohama introduced a Community Energy Management System to achieve efficient energy management by linking individual management systems (e.g. in homes, office buildings and factories) to stationary energy storage (OECD, 2019[3]). Specific achievements of the programme include, for instance, the installation of emergency management systems in 4 200 homes, the introduction of 2 300 electric vehicles and of 37 MW of photovoltaic generation, and the reduction of 39 000 tonnes of CO_2 emissions (IEA, 2016[76]).

Going beyond best practices to best matches: One size does not fit all

The mainstream view of traditional innovation policy is that upgrading of innovation processes follows an increased intensity in R&D. The linear R&D growth model consists of upward transitions from basic research to applied research, from basic research to exploratory development or from applied research to exploratory development or advanced development. These are upstream areas of the innovation value chain related to the "commercialisation of R&D", which are the core focus of traditional innovation policies. However, productivity depends not only on upstream R&D activities but also on absorptive capacity, diffusion and demand. The linear R&D model ignores the distinction between production capability and technology capability and ignores production capability and other downstream innovation activities as key sources of innovation and productivity growth.

Innovation policy needs to reflect heterogeneity in terms of innovation capacity within and across regions. However, the opposite is often the case. Highly heterogeneous regions or even countries are setting homogeneous policy mixes, not adapting to different local capacities and opportunities. This is unproductive because copying ready-made policy solutions that worked elsewhere and that do not adapt to regional contexts will likely fail to produce positive results. Learning from other regions' experiences is a fruitful policy exercise but requires identifying best matches instead of copying ready-made policies considered as best practices. Identifying successful policy cases in regions that share similar characteristics and innovation drivers is the first step, but successful policies need to be adapted to the region's own context. Chapter 4 discusses this point with a view of regions that are lagging behind the innovation frontier. For these regions, a linear view of technological upgrading is often misguided as different ways can improve the technological capabilities of a region.

Downstream areas of the innovation value chain are critical for productivity given their weight on absorptive capacity, innovation diffusion and demand. Many innovative activities are based on finding new uses or diffusion of existing knowledge and are not covered by the definition of R&D. For example, through technological adoption, the R&D embedded in purchased manufacturing equipment can give access to all the embedded knowledge that was necessary to produce it but is not considered as R&D investment, so is not of key importance in traditional innovation policies. Likewise, innovation requires operating or

production capabilities and design, engineering and associated management capabilities but these are usually out of the scope of innovation statistical surveys (Bell, 2007[77]). The inclusion of non-R&D business innovation expenditures in surveys such as the Regional Innovation Scoreboard (RIS) of the EC is a good move towards identifying and measuring such types of innovation activities (EC, 2017[78]).

Innovation policy in Poland can be used to illustrate different elements of the non-linear growth model across different EU programming periods. During the 2007-13 programming period, Poland focused on the adoption of technologies developed elsewhere, exploring embedded R&D. That policy favoured technology adoption and use, typically confining programmes to the purchase of the latest equipment and machinery. The 2014-20 programming period saw a break in the approach and an "innovation tsunami", focused narrowly on early-stage risk capital and R&D expenditures (Breznitz and Ornston, 2017[79]). While this represented a strong shift from technology adoption towards own R&D efforts, the critical challenge of innovation policy should be combining or coupling the two types of innovation efforts. The challenge for 2020-27 will be coupling investments in business R&D with significant investments in human capital (both university and vocational education) and technology upgrading or investments in activities such as design, engineering, production capabilities and management practices that are conducive to innovation (Radošević, 2018[9]).

Heterogeneous regional contexts with homogeneous policy mixes

Regional innovation policies remained fairly homogeneous with low levels of experimentation and adaptation to regional idiosyncrasies. Izsak, Markianidou and Radošević (2014[80]) identified a set of five policy approaches widely used in most EU countries, pointing at an unexpected convergence and very slow evolution among innovation policy mixes. Veugelers and Schweiger (2015[81]) reach the same conclusion by focusing on countries from Central Asia and Eastern Europe. They note that innovation policies "are surprisingly similar, characterised by an excessive focus on the creation of technology, particularly from public-funded research organisations and insufficient attention to the absorption of technology by the private sector". Most of the available assessments are based on innovation policies for the prior programming period, as Smart Specialisation Strategies (and its underlying entrepreneurial discovery processes) have further matured over the 2014-20 period and more regions have likely embraced experimentation.

Regions are following similar solutions to solve different problems and with different capacities to implement such solutions. Policy-specific evaluations confirm that innovation policy measures that work in some frameworks are inappropriate in others. For example, evaluations of the effectiveness of innovation tax incentives policies show that very similar measures can have extremely differentiated impacts (Mohnen, Vankan and Verspagen, 2017[82]).

Learning what best practices make policies work is important; however, best practices can be region-specific. Their underlying success factors can be conditional on regional characteristics. Identifying best practices is a necessary but not sufficient condition. Finding the best matches for best practices can enable learning from other policy experiences, as it requires looking at the specific regional conditions behind each practice. Policies that pass the design phase need to adjust to regional circumstances in order to successfully begin the implementation phase and ultimately stimulate regional development.

Implementing best matches requires identifying regions' innovation challenges and match the appropriate instruments to the existing capacities through a process of "entrepreneurial discovery". The entrepreneurial discovery process consists of engaging local innovation stakeholders to better understand their strengths and weaknesses. This can involve, for example, engaging the "quadruple helix" by identifying and gathering leaders from different regional stakeholders, such as local industries, academia, public authorities and non-profits, and pursue participative governance processes defining regional innovation strategies. Regional strategies for economic rejuvenation are likely to fail without support from local

innovation stakeholders. Chapter 5 provides practical examples of how to operationalise such participative governance structures for engaging multiple stakeholders.

Regional benchmarking

Regional benchmarking can be of great value for identifying best policy matches in the design and implementation processes of regional innovation policies. S3 policies present much space for improvement in enabling differentiated policy strategies based on regional assets. A tendency to mechanically imitate best practices from advanced countries or regions and maintain traditional interventions persists in S3 policy frameworks. For example, the case of "Estonia follows Finland" shows that:

> *"A number of interesting and similar issues are being experienced by Finland and Estonia in their application of smart specialisation, and indeed their trajectories are looking increasingly similar as the agenda progresses […]. The two countries are specialising in remarkably similar areas and pursuing surprisingly similar strategies in direct contrast to the central edict of the smart specialisation approach that it will reduce duplication and competition between European regions […]. The same issues and barriers may be faced by similar countries of a small, weak, and peripheral nature within the EU, and their needs and experiences could be quite different from their dominant and economically successful neighbours." (Tsipouri, 2018[10])*

An effective transfer of good policy practices and solutions between regions consists of finding the best practices that better match regional contexts. Such exercise requires a methodical comparison with peers that can help identify distinctive policy approaches that work in regions with similar characteristics. A sound exercise of regional benchmarking can thus support policymakers identify what policy practices can be transferred, followed and adapted.

The smart specialisation platform, in co-operation with Orkestra (Basque Institute of Competitiveness), jointly developed a methodology enabling to identify regions sharing similar structural conditions that are relevant for innovation-driven development. Examples of regional conditions include social, economic, technological, institutional and geographical characteristics. The tool can help other regions that share similar characteristics. The choice of characteristics is based on their relevance as innovation drivers and on being difficult to change in the short term. Examples of such characteristics include regions' institutional capacity, industrial structure, human capital and trade openness (Navarro et al., 2014[83]). The following step for this valuable tool is to provide examples of successful regional policies, enabling other regions to learn by identifying possible best policy matches.

Bridging gaps across levels of government and breaking policy silos

Implementing regional innovation policies by pursuing a best match approach requires giving a more prominent role to local governments. Since the 1970s, countries are increasingly decentralising responsibilities from the national to the regional level and there has been an increase in metropolitan governance arrangements.[10]

Cities are becoming increasingly active players in innovation policy. In a recent study, 77% of the surveyed cities indicated having dedicated funding schemes to support innovation (OECD/Bloomberg, forthcoming[84]). Most innovation efforts are tailored to improve service delivery (e.g. for emergency services, housing, mobility and social services), to improve internal government operations (e.g. streamlining budget processes and workflows and to foster inter-agency co-operation) and to improve residents' quality of life (such as health and job outcomes). Funding for cities' innovation instruments come from municipal budgets but also other sources, such as external (non-public) funding and national government budgets.

Multi-level governance in innovation policy

With decentralisation of policymaking on the rise, co-ordination across different levels of government becomes essential. The increasing decentralisation trend can facilitate policy adaptation to local contexts, but innovation policy is still dominated by national governments (Veugelers, 2015[85]), which makes co-operation between local and national governments a critical factor (see also Chapter 5).

Policy coherence across multiple levels of government has the potential to enable complementarities between instruments managed by local and national authorities. Coherence also helps to avoid potential duplications of efforts or even negative policy interactions. In some cases, the division of power between national and regional governments is clear but, in other cases, those powers are shared. For example, in most countries, national governments are responsible for intellectual property rights, while both the national and regional levels share responsibility for developing incubators and scientific parks, or funding R&D projects (OECD, 2011[31]).

Overlapping national and regional policy instruments can create synergies if both levels complement one another. Such complementariness can arise in the way the instruments are built in terms of their target actors, innovation phases or across different innovation factors. The proliferation of public support programmes at different levels can also lead to inconsistencies, bureaucratic and political conflict, lack of consensus when setting priorities and, ultimately, higher administrative costs, complexity and confusion for local actors. Examples of mechanisms to ensure efficient national-regional policy coherence include national-regional policy councils or agencies, national-regional contracts, joint funds and other more informal modes of co-ordination such as regular dialogue and consultation process (OECD, 2011[31]).

Policy co-ordination beyond silos

Policy success in a given region can be determined by the existence of other policies that address complementary sectors or agents. Copying a successful policy implemented elsewhere can still fail if important complementary policies are not in place, or if existing regional policies are in conflict with the policy being implemented. As innovation becomes ever more multidisciplinary and complex, breaking silos across policy areas becomes a priority in order to implement best matches.

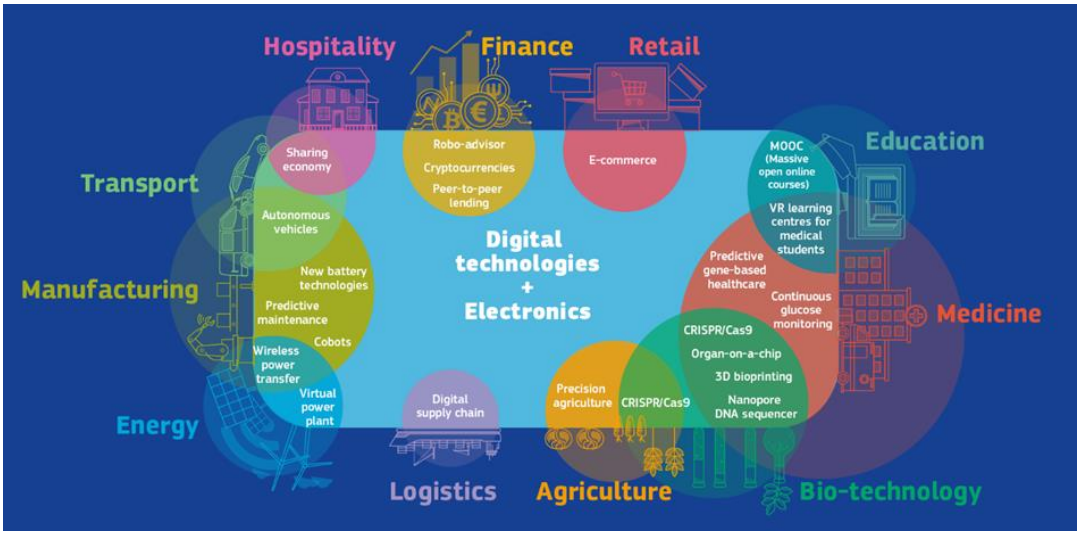
Innovation activities are taking place in the fringes of different business, technological and scientific sectors, and involving interactions across multiple actors in several stages of the innovation value chain. Disruptive changes are happening in the interaction of multiple sectors, e.g. of biotech and medicine, such as CRISPR, or at the intersection of transport and manufacturing, as autonomous vehicles (see Figure 2.2). Innovation is becoming increasingly complex as digital technologies are integrating with analogue technologies. For firms, this means that they need to combine different advanced technologies and implement new business models to take advantage of innovation. “Off the shelf” technologies become less powerful. The commercialisation of these innovations often involves collaborations between university scientists, entrepreneurs and large firms.

Policies targeting individual sectors with no coherence with other regional or national policies targeting complementary sectors will fail to support the innovation of multidisciplinary nature. An example concerning the importance of policy complementarities is the case of innovation grants. Innovation grants are often implemented by local governments but have been found to be rather ineffective when attention is not paid to the context set by other policies, targeting education, labour market, competition and macroeconomic stabilisation for example (Aghion, David and Foray, 2009[86]). The example shows that identifying best matches requires taking into account the necessary coherence across multiple policy areas in addition to coherence across different layers of government.

Breaking policy silos to enable an integrative approach, whereby several factors for growth are targeted simultaneously, pays off. For example, infrastructure improvements can have a positive impact when other factors are also present in a region, such as strong human capital, robust employment rates and good

entrepreneurship rates (Box 2.6). Creating regional bodies concentrating different innovation policy responsibilities or that oversee and co-ordinate different policy agents present in the region are examples of efforts to build policy coherence.

Figure 2.2. The convergence between the physical, digital and biological worlds



Source: EC (2020[87]), *Science, Research and Innovation Performance of the EU 2020: A Fair, Green and Digital Europe*, Directorate-General for Research and Innovation, European Commission.

Box 2.6. Pursuing an integrated approach to enable policy complementarities

OECD analysis of the determinants of growth at the regional level identifies a number of critical drivers, including infrastructure, human capital, innovation and agglomeration (OECD, 2009[88]). Importantly, these factors: i) are largely endogenous, i.e. they can be addressed by policy (as opposed to natural endowments or physical geography); and ii) complement each other, suggesting the need for an integrated approach. Relevant determinants fall under the responsibility of different policy areas across different levels of government, requiring efforts to ensure policy co-ordination.

- Improvements in infrastructure at the regional level do not automatically lead to higher growth. Such investments need to be combined with improvements in education and innovation. This suggests it is useful to co-ordinate policies for building human capital, enhancing innovation and providing physical infrastructure. The effects of infrastructure investment appear to last around 3-5 years.
- Human capital – both the presence of high-skilled workers in the regional workforce and the absence of low-skilled workers – appears to be the most robust supporter of growth in all types of regions. The effects of improvements in human capital also appear to last around five years.
- The third critical element is innovation (measured in terms of its science and technology components). Innovation appears to produce positive effects over a longer time span of approximately ten years.
- Economies of agglomeration also have a positive impact on growth, although they are neither necessary nor sufficient to ensure sustained growth rates.

Source: OECD (2009[88]), *How Regions Grow: Trends and Analysis*, https://dx.doi.org/10.1787/9789264039469-en.

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Notes

[1] See https://www.bbc.com/news/technology-39589967 (accessed 23 July 2019).

[2] See, for example, the discussion in OECD (2017[90]) that focuses on the challenge AirBnB poses for Amsterdam (Netherlands).

[3] While the potential exists for all types of firms, SMEs might require additional support to access the benefits big data and data analytics can provide (Bianchini and Michalkova, 2019[92]).

[4] The four sectors (splitting ICT producers and service providers) account for 75% of the total R&D expenditure of the largest 2 500 global private sector R&D investors. As they account for 90% of private sector R&D spending, the underlying assumption is that R&D investing firms excluded from the data have a similar industrial structure (Hernández et al., 2019[35]).

[5] Based on the 2019 OECD Survey of National Innovation Statistics and the Eurostat's Community Innovation Survey (CIS-2016), http://oe.cd/inno-stats, January 2020.

[6] The Fraunhofer IIS provides their view of the history of the development of the MP3 code at https://www.mp3-history.com/ (accessed 19 July 2020).

[7] See also OECD (2019[91]) and the collection of best practices for OECD countries available at https://www.oecd.org/gov/ethics/Going_Green_Best_Practices_for_Sustainable_Procurement.pdf (accessed 22 July 2020).

[8] Regions within the 37 OECD countries are classified on two territorial levels reflecting the administrative organisation of countries. Large (TL2) regions represent the first administrative tier of subnational

government and small (TL3) regions are contained in a TL2 region. TL3 regions correspond to administrative regions, with the exception of Australia, Canada, Germany and the United States.

[9] See the European Reshoring Monitor: https://reshoring.eurofound.europa.eu/reshoring-cases.

[10] Data on trends in responsibility for innovation policy at the subnational level are not readily available. The Regional Authority Index, which measures the authority of administrative regions in general, shows that decentralisation to the regional level is a general trend in all parts of the world. Fifty-two out of 81 countries in the Regional Authority Index experienced a net increase in the degree of regional authority and only 9 experienced a net decline (OECD, 2019[89]).

3 Regions managing industrial transitions and disruptive innovation

This chapter takes a brief look back across the first three waves of industrial transitions to draw lessons on how regions and cities can ride the current fourth wave. It discusses key elements of the regional innovation system that support a successful transition, as well as different development paths including specialisation and diversification of economic activity. The chapter concludes with a more general discussion of disruptive innovations and how regions and cities can prepare to benefit from their impact.

Introduction

Transitions of the industrial structure in regional and urban economies happen gradually and often imperceptibly, formed by combinations of several innovations. Some of these transitions are "industrial revolutions" that radically alter the way economies function and interact. Many regions and cities contribute to innovations that support "industrial transitions". No single place drives an industrial transition but all regions and cities have to adapt to them. This does not mean that paths are predetermined but rather requires active and anticipatory changes within regions and cities that ensure that all actors within the region are well placed to seize opportunities that industrial transitions and disruptive innovations can bring.

A combination of innovations can act as a catalyst for industrial transitions where methods of production and consumption change radically. Some regions may find new opportunities for growth but others may find it hard to change their economic model, especially when their industrial structure is too heavily concentrated in economic activities that become obsolete. Regions struggling to manage industrial transitions may require support to diversify their economies and find new paths of growth. Instead of supporting the transition process, policies often aim to retain existing structures, e.g. by subsidising traditional sectors. Replacing policies that aim to retain activity with narrow innovation policies is equally misplaced. Transitioning a regional or urban economy requires a concerted effort of both supply- and demand-side instruments that support the transition of the current workforce and looks forward towards preparing the next generation of workers.

Some authors argue that during the third industrial revolution, European policymakers favoured protecting the stock of existing jobs instead of encouraging innovation and industrial transition. When compared with Europe, the United States took the lead in the third industrial revolution, with the most successful players being US firms (Bloom, Sadun and Reenen, 2012[1]). Decompositions of productivity growth in the United States show that a large fraction of this advantage occurred in sectors that produce information technologies (IT) or use them intensively, while in Europe the disadvantage comes mostly from the lack of IT usage in non-IT sectors (van Ark, O'Mahony and Timmer, 2008[2]). The growing gap arose despite comparably high levels of human capital, talent and research infrastructures in Europe and the United Starts. Part of the explanation can be that Europe focused more on incumbency, helping regions avoiding downward spirals from deindustrialisation (which happened massively in the United States rustbelt). However, by prioritising incumbency, radical innovators can be penalised. As argued in Phelps (2003[3]) and Gordon (2004[4]) European institutions were more prone to protect incumbency and inhibit new entry partly explaining why Europe lagged behind the United States during the third industrial transition.

Industrial revolutions often lead to a displacement of workers or the reduction of the importance of certain infrastructures. Artisans who produced goods from start to finish became workers specialising in tasks along an assembly line, who then were replaced by robots that took over routine tasks whilst workers monitor and maintain the system. Similarly, waterways gave way to railroads, which in turn were superseded by motorways. These changes disrupt the lives of people and whole regions but they also produce huge gains as more can be produced with fewer resources and more places gain access to the knowledge and capacities that leading places within and across countries have.

Disrupting the way economies function might be more important now than it has ever been before. Disruptive innovations might be the only way to tackle "grand" societal challenges OECD countries are facing. Without significant changes to transport, energy production and a move towards less wasteful consumption, climate mitigation efforts and the transition towards carbon-neutral economies will fail. In many areas, innovations are becoming increasingly disruptive, completely moving markets away from existing practices introducing new paradigms and opening up avenues for further developments.

Whether through the effect of a combination of different innovations or individual disruptive innovations, new opportunities come along with the displacement of existing industries, workers and respective institutions. Innovation can have very different regional impacts. It can disrupt incumbent industries in all

types of regions but the most developed regions in the innovation frontier are more likely to create (and benefit the most from) disruptive technologies, finding new sources of jobs and growth paths. If regions behind the frontier cannot benefit from new opportunities related to industrial transitions and disruptive technologies, they can face prolonged unemployment due to automation.

This chapter first considers the impact of industrial revolutions on regions and identifies levers that regions can and have used to manage transitions of their economies. It then outlines the notion of "disruptive technologies" and describes strategies that regions can use to prepare for and manage their potential challenges.

This chapter and the full report draw from a series of expert workshops on "What works in innovation policy? New insights for regions and cities" organised by the OECD and the European Commission (EC). For each workshop, experts provided background papers that, together with the discussion during the workshop, form the basis for this report:

- Fostering innovation in less-developed regions, with papers by Slavo Radošević (2018[5]) and Lena Tsipouri (2018[6]).
- Building, embedding and reshaping global value chains (GVCs), with papers by Riccardo Crescenzi and Oliver Harman (2018[7]) and Sandrine Labory and Patrizio Bianchi (2018[8]).
- Developing strategies for industrial transition, with papers by David Audretsch (2018[9]) and Charles Wessner and Thomas Howell (2018[10]).
- Managing disruptive technologies, with papers by Pantelis Koutroumpis and François Lafond (2018[11]) and Jennifer Clark (2018[12]).
- Experimental governance with papers, by Kevin Morgan (2018[13]) and David Wolfe (2018[14]).

Paths for transition in regional economies

Innovation and innovation policy are central to ensure that regions transition from their current strengths towards new opportunities. The lessons from past industrial revolutions show that transitions are no mean feat. Even today, many European and OECD regions appear to be stuck in a "middle-income trap" (EC, 2017[15]; OECD, 2018[16]). These regions were once drivers of growth in their countries but lost momentum through the changing nature of manufacturing, the shift in mining production out of more affluent OECD regions and the rise of new (tradeable) service sectors.

Managing industrial transitions requires identifying and exploring areas of economic potential to generate new sources of regional growth. The identification of domains of competitive advantage should not be limited to the public sector. It requires engaging with the private sector, academia, as well as relevant actors from civil society. This "quadruple helix" approach is not new: the triple helix of government, private sector and academia was formalised in the early 1990s (Etzkowitz and Leydesdorff, 1995[17]) and even the addition of civil society as a fourth helix has been discussed for over 15 years (Liljemark, 2004[18]). There is, however, no consensus on how the approach can be operationalised in different regional contexts (e.g. for regions where governmental capacity is low), across levels of government or how continuous learning and improvement can be embedded in the process (see Chapter 5).

There is no unique path to success when it comes to economic transitions. Policy can build on a growing body of evidence that considers a wide range of regional settings. The applicability still requires a thorough assessment of the local assets in a region. The central question for economic transition is "where to?". Diverging success stories of Los Angeles and San Francisco (see also Chapter 5) and industrial policies that aimed at "picking winners" but failed to stir innovation (Dutz et al., 2014[19]) show how difficult it is for policy to set the right objectives and incentives.

The core question is whether it is better to specialise in those areas where a region is already strong or whether it is better to diversify. More specialised regions tend to be richer (in term of per capita gross domestic product [GDP]) but more diversified regions grew faster during the 2008-14 period (OECD, 2018[16]). Even if regions aim to diversify, the identification of suitable sectors and strategies to develop activity within these sectors is far from straightforward. In places with a well-diversified and vibrant economy, gaps might be easier to identify. The city of New York, for example, identified a lack of capacity in training engineers, in particular relative to tech-hubs around Boston and San Francisco, as a barrier to diversifying its economy. The result was the creation of a new graduate university "Cornell Tech" with a campus on Roosevelt Island (Katz and Bradley, 2013[20]). In places with a less diversified economic base and production that is focused on the extraction of raw materials, agriculture or low-tech manufacturing, the potential for diversification is much greater; but that also means it is harder to develop a concrete strategy (Balland et al., 2019[21]).

Specialisation and diversification of regional economies

The sectors and types of regional entrepreneurial activity will determine regional innovation paths. Three common pathways for regions' innovation development include: i) regional specialisation in a particular technology domain; ii) regional diversification in related technological domains; or iii) regional diversification in unrelated technological domains (Table 3.1). The common factor to each innovation path is the need for entrepreneurship discovering and exploiting opportunities to create value within each path, whether improving existing products or services, or creating new ones (related or unrelated with the regions' technological base).

Table 3.1. Stylised regional innovation and economic development paths

Different regional development paths explored through innovative entrepreneurship

Innovation development path	Definition	Opportunities	Challenges
Specialisation	The region increasingly develops its economic activity around one main sector.	Extensive exploration of economies of scale and scope.	Innovation is incremental, consisting mostly of smaller improvements. Lower resilience to shocks affecting the sector of specialisation.
Related varieties	Region branches into different sectors that share common features, such as similar knowledge and skills requirements.	Capacity to find new growth paths if one particular sector is negatively affected. Margin to explore scale and scope economies in the areas of sectoral "relatedness".	Not likely to enable the most impactful innovations, which require re-combinations of unrelated and distant types of knowledge.
Unrelated varieties	Region branches into a number of unrelated sectors.	More prone to develop successful radical technologies. Appropriate for the 4th industrial transition as artificial intelligence (AI) and connectivity enable cross-sectoral synergies. More resilient to shocks that affect negatively one sector.	Requires open innovation system and technological experimentation. High risk of technological failure.

Regional specialisation or regional diversification?

Specialisation of regional economies in certain sectors points towards comparative advantages. Strong sectors are the result of some form of local advantage, albeit this advantage might have eroded over time. Further developing the area of specialisation comes with concrete advantages. The skillset of the local workforce remains relevant, firms can incrementally move towards new fields without major disruptions and the risk of engaging in related activities is relatively limited. Once a competitive advantage is found, new opportunities emerge for local firms to further improve that field of knowledge (Boschma, 2004[22]). Many regions specialise in particular sectors and successfully innovate and grow for long periods of time by incrementally improving within existing sectors. They are thereby "extending" or "upgrading" their industrial development path (Grillitsch, Asheim and Trippl, 2018[23]).

An economy is "specialised" if a small number of sectors account for a relatively large share of its GDP, whereas it is "diversified" if each of a relatively high number of sectors accounts for a small share of GDP. Two examples for highly specialised (and successful) regional economies are the mid-sized cities of Erlangen and Wolfsburg in Germany. Volkswagen employed 60 000 workers at its seat in Wolfsburg, compared to a total working-age population in the municipality of 77 000. The "campus" of Siemens in Erlangen had about 25 000 employees compared to a total working-age population of about 71 000 (The Economist, 2016[24]). Examples are not limited to Germany but smaller cities and rural areas often have to rely on specialisation as they lack the critical mass to build strength in many sectors (OECD, 2016[25]).

A distinction is necessary between specialisation in growing and dynamic industries, and specialisation in mature and declining industries. Like Wolfsburg, the city of Detroit in the United States was heavily invested in its automobile industry, leading to its nickname "Motor City". But the sector failed to sustain growth through the third industrial revolution. In the fourth industrial revolution, regions specialised in industries relying on routine tasks are likely to experience more disruption from automation. Too much specialisation in one or a few mature industries relevant in past industrial transitions can expose regions to negative shocks affecting those industries (Storper et al., 2016[26]). Regional specialisation affects the patterns of risk of automation among metropolitan areas in the United States. Between one-half and three-quarters of workers in metropolitan areas may face severe disruption in the near future (Frank et al., 2018[27]). The risk decreases with the size of the city, in part because larger cities have a higher share of employment in occupations whose tasks are more resilient to automation.

Excessive specialisation can affect regions' innovation capacity negatively, since innovating within the same mature sector consists mostly of incremental innovations producing small improvements. This can lead to persistent economic slowdowns if regions find themselves incapable of adapting their industrial base to explore other opportunities, which is the case when the impact is a complete industrial transformation (Schoenmakers and Duysters, 2010[28]). But overcoming excessive specialisation can be difficult.

The mining industry in Pittsburgh (United States) was essential for the development of the city but contributed to crowd out entrepreneurship in the region (Chinitz, 1961[29]). Rochester (United States) provides another example of excessive specialisation. In 1879, when the emulsion-coating machine was invented in Rochester, the city of New York was the centre of the photographic industry. The Eastman Kodak Company in Rochester soon took over the market for photographic film and Rochester replaced New York City as the leading location in film production, becoming highly specialised in that sector. In the 1960s, Kodak was the largest employer in Rochester with over 60 000 employees. Yet, Kodak did not manage the disruption of digital technologies, nor did the region. When the company shut down its largest research and production facility, the population of Rochester witnessed a decline of the entire region. As Kodak's workforce dropped by almost 80% between 1993 and 2006, the whole region rapidly lost population (citi, 2016[30]).

Linking existing strengths with new ones through "related varieties"

Instead of further specialising within existing sectors, regions can aim to diversify their economies and thereby "branch" onto new development paths. Regions with more diversified economies can be better positioned to enable the recombination of existing knowledge pieces to find new growth strategies. Knowledge spillovers between different sectors within a region are an important source of innovation. A diversified regional economy can be more likely to innovate and create new growth paths (Henderson, Kuncoro and Turner, 1995[31]; Rosenthal and Strange, 2004[32]). At the heart of such innovative capacity is the creation of inventions that introduce novel technological approaches, recombining technologies in new ways (Arthur, 2009[33]). Knowledge from multiple sectors can be exchanged more easily when the distance between sectors in a region is not too large. Sectors need to be related or complementary, presenting low co-ordination costs of combining different types of knowledge (Frenken, Van Oort and Verburg, 2007[34]).

A strategy to identify and foster new paths that link with existing assets is diversification into "related varieties". The "related varieties" approach maps the presence of specific sectors or products ("varieties") in different countries and regions. This mapping can then be used to identify varieties that tend to co-locate, i.e. "related" variety. The idea is that the local assets in existing sectors or capacities to produce current products are easier to bridge to those required for related varieties. A growing literature has shown that the probability that a region will start exporting a new product (Hidalgo et al., 2007[35]; Hausmann et al., 2014[36]) or start patenting in a new technology field (Boschma, Balland and Kogler, 2014[37]; Petralia, Balland and Morrison, 2017[38]) increases with the number of related activities present in that location. A positive link between related diversification and economic performance, in general, has been found in several empirical studies (Content and Frenken, 2016[39]).

The concept of "related variety" as regional development path is consistent with the reality at the firm level, where diversified firms providing a related variety of products tend to outperform specialised firms. For example, companies in the energy sector require a broad range of goods and services, so an intermediary firm can sell drilling equipment, well completion services or environmental management instruments, for example, through three separate but related business units. In a single visit, sales staff can offer multiple products and services to clients, yielding marketing economies of scope, with the potential to outperform competitors, which only offer a single product or service.

An additional example of firm-level activity benefitting from relatedness is research and development (R&D). If a firm has different, but related business units, all can potentially benefit from inventions resulting from R&D activities. Sharing common R&D activities and manufacturing facilities enables to distribute common fixed costs across more revenue streams (Palich, Cardinal and Miller, 2000[40]). Pursuing related-variety diversification strategies are limited by the co-ordination costs of combining multiple product lines. A study on US equipment manufacturers finds that producers favour related diversification in their products if the potential synergies (e.g. in terms of shared inputs) but that this positive effect is attenuated if existing products have complex value chains (Zhou, 2010[41]).

Related variety fulfils two needs at the same time: diversity and relatedness. Some degree of proximity in terms of common costs, technologies, skills and knowledge (that is, relatedness between sectors) is required to ensure that synergies, effective communication and interactive learning between sectors take place at low co-ordination costs. However, some degree of distance (that is, variety between sectors) is needed to avoid cognitive lock-in and to stimulate novelty. Boschma (2009[42]) provides the example of Emilia Romagna in Italy as a case of the branching process in related varieties. Many successful sectors in the region, such as ceramic tiles, the packaging industry and robotics, emerged out of a pervasive regional knowledge base in engineering. These sectors not only built and expanded on this extensive knowledge base, they also renewed and broadened the regional economy of Emilia Romagna.

The "related varieties" approach works best for regions that aim to follow established developments paths into new sectors. The identification of what sectors or products are related relies on precedents set in other

places. This means that varieties might seem unrelated given the available data but might actually be closely related. This shortcoming is particularly important for innovation policy, where the explicit focus is on novel approaches. It might be the innovative activity itself that creates links between seemingly unrelated sectors or products.

Big push towards "unrelated varieties"?

In some regions, the transition towards new sectors constitutes a more radical shift. Conceptually these regions move towards "unrelated varieties", i.e. sectors or products that are not typically associated with the industrial structure of the region. The move from agricultural to industry-based economies is one such move that many regions have successfully taken. Radical innovations have the potential to connect previously unrelated knowledge bases and create new industries connected in a "related variety" fashion. For example, in the 19th century, the invention of synthetic dyestuffs gave birth to new related industries, as pharmaceutics, explosives, plastics, synthetic fibres and photography, all centred on the same new core technology (Malerba and Orsenigo, 2006[43]).

North Carolina in the United States is a successful example of branching through unrelated varieties. During the second industrial transition, North Carolina ranked as the poorest state in the United States (Link, 1995[44]), with its three main sectors being textiles, furniture and tobacco. However, during the third industrial transition, the region became one of the most innovative and prosperous regions in the world. North Carolina successfully branched into new high-growth sectors: IT, pharmaceuticals, banking, food processing and vehicle parts (Walden, 2008[45]). At the centre of this success was an innovation policy creating North Carolina's Research Triangle between the counties of Chapel Hill, Durham and Raleigh and their universities campuses. Within the Research Triangle lies one of the most prominent science and technology parks, the Research Triangle Park, that played a key role in the transformation (see also Box 3.7).

The growth "miracle" of South Korea that took the country from "developing country" status in the early 1960s into the group of "high-income countries" in mere decades,[1] is another dominant example of a "big push" towards new sectors. Targeted interventions by the central government promoted the development of competitive export-oriented sectors and those newly developing sectors that the government deemed worthy of promotion (Pack and Westphal, 1986[46]). As in the example of North Carolina, the knowledge base – here in the form of a well-educated labour force relative to the capital endowment in Korea – played an essential role in complementing the industrial policy and accompanying reforms (Rodrik, Grossman and Norman, 1995[47]). The Korean strategy is not without risk. Today, the legacy of the past interventionist policies impede progress towards fully transitioning the Korean economy (OECD, 2018[48]).

To adapt its economy to the fourth industrial revolution, Korea has changed its strategy. In 2014, the Centers for Creative Economy and Innovation (CCEIs) were created. In each of the 17 regions that house a CCEI, the centres link with existing strengths and the corporate fabric to push the local economy to the next stage. The approach focuses on linking research centres with entrepreneurship (Box 3.1). Having a dynamic regional entrepreneurial ecosystem contributes to the development of disruptive innovations because young firms are more likely to introduce disruptions. Large corporations can utilise this model for open innovation through CCEIs. Open innovation for those large incumbents will be crucial for success.

The most radical technological and scientific discoveries tend to combine knowledge pieces that were never combined before. Firms and inventors in regions that are diversified in unrelated sectors can find more opportunities to innovate by recombining unrelated pieces of knowledge. Such regions are likely to be in the scientific and technological frontier, with high innovation capacity for technological experimentation. Additionally, such knowledge pieces are more unrelated or distant, being more difficult to combine (Uzzi et al., 2013[49]; Wang, Veugelers and Stephan, 2017[50]). The recombination of unrelated knowledge pieces is also riskier: some generate the most impactful breakthroughs but many tend to fail.

In addition to being riskier, these radical technological and scientific discoveries can also be costlier, requiring a longer time to develop commercial applications.

Box 3.1. Centers for Creative Economy and Innovation, Korea

CCEIs in Korea were established in 2014 with the objective of supporting the creation of new industries and markets, functioning as a pivot for start-up incubation, small business innovation and regionally specialised programmes. The CCEI has 19 field offices covering 18 Korean regions and each focuses on promoting local entrepreneurship in line with regional industry characteristics and competencies of large regional corporations, fostering complementarities between incumbents and potential start-ups.

The centres promote partnerships and knowledge transfer between large Korean corporations and young firms. Additional services are provided, such as specialised consulting, according to the opportunities and challenges of each region. Consulting goes beyond technological considerations, covering strategic management skills, finance, marketing or R&D procedures for example. By providing specialised consulting along with facilitating partnerships with larger corporations, the CCEI supports young firms to start-up and scale-up using the networks of established corporations in order to grow faster and achieve global scale.

Source: CCEI (n.d.[51]), *Introduction of Innovation Center*, https://ccei.creativekorea.or.kr/eng/center/info.do.

Relatedness is more important for innovation in regions with a weaker innovation capacity. Xiao, Boschma and Andersson (2018[52]) find the effect of relatedness to decrease as regional innovation capacity increases. By focusing on exports, Saviotti and Frenken (2008[53]) find a related export variety to be linked with short-term gains in regional GDP per capita growth and productivity, while unrelated export variety promotes growth with a considerable time lag. They argue that related variety means knowledge is easily recombined in new products, causing direct growth effects, while unrelated variety, though harder to recombine, can, if successful, lead to completely new industries sustaining long-term growth.

Drawing on knowledge and resources residing in other regions can facilitate new growth paths through new and unrelated knowledge combinations, Multinationals, immigrant entrepreneurs and mobile scientists are examples of potential sources of external knowledge (Neffke et al., 2018[54]). In the context of the fourth industrial revolution, technologies such as artificial intelligence (AI) and machine learning can facilitate integration across a broad range of industries and types of economic activity. Thus, regions with a wide sectoral diversification can be better positioned to explore synergies and innovate across the fringes of different technologies and industries.

Regions, industrial revolutions and disruptive innovations

Often the gradual pace of substantial industrial change is misinterpreted as a temporary loss of competitiveness. The decline, for example, of Pittsburgh's steel industry or Acron's tire manufacturing (in the United States) was more than that. They were a symptom of a substantial change in the way industries are structured and production processes are functioning. Since the onset of modern production – the first industrial revolution – economies have undergone two further major revolutions and are currently taking the first steps in what will be the fourth industrial revolution.

Four industrial revolutions

Box 3.2. Past and current industrial revolutions

The first industrial revolution started in Great Britain in the late 18th century with the mechanisation of the textile industry and the introduction and spread of the steam engine, which in turn facilitated the development of manufacturing in factories. In the following decades, the use of machines to manufacture goods, instead of crafting them by hand, spread around the world.

By the mid-19th century, the second industrial revolution began with a broad range of technological inventions that gave rise to assembly line manufacturing, enabling mass production. Along with the emergence of large-scale manufacturing also came a deskilling of labour, as tasks became routinised and simplified. The enhanced specialisation made a greater division-of-labour and greater focus of each specific task on the assembly line possible.

The third industrial revolution came with the introduction, development and diffusion of the computer. The key inventions, beginning around 1970 and continuing through the remainder of the century, were also the personal computer, semiconductor, Internet and Web 2.0. Like its two earlier predecessors, the third industrial transition had a large impact on virtually all aspects of society. It led to a massive shift in the occupational structure of the labour force, resulting in individual winners and losers based on occupations, and had strong impacts on the prosperity of cities and regions.

The fourth industrial revolution is being fostered by a new wave of innovations and technological advances, with AI and connectivity at the heart of this new wave of technological change. Digitisation in manufacturing is having a disruptive effect in every industry, such as office equipment, telecommunications, photography, music, publishing and films. The effects will not be confined to large manufacturers, as these technological advancements are empowering small- and medium-sized enterprises (SMEs) and individual entrepreneurs.

Structural change in the industrial fabric happens gradually and often imperceptibly. It is often only recognised as a major event after reaching a critical level. Change in the structure of a region's core companies affects employment in their sector. As these firms are connected to other firms in the region through supply and demand links and often constitute a key pillar of the regional innovation system, many (if not all) other firms in a region are affected by major changes. Examples in Europe that underwent a strong decline due to industrial structural change include regions such as the Ruhr area (steel, mining, machines) in Germany, or Newcastle upon Tyne (mining, steel, shipbuilding) in the United Kingdom. Emblematic examples in the United States include the decline of Kodak and its impact on the region of Rochester and the decline of Detroit's automobile industry in Michigan. These major events are caused by a latent industrial structural change and have strong spatial repercussions, especially when regions are too reliant on those industrial sectors.

Source: Adapted from Audretsch, D. (2018[9]), "Developing strategies for industrial transition", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 15 October 2018, Paris.

The catalyst for each industrial revolution was a decidedly different and unique set of technologies. Ranging from steam in the first industrial revolution to transportation technologies and electricity in the second industrial revolution, computers, semiconductors and the Internet in the third. Finally, the current, fourth industrial revolution, is likely driven by the digitalisation of services and the development of AI and machine learning supported by automated exchanges between machines, the Internet of Things (IoT) (Box 3.2).

Economic history is replete with dramatic changes in economic structures at the regional, national and international levels. In the last two centuries, techno-industrial leadership shifted from Great Britain to Germany and the United States, and some countries in Southeast Asia have joined the ranks of leading industrial countries. Regions are subject to similar shifts, as the cases of Belgium, Germany and Great Britain demonstrate. Their core industrial areas have lost their economic dominance and have been replaced by a set of new growth regions in South East England, Flanders and the South of Germany respectively (Boschma, 2009[42]). In order to sustain long-term regional development, regions must constantly transform and renew their economic base (Martin and Sunley, 2008[55]).

The catalyst for the first two industrial revolutions were inventions that fundamentally changed the capacity to combine new tools and machines with natural resources that led to an unprecedented gain in productivity. Much more could be produced and distributed within a shorter period of time and significantly less need for human labour. The locational advantage of regions that helped attract capital investment was typically linked to an abundance of key natural resources. Investment was the main driver for economic performance.

At the beginning of the third industrial revolution, established manufacturing companies tried to adapt their traditional production formulas. The “just in time” production principle was the result. With the rise of the computer era, the key factors and resources that facilitated growth shifted from physical capital to knowledge, ideas, creativity, skills and human capital. This was partly due to the high component of human capital in the production or development of computers within the industry. The computer industry ranks among the most intensive users of human capital and R&D. Beyond the production of computers, the main beneficiaries of using computers at work were also workers with higher levels of education and “human capital”. Economists refer to “skill-biased technological change” that summarises the complementarity between human capital and using computerised technologies.

The first two industrial revolutions raised the demand for workers with low levels of skills, while in the third, the complementarities between computers and human capital resulted in an increased demand for human capital (Acemoglu, 2003[56]; Autor, Levy and Murnane, 2003[57]). The fourth industrial revolution is likely to continue to rely on similar factors and resources as the third but the relevance of these factors is likely to increase the importance of human capital (Frey and Osborne, 2017[58]). Box 3.3 defines the key elements typically associated with the fourth industrial transition.

Box 3.3. What is the fourth industrial revolution?

The fourth industrial revolution is still ongoing and its defining characteristics will only become evident after its resolution. There are, however, some elements that appear to drive current radical change. For this industrial revolution, it is the integration of the physical and digital worlds. The digitalisation of manufacturing transforms conventional manufacturing into “smart factories”. A key salient feature of the transition is machine communication, not just between humans and machines but also machine-to-machine. With extensions into artificial intelligence (AI), connectivity through IoT and flexible automation enabled by combining the two (WEF, 2018[59]).

The first set of enabling factors of the current industrial revolution is the combination of advances in computing power and the availability of big data, which are allowing AI algorithms to excel. AI is enabling event recognition and the translation of such recognition for automated decision-making. Speech and image recognition have already reached the accuracy of the human brain. AI is becoming the key enabling feature of progress, from self-driving cars and drones to virtual assistants and translation software. R&D have made impressive progress, from software used to discover new drugs to algorithms that predict tastes and cultural interests (Schwab, 2017[60]). AI can also contribute to the creation of entirely new industries, based on scientific breakthroughs in the same way as the discovery of

recombinant DNA technology led to a revolution in industrial biotechnology and the creation of vast economic value (OECD, 2018[61]).

A second enabling factor of the current industrial revolution involves the level of connectivity enabled by IoT. The miniaturisation of computers enables them to be attached to individual machines and then connected to the Internet. Sensors detect and report information online about machine operations. One example involves farm production, where sensors for temperature, water content and soil quality relay instantaneous information and feedback to the tractor operator about how to optimally adjust the planting procedure. Each sensor connects not just with each other but also larger systems in what constitutes IoT (EC, 2017[62]).

The combination of AI and connectivity can enhance productivity in factories. AI helps minimise interfaces with humans and, instead, production relies on the feedback and reactions that follow optimisation based on autonomous machine learning. For example, in aerospace, Airbus deployed AI to identify patterns in production problems when building its new A350 aircraft. A worker might encounter a difficulty that has not been seen before but the AI, analysing a mass of contextual information, might recognise a similar problem from other shifts or processes. Because AI immediately recommends how to solve production problems, the time required to address disruptions has been cut by one-third (Ransbotham et al., 2017[63]). More data from sensors and systems based on the IoT enhances the ability to make smarter decisions and ultimately boost both machine and system efficiency.

Source: WEF (2018[59]), "The next economic growth engine: Scaling fourth industrial revolution technologies in production", White Papers, World Economic Forum, https://www.weforum.org/whitepapers/the-next-economic-growth-engine-scaling-fourth-industrial-revolution-technologies-in-production (accessed on 20 November 2018); Schwab, K. (2017[60]), *The Fourth Industrial Revolution*, Crown Publishing, New York; OECD (2018[61]), *OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption*, https://dx.doi.org/10.1787/sti_in_outlook-2018-en: EC (2017[62]), "Industry 4.0 in agriculture: Focus on IoT aspects", https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Agriculture%204.0%20IoT%20v1.pdf (accessed on 27 November 2018); Ransbotham, S. et al. (2017[63]), "Reshaping business with artificial intelligence: Closing the gap between ambition and action", https://sloanreview.mit.edu/projects/reshaping-business-with-artificial-intelligence/ (accessed on 21 November 2018).

Disruptive innovation

Not all disruptive innovations trigger an industrial revolution but they disrupt part of the economic fabric in countries and their regions. Industrial revolutions are driven by a combination of several technological developments that affect regions through a continued period but a single disruptive innovation has the potential to disrupt regions immediately. Today, disruptive innovations are increasingly of larger scope, scale and faster speed, in large part due to the development of digital technologies.

Defining disruption

A possible framework to characterise innovations is in terms of their level of performance improvement compared to established solutions and in terms of their impact on incumbent players in the industry. Radical innovations are those that lead to larger performance improvement, and disruptive innovation those that have high levels of impact on incumbent agents. Disruptive innovations create entirely new markets and displace existing ones while sustaining innovations improve existing markets developing current products or services (Christensen, 1997[64]).

Disruptive innovation describes a process in which new entrants challenge incumbent firms, often despite inferior resources. This may happen in two ways: i) entrants may target over-looked segments of the market with a product considered inferior by incumbent's customers and later move upmarket as their product improves; and ii) they may create entirely new markets turning non-consumers into consumers.

Often incumbents fail to identify new opportunities or do not have incentives to explore them as they can cannibalise existing products or services. Incumbent firms are better placed than young firms to pursue sustaining innovations (in contrast to disruptive). Sustaining innovations enable incumbents to reach higher profit margins with their existing products or services. Incumbents have high incentives to compete for sustaining innovations and they have larger resources to win.

Disruptive innovation is a different concept from radical innovation, i.e. the degree to which the innovation differs from existing practices, goods or services. Innovations can be both disruptive and radical (see Table 3.2 for examples). Being able to distinguish radicality and disruption is important in order for regions to better manage different types of innovations as the local economy needs to adapt differently to each type. In particular, the degree to which incumbents are affected differs by the degree of disruption, even when innovation is incremental.

Table 3.2. Examples of innovative products and services by the degree of disruption or radicalness

	Sustaining innovation	Disruptive innovation
Radical innovation	Electronic cash registers were a radical but sustaining innovation relative to electromechanical cash registers, whose market was dominated in the United States by National Cash Register (NCR). NCR missed the advent of the new technology in the 1970s so that NCR's product sales dropped to zero. Electronic registers were so superior that there was no reason to buy an electromechanical product – a technological leapfrog within the same product space. Yet NCR survived on service revenues and easily introduced its own electronic cash register. With extensive sales organisation expertise, NCR quickly captured the same share of the market it enjoyed in the electromechanical realm.	When Netflix was founded, it was the first entertainment company offering DVDs by mail and later on-demand streaming service – a radically different operating model than the traditional retail store model. Its DVD rental competitor, Blockbuster, had never considered this market outside of its retail store model. In response to the new market and business model, Blockbuster responded with its own version of the Netflix approach, but at a price that could not compete. Blockbuster had all the costs related to operating the physical stores and infrastructure that Netflix avoided. Blockbuster ended up filing for bankruptcy.
Incremental innovation	Companies in mature industries can implement little improvements to their products e.g. adopting IoT features. Nest is a company with two products on the market: a thermostat and a fire and smoke alarm. The firm is advancing these products with sensors and intelligent algorithms, which enable these devices to understand user preferences, interact more humanely and talk to similar devices to ensure incidents are reported in a more informative way. Nest's products are fundamentally doing the same thing as devices from previous generations but providing connected user experience. Competing firms can equally adopt such technologies from IoT equipment providers.	The email service provided by Google – Gmail – was not born during the pioneering days of email, nor was the first email service to go mainstream. Once it was introduced, Gmail provided exactly the same service as other email providers – sending and receiving emails – but Gmail introduced little improvements. Such minor improvements include providing more storage space for users, new functionalities such as categorising emails, integration with other services as synchronising users' calendars to the email service, or even small mechanisms preventing people from sending "unwanted" embarrassing late-night emails for example. By providing such small improvements, Gmail disrupted existing players such as Yahoo or Hotmail, quickly becoming the dominant player in terms of market share in most OECD countries.

Source: Adapted based on Christensen, C. (1997[64]), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press; Reinsberg, R. (2009[65]), "Netflix", https://www.technologyreview.com/s/416843/netflix/ (accessed on 10 December 2018); The Economist (2017[66]), "Who's afraid of disruption?", https://www.economist.com/business/2017/09/30/whos-afraid-of-disruption (accessed on 10 December 2018); Kishore, S. (2013[67]), *The Power of Incremental Innovation*, https://www.wired.com/insights/2013/11/the-power-of-incremental-innovation/ (accessed on 10 December 2018); Covert, A. (2014[68]), "Gmail turns 10: How Google dominated e-mail", https://money.cnn.com/2014/04/01/technology/gmail/index.html (accessed on 10 December 2018); Snyder, C. (2008[69]), "Google's mail goggles prevents drunk emailing", https://www.wired.com/2008/10/googles-mail-go/ (accessed on 10 December 2018).

Radical innovations are not instant. They result from cumulative processes of multiple inventions and innovations, and their diffusion and adaptation to different circumstances (Warnke et al., 2019[70]). Radical

innovations are disruptive when they represent a technological leapfrog that disrupts incumbents or creates entirely new markets (Hopp et al., 2018[71]). Innovation is both radical and "sustaining" when it is a remarkable improvement in existing markets that does not disrupt incumbents. Incremental innovations, in contrast to radical, only represent small improvements. Incremental innovations can be disruptive when small improvements severely disrupt incumbents or sustaining when they just provide minor developments of existing products or services.

Identifying disruptive innovations

Based on the market-related definition, disruptions are only identifiable "post mortem", when the adverse effects on incumbents are already evident. A consistent framework to identify potential for disruption *ex ante* can help regional policymakers prepare for the challenges of disruption as well as explore potential opportunities.

Technological foresight exercises are therefore important for regions, as they create absorptive capacity by increasing local understanding and awareness about possible challenges and opportunities arising from future technological developments. Different technologies have heterogeneous impacts on regions; thus, equipping local agents with the tools that help them predict how specific technologies can affect them is particularly important since there is no one size fit all prescription for successful prediction.

Perhaps the earliest tool of quantitative technology forecasting is trend extrapolation, which consists of expecting new technologies to follow the same behaviour in terms of growth as previous technologies. However, trend extrapolation has major drawbacks. They rely heavily on the continuation of existing trends and, as a result, may not always be appropriate when attempting to construct scenarios for the very long run about technological disruption. For radical and disruptive technologies, especially digital technologies, there also appears to be a "holy cow" moment where progress is made at an exponential pace after a long run-up of slow progress (Baldwin, 2019[72]). Machine learning is an example of a technology where decades worth of theoretical work are resulting in massive payoffs in terms of practical progress within a few years.

A complementary approach that has been historically popular is to leverage experts' opinions. One such approach is the Delphi method, originally developed by the RAND Corporation in the 1950s.[2] The method follows an iterative approach that asks experts to forecast events and to update their forecasts after receiving the aggregate results of all experts' views from the previous round. Delphi aims to use the wisdom of crowds in repeated interactions while avoiding bias from concerns about a reputational effect. Advances in behavioural economics and psychology are providing further was of "debiasing" expert opinions (Koutroumpis and Lafond, 2018[11]).[3] Questions remain whether expert opinion actually outperforms the predictions by a random group of individuals, e.g. experts' fame has been found to be negatively associated with the accuracy of their predictions in political science. Selecting the right experts is, therefore, a critical and difficult part of the process as well (Tetlock and Gardner, 2016[73]).

"Prediction markets" use pecuniary incentives to elicit (informed) views from many forecasters. They allow individuals to trade on future events, i.e. to "put their money where their mouth is". The difficulty with implementing such markets is to delineate between gambling (and accordingly gambling regulation) and prediction markets. The quality of the information that prediction markets provide is still a matter of research as well and subject to a complex interaction between the availability of external information and the experience of participating individuals (Brown, Reade and Vaughan Williams, 2019[74]).

The combination of machine learning techniques and "big data" opens up new avenues for forecasting. Patent data has been used in some recent applications, to map patent data as innovation networks for predictive purposes for example (Acemoglu, Akcigit and Kerr, 2016[75]). The network is constructed using citation data and the results show that levels of patenting activity predicted using activity in an upstream (cited) category is correlated with actual patenting in the future. A second approach starts from the idea that innovation networks are in a sense too static because the number of nodes (technological domains) is given, whereas it seems important to try to predict radically new domains. This approach considers new

technological categories in patents and aims to identify patterns to predict their emergence (Koutroumpis and Lafond, 2018[11]).

Big bang disruptions

Developments in digital technologies are enabling a new form of extreme disruption. Disruptors are typically considered as new entrants, spotting opportunities in lower ends of traditional market spaces or addressing types of demand ignored by incumbents, and disrupting thereafter by upgrading their value proposition (Christensen, 1997[64]). "Big Bang Disruption" – a concept proposed by Downes and Nunes (2013[76]) – is a new kind of disruptive innovation. "Big Bang Disruptors" provide better and cheaper products or services at a global scale from the moment of creation, instead of entering a market with an inferior product than those of established incumbents.

Disruptions can severely hit regions due to their level and speed of impact on incumbent firms and the speed of such impact. Big Bang Disruptors can destabilise mature industries in record time, in great part enabled by digital technologies such as broadband networks, cloud-based computing and increasingly powerful and ubiquitous mobile devices. The accelerating pace of Big Bang Disruption is driven by core technologies that became better and cheaper. The most familiar of these exponential technologies is the computer processor that has continually become faster, cheaper and smaller. A new generation of exponential technologies is emerging in fields such as chemistry, optics, materials and energy, promising to destabilise mature industries and their regions (Accenture, 2013[77]).

Developments in digital technologies are reducing barriers to entry by driving down entry costs for new entrepreneurs. Digital technologies are driving down the core costs of developing new products and services, such as the cost of innovation activities, of accessing information and of experimentation (Downes and Nunes, 2013[76]). These three driving forces are further explained:

- *Declining cost of creation*: Steep declines in the cost of key input materials, including computer hardware and software, along with increasingly efficient supply chains, enables innovators to provide new or better solutions than existing ones. Products and services can begin life with higher quality, at a lower price and more easily customised than those of traditional competitors.
- *Declining cost of information*: As social networks, microblogging and independent review services proliferate, consumers have easy access to more market information. Customers can discover and adopt new successful products and services much more rapidly across every traditional segment. Innovators no longer need to cultivate "early adopters" to establish new markets.
- *Declining cost of experimentation*: Due to global broadband networks and ubiquitous computing devices, innovators and users are increasingly connected in an environment optimised for collaboration. New products and services often begin life as simple combinations of existing components, tested with little cost or risk directly on the market with real consumers.

An example of digital disruption with a large regional component is the blockchain. The technology is a database that allows the transfer of value within computer networks, facilitating the shared understanding of value attached to specific data and thus allows for transactions to be carried out (see Box 3.4).

Box 3.4. Blockchain as a disruptive technology

The blockchain is a distributed database that acts as an open, shared and trusted public ledger that nobody can tamper with and that everyone can inspect. This technology may disrupt several markets by ensuring trustworthy transactions without the necessity of a third party.

Applications range from the administration of financial transactions to the creation and maintenance of trustworthy registries, or conditional transfers (smart contracts) relying on data that specify certain rules must be met before a transaction takes place. The technology can be of immense value in regions with lower institutional capacity because it provides an unfalsifiable record of transactions and ownership. Thus, it can generate improvements in transparency, efficiency and trust. Indeed, the blockchain can be a cheap platform for more efficient public services and trust in contracts. Possible uses include the registration and proof of ownership of land, business transactions, birth records, titles or pensions. A blockchain acts in this sense as a verification system of authenticity, creating permanent and secure records which cannot be distorted by corrupted activities.

The potential benefits of the blockchain are also fostering the development of innovative regulatory frameworks that enable countries and regions to fully benefit from this technology by providing a safe and transparent environment. An example of regional regulatory framework development is the "Crypto Valley" in the small Canton of Zug outside of Zurich (Switzerland). Zug put in place clear guidance as to how it would treat (blockchain-based) cryptocurrency companies and those that dealt with its assets. The new rules helped attract Ethereum, the second-biggest cryptocurrency by value, and that triggered the set-up of a new ecosystem, including law firms, tax, accounting, smart contract evolvement firms, start-ups and universities for example.

Source: OECD (n.d.[78]), *OECD Blockchain Primer*, http://www.oecd.org/finance/OECD-Blockchain-Primer.pdf (accessed 21 August 2019); Berryhill, J., T. Bourgery and A. Hanson (2018[79]), "Blockchains Unchained: Blockchain Technology and its Use in the Public Sector", https://dx.doi.org/10.1787/3c32c429-en.

Leveraging disruptive innovation in regions

Drivers and regional impacts of disruptive innovations change over time and space and from one technological domain to another. Regional characteristics interact with those of the disruptive innovation to determine how different technologies affect specific regions and what opportunities regions can derive. Broadly, there are three groups of characteristics. The first is regional assets and networks that are determined by policy and the legacy of past development. The second consists of spatial and geographical characteristics of the region and the third is the local workforce, population and prevailing culture. The list does not attempt to be comprehensive, as technologies and academic research develop the characteristics and their importance change as well.[4] For example, with constant improvements in virtual meeting technologies and progress in increasing speed and reliance of broadband Internet access, the promise of a "death of distance" allowing the replacement of face-to-face interaction and thereby reduces one of the advantages of large cities is again under discussion (Baldwin, 2016[80]).

Disruptive innovations are often seen as new products but many disruptive technologies take the form of innovative services with a strong local dimension. Health services or services related to the "sharing" economy are critical fields of disruption and very much embedded in the local area. Some technologies can be more "material" than others in their inputs and the degree to which a technology relies on tangible or intangible capital. Concretely, a new start-up in micromobility that rolls out a fleet of electric scooters in a city has the scooter as a physical component that is locally bound, but supporting services and the IT infrastructure (and algorithms) that manage the fleet are not bound to a place. The degree to which disruptive innovations are "material" in turn determines their off-shorability or territorial embeddedness. Some innovations can enable the development of an ecosystem of supporting services, or services that are themselves supported by technology. These services can represent a great share of jobs, value-added and can be knowledge-intensive and non-offshorable. While it seems difficult for policy, for instance, to change a product innovation into a service innovation, encouraging the development of associated supporting services that operate locally may sometimes be possible. In particular, the advances of AI raises concerns about the ability of regions to retain jobs and high value-added activities (OECD, 2019[81]; 2018[82]).

Some technologies cannot be implemented in the same way everywhere. Agricultural technologies are a good example of this issue, with tools, livestock and plant varieties requiring important modifications to suit local conditions. In comparison, digital technologies require little adaptation apart from language or cultural factors. Technologies that require local adaptation often diffuse and progress less fast – precisely because experience cannot be shared – but also offer more promise for regions lagging behind the frontier to engage in "technological dialogue" and develop specific capabilities to meet their own demand. The need for local adaptation is not a technological trait that can be easily influenced by policy.

What affects successful transitions in regions?

Changing benefits from the agglomeration of economic activity

The share of the global population that lives in cities has continuously increased over the last centuries. In 2015, nearly two-thirds of the people living in OECD countries lived in a functional urban area (a city and its commuting zone) with 250 000 or more inhabitants. The majority of these live in large metropolitan areas with 1.5 million or more inhabitants (39% of the total population).[5] Large cities clearly provide some benefits that attract people and outweighs the "cost" of living in big cities, such as congestion, noise, pollution and the high cost of housing that means people live in (much) smaller apartments in large cities than in rural areas (OECD, 2015[83]).

Larger cities provide a greater variety in consumption and leisure activities than smaller places. They also provide greater earnings potential for their residents. The density of cities allows workers to specialise and thereby raise their productivity and income. Density allows firms to tap into a larger and more varied pool of workers, making it easier to find the right "match" for the vacancy they want to fill. Density also allows knowledge and information to flow more easily as people can meet and exchange both formally and informally, which again raises productivity and wages. All of these factors are summarised by economists as "agglomeration economies", i.e. the pecuniary benefits that larger cities provide to their firms and residents (Duranton and Puga, 2004[84]).

The geographical concentration of innovative activities has been a common element of all first three industrial transitions. Prior to the first industrial transition, most of the population in the developed countries resided in rural regions and small towns. The inventions driving the first industrial transition facilitated the development of urban density and the emergence of cities on an unprecedented scale. From the mid-18th century onwards, thousands of people moved to the rapidly growing industrial cities of northern England, such as Leeds and Manchester, to take advantage of the opportunities that new factories and textile mills provided. The combination of job opportunities and the provision of improved infrastructure (including the Underground) allowed London to grow from 1 million inhabitants in 1800 to 3 million in 1860 and by 1900 had reached 6.5 million inhabitants (White, 2008[85]).

The English experience is not unique. In the United States, the industrial centres developed in Midwestern cities such as Detroit and Akron or Pittsburgh. In general, as countries develop and income levels rise, people flock to cities. There are no countries where increased income levels (measures in per capita GDP) have not been accompanied by a rise in urbanisation. The opposite is, however, not the case as urbanisation has not provided higher income in all countries (OECD, 2015[83]). Especially, developing countries are struggling with the move towards higher income levels despite increasing urbanisation. The difference might be linked with the drivers of income growth. Resource-intensive production in developing countries leads to urbanisation in "consumption cities" that focus on the provision of non-tradeable services to the local population, rather than "production cities" that are the hallmark of industry-led attraction of people to cities (Gollin, Jedwab and Vollrath, 2016[86]).

Cities continued to grow in the main capitalist countries over the twentieth century on the basis of manufacturing but, starting in the 1970s, many of them went through a period of deindustrialisation as jobs dispersed to low-wage regions and countries, leading in many cases to severe crisis conditions in the core. After a transitional period of slow growth in the 1970s and early 1980s, large cities in the core again experienced a strong resurgence as the 1980s passed by. Cities now found themselves at the focal point of a new "post-Fordist" economy, characterised by a decisive shift away from materials-intensive manufacturing to various kinds of high technology, management, logistical, service, design and cultural sectors (Scott and Storper, 2014[87]). Many cities have not transitioned from the manufacturing era associated with the previous industrial revolutions to the knowledge area associated with the third. As the fourth industrial revolution unfolds, such cities face the risk of a double industrial transition shock.

Geographic proximity to natural resources was a key driver of location choice in past industrial revolutions. As transport cost declined and the cost of extraction rose in developed countries, the need for colocation of resources and production disappeared. Some resources still favour local economic development. Stable and vibration-free ground soil in Wales supports the development of a cluster for the production of compound semiconductors and advanced optical instruments (OECD, 2018[16]). An abundance of cheap and "green" electricity is an important asset for heavy industrial production. More than 75% of Iceland's annual energy production is used for the production of raw aluminium.[6] Energy is the main contribution of Iceland to the production process as raw material (aluminium oxide) is imported. The sector is critical for Iceland's exports. More than one-third of the value of exports comes from raw aluminium.[7]

Whether sectors solely use the available resource for production or become part of a wider regional development strategy depends on policy choices, especially innovation policy. Iceland's cheap energy (and cold climate) have attracted a large number of data centres. Their total electricity consumption remains below the needs of the aluminium sector but is rapidly expanding. In 2013, data centres consumed 5 kWh, less than 3% of the 218 kWh used by the sector in 2016.[8] Estimates suggest further rapid expansion with 90% of the sector's electricity use driven by data centres specialising in the "mining" of cryptocurrencies (KPMG, 2018[88]). The link with other sectors is limited, as it is for the aluminium smelters that drive exports in Island. Norrbotten in Sweden has taken a different route. Using its arctic climate as a resource, the region has attracted data centres as well. The region went beyond the provision of data storage and computation services by developing itself as a testbed for machinery, construction and military equipment in cold climates through the Swedish Proving Ground Association. It also leveraged its position as an established base for satellite launching and development. The local University of Technology, based in Luleå, played a proactive and important role in promoting innovation to diversify the economic base of the region (OECD, 2017[89]).

Through the third industrial revolution, economic activity and – even more so frontier innovation – has concentrated in few metropolitan areas. In 2015, one-third of international patents were filed in only five TL2 regions.[9] Most assets associated with the knowledge economy are more spatially concentrated than people or economic activity. R&D expenditure is highly concentrated in a small number of firms (see Chapter 2). Around one-third of tertiary-educated workers are concentrated in only 20% of OECD regions (Maguire and Weber, 2017[90]). The concentration is not just evident on a global scale but also within countries, e.g. patent filings are twice as concentrated as GDP. This is true for both low patenting-intensive countries of the OECD, such as Chile or Mexico, as well as higher patenting-intensive countries such as Germany, Japan and the Netherlands.

Prominent examples of geographical concentration of computer technologies are Silicon Valley in California, Austin in Texas, or the Research Triangle in North Carolina (United States), as well as Cambridge in the United Kingdom, Munich in Germany, or Stockholm in Sweden. Because they also draw heavily on knowledge and ideas, the economic activities associated with the fourth industrial transition are likely to present geographic concentration paths similar to the third transition.

Clusters can be an important facilitator for regional innovation diffusion and cross-regional links. Policies fostering cross-cluster collaborations can link local firms to interregional value chains with the potential to benefit all organisations in the clusters being linked (see also Chapter 4). The European Strategic Cluster Partnerships for Smart Specialisation Investments consists of leveraging existing clusters as accelerators for the promotion of cross-regional links that connect different clusters (Box 3.5).

Box 3.5. European Strategic Cluster Partnerships, European Union

The overall objective of European Strategic Cluster Partnerships is to boost industrial competitiveness and investment in the EU via cross-regional co-operation and networking. Partnerships aim at facilitating co-operation across different clusters in thematic areas related to regional smart specialisation strategies.

The programme provides incentives to the collaboration of firms, especially SMEs, across regional and sectoral silos towards generating joint investment projects. The type of targeted activities ranges from preparation to implementation and investment phases of joint innovation and investments projects. Supported projects include strategy-setting and road-mapping, matchmaking activities among partners, facilitating demonstration and pilot assignments.

In its first call (2016-17), 15 cross-cluster partnerships received funding and 10 additional partnerships were on the reserve list of the call accepted to keep working on a joint co-operation agenda without direct funding. In the second call (2018-19), 25 cross-cluster partnerships received funding.

Source: EC (2019[91]), *EU Cluster Partnerships*, https://www.clustercollaboration.eu/eu-cluster-partnerships (accessed on 30 January 2019).

Breaking sectoral and spatial divides

The fourth industrial revolution does not only change the speed of innovation but also the breadth of technologies involved. Innovations increasingly integrate technologies from different sectors. Digital general-purpose technologies are becoming a central element in many products and services. This means that the importance of tacit knowledge that helps link across different fields may have risen as the complexity of technologies has increased over time. It also means that the amount and sophistication of complementary investments required for technological adoption increases (Andrews, Criscuolo and Gal, 2016[92]).

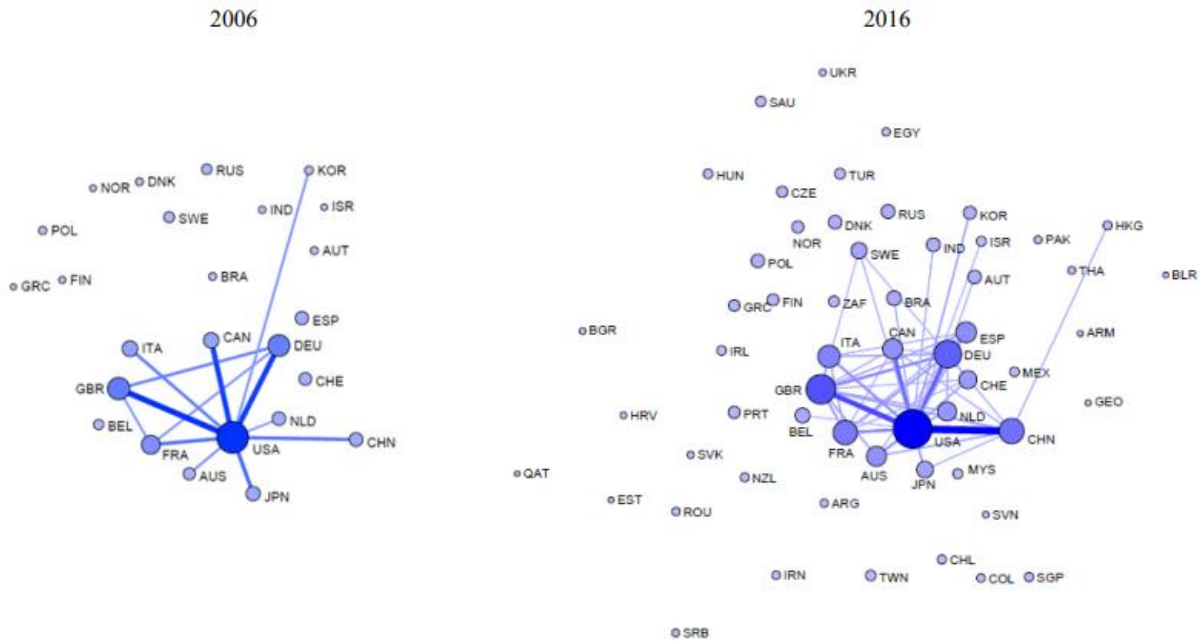
Complexity is accompanied by unprecedented access to information and ease to engage in international collaborations. Through the Internet, people can access learning opportunities provided by leading research institutions and even participate in degree courses. MIT OpenCourseWare, the online learning platform of the Massachusetts Institute of Technology in the United States, provides material for 2 400 different courses to a global audience. More than half of the approximately 1.6 million monthly visitors to the website come from outside North America.[10] This growth in global reach is also evident in academic links. Compared to 2006, the number of countries with more than 10 000 academic publications has increased significantly. The number of co-authored papers, the global network of co-authors and the intensity of collaborations have increased as well (Figure 3.1).

Collaboration between larger companies and small (young) firms can help bridge sectoral divides and help manage the higher risks associated with the increasing speed of technological development. Young firms are more innovative and riskier, while established firms have deep-rooted processes, networks and larger financial capacities. Collaborative innovation partnerships enable exploiting these complementary capabilities, which have led to the advent of “project entrepreneurship” – where entrepreneurs and

"intrapreneurs" create and develop new ideas inside large organisations. The speed at which firms pursue innovation activities is an important determinant for their survival (Ringel, Taylor and Zablit, 2016[93]). In a risky environment, collaborating with larger, established firms can be a valuable strategy in order to access a variety of financial and organisational resources. Similarly, established firms seeking to improve their external innovation capabilities can take advantage of the new radical ideas and energy of young firms (Box 3.6).

Figure 3.1. Academic co-authorships networks span through Asia, Europe and North America

Whole counts of internationally co-authored academic publications



Note: The position of selected economies (nodes) exceeding a minimum collaboration threshold of 10 000 documents is determined by the number of co-authored scientific documents published in 2016. Bubble sizes are proportional to the number of scientific collaborations in a given year. The thickness of the lines (edges) represents the intensity of collaboration between countries (number of co-authored documents between each pair) with a minimum threshold of 5 000 collaborations.
Source: Paunov, C. et al. (2019[94]), "How has the geographic inclusiveness of innovation evolved in the digital age? An exploration of the concentration of patenting in cities", *Science, Technology and Industry Policy Paper*, OECD Publishing, Paris, based on Scopus Custom Data, Elsevier, Version 1.2018.

Box 3.6. Collaborative innovation between young and established firms

Innovation collaborations among young firms and larger established corporations

Young firms can benefit from collaborating with larger, established firms to access a variety of financial and organisational resources. Similarly, established firms seeking to improve their innovation capabilities can take advantage of the different approaches, risk outlooks and perspectives of smaller young firms. Young, dynamic firms are often structured around the development of novel and potentially disruptive products or services, while established firms have established processes and resources, and valuable networks. Collaborative innovation partnerships can exploit these complementary capabilities.

This is not to say that potential benefits are not also balanced by obstacles that need to be overcome for collaboration to be effective (Table 3.3).

Table 3.3. Benefits and challenges for collaborations between young and established firms

Benefits for established firms	Benefits for young firms	Barriers or obstacles to collaboration
New technologies, services or products	Visibility/enhanced publicity	Speed (e.g. slow decision-making)
Brand innovation	Access to new markets	Co-ordination (e.g. changing contact points)
Fresh thinking to solve problems	Market knowledge	Culture
Increased market share and new markets	More business (e.g. increased revenues)	Contracts and negotiation (e.g. IP issues)
Rejuvenated corporate culture	Technical knowledge	Initiation (e.g. search problems)
Increase in shareholder value	Other resources (e.g. workspace)	Alignment of goals
Specialised talent and resources	Investment	Lack of access to resources
Agility to adapt more quickly to changes	Financial benefits (e.g. increased valuation)	Trust (e.g. abuse of power imbalance)

Source: Adapted from Bannerjee, S., S. Bielli and C. Haley (2016[95]), *Scaling Together: Overcoming Barriers in Corporate-startup Collaborations*, https://www.nesta.org.uk/report/scaling-together-overcoming-barriers-in-corporate-startup-collaborations/; WEF (2014[96]), *Enhancing Europe's Competitiveness Fostering Innovation-driven Entrepreneurship in Europe*, http://www3.weforum.org/docs/WEF_EuropeCompetitiveness_InnovationDrivenEntrepreneurship_Report_2014.pdf.

The value of entrepreneurship

Entrepreneurship translates innovation into regional economic rejuvenation. The prevalence of start-ups is systematically and strongly related to local employment growth across and within regions (Glaeser, Pekkala Kerr and Kerr, 2015[97]). Small (and often young) firms have greater incentive to focus on market-changing "radical" innovations than large (established) firms. Conceptually, firms have to choose between investing in improving their existing products and developing new ones. For larger firms, this incentive favours existing products more than it does in small firms as innovation in new products will "cost" part their current revenue streams (Akcigit and Kerr, 2018[98]).

Young firms, in comparison with established firms, are more prone to develop products that are new to the market and have a larger share of sales associated with the introduction of such new products. In Spain, 62% of young firms (defined here as less than 10 years old) introduced products that are new to the market, compared with 56%-58% of established firms. New products or services account for 14% of young firms' revenues, while for established firms they represent only 8%-10% (Coad, Segarra and Teruel, 2016[99]).

The growth phase of new sectors and industries is characterised by an increase in competition and innovation through new entrants. The life cycle of products and even industries exhibits typically four distinct phases – birth, growth, maturity and decline (Audretsch, 2018[9]). The birth phase characterises the development of a new market, often by few "first movers", i.e. innovating firms that establish a new product or service. The following "growth phase" is the expansion of the sector through the entry of new competitors and continued growth of the initial innovator. Growth slows down through the maturity phase as processes become routinised and firms exit the market as cost reduction in production becomes increasingly important.

The German company SAP provides a prominent example of knowledge spillover through entrepreneurship. Five IBM engineers were involved in working on developing a new product: Scientific Data Systems (SDS)/SAPE software. The company, however, did not value the potential value of the

product and decided to drop the project. Convinced of its potential value, the five engineers left IBM and instead started their own firm, System Analysis and Program Development, or SAP, which became Europe's most prominent example of an entrepreneurial start-up that achieved global dominance. The investment in the new knowledge was made in one firm, IBM, but the actual innovations were realised in the context of a new entrepreneurial start-up, SAP (Audretsch and Lehmann, 2016[100])

High levels of entrepreneurial activity are also likely to characterise the fourth industrial revolution. However, the nature of entrepreneurship and the speed at which young firms can scale due to digital technologies is becoming faster. The pace of technological uptake is becoming increasingly fast: it took 30 years for electricity and 25 years for telephones to reach 10% adoption by households in the United States, but less than 5 years for tablet devices to achieve the same 10% rate. It took an additional 39 years for telephones to reach 40% penetration and further 15 before they became ubiquitous. Smartphones, on the other hand, accomplished a 40% penetration in just 10 years (DeGusta, 2012[101]). The higher speed of innovation came along with a higher risk of failure, with the examples of fast rise and fall of companies like Blackberry and Nokia being paradigmatic examples (Doz, 2017[102]; Inkpen and Himsel, 2017[103]).

The rise of digital platforms is a double-edged sword for regional development and regional innovation policies. Firms and entrepreneurs can access global knowledge and markets through digital platforms, providing opportunities to sell goods and services far beyond the local market. The small rural municipality of Fundão in Portugal decided to partner with a private company that provides intensive courses for software developers that were initially offered in Lisbon and Porto, Portugal's largest cities. Underpinning the rationale for this initiative was the ability of graduates of the intensive course to live and work from Fundão by offering their services online through digital platforms. The municipality, supported by the Centro region in which it is located, used EU funds to complement the training with the development of a Business and Shared Services Centre that hosts 14 information and communication technology (ICT) for education businesses that have created over 500 jobs, hosted 70 start-ups and over 200 privately-funded innovative projects within the first 4 years of its inception in 2013.[11] The advantage of accessing large markets through digital platforms are not limited to programmers that provide digital services but create new opportunities for a wide range of SMEs (OECD, 2019[104]).

Despite the opportunity for global access from all (connected) regions, entrepreneurial activities continue to concentrate in and around urban centres. In Europe, urban areas have an entrepreneurial advantage in terms of high-growth entrepreneurship (Bosma and Sternberg, 2014[105]). In the United States, innovative and entrepreneurial activities are typically urban-based. Technological innovation has been and remains concentrated in urban areas (Paunov et al., 2019[94]) and entrepreneurship (measured as start-up activity) has become even more concentrated in urban areas than innovation (Florida and Mellander, 2016[106]; Forman, Goldfarb and Greenstein, 2016[107]). For new start-ups, there are clusters in areas providing infrastructure (such as co-working spaces, incubators and labs) but other factors play a role for the location decision within cities as well, e.g. access to a pool of skilled workers, specialised finance and suppliers, as well as large multinationals for potential fruitful collaborations (Coll, Jové and Teruel, forthcoming). In Catalonia (Spain) the main hub for start-ups is Barcelona, with smaller cities attracting significantly fewer entrepreneurs. In Barcelona, start-ups cluster within a small number of neighbourhoods located along the east-west trunk road of the city. The same neighbourhoods also provide the highest density of local assets e.g. urban-cultural amenities, good transport accessibility, availability of talent, investors and incubators.

Another concern that is raised by the rise of digital platforms is the potential for platforms to become natural monopolies that stymy innovation. Digital platforms grow through network externalities: the more users a platform has the more interesting it is for providers and vice versa. In such a market, the platform provider can utilise their market power to extract rents that would otherwise support innovative activity. Antitrust tools and frameworks are still adapting to the new environment and might require a reassessment (OECD, 2018[108]).

Skills development was, is and will be crucial

The fourth industrial revolution has the potential to boost labour productivity but concerns abound regarding the potential impact of automation on technological unemployment and inequality. A common characteristic in all industrial transitions is that a broad range of activities that were initially labour intensive are simplified by new tools, machines or even completely replaced or automated. Technological progress and automation represent an opportunity to boost labour productivity – the key determinant of long-term economic and sustainable wage growth. However, automation displaces jobs in the short term, while new jobs enabled by the technological transition can take longer to be created and might not be created in the same place where jobs were initially displaced.

Previous waves of technological breakthroughs have shown that new technologies do not spread evenly across space and results in a variety of outcomes across regions. A common lesson is that high levels of "human capital" are a key element for regional resilience. Human capital is the summary term that economists attach to the knowledge, ability and skills that a person possesses. Equipping workers with the right human capital to give them the flexibility to exit from the industries where labour has been displaced by technology and capital and enter into industries where human skills are still needed is critical to make regions more resilient to industrial transitions (OECD, 2018[82]).

Regions with high levels of human capital are less affected by automation. With some exceptions, the risk of automation decreases as educational attainment required for the job increases. Thus, regions that have a highly educated workforce have a low share of jobs at risk of automation. The OECD (2018[82]) shows evidence of a negative relationship between the risk of automation and the share of workers with tertiary education. Regions that have the highest share of jobs at risk of automation also have the lowest share of workers with tertiary education. Reducing the risk of automation in those regions will therefore require efforts in training and education.

Human capital is more than formal education. Educational attainment alone fails to capture all aspects of knowledge, talent and skills that are critical for regions to manage the current industrial transition to an ever more intensive knowledge economy. Albeit higher levels of education are typically associated with stronger cognitive abilities. Areas with a higher share of jobs relying on routine tasks are likely to experience more disruption, whereas places where more jobs require tacit skills will face lower levels of risk. Tacit skills are based on experience and intuition instead of formal rules. Thus, they are more difficult to replicate through mechanical processes or standard algorithms. These jobs are in occupations such as engineering and sciences, but also those with a large component of social intelligence and creativity.

The skills that are becoming increasingly useful in the coming years are complementing formal education and training. Building on expert judgements, Frey and Osborne (2017[58]) estimate the likelihood that occupations can be automated, and the associated tasks and skills used in the occupations. Those skills that arise in the estimate with a lower risk of being automated are:

- Skills linked to perception and manipulation, especially if they require being involved in unstructured processes.
- Skills that require creativity, such as artistic activities or coming up with original ideas.
- Skills that rely on social intelligence, such as being persuasive, negotiating aspects of a project or caring for others.

All jobs have tasks with a different likelihood of being automated, not just those that "low-skilled" workers perform. This means that policies should stimulate skill upgrading across all types of jobs towards those that are less automatable, such as e.g. programming, presenting, influencing or training others. Employers already invest in training to upgrade the skills of their employees towards more relevant (or new) tasks. However, training is typically funnelled towards those workers that are already in high-skill categories, therefore policies may be required to address the re-skilling of lower-skilled workers.

Interpersonal and interregional inequality is likely to continue to rise through the fourth industrial revolution. As technological improvements allow substitute routine cognitive and manual skills, the wages of workers that rely on these skills will fall. This will affect workers in manufacturing but also services. This distinguishes the current transition from past transitions where the decline in manufacturing jobs was compensated by job creation in service sectors.

Regional networks and social capital

The element that binds the actors and assets within regional innovation systems are the regional "institutions". These institutions include formal and informal links, networks, local leadership but also cultural norms and the local image or identity. The presence and strengths of these institutions can be considered a form of "social" capital (Audretsch, 2015[109]), highlighting the productive nature of institutions. There is a wide consensus that social capital is important for fostering innovation but there is less agreement as to the importance of different aspects of social capital and even what aspects should be included altogether. The first volume of the *Handbook of Economic Growth*, published in 2005, which summarises the state of knowledge on growth theory, included a chapter on social capital as the 26th out of 28 chapters (Durlauf and Fafchamps, 2005[110]). The second volume published in 2014 included "culture", "trust" and "family ties" as topics in Chapters 1, 2 and 4.[12]

Social capital breaks silos between the main ingredients of well-functioning regional innovation systems. The key ingredients regions need for managing the third and fourth industrial transitions, such as knowledge, skilled labour and knowledge-intensive specialised suppliers, do not act in isolation. Regions may need social capital as co-ordinating social glue that enables finding synergies and generating new ideas through favouring a culture of networks and (productive) interactions (Audretsch, 2018[9]). Repeated social interactions raise social capital, as they reduce opportunism and increase the chances to escape from co-ordination failures (Moesen and Van Puyenbroeck, 2000[111]). A variety of regional institutions provide technical, financial and networking services enabling social interactions that contribute to the dynamism of regional innovation ecosystems. Examples of such institutions include universities, trade associations and local business organisations, as well as specialised consulting, market research, public relations and venture capital firms.

Social capital lowers transaction costs by increasing the quantity and quality of information available to local agents or by reducing the need for such information in the event agents greatly trust each other (Knack and Keefer, 1997[112]). Places with higher social capital do not need to rely on formal institutions, complete contracts and legal dispute resolution as much as in places where trust is less present (Tura and Harmaakorpi, 2005[113]). The resulting high trust in regions with high social capital favours the creation and diffusion of knowledge, which is critical for innovation and increases the feeling of mutual identification among agents, increasing the willingness to collaborate (Dincer and Uslaner, 2009[114]; Hauser, Tappeiner and Walde, 2007[115]).

The economic literature provides several examples of why social capital is important for economic growth due to its relevance for innovation activities. Higher levels of social capital increase the propensity of venture capitalists to finance risky projects because it lowers monitoring costs over the firms they decide to finance and decreases the probability of cheating by inventors, who are more concerned about their reputation when social capital is present. Social capital has an impact on patenting activities, which in turn explains 15% of GDP per capita growth in European regions between 1990 and 2002 (Akçomak and ter Weel, 2009[116]). Social capital can, however, also hinder innovative activity and the development of new economic sectors, in particular when it reinforces reliance on existing sectors (de Vaan, Frenken and Boschma, 2019[117]).

Social capital is often highlighted as the key factor that led to the innovation-driven rise of Silicon Valley, the tech-hub of the Bay Area around San Francisco in the United States. The seminal work of Saxenien (1994[118]) compares the development of Silicon Valley with the greater Boston area. Her analysis suggests

that the regional innovative advantage of Silicon Valley stemmed from social capital. She found that while Silicon Valley was characterised by rich and vibrant networks and linkages, by contrast, people in the Boston region tended to work in a disconnected, autonomous manner with few linkages and interactions.

Two decades after the publication of her analysis, the upward trajectory of the Bay Area has barely changed. Greater Los Angeles (that had a similar starting point to the Bay Area in the 1970s), conversely has steadily fallen behind other US metropolitan areas. Networks, in particular among leaders within the private sector, remain a key distinguishing feature of the Bay Area. Through board memberships and, in particular, the linking role of business leadership organisations (such as the San Francisco Chamber of Commerce or the Bay Area Council), the network of private sector leaders is significantly denser in the Bay Area than in Los Angeles (Storper, 2018[119]). This is evident in other parts of the economy as well: 55% of inventors that filed a patent in biotechnology in Silicon Valley were part of a densely connected network of co-patenting inventors, while the same core group accounts only for 2% of inventors in Greater Los Angeles (Casper, 2009[120]).[13]

Social capital alone does not suffice to create innovative momentum but it can distinguish places that successfully transition from those that remain trapped in their current structures. The Bay Area, Greater Boston and Greater Los Angeles all had strong economic assets at the outset. Leading industries were concentrated in all three metropolitan regions, capital investment was high and the knowledge and skills of the local workforce strong. The networks within San Francisco, as well as the mindset of local leaders, supported the alignment of these assets towards new sectors. From the 1980s onwards, the public discourse in the Bay Area focused on the “new economy”, while Los Angeles focused on the loss of manufacturing, civil unrest and the development of traditional infrastructure (Storper et al., 2015[121]).

Strategies to adapt to disruptions and transition

Innovation systems need to become more resilient and more adaptive in the face of disruptive technologies. A core dilemma is that disruptive innovations as well as innovation policy itself will create stronger gains in some places than in others and might even leave some places to fall behind. The solution to this dilemma is not to avoid innovation or to try to avoid disruption but rather to focus on preparing regions to be in the best possible position to seize new opportunities. Only a small number of regions might be able to be the “first mover” in a new sector or technology field but the diffusion of new knowledge and adaption of innovation is possible for all regions. A rise in inequality is endogenous to the diffusion process and social rather than innovation policy might be better suited to address it.

No single policy changes the economic makeup of a region. Whether regional policymakers aim to broaden or upgrade existing sectors or branch into new (related or unrelated) varieties, a combination of different efforts is required. In some cases, there are successful examples that regions can draw from but in many instances, there is no blueprint that can be adapted. Even past successes might not provide adequate guidance. The changing industrial and competitive landscape that characterises industrial transitions means that framework conditions are constantly changing.

How can a region prepare its economy for an industrial transition? A broad-based approach to innovation policy builds on some form of effective leadership in the region, engages all actors in the innovation system and actively seeks to harness knowledge from outside the region. Regional leadership helps to set a common agenda. It has the capacity to help develop a local mindset that helps discover new domains that secure existing and future competitiveness (Grillitsch and Sotarauta, 2018[122]). This requires an entrepreneurial attitude in the region (Grillitsch and Asheim, 2018[123]). This attitude is not just important for development in the private sector but “institutional entrepreneurship” within the public sector and at universities can be catalysts as well. The local assets in a region might not suffice to support the transition of a regional economy. Drawing from interregional networks, through links established by the public or the private sector, is an important source of stimulus for new development.

Looking back across the different industrial revolutions and the accompanying transitions, several elements emerge as drivers of success and failure of regions' ability to deal with change (Audretsch, 2015[109]). They are closely linked with the regional innovation system (see Chapter 2) as they build on local actors and resource endowments, the networks that connect them and the institutions and policies that shape their behaviour. These characteristics can be grouped into the four categories listed below.

Building on regional endowments

Leader vs. follower

First adopters often have an advantage over firms and regions that follow suit. The "first-mover advantage" is an integral part of the lifecycle of a product or even of industrial revolutions (see above). As markets develop, the early entrants can gain market shares and establish a dominant position that is only gradually challenged by new incumbents as the underlying technologies and products mature. In the regional context, this applies as well. Employment in knowledge-intensive services, such as ICT, is highly concentrated in one or two regions within a country (Daniele, Honiden and Lembcke, 2019[124]).

New disruptive technology is by definition a challenge for incumbents and thereby provide a window of opportunity for new entrants. To enter these windows of opportunity, latecomers need a reasonable productive capacity, human resources and locational advantage. Along the life cycle of a technology, windows of opportunity emerge as the industry undergoes changes in knowledge and technology, changes in demand, and changes in institutions and public policy (Lee and Malerba, 2017[125]). Frontier regions are well placed to benefit from the next wave of technological development but in the past some frontier regions were able unable to reinvent themselves, turning collections of resources into "communities of inertia".

To go through an open window of opportunity, regions behind the frontier need to develop their own distinguishing profile, providing that they have sufficient "absorptive capacity" (Foray, 2015[126]). Absorptive capacity is a broad concept and includes a workforce that can (easily) adapt to work in new sectors, entrepreneurs that can exploit new opportunities, policymakers that set the right framework conditions and provide support where needed and academic institutions that are willing to and can engage with the business sector.

The reflex in regions is often to "attract talent". Advanced regions can leverage their position as innovation leaders. Their existing knowledge base, the presence of leading firms and other advantages such as the availability of risk finance make them a natural point of attraction. Leading regions therefore often manage to sustain their advantages for long periods of time (OECD, 2018[16]). Attracting firms, innovative entrepreneurs or a skilled workforce can complement existing assets of a region but developing a whole ecosystem takes time and requires significant local efforts. Training and retaining should complement the efforts to attract outside support.

"Follower" regions have the advantage of learning from mistakes and successes in first-mover regions. Regions can thereby reduce the transition cost associated with disruptive innovations and maximise the benefits. A second advantage is that innovations and their supporting technologies have time to mature, capacity to produce or use the technologies can spread and firms and workers can learn from examples in other areas (OECD, 2019[81]). This means that the cost of production and adoption are lower. Regions that are competing on cost of production (as opposed to productivity and innovation) have therefore opportunities to enter new markets.

Industrial structure and embedded knowledge

Whether the region is a technological leader or a follower is only one aspect of their wider knowledge portfolio. The existing industrial structure, the knowledge embedded in the firms operating in a region and the strength and specialisation of local universities are essential assets when facing disruptive innovations.

Regional economies adapting innovations can – often most easily – branch into related technology fields (see the above discussion on regional diversification). This is also the case for disruptive technologies. When assessing regional capacity to manage disruptions, considering the region's current technological specialisation and firm capabilities is therefore one of the most important factors.

Disruptive technologies may open windows of opportunity for regions that have developed sufficient absorptive capacity. Regional branching is often into related varieties, so existing specialisations can largely determine the ability to take advantage of current developments in a new domain (Frenken, Van Oort and Verburg, 2007[34]). By upsetting the existing order and challenging incumbents, a sufficiently prepared and flexible region can also establish itself as a new leader. An important enabler for such a move can be the spread of "general-purpose technologies", i.e. those underlying technologies that enable disruptive innovations. Recent evidence for 26 European countries suggests that regions with some activity in general-purpose technologies are more likely to develop a broader industrial base and activity in more – unrelated – sectors (Montresor and Quatraro, 2017[127]).[14] The study relies on patent activity in general-purpose technologies, which has the drawback that patenting tends to be very much concentrated in leading regions. Whether and how regions with a less technologically advanced knowledge base can benefit remains an open question.

The position of a region and its firms within supply and (global) value chains affects the risks and opportunities from disruptive innovation. Some technologies are more upstream or downstream than others in the innovation network. This implies a structure of interdependence between regions (Acemoglu, Akcigit and Kerr, 2016[75]). Regions focusing on downstream technologies are potentially able to benefit from externalities from innovation in other domains or region, but this also makes them dependent and thus vulnerable in case the upstream knowledge generation decreases. Examples include health, where applications of new therapies rely on continuous innovation in pharmaceuticals, and renewable energy, where progress in renewable energy has been partly driven by semiconductors and digital technologies. Technologies can be more directed towards specific parts of the value-chain, from conception to production, marketing and distribution. Regional positioning in the value chains matter because upstream activities, such as R&D, have more value-added than middle stream activities, such as manufacturing marketing (OECD, 2018[128]).

Legacy infrastructure

The regional impact of a disruptive technology depends on the existing infrastructures and ability of a place to adapt them. Transport infrastructure, the telecommunication and broadband network but also infrastructures such as science and technology parks determine the adaptability of a region. Market failures are likely to be more important in infrastructure building than in other domains, as decisions taken years or decades ago affect current capacities. As a result, public policies for infrastructure remain not only a major priority for overall development but also a key instrument for ensuring access to development opportunities across regions and thereby territorial inclusiveness.

Each industrial revolution has been associated with key technologies (see above) as well as the supporting infrastructure network. Investment in railways, electricity networks and today's digital infrastructure are necessary for regions to be part of the industrial revolution. The more infrastructure-dependent technologies are, the stronger will be their local effect (Perez, 2003[129]). An example of relevant infrastructure for disruptive technologies is digital infrastructure. The "digital divide" in terms of access to broadband infrastructure remains important (in particular in terms of speed of Internet access) but disruptive technologies in energy and transport may appear even more infrastructure-intensive.

Geography

Agglomeration tends to be driven by human factors rather than physical geography but some aspects of physical geography may matter, especially in relation to global trends. Climate change will affect regions differently, both directly through disasters and sea-level rise and through migration from adjacent areas. Accessibility to input materials remains an important factor for technological breakthroughs or incremental technological change. However, physical materials are most often sourced from the international market, not having to be sourced regionally.

Proximity to other regions

Distance matter in innovation, both for the frontier and innovation diffusion. Innovation processes have no borders. Recent empirical work emphasises that regions are not isolated, being important to consider spatial structure to understand the impact of policies (Autant-Bernard, Fadairo and Massard, 2013[130]). Regions should consider their strength and weaknesses in link with that of their neighbours, considering system-wide implications, and this, of course, requires significant efforts of policy co-ordination at the national and supranational levels (OECD, 2018[128]). Interregional links are particularly important when physical infrastructure plays an important role, as a region can benefit from connecting to a neighbour's network. Physical proximity also matters for migration, including (in- or out-) migration of skilled workers (Miguélez and Moreno, 2015[131]) as well as for patenting activity – even within Silicon Valley (Kerr and Kominers, 2015[132]). Despite the increased possibility of accessing knowledge remotely, distance thus remains an important regional characteristic to consider (Paunov et al., 2019[94]).

City systems and agglomeration economies

"Cities deliver the random exchanges of insight that generate new ideas for solving the most intransigent problems" (Glaeser, 2011, p. 51[133]). This does not mean that only the largest megacities can produce innovation, but density and "agglomeration economies" favour both productivity and innovation (OECD, 2015[83]). Large cities create more opportunities for interactions but they also attract a larger share of more qualified or "skilled" people.[15] The higher share of highly skilled workers makes cities more resilient to disruptions. They tend to have more managerial and technical professionals, reducing the risk of job losses from automation (Frank et al., 2018[27]). They also offer larger and more diverse labour markets that make it easier for workers to transition to new opportunities.

Cities can create benefits beyond their borders. This is particularly evident for cities that are "well-functioning" (OECD, 2018[128]), i.e. well integrated with their surrounding commuting zone. Achieving this goes beyond purely urban planning and needs a regional view that acknowledges agglomeration costs and considers well-being beyond purely economic indicators. Beyond the urban-rural dichotomy, geographers have shown that it not possible to understand city growth and the location of activities without reference to systems of cities. Urban economic and innovation policy should strive to consider cities within their wider sphere of influence, as (physical or otherwise) proximity to other cities influences innovation diffusion and competition.[16]

Some technologies might have a more Jacobian (across sectors) or more Marshallian (within sectors) potential, and this determines what region should target them or be affected. Some technological ecosystems with very wide applicability, such as all technologies related digital innovation, could thrive in diverse cities thanks to the good match between the diversity of the city and the large potential applications of the technology. In contrast, more specific technological domains are likely to benefit more Marshallian externalities, such as health technologies thriving in regions with large medical universities producing a pool of highly specialised workers. For instance, current national strategies for AI discuss both developments of the technology in terms of fundamental capabilities and in terms of "recombining" AI with various applications domains.

Developing local and regional leadership

The role of regional leaders is to develop a shared vision providing local actors with a sense of direction, in order to enable regional industrial rejuvenation. Regional leadership consists of an orchestration in "quadruple helix" processes that gathers leaders from local industries, academia, public authorities and non-profit organisations. Regional leadership played a key role in the success of Silicon Valley (see above). Interactions between local leaders from different communities fostered a new vision for the region centred on a "technological approach to better modern living". Important members of the San Francisco downtown finance and corporate elite were on the boards of directors of the major environmental organisations, resulting in the creation of networks interacting with the technology community (Storper, 2018[119]).

Regional leadership in Silicon Valley helped bring different groups together under a shared vision. Leaders from traditional engineering networks from the defence-aerospace-communications sector, intertwined with leaders from "hippie" groups proposing alternative technology futures for cities and modern life, and started working on common goals. The elite leadership groups in the Bay Area endorsed early on the new economic vision for the world and the Bay Area's role in it, engaging in "making it happen". A key element of success was not only the existence of leaders but also the depth of how interconnected their networks became (Storper et al., 2015[121]). A prominent example is the creation of an organised site of contact between local networks established in 1969, by Xerox, founding the Palo Alto Research Centre (PARC). Three networks came together there embracing a common vision: the engineering-based corporate world, with its focus on military procurement; the conventional, academic engineering research community; and the Bay Area alternative technology and environmental circle.

A shared vision for a region might require democratising the process of policymaking, including the design of regional innovation policies and defining strategic technological paths. This can involve, for example, engaging the "quadruple helix" by identifying and gathering leaders from different regional stakeholders, such as local industries, academia, public authorities and non-profit organisations, and pursuing participative governance processes defining regional innovation strategies. Regional innovation policies are likely to fail if local agents do not support the broad strategic vision for the region's economic rejuvenation. In addition to a well-defined vision, stimulating interactions across different local leaders can contribute to increasing innovation ecosystems' dynamism, with for example the promotion of internal events (for local networking) or external events (representing the region, e.g. at trade fairs), and incentives for collaborative R&D.

Regional leadership contributes to innovation by formulating and implementing both a vision and strategy for innovation, as well as in communicating that strategy and innovation to local agents. In addition, leadership can help transform the identity of a region to the rest of the world as well as the region's own self-image, which is important in order to attract and retain talent and foster human interactions among local agents. Regional leadership can come from the public sector, but examples of leadership from the private sector or civil society, as well as shared leadership, exist (see Box 3.7).

Box 3.7. Leadership in regional innovation policy

North Carolina, United States

Leadership can come from outside the public sector, for example through philanthropic contributions. Wealthy and established citizens originally capitalised North Carolina's Research Triangle Park largely through philanthropic contributions. During the second industrial revolution, North Carolina ranked as the poorest state in the United States. However, during the third industrial transition to the computer era, the creation of the Research Triangle helped to turn the region into one of the most innovative and prosperous regions in the world.

A number of anonymous North Carolinians bought the land for the park's site, which was then transferred to the non-profit Research Triangle Foundation (Link, 1995[44]). These funds also enabled the establishment of the Research Triangle Institute, which performed contract research for industry and government sponsors. The establishment of foundations can reduce the cycle time for decisions and their execution, which is a key factor in regions' competitiveness. Foundations can be more agile as they are not subject to the bureaucracy of state universities and thereby enable researchers to interact with firms competing in a rapidly evolving technological landscape.

Basque Community, Spain

Regional leadership played a key role in facilitating a positive shift from the second to the third industrial transition in the Basque Community in Spain. During the second industrial era, the region developed a policy strategy around shipbuilding. However, by the 1980s, during the third industrial transition, the Basque Community region lost its competitive advantage in shipbuilding, economic growth stagnated and unemployment rose abruptly (OECD, 2011[134]).

The strategy to help the region manage the industrial transition consisted in shifting the identity and image of the region from manufacturing, based on combining physical capital and low skills, to a region featuring culture, hospitality and innovation. The strategy included procuring the Guggenheim at Bilbao, requiring a substantial investment. Regional leadership was important to overcome the inertia and resistance against the new policy approach (OECD, 2011[134]).

Tampere, Finland

From the 1990s, Tampere moved towards a university-driven knowledge economy, becoming a Nokia-led global ICT hub in the early 2010s. With the closure of Nokia's research facility, Tampere needed to act quickly to retain the highly qualified workforce in the region and to maintain its image as a dynamic and innovate region. Local and regional politicians worked with local firms to develop ad hoc actions in response to the crisis. The region also realised that it was necessary to transition from its regional cluster specialisation policy (1994-2013) towards an open innovation platform policy, which started in 2009 (OECD, 2018[16]).

Tampere was able to reshape its economic structure based on the dominance of a large company, into an entrepreneurial ecosystem of innovative technological start-ups, combining the regions' knowledge about building machines, with IoT features. Nokia's former employees launched some of these start-ups. Tampere uses its regional branding as a dynamic, innovative and pleasant region to live, in order to attract and retain talent and thereby attract companies to set up R&D labs.

Source: Link, A. (1995[44]), *A Generosity of Spirit: The Early History of the Research Triangle Park*, Research Triangle Foundation of North Carolina; OECD (2011[134]), *OECD Reviews of Regional Innovation: Basque Country, Spain 2011*, https://dx.doi.org/10.1787/9789264097377-en; OECD (2018[16]), *Productivity and Jobs in a Globalised World: (How) Can All Regions Benefit?*, https://dx.doi.org/10.1787/9789264293137-en.

Institutional entrepreneurship

Institutions are seen as a set of formal and informal rules, regulations and constraints on the one hand, and organisations in the form of economic, political, social and educational bodies on the other. Institutional entrepreneurship consists of the adaptation of formal or informal rules and the creation of new institutions and public programmes that are conducive to entrepreneurship and innovation (Rodríguez-Pose and Storper, 2009[135]). Institutional entrepreneurs are individuals, groups or organisations initiating change processes and contributing to the creation of new institutions or transformation of existing ones (Battilana, Leca and Boxenbaum, 2009[136]).

Institutions can foster a regional culture that is prone to entrepreneurial activity. A starting point for the creation of an entrepreneurship culture can be to install an entrepreneurship-friendly institutional framework. For example, Darnihamedani et al. (2018[137]) show that well-designed tax policies can increase the level of entrepreneurship. Measures that can indirectly spur the public opinion about entrepreneurship include awareness campaigns (e.g. portraying of successful entrepreneurs in the media) that may trigger a positive perception of entrepreneurial behaviour (Fritsch and Wyrwich, 2018[138]).

The role of institutions goes beyond setting formal and informal rules or acting as intermediaries; institutions can also make market-related entrepreneurship possible. Public procurement through the Defense Advanced Research Projects Agency (DARPA) in the United States resulted in many of the inventions that underpinned the third industrial revolution. Research funded by the long-standing agency resulted, among others, in the development of the Internet (Mazzucato, 2013[139]). DARPA is the most prominent example of active institutional entrepreneurship but other agencies, e.g. the Korean Centres for Creative Economy and Innovation follow a targeted approach in intervening on specific technological fields (Box 3.1).

Developing an attitude of institutional entrepreneurship in a region takes time. Agencies that support an entrepreneurial approach can be a starting point. An example of the creation of new agencies that aim to foster innovation in a region are regional innovation intermediaries such as the Centre for Economic Growth in the capital region of the state of New York, or the Centre for Technological Innovation and Advanced in Andalusia, Spain (Box 3.8).

Box 3.8. Leveraging innovation intermediaries

Center for Economic Growth, New York (United States)

The Center for Economic Growth (CEG) was created to address the fragmentation of local authorities in New York's capital region. The Albany-Colonie Chamber of Commerce created the CEG to spearhead the development and implementation of coherent strategies for regional development. New York's capital region faced challenges with balkanised governmental jurisdictions and institutions that were viewed by the business community as obstacles to regional economic growth.

The CEG functioned as an advocacy group as well as a think tank organisation that committed resources to survey and understand successful innovation-based development initiatives in other parts of the United States and around the world. It promoted the use of the term "Tech Valley" to rebrand the capital region and to market it to high tech companies. Subsequently, CEG played a major role in breaking down institutional barriers to co-operation and forging co-ordinated regional initiatives able to attract state support.

Leveraging the entrepreneurial discovery process, Andalusia (Spain)

Andalusia has bundled its investment promotion, risk capital funding and innovation programmes in its Innovation and Development Agency (IDEA). IDEA focuses on Andalusian business support, managing projects and programmes of the Ministry of Employment, Enterprise and Commerce, as well as on promoting the establishment of industrial and technological infrastructures related to Andalusian strategic clusters. Leveraging the "Entrepreneurial Discovery Process" that was part of the development of the Andalusian Regional Innovation and Smart Specialisation Strategy, the region developed a plan to extend its existing strength in the aerospace industry.

The assessment found that a facility of researchers who can co-develop prototypes with SMEs was missing. With the Centre for Technological Innovation and Advanced Aeronautical and Naval Manufacturing (CFA), the region provides a place and infrastructure (80% of the investment will be in

machinery) where collaboration can take place. The project aims to support cross-sectoral space, naval and aerospace technologies. Technical specifications were developed in collaboration with the business sector and with the universities. The initiative also includes the development of dual degree programmes at the university that aim to train students to work in the facility.

The centre is an example of a multi-stakeholder collaboration between the Junta de Andalucía, local public agencies such as IDEA and the main actors of the private sectors including Airbus, Navantia, the University of Cádiz, the naval maritime cluster of Cádiz and the Andalusian aerospace cluster. The CFA contributes to the identification of opportunities for collaborations both globally and locally, develops foresight capacity and anticipatory action to potential external shocks, connects regional capacities and upgrades them through multi-stakeholder collaborations on new joint projects.

Source: Wessner, C. and T. Howell (2018[10]), "Smart specialisation in U.S. regional policy: Successes, setbacks and best practices", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 15 October 2018, Paris; OECD (2010[140]), *Higher Education in Regional and City Development: Andalusia, Spain 2010*, https://dx.doi.org/10.1787/9789264088993-en; EC (n.d.[141]), *Innovation and Development Agency of Andalusia (IDEA Agency)*, https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/organisation/innovation-and-development-agency-andalusia-idea-agency (accessed 10 July 2019); Invest in Spain (n.d.[142]), "The Andalusian Regional Government equips the Innovation Centre of Cádiz", http://www.investinspain.org/invest/en/press-room/Business/news/NEW2017737967_EN_US.html (accessed 10 July 2019).

Experimentation, learning and openness

A large degree of uncertainty surrounds the opportunities that innovation will bring in the coming years and how they will affect different regions and populations. To ensure that regions remain competitive through fulfilling their development potential, policy needs to tackle this uncertainty. This means building on the existing evidence base and extending it. Many aspects of the innovation process are not systematically measured. Links between actors, institutions and policy that underpins innovation systems are hard to capture. Progress needs to be made in using and linking different microdata sources that allow to systematically assess the importance of different links and the ability of policy to affect them. Another aspect is the role of investment in intangible assets and the capacity of firms to collateralise intangibles (OECD, 2013[143]). Especially at times where "data is the new gold", the question of how access to data can be facilitated, governed and aligned with privacy concerns is critical.[17]

To address uncertainty, policy experimentation and learning are key. Experimentation for large-scale programmes is rare. One more common approach to policy experimentation is to assemble a portfolio of promising projects and programmes that are then implemented at a small scale as pilots or trials. Key is that they can be implemented, financed and scaled up once they show promise through the monitoring phase. The monitoring phase should not be passive but policymakers should use the phase to revise or even eliminate poorly performing initiatives (Dutz et al., 2014[19]). The objective of monitoring and evaluation should, however, not be on deciding what to cut but on improving the programmes and drawing lessons from the process that help in policy (re)design (OECD, 2017[144]). Whether policies or programmes are rolled out widely or in smaller trial phases, a critical element is how policymakers learn from success and failure (see also Chapter 5). Learning through peer exchanges with other regions can be an important tool in this respect.

Disruptive innovations often come through recombination of existing technologies and much of the expected progress in the coming years is at the intersection of a different academic field. An interdisciplinary approach both in the private and public sectors is therefore critical. An open question is whether traditional R&D models can facilitate this approach or whether the traditional "closed" innovation system approach needs to become an "open" innovation model (Chesbrough, 2003[145]). In the traditional development model, the R&D process was fully integrated within the boundaries of a firm and often physically separated by highly protected research facilities. This closed system can help firms capitalise

on inventions and innovations as learning by competitors is slowed. But a closed system misses opportunities to gain knowledge from external sources and co-creation of innovation, e.g. along the supply chain or with academia. This is particularly important when the knowledge base is tacit, i.e. hard to codify. In this case, communities of practice will develop and the industry may have a strong local dimension (Amin and Cohendet, 2004[146]).

Universities as a catalyst of regional innovation and entrepreneurship

Universities will play a key role in the fourth industrial revolution, given their importance in addressing the main factors and resources associated with the knowledge economy, such as human capital, creativity and other skills. Universities and other public research organisations have a strong local impact on innovation outputs. Half of all inventors who filed patents in the 36 countries in the OECD database of higher education and public research institutions live within 30 kilometres of a university or public research institution. In part, this link is driven by local characteristics that support both academic and patenting activity (e.g. a strong industrial economy). Regression results that account for these confounding factors confirm that universities and public research institutions have an additional, local effect on patenting activity (OECD, 2019[147]). The creation of the College of Nano Scale Science & Engineering (CNSE) is an example of a new research institution with a strong regional impact (Box 3.9).

Box 3.9. The College of Nano Scale Science & Engineering, Unites States

The Albany-Malta corridor along Route 9, also termed Nano-tech Valley in New York State (United States) provides a successful example of policies leveraging the role of universities for regional technological rejuvenation. The state invested in industry-relevant R&D in local research universities, which helped these institutions secure recognition by the industry's Semiconductor Research Corporation. New York State universities were open to engagements with industry, able to carry out applied research and train students to work with new technologies.

The region benefitted from a new research institution specifically designed to address the opportunity of nanotechnologies, with a focus on the needs of the semiconductor industry: the College of Nano Scale Science & Engineering (CNSE). The CNSE became a driver of regional employment and catalyst of an ecosystem, attracting major players in the field interested in maintaining and exploiting the college's facilities.

The CNSE created numerous research consortia with semiconductor device, equipment and materials companies, with arrangements that minimised the cost and risk associated with introducing new tools and processes. Sharing the costs of research, participating firms could test equipment and techniques developing and refining expertise and identifying and ironing out "bugs" in new-generation tools and processes before investing in their own manufacturing facilities. The college shared research facilities in which companies and CNSE staff could collaborate as well as proprietary space rented by individual companies where the firms can take expertise and technology generated in the joint activity for refinement into their own proprietary products and industrial processes.

Source: Wessner, C. and T. Howell (2018[10]), "Smart specialisation in U.S. regional policy: Successes, setbacks and best practices", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 15 October 2018, Paris.

The mechanism behind the well-established fact that firms with closer science links perform better is still much of a black box. The role that universities play for regional innovation differs depending on the characteristics of the university and of the region. Spending on universities that grant advanced degrees

(four-year degrees in US colleges) has a stronger impact on patenting in regions that are already close to the technological frontier (Aghion et al., 2009[148]). The type of expenditure, competition among universities and the autonomy of the university also affect patenting and academic publication activity, with some evidence that institutions learn and become more productive through repeated participation in funding competitions (Aghion et al., 2010[149]). Moreover, Bloom et al. (2017[150]) find that firms located close to universities are more likely to adopt structured management practices that are associated with better firm performance.

Universities are important catalysts for entrepreneurial ecosystems. University research and other public research organisations contribute with applied research that can lead to new innovative products and services, that can be commercialised for example through academic spin-offs and collaborations with established firms. Universities also contribute to attract and educate students with entrepreneurial skills through their education function. Including entrepreneurship courses as part of a formal university curriculum and hosting incubators are examples of approaches to strengthen links with local entrepreneurs (Box 3.10).

Box 3.10. The role of universities in Chicago's entrepreneurial ecosystem

During the early 2000s, the city of Chicago in the United States was not a major player in the start-up ecosystem but in about 10 years the city became one of the most important cities in entrepreneurial technology. Chicago's entrepreneurial ecosystem started to emerge after numerous public initiatives started using regional universities to foster entrepreneurship. The state of Illinois managed to shift away from a focus on large and established firms.

Public initiatives to change this scenario included, for example, increased budgets for scientific research that can lead to university spin-offs, the creation of funds to invest in student entrepreneurship and the creation of university start-up accelerators. The International Institute for Nanotechnology was created at Northwestern University with the objective of launching start-ups to commercialise nanotechnologies developed at Northwestern University.

The University of Illinois created curricula designed to foster entrepreneurship, including business plan competitions, funding for proof of concept and a residential dormitory for students from different fields who are interested in becoming entrepreneurs. The University of Chicago's New Venture Challenge programme has been recognised as the number one university accelerator in the United States, and its Innovation Fund invests in local start-ups.

Source: Wessner, C. and T. Howell (2018[10]), "Smart specialisation in U.S. regional policy: Successes, setbacks and best practices", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 15 October 2018, Paris.

Interregional collaboration for economic diversification

Moving into new sectors often requires an external stimulus. Regional economic rejuvenation centred on the pursuit of innovation requires both intra- and inter-regional networks for innovation and the development of new specialisations. The most innovative regions generally engage in a large number of collaborations. For example, Baden-Württemberg in Germany has an open and international network focused on Northern Europe and North America. In the United States, California is a leading hub in the global network and collaborates frequently with firms from emerging countries such as China and India.

Interregional links do not need to be international. Public policy can contribute to foster knowledge diffusion by strengthening rural-urban linkages. Leveraging local and proximate urban centres is a key asset for

rural regions. Productivity in rural regions close to cities has grown faster than in remote rural areas. Since 2009, rural regions close to cities have been able to narrow the productivity gap to predominantly urban regions (OECD, 2018[151]). Diffusion of knowledge and shared innovation activity is facilitated by proximity, but rural and urban regions are connected in various ways that also shape the effectiveness of diffusion channels, e.g. through the delivery of public services and multi-level governance interactions (OECD, 2016[25]).

Rural-urban linkages may be difficult to achieve through market processes due to barriers such as weak regional ties, differences in regional regulation, institutional fragmentation or differences in language or business cultures. Policies fostering the development of regional collaborations have a pivotal role in harnessing the development of interregional value chains. They also often require initial policy incentives to get actors at the table since they face an inherent asymmetry in power relations between big and small regions. Many OECD countries encourage rural-urban partnerships by mandating co-submission as a requirement to access programme funding. France's reciprocity contracts offer one example of an approach that promotes intermunicipal collaboration (Box 3.11).

Box 3.11. Reciprocity contracts for stronger regional linkages, France

Well-aware of the complementarity potential of its different urban and rural territories, France has developed a new experimental tool to promote intermunicipal collaboration: "city-countryside contracts of reciprocity" (*Contrats de réciprocité ville-campagne*). These agreements are adaptable to different territorial realities; their jurisdictions are not pre-defined which allows them to cover different areas depending on the issue at hand. The process is primarily led at the intermunicipal level, with the state, regions and *départements* being asked to support local initiatives.

France's "contracts of reciprocity" acknowledge the diversity of rural areas and seek to strengthen and valorise urban-rural linkages. This is driven by an understanding that urban-rural interactions should address not just proximity issues (e.g. commuting patterns) but also consider reciprocal exchanges in order to build meaningful partnerships. Potential areas for co-operation include:

- Environmental and energy transition (e.g. waste management, food security, the preservation of agricultural land and natural areas, and bioenergy development).
- Economic development (e.g. the joint promotion of the territory and the development of joint territorial strategies, land use policies, support for businesses and the development of teleworking to help maintain remote towns centres).
- The quality of services (e.g. promoting tourist sites, access to sports facilities, leisure, heritage and access to health services).
- Administrative organisation (e.g. mobilisation of staff with specific skills to support key projects or needs).

Source: OECD (2016[25]),, *OECD Regional Outlook 2016: Productive Regions for Inclusive Societies*, https://dx.doi.org/10.1787/9789264260245-en; based on CGET (2015[152]), Note d'information sur les contrats de réciprocité ville-campagne; Ministère de la Cohésion des territoires et des Relations avec les collectivités territoriales (n.d.[153]), *Point sur l'expérimentation de contrats de réciprocité*, www.logement.gouv.fr/experimenter-les-premiers-contrats-de-reciprocite-ville-campagne-crvc (accessed 22 June 2016); French Government (2016[154]), *Compte rendu du Conseil des ministres du 6 juillet 2016*, www.gouvernement.fr/conseil-des-ministres/2016-07-06/le-pacte-etat-metropole (accessed 18 July 2016).

International affairs are traditionally in the purview of national governments, but regional and local governments can and increasingly do play an important role in linking their economies with those in other countries. Just pushing development through measures that regional or national government can affect is often not enough, but requires external links. This helps regions to focus on their core competencies and

leverage knowledge and capacity from other places. These efforts can come through policymakers in the region itself but can also be facilitated at higher levels of government. The European Vanguard Initiative is an example of a bottom-up effort to link regions with economic complementarities across Europe (Box 3.12).

Box 3.12. The Vanguard Initiative, European Union

The Vanguard Initiative for New Growth through Smart Specialisation is a platform of European regions that strive to be frontrunners in applying "smart specialisation" as a strategic principle in EU innovation and industrial policy, to promote new growth by bottom-up dynamics stemming from the regions. Vanguard is a voluntary commitment by regions that adhere to the 2013 Milan Declaration. It seeks to promote multi-level governance and interregional collaborations, and identifies synergies between policies and works to explore regional complementarities identified in smart specialisation strategies.

The key objectives of the policy initiative are to:

- Bring together regions where there is a political will to play an active role in transforming regional clusters into world-class clusters.
- Create favourable framework conditions for cross-regional private co-investment.
- Develop new instruments to support bottom-up entrepreneurship, co-creation and clusters.

Vanguard builds on the idea that all levels of government in Europe can contribute to foster innovation and demand-driven investment. Regions are the right place to address innovative ecosystems, making the links between Europe, industry and research centres, as well as citizens.

The underlying rationale is that regionally developed ecosystems, connected across Europe, can be the driver of new European value chains. This requires the development of a stronger multi-level governance model, combining policy levers at different levels to reach shared goals.

Source: OECD (n.d.[155]), OECD STIP Compass, OECD, Paris, https://stip.oecd.org/stip.html (accessed 21 August 2019); Vanguard (2016[156]), "Regions and future EU policies for growth and investment", https://www.s3vanguardinitiative.eu/sites/default/files/contact/image/vi_position_paper_post2020_final_7nov2016.pdf.

The new industrial policy of the Italian region of Emilia Romagna introduced in 2015 stresses the importance of external links. The policy acknowledges that complementarities can not only be found within the region but across a wider network. It also builds on the idea that the search for economic complementarities should not be left to the private sector alone. Links outside the region are formalised through strategic partnerships with regions in Europe, the People's Republic of China, South Africa and the United States (Box 3.13). Emilia Romagna also engages in international collaboration within Europe through bottom-up networks, such as the Vanguard and through European Commission (EC) initiatives (e.g. the region is engaged in different Interreg projects).[18]

Regional networking within Emilia Romagna has a dedicated agency as a facilitator. ASTER was created in the 1990s to favour interactions within the regional innovation system. Its main concern is the industrial application of research and the promotion and realisation of concrete projects in this respect. It was reorganised in 2001 as a consortium gathering all regional actors of the innovation system: universities, research centres, business associations and the regional government. In 2019, the role of the agency was further strengthened through the merger with the regional development agency (*ERVET*) into a combined agency ART-ER (*Attrattività Ricerca Territorio*). ASTER initially aimed to promote technological transfer within the region but its role has evolved to also support extra-regional links since it is involved in the management and realisation of Emilia Romagna's projects that are part of the European Interreg programmes and those that contribute to the Vanguard Initiative (Labory and Bianchi, 2018[157]).

Box 3.13. Interregional collaborations in Emilia Romagna, Italy

The region of Emilia Romagna has pursued complementarities beyond regional borders, collaborating with other Italian regions and in foreign countries. The regional government has favoured the development of linkages with other regions encouraging the participation of regional businesses (and other institutions such as universities). An example of this approach is the development of the Big Data Technopole. The technopole is included in a national network of big data centres that the region contributed to creating.

The region has six key partner regions, with which it develops close relationships in all fields. Key partners include the European regions of Aquitaine (France), Hessen (Germany) and Wielkopolska (Poland), and the three extra-EU regions are California (United States), Gaudeng (South Africa) and Guangdong (People's Republic of China). Emilia Romagna is also a member of various interregional programmes, such as Adrion with regions bordering the Adriatic and Ionian seas, the Italy-Croatia programme or the Alps programme. These programmes finance R&D projects in fields of common interest (e.g. marine technologies for SMEs in the regions bordering the Adriatic Sea) so that interregional complementarities can be exploited.

The Agenzia per lo Sviluppo Tecnologico dell'Emilia Romagna (ASTER) agency is an innovation intermediary organisation that supports interregional networking activities. It was created in the 1990s to favour interactions within the regional innovation system and was re-organised in 2001 as a consortium gathering all the regional actors of the innovation system. Actors include universities, research centres, business associations and the regional government. The primary aim of ASTER is to favour technological transfer in Emilia Romagna and the promotion of extra-regional links, being involved in the management of projects within Emilia Romagna's interregional programmes.

Source: Labory, S. and P. Bianchi (2018[8]), "What policies, initiatives or programmes can support attracting, embedding and reshaping GVCs in regions?", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 21 September 2018, Paris.

International collaborations are often easiest across a shared border. These cross-border collaborations can be a bridge that complements other global interactions. Innovating with a cross-border partner requires a degree of openness, which can be a first step towards internationalisation. Cross-border linkages are especially relevant for many SMEs that often lack the capacity for engaging in innovation and knowledge sourcing activities on a global scale. For example, commercial ties among SMEs across the border between Ireland and Northern Ireland (United Kingdom) were used as a stepping stone for wider engagement with GVCs (OECD (2013[158]); see also Chapter 4).

Political commitment is an important factor for kick-starting or securing long-term support for cross-border efforts. Generally, the local level has the strongest interest because it feels the costs and benefits most directly. For innovation policy, a region is typically a more appropriate scale than a locality to include the relevant range of firms, universities, workers and other innovation actors. Despite the potential gains, barriers in terms of sharing the benefits and risk associated with joint innovation efforts often limit effective collaboration (OECD, 2013[158]). InterTrade Ireland is one of the few examples of co-funded cross-border innovation initiatives that promote cross-border regional collaboration between Ireland and Northern Ireland (Box 3.14).

Box 3.14. InterTrade Ireland, Ireland and the United Kingdom

InterTrade Ireland (ITI) is a cross-border Trade and Business Development body that supports companies and researchers from Ireland and Northern Ireland to collaborate on Horizon 2020 (EU Science funding project). The key objective of the policy is to assist companies and researchers from Ireland and Northern Ireland to collaborate on Horizon 2020. It is a rare example internationally of a cross-border entity to promote trade and innovation that is co-funded by the respective governments.

During 2017, InterTrade Ireland has continued to expand its Horizon 2020 activities with a view to increasing joint North-South participation and a range of awareness-raising initiatives and supports for potential partners have been organised. Between January 2014 and June 2017, 52 partnerships received funding.

Source: Nauwelaers, C., K. Maguire and G. Ajmone Marsan (2013[159]), "The Case of Ireland-Northern Ireland (United Kingdom) – Regions and Innovation: Collaborating Across Borders", https://dx.doi.org/10.1787/5k3xv0llxhmr-en; country responses to the OECD Science, Technology and Industry Outlook 2016 policy questionnaire; EC/OECD (2016[160]), *International Science, Technology and Innovation Policy (STIP) Database*, https://www.innovationpolicyplatform.org/sti-policy-database.

Breaking silos through innovation centres and districts

Two popular modes of innovation support are linked to closed and open innovation systems. Regions and cities can leverage research centres in a targeted effort to promote innovation districts that have a broader mandate in linking actors. Under the research centres approach, a wide range of innovation-related policies are co-ordinated and consolidated under one administrative structure. The centre develops policies that support the adoption of disruptive technologies at the regional scale through continuing investments in regional innovation systems, such as specialised labour markets, firm networks and connecting fundamental research in universities and national labs to existing industry and firms. Under the innovation districts approach, cities or regions target the diffusion and absorption of enabling technologies at the regional scale. Cities or regions design and implement policies and services at a local level targeting start-up and scale-up activities, migration, workforce development and certification, and other innovation-related policies for example.

Research centres approach

Regional and national governments use research centres to centralise regional innovation policy under one administrative roof. Research centres serve as market intermediaries tasked with technology diffusion and development, and attempt to co-ordinate and align local actors and activities. Research centres increasingly bridge the gap between basic research financed and supported by public sector actors and the commercialisation of innovations facilitated by private-sector actors. The regional presence of research centres can follow a top-down (national to regional) approach where institutes of national importance are spread across different regions, or a bottom-up approach where centres answer to the needs of local agents supporting existing and evolving regional specialisations.

The National Network of Manufacturing Institutes (NNMI) is an example of a top-down policy effort in the United States using research centres to sustain regional innovation systems (Box 3.15). The network is composed of a total of 14 centres. The NNMI attempted to affect regional industrial specialisations through elaborated research, design and commercialisation centre model focused on targeted technologies rather than existing local industrial sectors (Clark, 2018[161]).

Box 3.15. National Network for Manufacturing Innovation Institutes (NNMI), United States

Beginning in 2010, the Obama Administration initiated the Advanced Manufacturing Partnership (AMP), which entailed rounds of private-sector and university-led policy development charged with diagnosing, analysing and acting to support industrial development and specifically address the gap between innovation and commercialisation in the United States economy. Co-ordinated by the President's Council of Science and Technology Advisers which spanned across departments such as Energy, Defence, Commerce and Transportation, the resulting policy prescriptions primarily addressed the economic crisis by initiating an architecture for a national innovation system that connected local and regional production systems to emerging and enabling technologies.

The Advanced Manufacturing Partnerships 1.0 (AMP 1.0) and 2.0 (AMP 2.0), which operated from 2011 to 2014, resulted in two policy strategy reports. Both reports recommended a NNMI. The NNMI initiative created large-scale research centres (individually manufacturing innovation institutes or MIIs) connected to industry, universities and the broader set of institutions constituting both regional and national innovation ecosystems defined by targeted technologies. This policy model explicitly acknowledged that national innovation investments diffuse more effectively when they are co-located with regional production capacities, as they are in the EU, Canada and Germany (Clark, 2014[162]). The original Advanced Manufacturing Partnership proposal for the NNMI suggested 50 or more MIIs, each focused on technology relevant to the future of advanced manufacturing in the United States. The new policy targeted federal investment in technologies rather than industries (i.e. steel) or sectors (i.e. energy) which were more frequently the focus of trade policy or basic research investments. Fourteen individual MIIs were designated between 2012 and 2015.

By 2018, the NNMI evolved into a federal programme that: i) invests in basic technology; ii) sites those investments within newly formed regional technology institutes (MIIs); and iii) works to link technological development to industrial capacity and, ultimately, job growth. In addition to disrupting previous innovation policy approaches by focusing on regional innovation systems, the MIIs were all initiated around technologies rather than industries. Among the targeted technologies are several often identified as "disruptive", including additive manufacturing, digital design in manufacturing, flexible electronics and biopharmaceuticals.

Table 3.4. Manufacturing Innovation Institutes in the United States

Manufacturing innovation institutes	Targeted technology	Primary city	State	Year
National Additive Manufacturing Innovation Institute (AmericaMakes)	3D printing and additive manufacturing	Youngstown	Ohio	2012
Digital Manufacturing and Design Innovation Institute (DMDII)	Digital manufacturing	Chicago	Illinois	2014
Lightweight Innovations for Tomorrow (LIFT)	Lightweight materials	Detroit	Michigan	2014
American Institute for Manufacturing Integrated Photonics (AIM Photonics)	Photonic integrated circuits	Albany	New York	2015
Flexible Hybrid Electronics Manufacturing Innovation Institute (NextFlex)	Flexible electronics	San Jose	California	2015
Next Generation Power Electronics Institute (PowerAmerica)	Wide-bandgap semiconductors	Raleigh	North Carolina	2014
Institute for Advanced Composites Manufacturing Innovation (IACMI)	Composite materials	Knoxville	Tennessee	2015
Advanced Functional Fabrics of America (AFFOA)	Textiles	Cambridge	Massachusetts	2016

Advanced Tissue Biofabrication Manufacturing Innovation Institute (ATM-MII)	Regenerative medicine and tissue engineering	Manchester	New Hampshire	2016
Clean Energy Smart Manufacturing Innovation Institute (CESMII)	Smart sensors and digital process controls	Los Angeles	California	2016
National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)	Biopharmaceutical	Newark	Delaware	2016
Advanced Robotics Manufacturing (ARM)	Robotics, AI and automation	Pittsburgh	Pennsylvania	2017
Rapid Advancement in Process Intensification Deployment (RAPID)	Process intensification and modularisation	New York	New York	2017
Reducing Embodied-energy and Decreasing Emissions (REMADE)	Design for reuse and remanufacturing	Rochester	New York	2017

Source: Clark, J. (2018[161]), "From theory to practice: What policies can prepare regions for the challenges and opportunities associated with disruptive technologies?", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 November 2018, Paris.

In Sweden, RI.SE is an example of a centre providing applied innovation infrastructure (Box 3.16). The EU has a strong strategy for scientific research infrastructure but innovation infrastructure may be lacking. Innovation infrastructure is essential for innovators to reduce risk, reduce time to market and connect different innovation ecosystems to explore complementarities. Establishing an innovation infrastructure strategy by fostering the creation and connection of organisations like RI.SE across the EU can be a "functional equivalent" to the megacities mode from China and the United States. Megacities provide a space for exploring new ideas and innovation complementarities across a diversified industrial base and skillsets. Strengthening and scaling initiatives such as the Vanguard Initiative (2016[156]) is an example of an approach to link fragmented innovation ecosystems and infrastructures.

Box 3.16. RI.SE innovation infrastructure, Sweden

RI.SE is an independent state-owned institution in Sweden providing innovation infrastructure in different regions, in the form of a broad range of testbeds, laboratories and demonstration centres with real-life conditions. It employs 2 700 people, 30% of whom hold PhDs and manages over a 100 testbeds and demonstration facilities that are open to businesses and higher education institutions. The purpose of the organisation is to be profit-driven but not to pay dividends to the shareholder, re-investing its profits. The revenue streams of the centre accrue primarily from conducting industrial research in collaboration with firms and universities and by providing testing facilities, certification and training. A large proportion of customers are SMEs that are responsible for approximately 30% of RI.SE's revenue.

RI.SE's regional presence has spread, growing organically based on the business needs of local communities, with regional nodes giving local agents access to national infrastructure. The organisation has offices, testbeds and demonstration environments in 11 cities. RI.SE works with local governments to develop regional innovation strategies, helping to co-ordinate policies across different layers of government, finding complementarities and avoiding overlaps. RI.SE's co-ordinating role is especially relevant within complex and highly fragmented innovation ecosystems where a multitude of actors and programmes target different sectors or innovation-related activities, often leading to duplication of efforts or negative interactions. RI.SE is often the only national actor with a regional presence that helps to make national input available at a local level to universities and firms.

Source: RI.SE (n.d.[163]), *Homepage*, https://www.ri.se/en (accessed 24 April 2019).

Innovation districts

The innovation districts approach consists of having cities or regions themselves managing disruptive innovation. Through a combination of development incentives (or facilitated permitting and certifications) for private enterprise and strategic investments in public sector deployments, regions can push the implementation of the enabling platforms and systems required for the diffusion of disruptive innovation. Cities can tailor how that diffusion happens by minimising the extraction-oriented revenue models that can compromise privacy, safety or security of citizens such as through targeted regulations of data and connectivity.

Since 2010, a wave of local philanthropic investments has increasingly targeted capacity-building in urban and regional governments to address the application of disruptive innovation in cities. In the private sector, the promise of disruptive innovation relates to productivity and growth. In the public sector, the promise of increasing productivity of public services is also appealing. The potential to provide city services more sustainability, more efficiently and more equitably is particularly promising. Concerns about city-scale responses to climate change have increased interest in developing and diffusing urban policies for resilience planning.

Many urban innovations in the interest of municipal authorities attempt to leverage the same disruptive technologies that drive interests in the private sector. Necessary deployments require many of the same interventions and platforms that the private sector requires in terms of data and connectivity. Such innovations include municipal wireless, small cell deployments, environmental sensor arrays (array of things), electric charging stations, smart cities testbeds, 5G and autonomous vehicles.

In Korea, the city of Daegu has been pursuing multiple investments to manage the introduction and diffusion of electric vehicles and beyond to autonomous vehicles (Box 3.17). Many large cities such as Boston, Chicago and New York (United States), London (United Kingdom) or Paris (France) have identified the need for increased internal expertise in disruptive technologies and the analytical ability to understand how they might affect the management and administration of city services and operations. Often local governments did not have the resources to invest in the expertise required in the wake of the public sector downsizing exacerbated by the 2008 recession, collaborating with the private sector for seeding capacity within through “innovation delivery teams” and resilience officers (Clark, 2018[161]).

Box 3.17. Electric Vehicle Leading City, Daegu, Korea

The Metropolitan City of Daegu in Korea has been adapting to disruptive technologies promoting industrial rejuvenations both through the demand and through the supply side. The city was a traditional textile manufacturing hub that gradually moved to auto parts and machinery production. With the 2016 “C-Auto” mid- and long-term comprehensive plan, the Metropolitan City of Daegu decided to aggressively pursue a strategy to establish the city as a leader in electric vehicles.

The strategy involved infrastructure investment in charging stations, subsidies to the producer as well as consumers. To start the local production, the city focused on cargo delivery vehicles (both four- and two-wheelers) and supported strategic partnerships between domestic logistics and delivery companies, local electric vehicle producers and in particular local start-ups (Zein Motors and Green Mobility). Investment in charging infrastructure, production infrastructure and subsidies for the purchase of electric vehicles is combined with additional monetary incentives (reduced fares on toll roads, reduced parking fees, support for charging fees and various other tax cuts) and regulatory support for electric vehicles. The efforts have led to Daegu having the highest rate of new electric vehicles per capita in Korea (in 2019) and winning the Korean brand award as “Electric Vehicle Leading City” two years in a row (2018 and 2019).

The ambition of the Metropolitan City goes beyond electric vehicles. With the Daegu International Future Auto EXPO and investment in research and testing infrastructure, the city aims to build an ecosystem for autonomous vehicles.

Source: Daegu (2019[164]), http://info.daegu.go.kr/mnews/view.php?key3=238650; MK (2018[165]), "Zein Motors opens Korea's 1st electric truck production factory", https://www.mk.co.kr/news/english/view/2018/05/314069/.

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Notes

[1] See http://data.worldbank.org/about/country-and-lending-groups (accessed 5 August 2019) for the World Bank classification of countries by income level.

[2] See https://www.rand.org/topics/delphi-method.html (accessed 21 August 2019).

[3] See Bosetti et al. (2012[169]) for a survey design that aims to test and minimise bias.

[4] The discussion of regional characteristics follows Koutroumpis and Lafond (2018[11]).

[5] See OECD (2018[151]) for details.

[6] Total consumption for aluminium production was14 334 kWh in 2016 and total overall consumption 18 059 kWh according to Statistics Iceland, https://px.hagstofa.is/pxen/pxweb/en/Atvinnuvegir/Atvinnuvegir__orkumal (accessed 13 August 2019).

[7] Calculations based on UN COMTRADE data for 2018, https://comtrade.un.org/data (accessed 13 August 2019).

[8] Based on Statistics Iceland, https://px.hagstofa.is/pxen/pxweb/en/Atvinnuvegir/Atvinnuvegir__orkumal (accessed 13 August 2019).

[9] Southern-Kanto (12.1%) and the Kansai region (4.9%) in Japan, Guangdong (7.9%) in the People's Republic of China, California (7.1%) in the United States and Korea's Capital Region (4.9%). Calculations based on OECD Regional Statistics (database), https://doi.org/10.1787/region-data-en (accessed 13 August 2019). The shares slightly overestimate the total as only OECD countries with TL2 regions and large patenting countries are considered. The OECD database includes slightly more than 208 000 Patent Cooperation
Treaty (PCT) patents for 2015 whereas the global total was about 218 000, https://www.wipo.int/export/sites/www/ipstats/en/docs/infographics_pct_2015.pdf (accessed 14 August 2019).

[10] MIT OpenCourseWare Site Statistics and Monthly reports, https://ocw-origin.odl.mit.edu/about/site-statistics/ and https://ocw-origin.odl.mit.edu/about/site-statistics/monthly-reports/ (accessed 14 August 2019).

[11] The project won the 2018 Regio Stars Award in the category "Smart Industrial Transition", https://ec.europa.eu/regional_policy/en/projects/portugal/business-and-shared-services-centre-supports-smart-growth-in-portugals-centro-region (accessed 13 August 2019).

[12] The chapters are Culture, Entrepreneurship and Growth (Doepke and Zilibotti, 2014[170]), Trust, Growth and Well-Being: New Evidence and Policy Implications (Algan and Cahuc, 2014[168]) and Family Ties (Alesina and Giuliano, 2014[167]).

[13] The shares refer to the "main component" of the co-patenting network, i.e. the largest, weakly connected component of the network of co-patenting inventors. Casper (2009[120]) considers both direct co-patenting relationships, i.e. two or more inventors that file a joint patent and indirect relationships. Indirect relationships link inventors that do not co-patent themselves but have a joint co-inventor with whom they filed separate patents (with patents being filed no longer than five years apart).

[14] The study measures general-purpose technologies (and other technologies) using patent data. The definition of general-purpose technologies follows the EC's "key enabling technologies" (Vezzani et al., 2014[172]). They are: i) nanotechnology; ii) photonics; iii) industrial biotechnology; iv) advanced materials; v) micro- and nano-electronics; vi) advanced manufacturing technologies.

[15] In addition larger cities also provide those individuals with stronger skills greater opportunities to learn and increase the economic returns to their skills (Roca and Puga, 2017[171]).

[16] These systems of cities can span large distances and form "megaregions" connected through infrastructure, economic connections, settlement patterns and land use, topography, an environmental system or a shared culture and history that together shape a common interest for the wider region (Glocker, 2018[166]).

[17] The OECD is working towards the development of general principles for enhancing access to and sharing data across the economy in a coherent manner, https://www.oecd.org/internet/ieconomy/enhanced-data-access.htm (accessed 24 July 2019).

[18] Interreg Europe helps regional and local governments across Europe to develop and deliver better policy. Interreg Europe has a total volume of EUR 359 million for the 2014-20 period and co-finances up to 85% of project activities that are carried out in partnership with other policy organisations based in different countries in Europe.

4 Supporting innovation in all types of regions

This chapter highlights the need to go beyond a research- and patenting-oriented approach to innovation policy in regions that do not (yet) have broad-based capacity for frontier research. It highlights the external nature of knowledge flows and the different skill needs in regions that are not at the innovation frontier. The chapter provides guidance on a sequential approach to upgrading regional capacity, building and developing existing strengths.

Introduction

Innovation is key for growth in all types of regions but many regions are struggling to transition towards new growth opportunities and to reap the benefits that a constantly expanding global pool of knowledge offers. Regional productivity and innovation gaps highlight that knowledge diffusion is by no means automatic. What helps regions to innovate depends on the capacity of their regional innovation system. Research highlights the role of "absorptive capacity" of regional innovation systems. For instance, larger investments in research and development (R&D) have different growth impacts in regions depending on the degree of "absorptive capacity" (Ahlin, Drnovšek and Hisrich, 2014[1]). Incentives for firms, national framework conditions and infrastructure play a role in solving the "diffusion puzzle" (Andrews, Nicoletti and Timiliotis, 2018[2]), as do regional factors (OECD, 2016[3]), much of the puzzle remains unsolved.

Countries are seeking strategies to promote innovation activities that are effective for all types of regions. In some cases, they do so by adapting rules in an attempt to enable all regions to participate in research activities, e.g. through modified co-financing and eligibility criteria for grants for different regions to overcome a lack of public funds. European Union (EU) funds, for example, have co-financing rates that vary by the income level of countries and regions. Relaxing eligibility criteria for participation in programmes has been an additional strategy, e.g. the Entrepreneurs' Programme in Australia has support strands with lower requirements in terms of annual turnover or operating expenditures for firms applying from remote regions.[1] Some countries allow for deviations from excellence-based criteria beyond minimal quality requirements for applicants to programmes from less-developed regions (Maguire and Weber, 2017[4]).

Modifying the access and funding criteria of traditional innovation policies can help overcome some barriers, but is not enough to facilitate regional catching-up. Making sure all regions benefit, independently of their level of development, will require new policy instruments that go beyond simply modifying traditional innovation policies and address the root causes of the lack of innovation. It also requires going beyond traditional indicators used to benchmark innovation efforts to better account for the nature of innovation in less-developed regions. Innovation policy and respective indicators need to be broadened, adapting to factors that act as framework conditions for innovation diffusion and the specific needs of firms far from the technological frontier. Any strategy that supports innovation diffusion also needs to account for the capacity of local actors and the regional innovation system as a whole.

This chapter focuses on innovation in regions lagging behind the technological frontier. It considers how innovation policy can be broadened and dynamically adapted to match regions' development and institutional capacity. Broadening innovation policy aims at including factors that are typically overlooked by traditional policies. Different policy instruments are presented, along with practical regional examples with a focus on "non-frontier regions", i.e. those lagging behind the innovation and science frontier.

This chapter and the whole report draw from a series of expert workshops on "What works in innovation policy? New insights for regions and cities" organised by the OECD and the European Commission (EC). For each workshop, experts provided background papers that, together with the discussion during the workshop, form the basis for this report:

- Fostering innovation in less-developed regions, with papers by Slavo Radošević (2018[5]) and Lena Tsipouri (2018[6]).
- Building, embedding and reshaping global value chains, with papers by Riccardo Crescenzi and Oliver Harman (2018[7]) and Sandrine Labory and Patrizio Bianchi (2018[8]).
- Developing strategies for industrial transition, with papers by David Audretsch (2018[9]) and Charles Wessner and Thomas Howell (2018[10]).
- Managing disruptive technologies, with papers by Pantelis Koutroumpis and François Lafond (2018[11]) and Jennifer Clark (2018[12]).
- Experimental governance with papers by Kevin Morgan (2018[13]) and David Wolfe (2018[14]).

Innovation in non-frontier regions

Innovation can create opportunities in all types of regions, regardless of their level of development. Policies fostering regional innovation, however, need to adapt to the nature of local innovation activities, which can vary substantially according to regional characteristics. The most developed regions at the frontier of science and technology (frontier regions) have very different types of innovation activities in comparison with regions that are lagging behind the frontier (non-frontier regions).[2] R&D investment, for example, comes mainly from the private sector in many frontier regions; in less-developed regions the academic or public institutions account for most of the spending. Private-sector R&D is, however, highly concentrated. Five out of 258 TL2 regions account for one-third of total private-sector R&D spending in 34 OECD countries, 13 regions account for half and 28 regions for two-thirds of total spending. The bottom half of OECD regions account for less than 4% of private-sector R&D spending.[3] Copying policies that were successful in frontier regions is not necessarily a good strategy, especially for regions that are far from the technological frontier. The nature of the innovation system in frontier regions that supports policy success is intrinsically different.

Innovation in non-frontier regions relies more on imitation and adoption than the development of own innovations. The distinction can be captured by a dichotomy between production capabilities and technology capabilities. Production capabilities are the capabilities of a region in using a given capital-embodied technology, labour and set of the organisational methods (e.g. managerial skills) to produce output. Technological capabilities, in contrast, are those that generate and manage technological change. For non-frontier regions, production capabilities are the main driver of growth through innovation (Kravtsova and Radosevic, 2012[15]). Technology transfer activities are therefore important drivers of innovation along with non-R&D-based innovation activities as they strengthen production capabilities. For firms operating in countries that are further from the technological frontier, R&D plays less a role in developing successful product innovations than technology transfer (Reinstaller and Unterlass, 2011[16]).

In regions that are further from the scientific frontier, the nature of innovation relates to production capabilities. It includes, for example, incremental changes to production processes, local adaptations of established technologies by importing capital and knowledge, or local institutional capacity building to manage innovation policies. Identifying instruments that can effectively foster innovation in non-frontier regions requires understanding local opportunities and bottlenecks, and dynamically adapt as local contexts change (because local needs will change over time if policies are successful). Investment in this context is a necessary but not a sufficient condition: what is required for catching up is structural transformation (Wostner, 2017[17]).

Traditional innovation indicators are not adapted to capture innovation in non-frontier regions. They are focused on technological capacities and perform well in capturing the type of innovation activity taking place in frontier regions, but not in any others. Traditional innovation indicators include metrics such as R&D expenditures, number of patents, numbers of academic publications or number people with PhDs. Lack of R&D, patents and scientific publications does not necessarily imply lack of knowledge, competitiveness or innovation capacity. Standard metrics based on R&D or science-based orientation of innovation policy do not represent the entire spectrum of innovation, in particular for regions that are farther from the scientific frontier. R&D based metrics are biased towards science efforts, which are only appropriate in frontier regions.

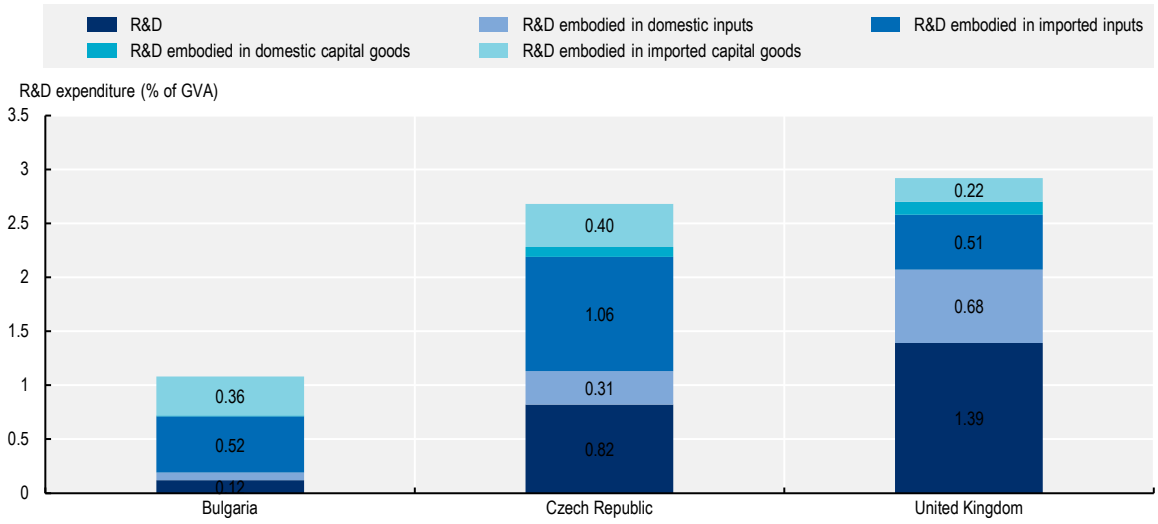
Knowledge diffusion, embedded R&D and intangibles

Investment in innovation in non-frontier regions differs in two important dimensions. The first is that investment is more focused on tangible capital than on intangibles (knowledge-based assets). The second is related to this aspect. R&D and development of new technologies are, for the most part, not implemented by the firms in non-frontier regions themselves but imported from other regions through capital investment (i.e. tools and machinery). Fostering the adoption of knowledge developed in frontier regions through

imported equipment and practices is a form of knowledge diffusion promotion. Regional catching-up depends largely on the capacity to adopt imported technology and knowledge, making embodied R&D in imported technology and inputs an important policy goal in non-frontier regions.

Firms in non-frontier regions can buy the same sophisticated equipment and inputs as firms in frontier regions. Innovation is therefore targeted towards generating value-added based on similarly sophisticated equipment and inputs without making many own R&D efforts. Firms in Bulgaria, invest three times as much in R&D that is embedded in imported tools and machines than they spend on their own R&D (Figure 4.1). Even more important is the knowledge-intensity of inputs that firms import. The Czech Republic was close to the United Kingdom terms of total R&D used in production. The countries differ substantially in the contribution of different components. About 50% of R&D investment in the United Kingdom is direct spending on R&D, which accounts for less than one-third in the Czech Republic. Instead, about 40% of R&D expenditure used in the production in the Czech Republic comes in the form of imported inputs, e.g. instead of developing and building high-tech components of cars locally, the focus is on the design of the outer body and the assembly of components, R&D-intensive modules imported from other countries (Pavlínek, 2012[18]).

Figure 4.1. Direct R&D and R&D embodied in inputs and capital goods, 2000-01



Note: Bulgaria (2001), Czech Republic (2000) and United Kingdom (2000). See source for detailed methodology to calculate the expenditures.
Source: Radošević, S. (2018[5]), "Fostering innovation in less-developed and low institutional capacity regions: Challenges and opportunities", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris, based on Knell, M. (2008[19]), *Product-embodied Technological Diffusion and Intersectoral Linkages in Europe*, https://www.researchgate.net/profile/Mark_Knell/publication/265369750_Product-embodied_technological_diffusion_and_intersectoral_linkages_in_Europe/links/5409c8550cf2d8daaabf3431/Product-embodied-technological-diffusion-and-intersectoral-linkages-in-Europ.

As R&D is embedded in inputs and capital investment, innovation in less-developed regions comes from the side of trained workers, skilled technicians and firms' engineers, rather than from the academic side, i.e. PhDs and university engineers. Innovation policy is, however, very much geared towards academic R&D and firm links. This focus works in regions with a strong local R&D base, where pure science, basic and applied research rely on PhD-level of knowledge. Embodied R&D, based on improvements in quality and features of products and processes require either skilled engineers or skilled technicians working together. The areas in between – exploratory and advanced development – do not necessarily require PhD, but MSc and BSc levels of knowledge or even vocational training. The different knowledge levels required in own or embodied R&D are not necessarily hierarchical in terms of complexity. The knowledge base in the applied research area is more about science and of experimental nature. In advanced

development, the required knowledge is mainly about engineering and is oriented towards solving concrete problems (Radošević, 2018[5]).

Investment in tangible capital can benefit from complementary investment in knowledge-based capital. Intangibles in many definitions focus on the innovative property of firms, i.e. exploitable and concrete assets such as patents, copyrights or trade names.[4] These can be an important stimulus for growth, even in less-developed countries or regions (WIPO, 2017[20]). There is, however, also a broader notion that includes computerised information (software and databases) and – importantly – economic competencies: firm-specific human capital, networks of people, managerial capacity, etc. (OECD, 2013[21]). Economic competencies can complement tangible capital and are often a bottleneck in underperforming firms. The introduction of structured management practices in textile companies in India raised productivity by 17% and led to openings of new plants within 3 years (Bloom et al., 2013[22]). Such gains are not limited to the developing country context. The productivity difference between a US firm that is among the 25% with the worst management practices and a firm around the median is about 13.6% (Bloom et al., 2019[23]).

Managerial practices are important but any strategy to upgrade innovative capacity needs to consider a wider range of knowledge-based assets. Computerising business processes and using computerised information is a key asset for many companies. Data are increasingly generated along with business operations (process data) and compiled at various stages of business transactions, e.g. in the form of user, customer or supplier data (OECD, 2019[24]). Firms relying more heavily on data analytics in their operations produce more and are more productive, but limited digital skills can hold back uptake of these opportunities (Bianchini and Michalkova, 2019[25]). Digital literacy is, however, rather limited across the workforce in OECD countries. More than 40% of employees who use software at work every day do not have the skills required to use digital technologies effectively (OECD, 2016[26]).

A non-linear model of technological upgrading

Innovation policy often follows a linear notion of technological upgrading. In such a view, fostering academic excellence and private-sector R&D underpin progress in a region. Developing local excellence in basic or fundamental research just needs to be translated into applied work with incentives to secure and exploit intellectual property rights. Private-sector R&D complements academic research and engagement between the two sectors provides mutual gains for both sides as well as the region as a whole. Public policy finds its role in fostering links between research and private sector, ensuring an environment where firms and academics see benefits in the commercialisation of new ideas and providing a regulatory and fiscal framework that encourages R&D investment.

While this approach can be very successful in regions with a strong innovation system, emulating it in less-developed regions is unlikely to provide the same gains. Developing “excellence” is far from trivial. It takes time to develop talent locally and the rewards resulting from investment can take a long time to materialise. The foundations for today’s breakthroughs in artificial intelligence (AI), machine learning and deep learning are more than 20 years old. It took decades for computational power to evolve to the point where the theoretical approaches could become reality. Canada’s Edmonton, Montréal and Toronto regions are leveraging the seminal contributions made by professors at their local universities and developed AI clusters attracting significant public and private investment.[5] By trying to attract top researchers, countries or regions can try to reduce the timespan required, but they still have to choose a field and specific researchers they want to target. The competition for those already identified as “superstars” through their academic record can be fierce and end up in benefitting mostly those targeted academics.[6]

Even in places where there is academic excellence in some field, the question remains on how to create local links and commercialise ideas. For academics, the benefits of collaborating locally might be lower than finding partners in other parts of the country or even internationally. In many countries, academic career incentives focus on academic publication and securing research funding, patenting or

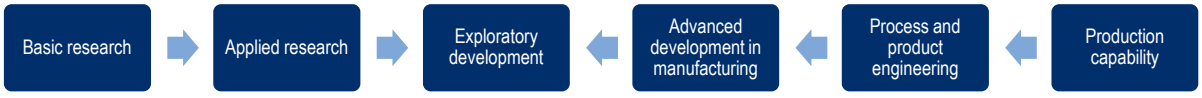
entrepreneurial activity are much less relevant (if at all). This means that effective policies or programmes that incentivise commercialisation and – more generally – university links with the private sector, require establishing a regulatory framework, including links with funding, clear property rights, settling potential confidentiality issues, aligning career incentives for professors and establishing trust among actors (OECD, 2018[27]).

The local industrial structure and the position a region takes within local, national and global value chains (GVCs) differ substantially between regions. Manufacturing plays a crucial role for both the district of Biberach in the southern German state of Baden-Württemberg and the north-western Hungarian county of Győr-Moson-Sopron. In both places, about 50% of total gross value added (GVA) produced comes from manufacturing and more than one-third of jobs fall within the sector.[7] But whereas production in Biberach is a mix of pharmaceuticals, machinery and specialised consumer and medical products with headquarter and research functions located in the area, production in Győr-Moson-Sopron is concentrated in the manufacture of automotive parts with major multinational companies locating their production facilities in the county. Branching out into new fields or upgrading existing activities is unlikely to follow the same path in the two places. Cost-competitiveness plays a major role in the attractiveness of production locations in regions that are lagging behind the innovative frontier. That does not mean that there is no room for upgrading.

Regions can follow very different growth paths, from focusing on existing specialisation to branching out in related or unrelated varieties (Grillitsch, Asheim and Trippl, 2018[28]). Between the stylised extremes of pure specialisation and branching out into completely new fields, there is a myriad of mixed models of development. What path regions follow depends on the choices by many different actors, with national and regional policy playing an important role in setting framework conditions and incentives for the actors in the innovation system. What path would be the most prudent to follow in a given regional context is therefore an important question for policymakers at different levels. There is, however, no unique answer as to "what works?". Which path proves successful depends very much on the characteristics of local firms and their business models, the local academic and non-academic research infrastructure, the skills of the local workforce, the national and international links of the region, the policy framework and the individual instruments that are in place, etc.

The steps that non-frontier regions take to reach more advanced modes of production can be very different from those taken by frontier regions. The traditional view of achieving commercialisation of R&D investment and innovative activity is primarily dominated by transitions from basic research to applied research and then to exploratory development or advanced development (Figure 4.2).[8] To reach the stage of commercialisation of ideas – often the focus of innovation policy – non-frontier regions tend to start from and focus on production capabilities. Building on improvements in production capability, regions can achieve an expansion of process and product engineering activities that are not research or development-focused but rather adoption and adaptation of existing technologies. These two processes are facilitated by skilled workers but not necessarily university-educated workers. They can serve as stepping stones towards advanced (prototyping in manufacturing) and exploratory development (prototyping in a system), the areas that are vital to the technology upgrading of regions and countries with less advanced innovation capacities (Radošević, 2018[5]).[9]

Figure 4.2. A two-way model of technology upgrading



Source: Radošević, S. (2018[5]), "Fostering innovation in less-developed and low institutional capacity regions: Challenges and opportunities", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

Leveraging geographical spillovers

Attracting firms with more advanced knowledge to non-frontier regions has the potential to boost local innovation capacity and help regions develop. However, advanced firms tend to favour frontier regions. Non-frontier regions have to compete with the wider availability of skilled workers, good accessibility, as well as a strong innovation system in leading regions within their own country, as well as internationally.

Their geographical location can be an advantage for non-frontier regions. Especially for low-density regions that lack the critical mass to establish a diversified economic base with advanced services and academic institutions. Cross-regional collaborations in this case are significantly easier when physical distances are short. By concentrating on their local comparative advantage and drawing on the innovation system in more advanced regions that are in close proximity, non-frontier regions can accelerate their own upgrading. This is evident, for example, among rural regions, those close to cities are more dynamic and resilient as compared to rural remote regions. Rural regions close to cities are home to more than 80% of the rural population and their income and productivity growth tend to be more similar to that of urban regions (OECD, 2016[3]). Between 2010 and 2015, rural regions close to cities have even narrowed the productivity gap with predominantly urban regions by 3 percentage points (OECD, 2018[29]).

Well-designed policies can support the mutual benefits of cross-regional integration. The lack of local knowledge can be compensated with frequent interactions and collaborations with firms from nearby regions (Jakobsen and Lorentzen, 2015[30]). Specialised services or top universities that can be found in one region can be complemented by affordable land prices, housing cost and environmental amenities in others. Policies promoting cross-regional collaborations and decreasing communication costs, such as the promotion use of digital tools, have the potential to facilitate such interactions and collaborations. Digital technological developments can also benefit non-frontier regions with traditional or mature manufacturing industries. Integration of digital technologies in production, sales and even in the development of new products is an important transformation for many traditional manufacturing firms (Bailey, Corradini and De Propris, 2018[31]).

From a regional policy perspective, the diffusion of knowledge is an important objective. For firms, diffusion is often considered leakage that benefits competitors. The knowledge leak might not outweigh potential gains of capturing knowledge from others, especially for leading innovating firms already in the knowledge frontier. In places with fewer similar firms, a leading company might be better able to internalise the gains from knowledge diffusion, e.g. by engaging local firms in their supply chain and supporting their technological upgrading. In frontier regions, firms also face more intense labour poaching (Angeli, Grandi and Grimaldi, 2013[32]). For example, in Sweden, knowledge-intensive firms do not seem to grow faster in frontier regions and the relation between their internal knowledge intensity and regional knowledge intensity is negative. Firms with less inhouse knowledge capacities are benefitting more from locating in frontier regions, possibly because of being less capable of sourcing knowledge from outside. Firms with high inhouse knowledge capacity are penalised from locating in frontier regions, potentially due to knowledge leaking and labour poaching (Grillitsch and Nilsson, 2016[33]).

Local institutional capacity for innovation policies

Effective investment in innovation in non-frontier regions requires more than transfer of resources (Tsipouri, 2018[6]). An effective innovation system builds on the complementarities between investments (in physical and human capital), technology (knowledge of production and management) and institutions (effective governance). The performance of systems with strong complementarities depend on the performance of its weakest link rather than on the performance of the strongest performers.[10]

A bottleneck in regions growing below the average is often the institutional capacity of local or regional governments. Building institutional capacity needs to be a priority before or in parallel with other innovation

policies. Poor and inadequate governments limit the efficiency of knowledge spillovers and learning. Regions with governments that are capable of designing and implementing effective policies, while at the same time controlling corruption, are much more innovative than those where governments are ineffective and corruption is widespread. Government institutions are responsible for regulating learning processes, supporting the formation of mutual trust and facilitating the transmission of knowledge between innovation players.

For low levels of institutional capacity, little improvements in the quality of government yield large gains in regional innovation capacity. Institutional capacity for innovation policy in less-developed regions is rarely addressed in policy packages. However, the reality is that knowledge and technical skills requirements for innovation policy are demanding, often above competencies in the public sector in these regions. Improvements can support the uptake of innovation but even foster the production of knowledge (measured in terms of patents). Improvements in government quality have only a small effect on patenting in regions with strong innovation performance but significantly larger effects in less-developed regions (Rodríguez-Pose and Di Cataldo, 2015[34]).

A key institutional factor facilitating regional growth is the capacity to use negotiation and dialogue as tools for mobilising key actors. Additional factors include the institutional arrangements that support economic development, the space for regional actors to have a common voice and a strong position, and the active role for key local public and private actors focusing on innovation (see Box 4.1). The most common institutional bottlenecks include the poor mobilisation of stakeholders, the lack of continuity and coherence in policy implementation by institutions, the lack of a common and strategic vision, the low institutional stability and capacity, and the gaps in multilevel governance (OECD, 2012[35]) Ensuring coherence of innovation policy with other policy fields within a region, as well as across levels of government is often a challenging task in less-developed regions. Leveraging existing initiatives and well-functioning agencies, e.g. by broadening the mandate, can ease the task (Aridi et al., 2019[36]). Concentrating policy functions in one institution can enable more efficient use of resources by finding policy complementarities and funding synergies. For example, giving the responsibility of managing local clusters to investment promotion agencies (IPAs) has the potential to better co-ordinate regional development policies with the function of attracting foreign capital and GVC integration. Upgrading IPAs to institutional pockets of excellence by managing foreign direct investments (FDI) and cluster policies has the potential for enabling complementarities because clusters are more likely to succeed if well integrated in GVCs.

Choosing to extend the responsibilities of an existing institution requires careful identification of the right capabilities and incentives. Moving from the abstract notion of “innovation policy” to concrete tools often requires specialist technical knowledge or experience, favouring specialist staff over generalists. In many cases, innovation agencies, therefore, rely not only on recruiting staff with specific technical skills but also specific industry experience (Glennie and Bound, 2016[37]). Finding the right kind of skills is often difficult in less-developed regions. At a minimum, frontline staff need to be able to identify private-sector providers that can implement support programmes (Cirera and Maloney, 2017[38]).

Box 4.1. Examples of institutional factors acting as enablers or bottlenecks for growth

Field interviews and a survey conducted in 23 regions with key regional stakeholders including the private sector, the academic community, non-governmental organisations (NGOs) and regional policymakers showed that next to infrastructure investment and regional policy, the institutions, such as governance, leadership, capacity, continuity and mobilisation, in a region are crucial in enabling growth (OECD, 2012[35]).

Regional examples of institutional factors facilitating regional growth include:

- Institutions that facilitate negotiation and dialogue are important for mobilising key actors in several regions as Asturias (Spain), Jalisco (Mexico) and Zuid-Nederland (Netherlands).
- Institutional arrangements supporting economic development, such as building local institutional capacity and guiding regional development are important elements in Wielkopolskie (Poland).
- In Zuid-Nederland, a common voice and strong position among the public, private and education sectors at the regional level is an asset for communicating with the central government.
- The active role played by key local public and private actors focusing on innovation and workforce development/retention is an important element in Marche (Italy).

Source: OECD (2012[35]), *Promoting Growth in All Regions*, http://dx.doi.org/10.1787/9789264174634-en.

Adapting innovation policy

There is no need to "reinvent the wheel" when it comes to innovation policy in non-frontier regions. Regions have many opportunities to learn from experiences in other regions within and outside their own country. What is, however, important is that identifying potential policies is only a first step before adapting them to the region's local context. The mechanical transfer of policies can prove ineffective as it might not be appropriate for the industrial structure, the academic support network, the institutions in the region or the (lack of) relationships between them. This is the case for innovation policy mixes as a whole, but also for individual tools and measures.

The crucial step of adapting policies and policy mixes is often missing as governments follow a "cookie cutter" approach. An assessment of national innovation policies for 29 European countries over the 2004-12 period finds that policy mixes fall into 5 broad groups. Countries with very different innovation performance and challenges are combined in each of the five groups. Such strong similarities in innovation policy are driven by positive trends, such as peer learning and integration of policy efforts in the EU. But the lack of variety in innovation policy across heterogeneous countries might also indicate that innovation policies are not being tailored to the actual needs and strengths of each place (Izsak, Markianidou and Radošević, 2015[39]). The results also suggest that the overall policy mix remains fairly stable over time. Only one country, Germany, is found to have substantially shifted between policy mix groups between 2004-08 and 2009-12, whereas changes are otherwise focused on shifts in funding priorities.

To adapt policies, non-frontier regions should follow an iterative model of learning, adaptation and revision. To be successful, this requires that innovation instruments have to be regularly reviewed and evaluated, adjusting to the changing stage of development and increasing capacity in different regions (see Chapter 5).

Innovation policy as a moving target: From enclaves to innovation ecosystems

The path towards new technological capacities in less-developed regions depends on the stage of the regional innovation system. For places with little capacity, the first step is to establish an anchor, a "pocket of excellence" that can be the starting point for technological upgrading of the region (Table 4.1).

Table 4.1. Building innovation ecosystems

	Building an enclave	Building critical mass	Becoming a globally connected innovation hub
Policy challenge	Generating pockets of excellence	Supporting complementarities, synergies, co-ordination issues	Internationalisation
Policy focus	R&D/knowledge generation capacity Absorptive capacity	Local networking and local demand	International networking
Success criteria	The functioning centre of excellence (R&D/upstream or manufacturing/service/downstream)	A critical mass of knowledge and commercial interactions	Globally plugged
Stages	A nucleus of the potential innovation ecosystem	Emergent innovation ecosystem	Globally or internationally relevant innovation ecosystem
Scope of focus	Internally focused	Intra-regional/intra-country focused	Internationally oriented

Source: Radošević, S. (2018[5]), "Fostering innovation in less-developed and low institutional capacity regions: Challenges and opportunities", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

Developing regional pockets of excellence

Developing pockets of excellence is an example of a strategy that needs a dynamic view, continued adjustment and links with external actors (e.g. through GVCs). The aim is not to stop at the development pockets of excellence but to support the spillover of knowledge and capacity of firms and workers within the pocket to stimulate innovation activity across the region. In this way, regions can build a critical mass for broader innovation efforts and cross-fertilisation. The final step towards the technological frontier is the internationalisation of innovation activities (Radošević, 2017[40]).

The pockets-of-excellence approach poses the risk of "enclave trap", whereby the organisations in the clusters operate in disconnection from local agents. The enclave trap is more likely to take place when the areas of specialisation of the cluster are poorly related to regions' industrial structure (Tsipouri, 2017[41]). Lack of relatedness can take place, for example, when the gap of technological advancement is too large, or when the modes of operation (e.g. business practices) are too different. In successful pockets of excellence, policies need to dynamically assess and focus on the factors that enhance the compatibility between the cluster and local agents.

Pockets-of-excellence policies need to move away from a "Robinson Crusoe" idea of innovation strategies. Policies need to be designed taking into consideration that local learning in regional innovation systems depends in large part of external knowledge and stimulus from experiences with external agents. To a large extent, innovation in less-developed regions is likely to come from interactions with more advanced regions through, for example, knowledge embedded in acquired machinery or copying business practices. Box 4.2 describes the example of the region of Shenzen in the People's Republic of China ("China" hereafter) and its adjustments to regional innovation policies over time.

Box 4.2. Shenzhen's growth into a global leader, China

Chinese industrial policy is mostly centralised but provides room for regions to decide on how to develop specific capabilities.

The Chinese government encouraged industrial development in Shenzhen in the 1980s with the introduction of some elements of the market economy in the socialist system. In this phase, FDI was strongly encouraged to help bring industrial knowledge and competencies to the region. Shenzhen

benefitted from becoming a Special Economic Zone and its localisation as gate for Hong Kong (China) to the rest of China.

Shenzhen did not have any universities in the 1980s. However, the government was increasingly concerned about the upgrading of the local industries and R&D capabilities were progressively developed in the region. At the same time, the policy of FDI attraction to access new knowledge and competencies continued. Shenzhen University was created in 1983 and the Shenzhen Polytechnic in 1993; external universities from other regions and abroad were also attracted so that many of them established divisions in the city-region. The Shenzhen Technological Park was also created in 1985, followed in 1996 by the Shenzhen High-Tech Industrial Park. These parks favoured the development of R&D in many fields and did not specialise on specific technologies.

From 2000 onwards, Chinese industrial policy shifted focus from FDI attraction to developing domestic capabilities. For this purpose, regions or city-regions were given some autonomy to implement specific actions. For instance, seven strategic emerging industries were defined in 2010, in various fields such as energy generation, biotechnologies, new materials, new energy vehicles, that would have to upgrade and develop R&D capacity. One of these strategic industries was the light-emitting diode (LED) industry in Shenzhen. The increased focus, however, led to overcapacity and the municipal government had to end their support (Yang, 2015[42]). Overall Shenzhen has been highly successful in developing autonomous capacity to upgrade its GVCs and develop new GVCs. This autonomous capacity has been developed by a mix of imported and domestic knowledge and competencies, as well as co-ordinated national and regional industrial policies (Prodi, Frattini and Nicolli, 2017[43]; Prodi, Nicolli and Frattini, 2016[44]).

Source: Labory, S. and P. Bianchi (2018[8]), "What policies, initiatives or programmes can support attracting, embedding and reshaping GVCs in regions?", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 21 September 2018, Paris; Yang, C. (2015[42]), "Government policy change and evolution of regional innovation systems in China: Evidence from strategic emerging industries in Shenzhen", *Environment and Planning C: Government and Policy*, Vol. 33/3, pp. 661-682; Prodi, G., F. Frattini and F. Nicolli (2017[43]), "The diffusion and embeddedness of innovative activities in China", http://dx.doi.org/10.1007/s40888-017-0088-9; Prodi, G., F. Nicolli and F. Frattini (2016[44]), "State restructuring and subnational innovation spaces across Chinese prefectures", http://dx.doi.org/10.1177/0263774x16664519.

Pockets of excellence in business: Cluster policies

Cluster policies can support the development of pockets of excellence that enhance regional competitive advantage helping firms and entrepreneurs within clusters move up the value chain through innovation and greater specialisation. Regional clusters contribute to regional competitiveness bringing together firms, higher education and research institutions, and other public and private entities to facilitate collaboration on complementary economic activities.

Governments support clusters through investments in infrastructure and knowledge-based capital. Most OECD countries have programmes to promote the creation of new clusters or to strengthen existing ones; for example, Belgium, France and Portugal have made cluster-based policies an integral element of their national innovation strategies or plans (OECD, 2014[45]).

As outlined above, there are pitfalls associated with cluster policy in less-developed regions. Whether the development of a new cluster succeeds depends strongly on the existence of a strong economic base in the region and on whether there is already economic activity in related sectors. Without those building blocks, cluster development is difficult (Ketels, 2013[46]) The ability to promote new cross-sectoral combinations for innovation and to avoid a purely sectoral approach to clusters that locks in existing sectors (e.g. automotive) can be more difficult to achieve in lagging regions with less economic diversity. To overcome these challenges, policymakers can be more stringent and allocate funds based on documented existing capacities and potential in the region. Cluster policies should avoid permanent ongoing cluster

support and promote cross-cluster linkages to reduce the potential for locking in certain sectors of the regional economy that prevent diversification to related and new fields (OECD, 2017[47]).

Instead of trying to artificially create clustered economic activity, cluster policy is often focused on delivering policy through clusters (Ketels, 2013[46]). Leveraging the existing agglomeration of activity can enhance the efficiency and effectiveness of policy. For example, co-ordination of R&D activities can be achieved with investments in the necessary skills and infrastructure, direct support for innovation in firms in the form of loans, tax credits and innovation vouchers, or with service support for entrepreneurs. The Innovation Superclusters Initiative in Canada (Box 4.3) and the Digital Park Thailand (see Box 4.4) are recent examples of cluster-based policies.

Box 4.3. Innovation Superclusters Initiative/ Initiative des supergrappes d'innovation, Canada

The Innovation Superclusters Initiative (ISI) invites industry-led consortia to lead and invest in bold and ambitious proposals that will supercharge regional innovation ecosystems. The programme supports new partnerships between large firms, small- and medium-sized enterprises (SMEs), and industry-relevant research institutions, promoting the development of globally competitive technology. A small number of high value, strategic investments will be made to build on shared private-sector commitment, demonstrated through matched industry funding, to position firms for global leadership.

The policy has the following key objectives:

- Generate new companies and commercialise new products, processes and services that position firms to scale, connect to global supply chains, transition to high-value activities and become global market leaders.
- Build a shared competitive advantage for their cluster that attracts cutting-edge research, investment and talent by addressing gaps, aligning strengths, enhancing attributes and positioning it as a world-leading innovation hotbed.
- Increase business expenditures on R&D and advance a range of business-led innovation and technology leadership activities that will address important industrial challenges, boost productivity, performance and competitiveness for Canada's sectors of economic strength.
- Foster a critical mass of growth-oriented firms and strengthen collaborations between private, academic and public sector organisations, pursuing private-sector-led innovation and commercial opportunities to enhance the cluster's pool of resources, capabilities and knowledge.

ISI was launched as part of the Innovation and Skills Plan to accelerate the development and growth of business-led innovation superclusters that will create new commercial and global opportunities for Canadian firms in fast-growing areas such as AI, advanced manufacturing and clean technology. Through the ISI, the government will provide non-repayable contributions to industry-led, non-profit entities with ambitious proposals that build a competitive advantage for Canadian firms.

The policy will support five key areas of activity:

- Creating technology leadership by supporting collaborative R&D or demonstration projects that enhance productivity, performance and competitiveness of member firms.
- Creating partnerships for scale by increasing demand for cluster products, linking SMEs with large firms and supporting integration into global supply chains.
- Creating a diverse and skilled workforce by addressing industry needs for talent.

- Creating access to innovation by investing in and providing access to assets services, or resources that benefit a range of cluster firms over a period of time.
- Creating a global advantage by enabling firms to seize market opportunities and attract international investments and partnerships.

Source: Country responses to the OECD Science, Technology and Industry Outlook 2016 policy questionnaire; EC/OECD (2016[48]), *International Science, Technology and Innovation Policy (STIP) Database*, https://www.innovationpolicyplatform.org/sti-policy-database.

Box 4.4. Digital Park Thailand, Thailand

Digital Park Thailand is set to be a new economic cluster, strategically located on 240 acres of land on the Eastern Economic Corridor (EEC), aiming to be the destination for digital global players and innovators to converge.

Digital Park Thailand has the following key objectives:

- To promote digital tech start-ups, and convert Thailand from a user to a developer of digital innovations to create a new business to compete in the world market, and to support the growth of other new industries in the near future.
- To attract and promote investment and reinforce Thailand as a regional hub for commerce and investment in the digital business.
- To develop telecommunication and digital technology infrastructure, expand submarine cable networks to establish Thailand as the Association of Southeast Asian Nations (ASEAN) telecommunication hub and gateway to the world.
- To generate a high-quality workforce to support future development and Thailand in becoming a regional digital workforce hub.
- To enhance the capability of Thai digital industry by upgrading information and communication technology (ICT) industry to digital industry according to the government's S-curve concept.

The 20-Year National Strategy (2017-36) and the 12th National Economic and Social Development Plan (2017-21) have emphasised the use of digital technology to drive the nation's economy and society. The 8th strategy on science, technology, research and innovation has set the framework on the areas to which digital technology can lend its support, namely: design and business management, digital transformation and manufacturing and service industry. Digital technology has been identified as one of the ten target industries and new engine of growth. In addition, Thailand 4.0 policy calls for the transformation from value-added industry to value-creation industry and digital technology is one of the key drivers to achieve this goal.

The Ministry of Digital Economy and Society designated the Digital Economy Promotion Agency (DEPA) and CAT Telecom Public Company Limited to establish Digital Park Thailand to support and promote the creation and transfer of digital technology. The plan was approved by the EEC Policy Committee on 6 July 2017.

Source: Country responses to the OECD Science, Technology and Industry Outlook 2016 policy questionnaire; EC/OECD (2016[48]), *International Science, Technology and Innovation Policy (STIP) Database*, https://www.innovationpolicyplatform.org/sti-policy-database.

University parks as pockets of excellence

Clusters policies are often centred around the development of an R&D intensive institution such as a university or other public research organisation. Such institutions act as a pole of knowledge creation both through their education function (contributing to generate a high-skilled workforce) and by conducting applied research of relevance to firms, which thus gain from locating in the cluster to benefit from local talent, R&D infrastructure and explore potential science-industry partnerships. Research, science, and technology parks are a means to create dynamic clusters that accelerate economic growth and international competitiveness through the transfer of knowledge and technology. A park is a type of public-private partnership that fosters knowledge flows between park firms and universities and among park firms.

Public-private partnerships in this context leverage, formally or informally, the innovation that takes place within local firms and universities. The public aspects of university parks relate to any aspect of the innovation process that involves the use of governmental resources (local, national or supranational). Private refers to any aspect of the innovation process that involves the use of private-sector resources, mostly firm-specific. Local resources include financial, infrastructural or research resources that affect the general environments in which innovation occurs. The term partnership refers to innovation-related relationships, including, for example, formal and informal collaborations in R&D and tacit knowledge spillovers (Link and Scott, 2003[49]).

The Research Triangle Park is an example of the "pockets of excellence" science park approach that leverages the academic infrastructure in a region. Located between three universities, the Research Triangle Park contributed to leapfrog the state of North Carolina from one of the poorest regions in the United States to one of the most innovative and dynamic (Box 4.5).

Box 4.5. Research Triangle, Unites States

After World War II, the state of North Carolina (Unites States) was one of the poorest states in the country with a very unstable economy. Historically, the state's economy had relied almost exclusively on three traditional industries: furniture, textiles and tobacco. The furniture industry was leaving the state and expanding into the northeast; the textile industry was beginning to face growing competition from Asian producers; and tobacco manufacturing employment was on the decline, in part because of automation and in part because of decreasing demand.

North Carolina's per capita income had long been one of the lowest in the nation and the decline in its traditional industries made it even more difficult for the state to employ its own college graduates. During the early 1950s, the academic community was becoming increasingly concerned about the out-migration of its better college graduates and began a dialogue with the state's economic development leaders about ways to attract new industries to North Carolina.

The idea of using universities to attract research companies into a cluster area quickly emerged. The term "Research Triangle" was created, used to refer to the geographic area defined by Duke University in Durham, North Carolina State University in Raleigh, and the University of North Carolina at Chapel Hill. The Research Triangle project should be seen as an effort where universities, "by the research atmosphere that their very existence creates," act as a magnet to attract industry "by providing a wellspring of knowledge and talents for the stimulation and guidance of research by industrial firms" (Link, 1995[50]).

In 1960, the Research Triangle attracted its first company – Chemstrand – the inventor of AstroTurf. However, for the next five years, the park had little success in attracting companies. The year 1965 marked the turning point with the announcement that the United States. Department of Health, Education, and Welfare had selected the Research Triangle Park for its USD 70 million National

Environmental Health Sciences Centre. Shortly thereafter, IBM joined the area with a 55 000m² research facility, kick-starting a momentum for the park's expansion.

In 2018, the Research Triangle is the largest research park in the United States, hosting more than 250 companies and 50 000 people with expertise in fields such as microelectronics, telecommunications, biotechnology, chemicals, pharmaceuticals and environmental sciences. Industries invest more than USD 300 million in R&D at the region's universities each year – double the average R&D investment for innovation clusters elsewhere in the nation.

Source: Link, A. (1995[50]), "A generosity of spirit: The early history of the Research Triangle Park", Research Triangle Foundation of North Carolina; RTP (2019[51]), *About The Research Triangle Park*, https://www.rtp.org/about-us/ (accessed on 23 January 2019).

Pitfalls to avoid: Escaping the enclave trap

Scepticism about the development of regional pockets of excellence is attributable, in part, to policy failures of mass infrastructure investments, resulting in the famous "cathedrals in the desert". These policies ended up in the creation, and subsequent decline, of research infrastructure in locations with where they were weakly linked with the existing economy and where regions had little capacity to develop or attract talent. Such scepticism is exacerbated by the prevailing big-push focus of these projects that overemphasises the supply side of innovation rather than linking it with demand (OECD, 2011[52]; 2011[53]).

Regional innovation policies need to include a broader set of actions, such as specific support to enhance absorptive capacities of local firms or knowledge diffusion so that local firms benefit from interacting with the organisation in the cluster. Instead of relying solely on the attraction of large research organisations, policies can foster entrepreneurial ecosystems not only of academic spin-offs but also of new firms that supply the cluster's activity benefitting from local complementarities and knowledge spillovers. A well-functioning cluster cannot be in isolation from regions' economic structure. Thus, the creation of regional pockets of excellence needs to be followed by policy efforts, building a critical mass that enhances local absorptive capacity and linkages among local agents and organisations in the cluster.

Building critical mass: Local absorptive capacity and linkages

The knowledge-based economy depends on a number of local socio-economic factors that help determine regions' ability to generate, benefit from and diffuse new knowledge. Absorptive capacity is determined by a range of factors. Capacity relates to the local socio-economic characteristics of a region. Examples of these characteristics are education and skill levels as well as constraints on the local labour market and the regional demographic structure (Rodríguez-Pose and Crescenzi, 2008[54]). Capacity also depends on the availability of adequate infrastructures. Access to broadband and other infrastructural capital are also factors that can influence both the absorption capacity and the productivity of R&D investments. Another factor in the regional absorptive capacity is the quality of the government in the region. In particular, ineffective or even corrupt regional governments can stymie both innovation and its impact (Rodríguez-Pose and Di Cataldo, 2015[34]; Rodríguez-Pose and Garcilazo, 2015[55]).

"Soft" factors, such as local culture can also play a role. For example, entrepreneurship is widely regarded as a key performance factor of local economies due to its crucial role in driving job and wealth creation. Having a vibrant entrepreneurial culture is a key factor for technological progress and innovation, thus being an important element to take into consideration for the design of regional innovation policies aiming at building local absorptive capacity (Glaeser, 2007[56]; Obschonka et al., 2013[57]).

Support for emerging entrepreneurial ecosystems

A strategy to build linkages between pockets of excellence and local firms is fostering the creation of new firms with links to existing pockets of excellence. Entrepreneurship has become a central element in enhancing competitiveness and leveraging new ideas. Innovation and entrepreneurial activity tend to go hand-in-hand in regions, with regions with the highest shares of activity in knowledge-intensive services and academic R&D activity showing also the highest rates of new firm creations (OECD, 2017[58]).

New companies with growth potential do not emerge in isolation. The term of entrepreneurial ecosystems is widely used to denote a set of interdependent actors and factors co-ordinated in such a way that enables productive business creation. Well-designed policy action can support the development of such factors, creating the opportunities that entrepreneurial talent can explore. Support for regional entrepreneurship can range several areas such as access to finance, provision of information (as management advisory or consulting services) or promotion of technology adoption.

Box 4.6. Start-up Initiative, Slovenia

Slovenia had a number of different intermediaries and strategies with ambitious goals. A change in the landscape was made by the formation of a Start-up Initiative, a network of several dedicated partners with a clear objective to implement what was prescribed in a Start-up Manifest, which had set specific, measurable goals. The idea of the Start-up Initiative was that all the relevant stakeholders should co-operate and contribute, from governmental institutions to institutions, enterprises and other subjects of the innovative environment. Members of the network include Venture Factory and Technology Park Ljubljana as the lead partners, two more technology parks (Pomurje and Primorska), two incubators and a research centre on ICT. The Ministry of Economic Development and Technology, SPIRIT and the Slovene Enterprise Fund are public members of the initiative, while as many as 15 different types of institutions are ecosystem partners. They include venture capital funds, accelerators, business angels, etc.

The ambition of the partners in Start-up Initiative is to cover the whole spectrum of support activities, from help in developing the initial idea and turning it into a business proposal, to establishing an enterprise and finding appropriate forms of financial support for a particular stage of the enterprise. The co-operation of a wide range of complementary partners has resulted in an effective support system.

Source: Tsipouri, L. (2018[6]), "Fostering innovation in less-developed (with low institutional capacity)", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

Access to finance is a perennial challenge in supporting innovative activity and firms and in developing whole entrepreneurial ecosystems. Governments across the OECD implement a wide range of programmes to help overcome barriers in access to finance (OECD, 2019[59]). The JEREMIE programme of the European Investment Bank (EIB) is an example of a funding vehicle appropriate to SMEs and young firms. JEREMIE's financial resources have been deployed through selected financial intermediaries across the EU, which have provided loans, equity and guarantees (EC, 2016[60]). Greece benefitted substantially from the application of this programme as a co-funding instrument for Venture Capital (VC). In all, it has triggered the development of a start-up ecosystem, since new VC firms created the prospect of funding and initial success stories of acquisitions mobilised a community of young entrepreneurs (Tsipouri, 2018[6]).

Box 4.7. JEREMIE programme of the European Investment Bank, European Union

During the 2007-13 programming period, the EIB JEREMIE pilot offered the EU member states, through their national or regional managing authorities, the opportunity to use part of their EU Structural Funds to finance SMEs in a more efficient and sustainable way. JEREMIE's financial resources have been deployed through selected financial intermediaries across the EU, which have provided loans, equity and guarantees to SMEs.

Greece is an example of a country that has benefitted substantially from the application of JEREMIE as a co-funding instrument for venture capital: it has triggered the nucleus of a start-up ecosystem since new VC firms were created and the prospect of funding, as well as initial success stories of acquisitions, has mobilised a community of young entrepreneurs. Regional policy has started intervening for the creation of VC markets in less-developed regions through the introduction of financial instruments, which have been gaining momentum over the years.

EU funding for financial instruments has increased considerably, rising from EUR 1 billion in 2000-06 to EUR 11.5 billion allocated in 2007-13 through the European Regional Development Fund (ERDF). Financial instruments played a crucial role in providing funding to SMEs during the credit crunch of the economic crisis – helping many firms to stay in business.

Financial instruments appear as a tool more likely to break path dependencies than others do. As emerged from interviews with managing authorities, the list of instruments selected for each programme is the result of the combination of lessons learned in the past about what worked well in the territory and of the need to adapt and improve the implementation of past interventions. In general, notwithstanding a certain path dependency, a willingness to adopt new modus operandi was observable. This was particularly clear in the use of financial instruments and more generally on repayable aid.

Source: Tsipouri, L. (2018[6]), "Fostering innovation in less-developed (with low institutional capacity)", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

Entrepreneurial brain drain

Successful entrepreneurs are likely to seek opportunities elsewhere if their region fails to provide the right conditions to scale their business. A sole focus on promoting start-up activity neglects the fact that entrepreneurial success requires conditions for scaling up businesses. In the process of scaling up, firms are likely to orient their sales and firm operations outside regional borders. Retaining their successful entrepreneurs and avoiding "entrepreneurial brain drain" is especially problematic for less-developed regions, which are also the regions where local entrepreneurs are more likely to face difficulties scaling up.

The brain drain of entrepreneurial talent is not a problem per se, entrepreneurial circulation is fruitful, potentially enabling interregional networks and enabling entrepreneurs to find locations where they can fulfil their maximum potential. Entrepreneurial brain drain can be offset with entrepreneurial brain gain. For example, when entrepreneurs leave a region and become more successful, the expected payoffs of entrepreneurial activities for the local population increase. The increase in payoffs raises incentives for others to become entrepreneurs and some will stay in the region – the entrepreneurial "brain gain effect".

Entrepreneurial brain drain becomes a problem when regions persistently lose their brightest entrepreneurial talent not being able to retain nor to attract other entrepreneurs. A persistent state of entrepreneurial drain is more likely to take place in lagging regions, which need entrepreneurial dynamism

the most. Programmes using local public resources to foster entrepreneurship may need to be re-designed as entrepreneurial drain shifts the benefits of these programmes away from the targeted regions.

Local policies fostering entrepreneurship may need to be broadened, in order to retain entrepreneurial talent by providing conditions for scaling up in addition to starting up. An important element for policies is avoiding "Robinson Crusoe" types strategies and, instead, co-ordinate innovation policies with policies towards internationalisation, for example by supporting local entrepreneurs in developing external value chains, start exporting or upgrade their position in GVCs.

Joining, embedding and reshaping GVCs

Supply chains are an important source of knowledge and access to new ideas for firms. Through their local networks, the links of a single firm can spread further within the region. This is particularly the case for firms integrated into GVCs. Since the 1980s, production of final goods has been increasingly distributed across space. The decline in shipping cost, increase in global trade integration and advances in communication (and thereby monitoring) technologies allowed companies to split production into smaller and smaller steps. Each step adds a certain amount of value to the final product, which led to the term global value chains (GVCs) that describes the process (OECD, 2018[27]). Some of the value is added by the firm that is directly integrated into the value chain but as this firm draws on local services and inputs, the total extent of GVCs' economic impact reaches beyond the directly engaged companies.

The distribution of tasks along a GVC is important for goods manufacturing but includes a large percentage of services as well. More than 70% of world services imports are intermediary services, so looking only at final services excludes the majority of the interactions that form GVCs. Considering GVCs (rather than purely exports) is crucial to understand the dependencies in the local economy. In the past, regions tended to view competitive advantage from a sectoral perspective and end up specialising in low-, medium- or high-value-added sectors; today competitive advantage can take place at a task level. The GVC literature introduced the trade-in-tasks framework (Grossman and Rossi-Hansberg, 2008[61]), where all sectors can comprise low-, medium- and high-value-added tasks, opening up more opportunities for regions to explore possible competitive advantages.

Greater integration in GVCs can consist of: i) participating in more economic activities at multiple stages of different value chains; or ii) being able to add more value to the production process at different stages. Diversification of value chains, like diversification in general, has benefits in terms of resilience of the local economy (as risks from global shocks are not concentrated in a single sector). Regions with greater diversification in their local economy also tend to grow faster (albeit more specialised regions tend to be richer).[11]

Leading regions and firms benefit from deepening and extending GVC networks. An example of a leading firm leveraging GVCs is ASML, a manufacturer of large-scale machines for the mass-production of microchips. The cost of a single machine can be close to EUR 95 million, much of the value accruing within ASML's supply chain. Up to 85% of the cost arises through the procurement of components from suppliers.[12] Risk management of the supply chain is therefore central to the viability of ASML's business model. A key requirement for suppliers is that their revenue from sales to ASML account only for the share of total sales (20%). This requirement aims to disconnect supplier business from demand fluctuations that affect ASML. The measures aim to support the resilience of suppliers during periods of economic downturn that affect ASML but it also pushes suppliers to interact with additional buyers and learn through this interaction, which in turn can improve the supply relationship with ASML.

The approach of ASML is not unique in the "Brainport" area in the region around Eindhoven. Firms in the region are continuously adapting and exploring interregional GVCs to pursue diversification strategies among both suppliers and clients. This strategy limits their exposure to external shocks. Such constant adaptation strengthens the region's resilience to sector or geographic external impacts, as local firms are

able to find different suppliers and clients across different sectors and regions. The Brainport Eindhoven agency actively supports these efforts with the goal to turn supply chains into value chains (Box 4.8).

Box 4.8. Diversification, cross-fertilisation and global links in the Brainport, Eindhoven, Netherlands

The region around the Brainport Eindhoven is one of the most innovative locations in the world, accounting for 4% of the Dutch population but 46% of patents filed in the Netherlands. The region is a top performer, translating patents into commercial products, currently with 23% of turnover coming from products that did not exist 3 years ago, while the Dutch average is 9.1%.

Brainport Eindhoven collaborates extensively across borders, mostly with regions in Belgium and Germany. Fostering collaborations within interregional value chains enables local firms and firms from other regions to diversify their suppliers and clients. This diversification is a good financial strategy for each individual firm and is a good source of mutual learning concerning, for example, best production procedures and business strategies. Mutual learning enables local knowledge spillovers, which have the potential to boost productivity across multiple sectors, being beneficial for all firms and the whole region and its partners. Cross-regional knowledge spillovers generate new ideas that can be further explored in firm collaborations and lead to the creation of completely new products and services.

Source: Brainport (2017[62]) *Brainport Monitor 2017*

The benefits of GVC integration extend beyond leading regions. Regions with greater integration in GVCs are, on average, those with better economic performance within a country. But not all regions benefit equally. In particular, regions that are at the final stage of production (i.e. the last steps before the final product is sold) retain the highest share of value-added created in GVCs (OECD, 2018[27]). Throughout each stage of the production process, value is added by producing new goods using several intermediate inputs or by improving intermediate inputs for example.

The value-added that regions derive from GVCs depends not only on the degree of participation but also on their location along the value chain. Early stages in a GVC include R&D activities, or design, which tend to be of high value-added. The final stages of the GVC also create high value-added. Final stages include services such as advertising, brand-management or specialised logistics. In contrast, extraction of raw materials, assembly, mass-production processes, etc., are in the middle of a GVC and often have low value-added.[13]

The challenge for non-frontier regions is that most of the high-value-added activities are knowledge-intensive and require staff with strengths in different fields. Upgrading a region's position in GVCs therefore requires a holistic view that does not only consider the single firm that integrates into a value chain but the ecosystem in which firms operate.

Policies can support regions to further integrate into GVCs or help them move to more desirable positions. Regions that are initially only able to attract low value-added activities in the middle of the GVC can try to expand upstream or downstream into activities of larger value-added. Alternatively, capturing a greater share of the value (covering more segments) can also be a valid option. First, integrating into GVCs and then progressively increasing the local content is the most common trajectory (UNCTAD, 2013[63]). See Table 4.2 for possible patterns of GVC evolutionary lines.

Table 4.2. Possible GVC development paths

Trajectory	Movement	Explanation
Engaging in GVCs	Low value-added (VA), Low integration (int.) -> Low VA, High int.	Imports of intermediate goods, components and services increase, as well as the importance of processing exports. This pattern often coincides with an influx of processing FDI and the establishment of relationships with multinational enterprises (MNEs).
Preparing for GVCs	Low VA,L int. -> High VA, Low int.	Exports remain predominantly within sectors and industries with domestic productive capacity (with limited need for imported content). FDI inflows help produce intermediate goods and services for export products, substituting imports. These patterns of trade and FDI preserve domestic value-added in trade, at times at the cost of more rapid integration in GVCs.
Upgrading in GVCs	Low VA, High int. -> High VA, High int.	When already with a significant level of integration in GVCs, increasing exports of higher value-added or in capturing a greater share of value chains (covering more segments). Such export upgrading patterns often combine with an influx of FDI in adjacent value chain segments and higher technology segments.
Competing in GVCs	High VA, Low int. -> High VA, High int.	Compete successfully at high-value-added levels through domestic productive capacity for exports. FDI is attracted to integrating domestic operators in international production networks.
Converting GVCs	High VA, Low int. -> Low VA, High int.	Composition of exports shifts towards processing industries requiring higher imported content, or have even seen the productive capacity for exports convert to engage in tasks and activities that are part of GVCs. This process can coincide with increased FDI in processing industries, including the establishment of relationships with MNEs.
Leapfrogging in GVCs	Low VA, Low int.-> High VA, High int.	A few regions have experienced very rapid development of domestic productive capacity for exports competing successfully at high-value-added levels. In these cases, FDI has often acted as a catalyst for trade integration and domestic productive capacity building.

Source: Adapted from UNCTAD (2013[63])*Global Value Chains and Development: Investment and Value Added Trade in the Global Economy*, http://unctad.org/en/publicationslibrary/diae2013d1_en.pdf.

MNEs, FDI and its linkages with local firms

Multinational enterprises (MNEs) play a key role in linking regions to GVCs. They account for around one-third of global output and half of global exports (Cadestin et al., 2018[64]). They also integrate value chains within their corporate structure, in particular where critical resources or inputs into a value chain are concerned. Integration takes the form of greenfield investments in regions, mergers and acquisitions (brownfield investment) and strategic partnerships. Linking local SMEs with foreign MNEs can be a key opportunity to increase regional productivity, as firms that operate internationally are more productive than those that do not. Local SMEs can integrate GVCs through backward and forward domestic linkages with MNEs (sourcing inputs from MNEs and supplying own outputs to MNEs respectively). Additionally, MNEs can also support regional growth in host economies by, for example, creating jobs and paying higher wages to the local workforce and fostering competition in the region.

Regions can upgrade their existing position along GVCs by exploring comparative advantages in activities of higher value-added. For example, in Korea, local firms started venturing into the computer hardware industry, producing “dumb terminals” for Apple computers in the early 1980s.[14] By combining strategies such as learning from interactions with global original equipment manufacturers (OEMs), such as Apple and IBM, as well as by reverse engineering and licencing their technologies, local firms started upgrading into stages of the GVC with more value-added, ultimately developing R&D centres and creating their own brands. This technological upgrading also benefitted from existing knowledge of the tasks related with the production of audio systems and colour TV receivers. Thus, local firms leveraged the knowledge associated such tasks not only to join a new GVC but also to upgrade their positions within it (Bae, 2011[65]).

Box 4.9. R&D niches within GVCs

Škoda (Czech Republic) and the Volkswagen Group

In 1991, the German-based Volkswagen Group (VW Group) acquired the Czech car manufacturer Škoda. The acquisition coincided with the spread of "platform" strategies in the car manufacturing sector, whereby the same components are used for different car models within a group of manufacturers. For Škoda this meant an opportunity to retain R&D capabilities within the Czech Republic as for marketing reasons, the appearance of Škoda models needs to differ from Volkswagen, Audi and Seat models that are also part of the VW Group. Within the VW Group, Škoda engineers design the upper bodies for Škoda's own cars, while common elements for the group (car platforms and lower bodies) are designed in Germany.

The combination of skilled labour and a local cost advantage helped further cement the position of Škoda's R&D within the VW Group. Experienced engineers are significantly less expensive than in Germany, lowering the cost of in-house R&D for the group. Škoda became responsible for routine development work, such as computer-aided design (CAD) operations. More knowledge-intensive engineering functions, such as the development of the platform for the group, remain in Germany. Local R&D focuses on the adjustment of the group-wide platforms to integrate with locally sourced components and testing of Škoda's own models. In addition, Škoda's engineers develop specific (three-cylinder gasoline) engines for the entire group.

With the combination of developing some niche elements and a strong focus on adapting groupwide elements to the local context, Škoda's R&D is typical for automotive R&D centres in non-frontier regions.

Source: Pavlínek, P. (2012[18]), "The internationalization of corporate R&D and the automotive industry of East-Central Europe", *Economic Geography*, Vol. 88/3, pp. 279-310.

Local contexts matter for GVCs

Both national and regional level contexts matter for how regions link up to GVCs; thus, policies towards building, embedding and reshaping GVCs need to adapt to such contexts. There is no one-size-fits-all recipe for success. A large body of evidence suggests that the quality of local institutions matters for linking up to GVCs, as well as factors such as market potential and access (Bénassy-Quéré, Coupet and Mayer, 2007[66]; Asiedu, 2006[67]).

Different production stages of each value chain require different local factors. For example, regional levels of education and productivity are critical for the most sophisticated knowledge-intensive stages of the value chain but less so for less sophisticated stages (Crescenzi, Pietrobelli and Rabellotti, 2014[68]). In joining GVCs by attracting FDI, different MNEs value local factors differently and pursue differentiated strategies, which introduce additional sources of heterogeneity (Duanmu, 2012[69]; Alcácer and Chung, 2007[70]). For example, direct equity investments represent 53% of all GVC participation activities of major MNEs in the food industry but such investments only represent 18% of all GVC participation activities of MNEs in Internet services, which favours more market transactions and strategic partnerships (Andrenelli et al., 2019[71]).

GVCs open new opportunities for regional development, with regional connectivity and openness being necessary but not sufficient conditions for local firms to actually benefit from GVC participation. In order to successfully benefit from their participation, openness and connectivity to GVCs need to be co-ordinated with improvements in areas such as human and institutional capacity, which are critical to ensure local firms remain competitive along the value chain (Elms and Low, 2013[72]).

Strengthening firms' innovation capability to establish their competitive advantages in GVCs is not only about large domestic MNEs or foreign-owned companies. Local and foreign SMEs are also important elements in GVCs' activities. "Democratising" GVCs' access to local SMEs can help to enable the discovery process of competitive advantages, finding new ways of participating in and benefitting from GVCs. For example, commercial ties among SMEs across the border between Ireland and Northern Ireland (United Kingdom) were used as a stepping-stone for later wider export strategies (OECD, 2011[73]).

In a survey conducted among OECD IPAs, they were asked what obstacles they see as most important for attracting investors outside of the capital city or to the different regions (Table 4.3). OECD IPAs consider that the top three obstacles to direct FDI outside of their country's capital city or to different regions are the distance to suppliers and clients, the lack of local skilled workforce and poor infrastructure or connectivity to important hubs (OECD, 2018[74]).

Table 4.3. Regional obstacles to the attraction of FDI according to IPAs

Ranking	Obstacles
1	Distance to suppliers and clients
2	Lack of adequately skilled labour or difficulty in attracting it into the region
3	Poor infrastructure or connectivity to important hubs
4	Image problems (e.g. security, lifestyle, etc.)
5	Difficulties in interacting with the local government
6	Lack of dedicated state support (e.g. special economic zones, etc.)

Note: IPAs responded to the following question: "What obstacles do you see as most important for attracting investors outside of the capital city/to the different regions?".
Source: OECD (2018[74]), *Mapping of Investment Promotion Agencies in OECD Countries*, http://www.oecd.org/investment/investment-policy/mapping-of-investment-promotion-agencies-in-OECD-countries.pdf (accessed on 25 January 2019).

GVC's policy tool mix

Well-designed policy instruments have a role to play in guiding and reshaping GVCs utilising the key vehicles of MNEs and FDI and promoting or deepening local firms' interactions with GVCs (Crescenzi and Harman, 2018[7]). GVC policies have to adapt to the socio-economic characteristics of regions and their industrial structure. Policy strategies and single instruments may need adjusted designs depending on whether they are being applied, for example, in non-frontier regions, such as less-developed regions and regions in industrial transition and frontier regions.

Investment promotion agencies

IPAs, both inward and outward can be critical tools at the regional policymaker's disposal to account for firm and locational heterogeneity when looking at reshaping GVCs in their areas. Crescenzi, Di Cataldo and Giua (2018[75]) study the impact on FDI inflows in European subnational regions where there is a presence of an IPA targeting certain key sectors and not others. They find that sectors with IPAs saw larger increases in FDI in comparison with the sectors without an IPA, suggesting that IPAs can be a good instrument for reshaping GVCs. Moreover, national and regional IPAs (when both are present) seem to be jointly beneficial to the regional economy in terms of FDI.

Co-ordinating and co-operating between national IPAs and subnational entities is an important topic as national IPAs are often formally charged with attracting and facilitating investment in regions. Even when it is not the case, they might have to address this topic when discussing potential investment project locations with foreign investors. To address and overcome the regional obstacles to the attraction of FDI,

national IPAs and subnational agencies in charge of the local economic development ideally need to work together (OECD, 2018[74]). Most IPAs work with external local stakeholders such as regional development agencies, local chambers of commerce and other promotion agencies at various subnational levels (e.g. regional or city level).

Co-operation with subnational agencies is particularly challenging, as regions can be very heterogeneous in terms of attractiveness due to competitiveness, workforce attributes and other local ecosystem characteristics. Moreover, interests are not always aligned, in particular in regard to the dilemma between catering to the desires of foreign investors, making the case for the best location, which can be a region already in the frontier, or focusing on bringing investment in less-developed regions that need it the most (OECD, 2018[74]). OECD countries have developed different tools to overcome the co-ordination challenges across agencies (Box 4.10).

Box 4.10. Tools for co-ordination between national IPAs and subnational agencies

In Sweden, a code of conduct agreement among the national IPA and the 15 regions was established to better communicate on opportunities and encourage the exchange of information. The IPA also uses software that allows sharing information with external partners, which requires some upstream work to define a common information-sharing framework (and decide who accesses what information).

In Latvia, a system was designed to incentivise people at the local level to share information about potential investment projects.

Business France has designed a formal information-sharing process to increase the efficiency of the collaboration with France's 13 regions. The agency created a "marketplace" of investment projects and shares information weekly with its regional partners. The aim is to organise joint efforts to respond efficiently to foreign investors' demands and needs, and to increase chances to win projects.

Source: OECD (2018[74]), *Mapping of Investment Promotion Agencies in OECD Countries*, http://www.oecd.org/investment/investment-policy/mapping-of-investment-promotion-agencies-in-OECD-countries.pdf (accessed on 25 January 2019).

Local content units and incentives for collaborations

The attraction of FDI can have limited impact on regional innovation when newly established MNEs do not interact with local agents, stymieing positive regional spillovers. Linkages between MNEs and local agents in non-frontier regions are often missing as the objective of MNEs might be linked to other factors. MNEs might be attracted to a region due to tax incentives, available natural resources or less stringent regulations for example and end up operating in isolation of the local economy, engaging mostly with other foreign suppliers.

Local content units (LCUs) set conditions for MNEs to interact with local agents. For example, LCUs can set conditions for sourcing from local suppliers a given proportion of inputs, or hiring and training part of the population from the region. LCUs can be viewed as a "matchmaking service" trying to get local companies integrated into MNE's supply chains (Sutton, 2016[76]). A targeted incentive to collaborations between MNEs and local firms is an additional example of an instrument to foster interactions between linkages. Both LCUs and collaboration incentives require more research to understand their optimal design and potential impact (Crescenzi, de Blasio and Giua, 2018[75]).

Mapping regional opportunities in GVCs

Mapping local opportunities and key actors for engagement with GVCs is an important tool to inform regional innovation policies. Diagnosing the characteristics of regions that support GVC integration, such

as geographical influence and stakeholder activities, through mapping is extremely useful to ensure regions are approaching the correct MNEs with the appropriate FDI vehicles and have a path for regional innovative upgrading.

In Emilia Romagna, Italy, a mapping of knowledge and competencies in all regional sectors was performed as part of the development of the regional smart specialisation strategy (Labory and Bianchi, 2018[8]). The mapping consisted of the identification of the main sectors in the region and identified 27 GVCs in the main sectors in the region. Identified sectors include mechanical engineering & automotive, agro-food, housing and construction, fashion, health and wellness, culture and creativity and tourism. Based on the mapping, seven "Clust.ER" associations were created to allow regional actors across different GVCs to meet and define common goals with a view of reshaping GVCs for wider regional development.

Finding the balance in developing local integration in GVCs

Local governments often compete fiercely by offering substantial incentives to industrial plants to locate within their jurisdictions. For example, in 2017, the state of Wisconsin, United States, passed a bill supporting a memorandum of understanding signed by the Governor and the CEO and chair of Foxconn (Hon Hai Precision Industry Co., Ltd.), a manufacturer of high-tech electronic equipment. Foxconn promised to invest USD 10 billion over 6 years and create up to 13 000 jobs over the same period. In return, the state offered USD 2.85 billion in refundable tax credits, as well as additional investment support (e.g. government land purchases and infrastructure development). These costs are partly borne by local governments (WSL, 2017[77]).[15]

Attracting firms can create local jobs, generate investment in innovation infrastructure and generate knowledge spillovers. It is in these spillovers that governments find justification to provide an incentive package to large firms. Estimates for the United States find that a plant opening positively affects (total factor) productivity of incumbent plants (12% after 5 years) and that this spillover effect is even larger for plants sharing similar labour needs and using similar technologies as the newly opened plant (Greenstone, Hornbeck and Moretti, 2010[78]). The productivity gain is also evident in higher wages in the county, as well as increased housing cost (Greenstone and Moretti, 2004[79]).

Spillovers that create local multipliers in terms of jobs, entrepreneurial activity or innovative activity can, from a theoretical point of view, justify public support for private-sector investment. In practice, there are a number of pitfalls to the approach. Estimating the extent of the spillovers is very difficult and at best an imprecise exercise. Investment and return periods differ, which can lead to hold-up situations. Contractual arrangements and guarantees are typically used to alleviate this challenge but contracts are always incomplete. What is more, if activity is displaced rather than newly created, the activity in one region might not outweigh the losses in another.

In many cases, this means that incentive packages are simply windfall gains for firms with competition between authorities having the potential to create absurd results. Between 2009 and 2013, 2 US counties that are part of the Kansas City metropolitan area, one in the state of Missouri, the other in the state of Kansas, spent USD 212 million to entice firms to move into their borders, leading to 3 289 jobs moving from across the state borders in one direction and 2 824 in the other (Mcgee, 2015[80]). Tax incentives represent a capture of value by the attracted firm and incentives for policymakers to attract firms to create a "race to the bottom" in terms of lost public revenues. To avoid this inefficiency, the EU has utilised "state aid control" as a means to prevent EU member states from outbidding each other for firms (Parilla and Liu, 2018[81]).

Despite the potential pitfalls, there are cases where the region's economic base can benefit from initial support to start a virtuous cycle of growth. In addition, 14 out of 31 OECD countries with available data experienced a widening of the gap between the most productive "frontier" region and the rest of the country (OECD, 2019[82]). Tax incentives to support firms develop opportunities in less-developed parts of a country are one of the strategies that governments use to overcome increasing concentration. Germany's eastern

federal states were classified as less-developed regions and therefore exempt from European state aid rules. They also received significant transfers to foster investment. While there are still gaps between them and western German federal states, the transition in the east helped narrow productivity gaps in Germany between 2000 and 2014 and supported aggregate growth (Lembcke and Maguire, 2017[83]).[16]

Regional tax incentives cannot fully compensate for all locational disadvantages. In particular, the aim to attract activities that require specific (scarce) skills to less-developed areas without a strong strategy to develop these skills locally is unlikely to succeed. The decision of Amazon, an MNE, about where to locate its second headquarters provides an illustration of how tax incentives play a limited role in influencing firms' location decisions. Amazon made cities bid for its location and accepted the offer by New York and Virginia that collectively offered about USD 2 billion in tax credits, rebates and other incentives. Amazon refused much larger packages, including New Jersey offering USD 7 billion, Maryland offering USD 5 billion, or Philadelphia that offered USD 3 billion. Amazon's refusal of much larger packages means other factors were more relevant. The size and quality of the winners' labour pools seemed to have decided the competition (New York Times, 2018[84]).

Moving beyond specialisation

The Mexican metropolitan zone of Puebla-Tlaxcala is strategically located between Mexico City and the port of Veracruz, the main port for international trade for Mexico in the 1960s (OECD, 2013[85]). The German car manufacturer Volkswagen started production in the metropolitan zone in 1964 and is now operating the largest automobile plant in Mexico. Since the 1960s, the region has developed a resilient, vertically linked automotive supply chain with a wide variety of firms, including very large to small suppliers, national and international actors, and has both terminal sector (assembly) and auto-parts sector businesses. Since 2016, Audi – another German car manufacturer and part of the Volkswagen group – followed suit, with the opening of its first North American production plant.

The specialisation of the region brings significant benefits. Spillovers and demand links along the supply chain help upgrade production in domestic firms and attract further international investment. Large firms have the capacity in staff development that can even help overcome some of the deficiencies of local training and education systems (OECD, 2013[85]). The strength as a car production hub comes with the drawback that the region is very fragile to industry-level shocks, such as the recession experienced by the automotive industry in 2009 (Haugh, Mourougane and Chatal, 2010[86]).

There is the risk of excessive specialisation, in particular sectors of competitive advantage, in order to attract MNEs and explore opportunities from GVC participation (see also Chapter 3). The point when specialisation turns from beneficial to excessive is difficult to assess. Most examples come from regions with reliance on natural resource extraction. Excessive specialisation in natural resources makes regions vulnerable to commodity price volatility, depletion of the local asset and can lead to the "Dutch disease" effect, whereby excessive commodity-sector exports appreciate the exchange rate and lead to a decline in non-commodity exports (OECD, 2007[87]). Excessive specialisation combined with large integration in GVCs also speeds up the transmission of potential impacts from region to region, limiting the capacity to buffer shocks.

Profiting from GVCs opportunities while avoiding excessive specialisation requires well-designed regional diversification policies in parallel with policies focused on GVCs. Chapter 3 presents examples of policies that can support regions preparing for the risks of excessive specialisation by fostering regional diversification in terms of technology sectors and external markets, which help regions being more resilient to shocks.

Box 4.11. Innovation and GVCs, Chile

Chile is one of the largest producers of copper. Chile's copper industry benefitted greatly from soaring copper prices and the country was the first Latin American economy signing a free-trade agreement with China, in 2005. Yet Chile has also been successful in reducing its reliance on mining over time: from making up 89% of merchandise exports in 1973, the mining content in exports decreased gradually, reaching 52% in 2016 (OECD, 2018[88]).

The Copper Stabilisation Fund, established in 1987, has helped to alleviate the negative effects of the copper cycle. What has been particularly important is the introduction of the fiscal rule, first adopted in 2000, that requires a structural surplus, adjusted both for trend gross domestic product (GDP) and the long-term copper price. Added to that, though not included in the rule, is a structural surplus target of 1%. Chile has also been strengthening its fiscal institutions with, among other features, increased and more transparent reporting. At the same time, monetary policy has consisted of full-fledged inflation targeting and exchange rate flexibility.

Chile's policy has been successful in limiting the unwanted consequences of the copper price boom, as can be seen in a comparison with other copper-based economies. Zambia is also highly dependent on copper. The country has implemented contrasting macroeconomic strategies to deal with price hikes. Chile followed a saving rule specifying that all incremental revenue was to be saved, whereas Zambia continued to run a fiscal deficit. In 2005, the real exchange rate mildly depreciated in Chile despite the boom, whereas in Zambia, it appreciated by nearly 80%, causing intense problems for its non-copper exports.

Chile has made significant efforts to diversify its export base beyond copper. This led to the development of other industries, including fresh fruit, wine and salmon production. In these sectors, there has also been innovation mostly through imported technologies. The introduction of new berry species, quality wine production and quality control, and certification of fruits for export have been among the achievements of Fundación Chile, a front-runner in innovation partnerships. Fundación Chile was initiated by the Chilean government and the United States ITT Corporation to transfer state-of-the-art technology, management techniques and human skills to natural-resource-intensive sectors. In 2005, the Chilean government introduced a mining tax to boost public R&D spending and also set up a National Innovation Council.

Chile still has a large potential to explore growth opportunities from higher-value-added sectors surrounding the copper industry, for instance through mining consultancy and mining-machinery production. One of the chief remaining challenges is to incorporate the private sector into financing innovation, as well as to achieve higher tertiary-education attainment in order to offset the lack of skilled personnel. Shortages in human resources are also one of the main reasons why the relationships between industry and science are not meeting their potential.

Source: OECD (2007[87]), *Latin American Economic Outlook 2008*, https://dx.doi.org/10.1787/leo-2008-en.

Policies to promote innovation in non-frontier regions

Often, science and technology policies are de facto directed towards leading firms and institutions that are often located in frontier regions. Instruments oriented towards catching up are therefore more common in the toolkit of regional development policy rather than national innovation policy (OECD, 2016[3]). Since the early 2000s, regional development policy has increasingly focused on innovation as a form of facilitating "catching up". A range of instruments are currently in use (Table 4.4) that fall into science, technology and innovation portfolios or under regional development policies. Some programmes explicitly target non-frontier regions, others support them indirectly by targeting specific sectors or types of firms that tend to be spatially concentrated in lagging areas.

Innovation and business support programmes are ubiquitous in OECD countries. They are generally accessible in all regions. Some programmes are adapted to non-frontier regions, e.g. through modified programme requirements. Others are targeted at specific places. The AusIndustry Regional Manager Network in Australia supports firms outside the main metropolitan areas. Iceland's multiple programmes support entrepreneurs and firms with innovative ideas in locations outside of the capital. In Portugal, some of the firm R&D, entrepreneurship and innovation voucher programmes have special calls for firms in low-density areas (OECD, 2017[47]).

Clusters and centres of expertise are among the most commonly used tools to support regions lagging behind the technological frontier (OECD, 2015[89]). These programmes are typically not limited to specific regions but can be more readily adapted to the needs of each specific place than other policy measures. Programmes can, for example, include different tracks for different types of regions. The French programme *Pôle de compétitivité* (Competitiveness Poles) has a tiered labelling system, with clusters labelled as regionally important having been selected in part to develop critical mass in places where the government did not see an existing "world-class" cluster. Despite their prevalence, cluster policies face significant challenges, in particular the so-called "wishful thinking" clusters might be even more wishful in places with fewer innovation assets. Promoting cross-fertilisation and recombination involving different sectors is more difficult in places with less economic diversity and few strong sectors (OECD, 2017[47]).

Capacity building for the public sector is often an important prerequisite for innovation policy. Support tends to focus on networks for knowledge sharing or strategy development capacities. For example, Sweden's Ministry of Enterprise and Innovation and the country's innovation agency are co-ordinating a regional network for dialogue on innovation and development for knowledge exchange. For the development of innovation strategies, Chile's Partnership Project Programme is an example that provided support to 11 of the 15 regional governments in the country to design and implement their regional innovation strategies. At the European level, both types of support are provided through a dedicated research and exchange platform for regional innovation and smart specialisation strategies and expert support (OECD, 2017[47]).

Beyond the public sector itself, policies that support capacity for other innovation actors often aim to build the necessary skills and expertise to compete for innovation-related funds. Regions that do not perform well in open calls of the US National Science Foundation are targeted by the Experimental Program to Stimulate Competitive Research that works with research centres in the region to improve their performance. Some countries provide additional support to research parks or research centres outside their main cities.

Table 4.4. Innovation instruments to promote territorial inclusiveness

Policy instrument	Common approaches	Examples
Innovation and business support programmes	Targeting firms in specific locations. Targeting firms led by particular population groups.	Australia – AusIndustry Regional Manager Network is a place-based approach to support firms outside the main Australian metropolitan areas. Canada – The Canadian Initiative for the Economic Diversification of Communities Reliant on Chrysotile explicitly targets business support to firms in a particular sector that is strongly place-based. China – China's S&T Envoy programme, begun in 2002, sends S&T specialists to rural areas nationwide to encourage rural entrepreneurship using S&T. The programme has also been important for the expansion and adoption of S&T methods in agriculture.
Clusters and centres of expertise	Same programme for all regions (so lagging regions included). 2nd-track policy for non-leading regions (possibly from a different policy stream, such as regional development). Firm-focus versus research-driven.	Chile – The country has a Regional Program of Scientific and Technological Research (CONICYT) that includes lagging regions. Finland – Smaller regions have a specific instrument for creating clusters at a smaller scale and encouraging their linkages with the Innovative Cities Programme. United Kingdom – The Catapult programme comprises a network of world-leading centres designed to transform the country's capability for innovation in specific areas and help drive future economic growth. In some cases, they are located in lesser performing regions and can contribute to regional economic performance.
Capacity building for the public sector	Regional innovation strategy development support. Networks of professionals across regions.	New Zealand – The cross-government Regional Growth Programme identifies and responds to economic growth opportunities in regions that face persistent economic challenges but have strong growth potential. The programme also has a particular focus on developing the Māori economy in each of these regions. It involves identifying the economic strengths and opportunities in the four regions, including their sector specialisations, investment opportunities and cross-cutting enablers of growth. A strong collaborative approach is being taken among local authorities, businesses and central government.
Capacity building for innovation actors	Focus on public/quasi-public actors. Co-applicants/co-sponsor to include lagging regions.	Iceland – Innovation Centre Iceland runs Fab Labs, digital fabrication labs in six locations in Iceland, all but one located in regions outside of national innovation hubs in order to increase innovation in these regions. All Fab Labs are run in close co-operation with schools in the regions to promote science, technology, engineering, and mathematics (STEM) and vocational education through creativity. New Zealand – The government is investigating possibilities for establishing regional research institutes located outside Auckland, Christchurch and Wellington. The government will work with regional stakeholders to identify the best location opportunities and will provide financial support to the best proposals.
Engagement of universities in regional development	Educational programmes relevant to regional firms. Supporting collaborative R&D. Involvement in regional economic and social development strategies.	Australia – Collaborative Research Networks (CRNs) are intended to effect structural adjustment in the research and research training capacity of smaller, regional and less research-intensive universities in the higher education system. The first two rounds have involved 15 CRNs for a total of around AUD 81.1 million. Portugal – The Colabs initiative is designed to develop research centres in universities located in interior (remote) regions.
Sectoral or place-based targeted R&D funding	Focus on specific sectors (e.g. agriculture). Focus on challenges for specific region types (e.g. remote rural).	Australia – the Cooperative Research Centre for Developing Northern Australia (CRCNA) will receive AUD 75 million in grant funding from 2017-27 to support industry-led research collaborations across the food, tropical health and agriculture sectors with the aim to increase the competitiveness and productivity of industry in Northern Australia. Norway – Innovation Norway is a jointly owned agency (around half by subnational governments and just over half by the national level), the priorities for R&D projects are designed to meet the development needs of the regional co-owners.

Source: OECD (2017[47]), *Making Innovation Benefit All: Policies for Inclusive Growth*, https://www.innovationpolicyplatform.org/system/files/Inclusive%20Growth%20publication%20FULL%20for%20web.pdf (accessed on 9 October 2018) and OECD (2016[3]) *OECD Regional Outlook 2016: Productive Regions for Inclusive Societies*, http://dx.doi.org/10.1787/9789264260245-en, based on OECD (2015[89]), "Regional Outlook Survey", GOV/RDPC(2015)8, OECD, Paris, (CRCNA, 2020[90])

Engagement of universities in regional development or the "third mission" of supporting not just education and research but also local or regional development is another active field for innovation policy in non-frontier regions. Examples include efforts to align education at universities with the needs of local companies, collaborative research between public sector and academia and strategic links between universities and regional governments that underpin a holistic strategy to support regional development in general.

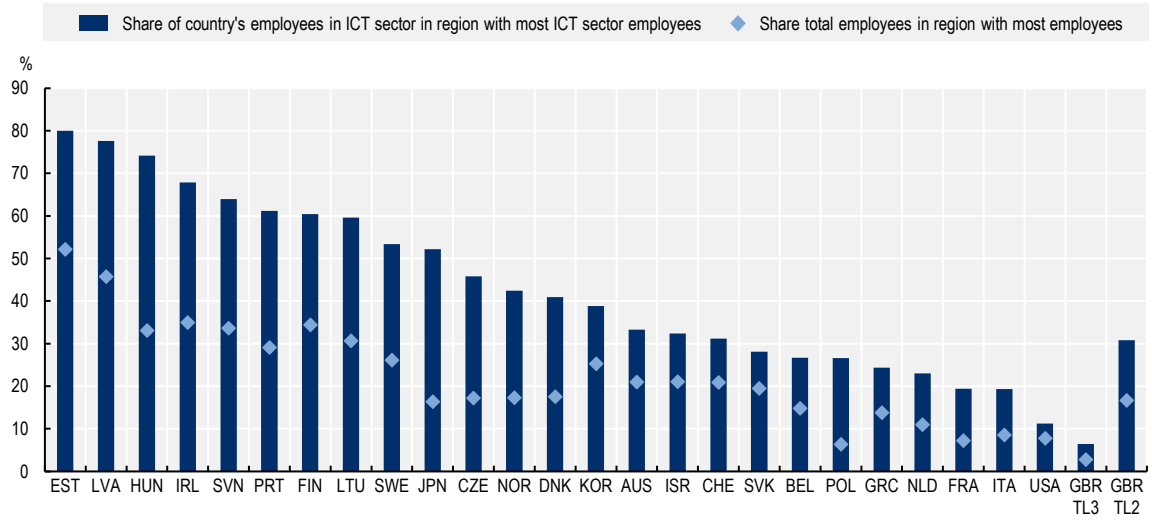
Funding for R&D is among the most common instruments in innovation policy and most countries have some form of targeted support with either sectoral or place-based targets. Norway has a place-based approach through Innovation Norway, which is jointly owned by national and subnational governments and which ensures that priorities in R&D support align with regional needs. Targeting through special economic zones is another approach to spatially distribute R&D activity. For example, Israel's Periphery programme supports the relocation of R&D activities of large firms into peripheral locations (OECD, 2017[47]).

Opportunities from digital disruptions

Employment in firms in the ICT sector is highly concentrated in all OECD countries. In 10 out of 26 countries with available data, more than half of employment in ICT is located in a single TL3 region (Figure 4.3).[17] Smaller countries tend to have a greater concentration than larger ones but the concentration of jobs in the ICT sector is not simply a mirror image of the overall concentration of population and jobs. The share of jobs in ICT in the region where most people work in the sector exceeds the concentration of overall employment in every OECD country with available data. In most countries, the gap is substantial, with the concentration of ICT jobs twice as high as the concentration in total employment in the country, both for the average and median country.

Figure 4.3. Employment in the ICT sector is highly concentrated in all OECD countries

Concentration of employment in ISIC Rev. 4 sector J (ICT) compared to the concentration of employment in TL3 regions overall, 2018 or latest year available



Note: Data for GBR reported for TL3 (Camden and City of London) and TL2 (London) level for better comparison with other countries. Latest year available: AUS, GBR (2018); PRT, SWE, DNK, BEL, USA (2017); EST, LVA, HUN, IRL, SVN, FIN, LTU, JPN, CZE, NOR, KOR, CHE, SVK, POL, GRC, NLD, FRA, ITA (2016); ISR (2013).
Source: OECD (n.d.[91]), *OECD Regional Statistics (database)*, https://doi.org/10.1787/region-data-en.

In part, this concentration might be due to the industries' product cycles being still in early stages of development (see Chapter 3). The non-rivalry in consumption of digital products may be partly responsible as well (Guellec and Paunov, 2017[92]). Recent technological developments lead increasingly to "winner-takes-all" competition due to network economies and data monopolisation. There are other possible explanations for the growing digital divide, such as an increase in the complexity of replicating innovations and a growing capacity gap in firms' capabilities to use and take advantage of digital technologies (OECD, 2015[93]; OECD, 2016[3]).

While production is concentrated, the uptake of digital tools does not have to be. Despite the ubiquitous availability of digital tools and technologies, uptake is often equally concentrated as the production. Several pioneering early adopters praise, for example, the positive impact of AI on productivity in different parts of the supply chain, however, adoption remains slow and limited to a few leading firms across all industry sectors. More than 70% of industrial companies are still either only starting to adopt AI or unable to go beyond the pilot stage (WEF, 2018[94]). Even in cases where companies do collect data that can be explored with AI, only a small fraction of data is actually used for decision-making. For example, Manyika et al. (2015[95]) found that less than 1% of the data being generated by the 30 000 sensors on an offshore oil rig was being used to make decisions. According to a survey run in Behrendt et al. (2017[96]), the two main obstacles to successfully explore these new production processes are: i) the lack of human knowledge and talent; and ii) data management and security issues.

The digitisation of everything (but not of everyone, nor everywhere)

Firms pursuing digitalisation strategies tend to outperform those that do not. As disruptive digital technologies increasingly converge with the physical world as a form of general-purpose technology. The difficulty in the uptake is that often different technologies have to be combined and complemented by organisational or management changes. For a sample of 600 large US firms observed between 1987 and 1994, Brynjolfsson and Hitt (2003[97]) find the short-term (one-year) productivity gains from investment in computers are outweighed by a factor of two to five when it comes to the longer-term (seven-year) returns. A study for the United Kingdom finds that the mere provision of broadband infrastructure alone does not lead to better productivity (or other) performance in firms (DeStefano, Kneller and Timmis, 2019[98]). There is, however, evidence that broadband availability leads to higher investment in complementary ICT technologies (DeStefano, Kneller and Timmis, 2018[99]) and, for plants without access to broadband Internet, there is even evidence that lack of access can lead to closures if they are part of a group that invests in cloud technologies (DeStefano, Kneller and Timmis, 2019[100]).

Supporting the adoption of digital technologies by firms in non-frontier regions (and in particular in SMEs in those regions) holds the potential to contribute to inclusive growth. Policy packages do, however, need to go beyond support for critical infrastructure and investment in tangible capital. Managerial skills, formal management practices and digital knowledge play a key role in generating productivity benefits from digitalisation. The effective adoption of digital technologies, which involves, for example, the use of automation and digitalisation in manufacturing, requires strong managerial skills (Bloom, Sadun and Reenen, 2012[101]). In this regard, evidence suggests that targeted programmes that combine the adoption of digital technologies with management training and advisory services can be especially effective (OECD, 2017[102]).

The effective use of digital technologies by firms is often constrained, e.g. by insufficient knowledge and financial resources, and by barriers to organisational change. Most policy initiatives targeting SMEs focus on: awareness-raising and training, often with a focus on enhancing ICT-related, and sometimes also organisational, know-how; financial support; and social networking (Box 4.12).

Box 4.12. Policy initiatives promoting the adoption of digital technologies by SMEs

In the United Kingdom, Digital Catapults are market-led technology and innovation centres that support the diffusion of digital technologies. The centres provide support for SMEs to get their new ideas and technologies quicker to market and include local digital innovation initiatives for 5G mobile networks, Internet of Things (IoT) and Low Power Wide Area Network (LPWAN) used for long-range communications among connected objects.

In Canada, the Business Development Bank of Canada (BDC) realigned its existing support to SMEs in 2011 to focus on ICT adoption. Its support is designed around three stages: awareness-raising (in particular via e-books and articles), success stories and testimonials and free ICT assessment of a company's technology situation in relation to other Canadian SMEs. Financial support for consulting services is provided to help SMEs tailor ICT solutions to their business and to address financial challenges providing loans to purchase hardware, software and consulting services.

In Germany, the initiative Mittelstand-Digital (SMEs Digital in English) of Germany's Federal Ministry of Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie) aims to show SMEs and skilled craftspeople the importance of using software for business processes and give support for digitalising these businesses.

In Korea, 17 creative economy and innovation centres have been created nationwide to promote digital innovation. A significant number of centres focus on digital innovation in production. Local governments and big Korean corporations (e.g. Doosan, GS, Hyundai-Kia, LG, Lotte, Samsung and SKT) jointly operate the regional centres. The tasks of these centres include:

- Supporting start-ups and SMEs in each speciality area.
- Organising the partnership or ecological relations between the relevant big corporations and regional enterprises.
- Arranging funds for them to overcome financial difficulties, encouraging managerial and technological innovation and advisory services (called mentoring).
- Promoting communication and co-operative work among participants.
- Exploring new markets at home and overseas.

Source: Adaptation based on OECD (2016[103]), "Stimulating digital innovation for growth and inclusiveness: The role of policies for the successful diffusion of ICT", https://dx.doi.org/10.1787/5jlwqvhg3l31-en and OECD (2017[104]), *The Next Production Revolution: Implications for Governments and Business*, https://dx.doi.org/10.1787/9789264271036-en.

The impact of digitisation on GVCs

The rapid emergence and expansion of digital technologies are creating new markets and new production processes to explore, and reshaping regional competitive advantage structures within GVCs. Examples of emerging digital technologies include sensors, machine-to-machine communication (M2M), data analytics and AI. New digital technologies can make labour costs relatively less important for regional competitive advantages in a number of manufacturing industries. For example, increased automation of production processes through the growing use of robots may erode the labour cost advantage of less-developed regions, as labour costs will represent a smaller share of total costs. The growing digitalisation is expected to increasingly allow for lower-cost and high-quality production in developed economies, discouraging offshoring from these countries and favouring reshoring (De Backer et al., 2016[105]).

3D printing (additive manufacturing) is an example of the process already being used in research departments and factories reshaping regional competitive advantages. 3D printing consists in using individual machines to build products by depositing layer upon layer of materials. For example, German sports-goods firm ADIDAS deployed two "speedfactories" in the town of Ansbach (Germany) in 2015 and Atlanta (United States) in 2017 that produce sport shoes – an activity that was largely offshored to China, Indonesia and Viet Nam. The speedfactories rely on software, robots, knitting machines and 3D printers to minimise worker input. The factory line can take instructions directly from a computer-design programme and automatically switch from making one type of shoe to another (The Economist, 2017[106]). The advantage of producing close to potential customers and with reduced lead times did, however, not overcome the cost advantage of offshoring. In November 2019, ADIDAS announced that the company would deploy the factories' technologies in two of its suppliers in Asia and close production in Ansbach and Atlanta in 2020.[18]

Digital technologies can enable some regions to attract previously "lost" activities through the process of reshoring, despite the cautionary example of the "speedfactories". Additional value may be generated if the reshored activities engage with local firms that by sourcing local intermediary inputs, or stimulate entrepreneurship and innovation through the generation of regional knowledge spillovers of business practices. The reshoring of certain activities may not necessarily lead to the reshoring of a large number of jobs, as robots explicitly take up a large part of value chains. Reshoring may mostly lead to additional capital investments instead of new jobs. Because of the extra investments, e.g. in robotics, 3D printing or sensors, reshored production will create only a limited number of additional jobs and these jobs will be increasingly high-skilled (De Backer et al., 2016[105]).

Lack of digital infrastructure and ownership issues

Broadband penetration rates in OECD countries increased spectacularly between 2010 and 2017. The share of households with broadband Internet access in the 30 best-connected TL2 regions in 28 OECD countries with available data rose from at least 79% to at least 95%, At the bottom end, less than 25% of households living in the 32 worst-connected regions in 2010 had access to broadband Internet; by 2017, this was the case in only 1 region. However, some regions still lack access to broadband infrastructure. While the share of households with access to broadband Internet rose in the median region from 63% to 82%, this still means that for half of the 291 regions, more than 18% of households lack access. Adequate Internet is an important precondition for the pursuit of innovation activities in the current world of ubiquitous digital technologies.[19]

The gap in firms' broadband access affects mostly small firms. The gap is narrowing but still large in some regions. The broadband penetration gap between medium and small firms remains substantial in Mexico (17 percentage points), Greece (14), Poland (7) and the United Kingdom (6) (OECD, 2017[107]). Disparities at the household level in broadband access are mostly explained by urban-rural divides within countries. Gaps in households' broadband access are largest in Greece (21 percentage points), Chile (19) and Portugal (15) (OECD, 2017[107]). Telecommunication companies may find it too expensive to build affordable fibre-optic broadband infrastructure in the countryside, limiting local residents to dialup or Wi-Fi from a library.

In some rural areas in the United States, groups of local populations have been tackling the lack of access to broadband by building the infrastructure themselves. Local groups form co-operatives and build broadband infrastructure with the support of low-cost government loans. For example, in rural Oklahoma, the Northeast Oklahoma Electric Cooperative installed enough fibre-optic cable to serve, as of 2018, about 9 000 members, offering broadband connections for less than urban residents pay for a comparable service. In terms of local impact, the rollout of broadband meant that an aerospace factory with the potential of 100 good-paying jobs was able to open in Grove, Oklahoma (population 7 060) in 2016. Area schools

are handing out Laptops, doctors are exploring telemedicine and people no longer need to make the journey to a library for faster connections (Thomson, 2018[108]).

For some regions, the problem is not the availability of infrastructure but its ownership and subsequent quality and price of access. In some cases, local co-operatives buy the infrastructure from private companies that continue operating it and achieve large market power, often being the sole providers. With large market power, firms charge excessively high prices to access broadband services.

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Notes

[1] To be able to apply for growth and innovation advisory support through the the Entrepreneurs Programme' the applicant must have an annual turnover (or operating expenditure) within the current, or one of the last two financial years of between AUD 1.5 million and AUD 100 million, or between AUD 750 000 and AUD 100 million for applicants from Remote Australia or Northern Australia.

[2] There is no unique definition of what constitutes the science, technology and innovation frontier within and across regions. The EU's Regional Innovation Scoreboard identifies innovation leaders (https://ec.europa.eu/growth/industry/policy/innovation/regional_en) based on a multi-dimensional assessment of regional innovation performance; other indicators might lead to slightly different rankings (OECD, 2011[53]). Regions that are considered "frontier" in this context are those with a focus on frontier research and patenting activity.

[3] Data for 2015, calculations based on OECD (n.d.[91]).

[4] See e.g. Cusolito and Maloney (2018[110]).

[5] https://www.international.gc.ca/investors-investisseurs/assets/pdfs/download/Niche_Sector-AI.pdf (accessed 11 October 2019).

[6] See e.g. De Fraja, Facchini and Gathergood (2020[111]) for evidence from salaries of UK academics.

[7] See OECD (n.d.[91]). Data for 2016 (latest year available).

[8] Or directly from basic research to exploratory development.

[9] The two-way model does not imply that science-industry links are unimportant. In less-developed parts of the EU there can be intensive links but they are different in that they are more downstream-oriented. This conclusion is similar to innovation surveys, where the significant difference is not in the commercial importance of innovation activities but their different nature between developed and less-developed regions.

[10] As famously outlined in Kremer's "O-ring theory" (1993[112]).

[11] See OECD (2018[27]) for details.

[12] Based on ASML 2018 Integrated Report. Based on US GAAP.

[13] A pattern that has been coined as the "smile" curve.

[14] "Dumb terminals" are terminals that enable interaction with a mainframe but without their own significant computational capabilities.

[15] The Legislative Fiscal Bureau of the Wisconsin State Legislature estimates that the tax credits alone will not amortise before 2042. The projections assume that the full number of jobs are created, each job creates 2.7 indirect and induced jobs and these jobs remain in place until 2042 (WSL, 2017[77]).

[16] Tax breaks are only one of the measures that countries take to distribute economic activity. Korea's National Balanced Development Act, relocated government agencies including research activities to a new administrative capital and nine "innovation cities" outside of Seoul (OECD, 2016[109]).

[17] Regions within the 37 OECD countries are classified on two territorial levels reflecting the administrative organisation of countries. Large (TL2) regions represent the first administrative tier of subnational government and small (TL3) regions are contained in a TL2 region. TL3 regions correspond to administrative regions, with the exception of Australia, Canada, Germany and the United States.

[18] Press release by ADIDAS AG on 11 November 2019, https://www.adidas-group.com/en/media/news-archive/press-releases/2019/adidas-deploys-speedfactory-technology-at-asian-suppliers-by-end-2019/ (accessed 04 August 2020).

[19] Calculations based on OECD Regional Social and Environmental Indicators (database) (accessed 04 August 2020), using data for 2010 and 2017 or closest year available.

5 Fostering place-based regional innovation policy: The role of (policy) learning

Complexity and uncertainty are core features of most policymaking today and innovation policies are no different. This chapter describes and analyses how policy learning can address these challenges. It reviews two core learning mechanisms – learning through interaction and learning through experimentation – and discusses their application to innovation-led regional development and policies. The chapter also explores how policy learning can work in less-developed regions and the barriers to overcome for successful network implementation and experimental governance in regions with low institutional capacity. It concludes by considering how to preserve and embed the impact of learning and experimentation over time.

Introduction

Innovation policy approaches characterised by top-down government approaches have often failed to produce tangible results. The reasons for the failures of such policies are well known and include the risk of capture by vested interests, lack of information on the economy, and strong information asymmetry between public and private actors, as well as a lack of public sector capability for effective policymaking (Dutz et al., 2014[1]).

A more appropriate and effective approach to innovation-led economic development policies involves experimentation, monitoring, learning and adaptation, all of which need to occur in a context of international openness to knowledge, trade, investment and competition. Such an approach also rests on close co-operation with private and non-governmental actors, which are often better placed than governments to identify barriers to innovation and can point to opportunities for productive investment or policy action.

The policy learning and experimentation approach rests on strong monitoring and evaluation, which need to be embodied in programmes and policies from the outset (Morgan, 2018[2]). Policy learning includes provisional goal-setting and revisions based on lessons drawn from experiences and from "learning by doing". The ability of actors to learn from success and failure determines the success of the approach.

A fundamental challenge in policy learning and experimentation is determining the underlying social and institutional criteria necessary to make policy learning successful. A second related challenge is whether and how policy learning and experimentalist approaches are applicable across all types of regions. Success might depend on the ability of local leaders to form collaborative arrangements allowing public sector institutions to work with the private sector in devising experimental approaches. The ability to do so often depends on the willingness of policymakers to enhance their capacity to lead and work with change.

This chapter provides an overview of the role of policy learning in innovation-led regional development to make policy governance more agile, legitimate and tailored to the needs of each local context. Learning matters for innovation policy because policymakers face a complex and continuously evolving innovation system with insufficient evidence of how to most effectively influence it.

While the theoretical importance of policy learning is widely acknowledged, its implementation is challenging in practice. The challenges that need to be overcome to increase policy experimentation are multi-faceted, ranging from questions of commitment to learning by monitoring on the part of ruling politicians and their public sector managers to an organisation's technical capacity for learning by monitoring. To adopt and adapt to the learning mechanisms described in this chapter – collaboration and exchange as well as greater experimentation – policymakers need different types and combinations of skills, which might not always be easy to acquire.

Questions remain about the applicability of policy learning in all types of regions. Not all learning mechanisms are applicable to all regional contexts. In particular, lagging regions – paradoxically those most in need of learning – face a range of barriers to learning because of their institutional weaknesses in terms of governance and capacity. One way to support these regions is through specific learning mechanisms, such as learning networks. A second mechanism is to carefully balance top-down policies with locally led policy efforts and to experiment with existing governance arrangements to allow actors at the margin to be part of the policy process.

Governments that have successfully embraced a culture of learning not only initiate collaboration and experiment with new ideas and processes but they also make sure the resulting learning and evidence are used in decision-making, scaling-up successful ideas while continuing to iterate and experiment. Ensuring that learning is not a one-off engagement but becomes a longer-term process can also help change the set goals if they are not the right ones.

Finally, many innovation policy challenges are dispersed among networks formed by governments, innovators, private platforms and users. This may mean leaving space for people to experiment and test

new solutions by themselves and to find ways of exchange and collaboration that help governments make use of them. The adoption of experimental governance as a policy approach to local and regional development will not induce greater involvement by citizens and civil society (including business networks and industry associations) on its own. Rather, it depends on the ability of those regions and localities to foster the creation of more networked and collaborative forms of governance in order to succeed. While the adoption of these forms of governance does not in itself guarantee the success of the experimental approach, many of the features of networked and collaborative governance provide the pre-conditions under which experimental governance is more likely to succeed.

This chapter and the whole report draw from a series of expert workshops on "What works in innovation policy? New insights for regions and cities" organised by the OECD and the European Commission (EC). For each workshop, experts provided background papers that, together with the discussion during the workshop, form the basis for this report:

- Fostering innovation in less-developed regions, with papers by Slavo Radošević (2018[3]) and Lena Tsipouri (2018[4]).
- Building, embedding and reshaping global value chains (GVCs), with papers by Riccardo Crescenzi and Oliver Harman (2018[5]) and Sandrine Labory and Patrizio Bianchi (2018[6]).
- Developing strategies for industrial transition, with papers by David Audretsch (2018[7]) and Charles Wessner and Thomas Howell (2018[8]).
- Managing disruptive technologies, with papers by Pantelis Koutroumpis and François Lafond (2018[9]) and Jennifer Clark (2018[10]).
- Experimental governance, with papers by Kevin Morgan (2018[2]) and David Wolfe (2018[11]).

The role of policy learning in innovation and innovation policy

The main goal of innovation policy is to support experimentation with new technologies, products, processes and business models, and accelerate their diffusion throughout economies and societies. However, innovation systems are inherently non-linear. Innovation activities can be both a consequence and a prerequisite for further innovation and thus are difficult to chart. Actors, institutions and policies interact in multiple and interdependent ways, making predictions about policy outcomes and funding allocation a challenging exercise.

In addition to the inherent uncertainty and complexity of innovation, a number of trends are currently reshaping innovation systems, with significant impacts on society. Such trends include the rise of GVCs, the globalisation of knowledge production beyond OECD countries, the diffusion of new and disruptive technologies (such as blockchain technology and artificial intelligence [AI]), increased market concentration and changing dynamics between start-ups and corporations (OECD, 2019[12]). Many of these trends also give rise to new challenges, such as the transformation of work or climate change, which will require innovative solutions.

In parallel, emerging technologies are also changing the way governments work and interact with their policy subjects and partners. Public and private domains are increasingly interrelated, not least due to increased interconnectivity. To effectively manage societal and technology changes, governments need to evolve and take an active role in the change process. They need to understand the impact of technology and innovation in order to respond to the changing expectations of citizens, companies and innovators.

Successfully navigating innovation in complex and unknown landscapes requires focusing on the process of learning how new knowledge, new technologies and new organisational structures are created, distributed and used in specific areas. Learning can be defined as a collective process shaped by the

existing structure of production, by organisations and by institutions (Heikkila and Gerlak, 2013[13]). Learning matters because the characteristics of any existing learning system are central to questions of higher productivity and inclusive growth (Cooke, Uranga and Etxebarria, 1997[14]).

Learning requires the ability to self-monitor and learn from past successes and failures – in other words, to learn how to learn. The concept of (policy) learning is closely linked to the notion of reflexivity. The learning capacity of individuals, organisations, and institutions determines their ability to monitor their own progress in adapting to ongoing changes in the environment. As such, policy learning is fundamental to cope with the need for constant innovation (Box 5.1).

Box 5.1. What is policy learning and how does it take place?

Policy learning is closely linked to the notion of experimentation

Policy learning implies a "change in thinking" that occurs through trial-and-error. Policy learning is directed towards using policy tools to resolve a policy issue differently or achieving specific goals with new ways of acting. Policy learning must include "policy forgetting" as part of the learning process. This means being able to abandon policy approaches that are outdated, no longer effective or may lead to counterproductive results. As is the case with innovation processes, policy learning is cumulative because policymakers build on their past knowledge and competencies to adapt to changing circumstances.

Policy learning takes place through processes of organisational learning

Policy learning can occur inside individual organisations, within organisations in the same network or systems, or across various organisations in different networks or systems. The networked dimension of policy learning adds a considerable degree of complexity to the learning process, as it must extend across the boundaries of several different organisations – including public and private ones – at more than one level of political jurisdiction.

Monitoring and evaluation is key for policy learning to be sustained over time

Learning by monitoring ensures that the knowledge derived through trying out new instruments, actions or processes is shared among all actors involved. In this way, the gains from learning are well distributed. Effective monitoring and evaluation require a careful combination of making sense of shifts in the wider context (politics, environment, social, etc.), monitoring relationships and behaviours of diverse actors, weighting up different sources of evidence and being open to unexpected results.

Source: Morgan, K. (2018[2]), "Experimental governance and territorial development", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris; Wolfe, D. (2018[11]), "Experimental governance: Conceptual approaches and practical cases", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

Linking policy learning to regional innovation systems

The regional innovation system (RIS) perspective has dominated the debate on regional development for the past two decades and has been used widely as a framework for the design, implementation and evaluation of innovation-based regional policies. A well-known example of its application is the EC's smart specialisation approach, which requires the development of regional innovation strategies as a prerequisite to receiving financing from the European Regional Development Fund (ERDF).

At the heart of the RIS perspective is the assumption that the most innovative regions are those in which the key institutions – firms, their supply chains, governments, universities and civic leaders – are able and willing to work in concert to find joint solutions to common problems (Asheim, 1996[15]; Asheim and Gertler, 2009[16]). One of the assumptions of the RIS approach is that many innovative firms operate within regional networks, interacting with other firms such as suppliers, clients and competitors, with research and development facilities, innovation support agencies, venture capital funds, and local and regional government bodies. Learning matters in all primary dimensions of RIS:

- Processes and policies supporting education and knowledge transfer.
- Arrangements for the governance of innovation.
- The level of investment, especially in research and development (R&D).
- The type of firms and their degree of linkages and communication, including networking, presence or absence of GVCs.

To a large extent, the diffusion of knowledge, information and technologies are transferred through regional channels, alongside national and international ones. Regional authorities have an important role to play to support diffusion processes by offering services and other mechanisms that augment the inter-linkages between all of these actors. A key challenge is to establish the conditions under which local stakeholders can engage in a consultative and interactive fashion with government authorities, as well as how public authorities can learn to collaborate with these actors under a more distributed pattern of authority.

This chapter analyses two important learning mechanisms that cities and regions are using to broaden their innovation policy and ensure that technology and knowledge diffusion reaches all types of region. The first mechanism is called learning through interaction. It focuses on how regional innovation policy can support interactions between a diverse group of actors participating in governance networks for the purpose of sharing information, knowledge and perspectives to achieve and implement more effective solutions to local problems, in particular in situations where solutions lie beyond the capacity of any single actor. The second mechanism focuses on learning through experimentation, which is testing out new ideas and processes at a small scale with new and innovative methods. Learning through experimentation can be applied both to experimentation in governance arrangements to deliver innovation policies as well as experimentation with innovation policy programmes and instruments, and this chapter will look at both.

The two learning mechanisms are closely related and their distinction can sometimes be blurry. Governments need to use both simultaneously to sustain learning. Networked and collaborative governance arrangements facilitate the flow of information, knowledge and understanding among participants within governance networks, which in turn is critical for the effective implementation of experimental governance.

Learning through interaction: Networked and collaborative governance

A shift has taken place from the post-World War II era of hierarchical and bureaucratic state-managed development models towards more distributed patterns of authority, which involve greater levels of collaboration and networking. Responding to this shift, policymakers are experimenting with novel ways of collaborating that bring together diverse stakeholder groups and provide more integrated and holistic responses. This section clarifies the concept of networked and collaborative governance and provides examples of its application in subnational innovation policy.

The paradigm of networked and collaborative governance

Taking a networked and collaborative approach to public governance implies increased reliance on (typically more informal) networks as a way to mobilise and engage citizens and organisations in the

development, implementation and monitoring of public policy. Governments continue to establish the basic rules governing the operation of the economy but place greater emphasis on the assignment of responsibility to a wide range of associative partners through the mechanisms of voice and consultation (Morgan, 2018[2]). The appeal of the networked approach is that it places a greater degree of responsibility for outcomes on firms and organisations that will either enjoy the fruits of their success or live with the consequences of their failure.

Implementing networked governance does not come without challenges. One challenge for government agencies operating in a networked manner is to establish the conditions under which actors at the regional and community levels can engage in a consultative and interactive fashion with government authorities. Network structures depend on informal exchanges based on interpersonal relationships far more than contractual arrangements do. In such structures, leadership primarily plays a facilitator or broker role. In addition, for the network to be effective, members must trust each other to work to their mutual benefit. Finally, governments also need to understand and be able to work with a key driver of more networked forms of governance – technology (see Box 5.2).

Box 5.2. The rise of networked governance

The rise of network governance and an increased reliance on collaboration points to a more fundamental transformation and proliferation of the network paradigm. The main driver in the emergence of networked governance is technology, primarily in the form of new information and communication technologies.

The rise of networked governance changes not only the nature of public discourse and opinion formation but also the form and content of concrete decision-making, policy development and implementation. Some scholars even argue that nation-states are being replaced by network states. This is defined as states embedded in local, regional and global networks of governance considered as necessary to meet the challenges of increased complexity, connectedness and globalisation (Bang and Esmark, 2009[17]). Such governance networks vary considerably in terms of the level of formalisation, stability and inclusiveness, but a common characteristic is the involvement of non-state actors from the private and third sector as stakeholders and partners in policy management and implementation.

Following the rise of networked governance, governments must engage in new policy design and implementation and demonstrate dynamic capabilities. They need to understand the impact of technology, as well as the changing expectations of citizens, companies and innovators. This includes making better use of behavioural insights and design thinking, as well as acquiring the skills and organisational capacities necessary for the public sector to innovate.

Source: Bang, H. and A. Esmark (2009[17]), "Good governance in network society: Reconfiguring the political from politics to policy", *Administrative Theory & Praxis*, Vol. 31/1, pp. 7-37; OECD (2018[18]), *OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption*, https://dx.doi.org/10.1787/sti_in_outlook-2018-en.

Regional networks function as innovation intermediaries

Regional networks often act as informal multi-stakeholder platforms. For example, having the right networks in place played a critical role in the success of Silicon Valley when compared to Greater Los Angeles. The networks in Silicon Valley were not only enabling a wide range of relevant stakeholders to talk, they were also talking about more relevant factors than in Greater Los Angeles. In the case of the Silicon Valley, networks were talking about the right things, focusing on high-skill, knowledge-based activities, while the networks in Greater Los Angeles were talking about less forward-looking topics such

as tax and cost strategies for restoring low-wage light mass manufacturing and logistics in the region (Storper et al., 2015[19]).

Strategic interactions through networks are critical for innovation. Policymakers can only elicit useful information from the private sector if engaged in an ongoing relationship with other local agents. Rodrik draws on this to argue that the best way to think about innovation policy is in terms of a process of discovery by the government as well as by the private sector (Rodrik, 2004[20]). Engaging the private sector in innovation activities can be facilitated through regional innovation intermediaries that connect companies to external networks and resources (Nambisan, Bacon and Throckmorton, 2012[21]). The Ontario Network of Entrepreneurs is an example of a network that has steadily evolved over the past two decades. It illustrates how regional governments can experiment with innovation policy design by drawing upon the knowledge and insights of innovation intermediaries (Box 5.3).

Box 5.3. The Ontario Network of Entrepreneurs, Canada

The Ontario Network of Entrepreneurs (ONE) provides Ontario-based start-ups and small businesses with a range of services and programming to help them start and grow their business. The network operates through 14 Regional Innovation Centres (RICs) located across the province. Each RIC is a not-for-profit organisation and offers a broad array of resources to local entrepreneurial communities. Their services include educational programmes to enhance entrepreneurial skills and talent development, advisory services that offer coaching and mentorship opportunities, as well as industry-academic programmes to encourage knowledge exchange and resource sharing.

The ONE programme originated as the Biotechnology Cluster Program (BCIP) in 2003. However, before it was fully implemented, there was a political change in the provincial government and, in 2005, BCIP was replaced with the Ontario Commercialization Network (OCN). While the network's overall objectives were established, the commercialisation framework and its service delivery model remained fragmented. A government-initiated programme review in 2008 helped establish a clearer vision for the network and transformed the OCN into the ONE.

What makes the ONE remarkable when it comes to innovation is its focus on engaging local research and innovation actors and encouraging them to link their activities to regional economic development. Member organisations of the ONE hold "regional alliance" meetings with their clients (local firms) to provide advice and guidance on what services best meet the needs of local innovators and entrepreneurs. These regional alliance meetings also help identify and build a pipeline of innovative companies supporting the economic activities that form the region's core strength.

Source: Wolfe, D. (2018[11]), "Experimental governance: Conceptual approaches and practical cases", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

The experience of the ONE programme provides an important illustration of innovative policy evolution and experimentalist governance. Policy evolution did not happen arbitrarily. Rather, it occurred through learning based on inputs from a variety of perspectives and "on-the-ground" participants (Bradford and Wolfe, 2013[22]). The network further illustrates that priorities, rationales and instruments change over time and that all actors learn over time, underscoring the inherently non-linear and systemic nature of knowledge exchange for innovation.

Cities provide important networking platforms for innovation

Cities can act as local policy promoters, initiating and inviting other actors to participate and allocate economic resources, or taking active participation in raising funding in areas such as urban planning, transport and education (Kronsell and Mukhtar-Landgren, 2018[23]). Cities can also participate in policymaking as enablers, without an explicit leading role. In this case, they can open space for other actors by enabling access to resources (e.g. providing expertise), by fostering collaboration (e.g. organising meet-ups and steering groups) and by defining local strategies and plans (e.g. urban branding and creating shared values). The Newcastle City Futures Initiative offers an example. Here, the city council promotes city innovation activities following networked forms of governance (Box 5.4).

Box 5.4. Newcastle City Futures Initiative, United Kingdom

In 2015, the Newcastle City Council established the City Futures Development Group, bringing together local authorities, universities, civil society organisations and the private sector to think about the city's long-term prospects and innovation needs. The group identifies growth opportunities, multi-partner and multi-sector projects, public and business engagement on city futures, and new research projects.

Pursuing a multi-stakeholders partnership enables citizen engagement and creation of a shared vision, and provides a means to design interventions that will positively contribute to the life and development of Newcastle. Larger corporate partners assist small- and medium-sized enterprises (SMEs) through collaborative project work including the use of co-designed demonstrator projects that have a direct impact on the city and create a "testbed city".

City Futures projects are identified by the group's partners, working together. Projects must address multiple sectors, depend on multi-partner involvement and use digital visualisation and other engagement methods. Selected projects are presented to the City Futures Development Group for comment and endorsement.

The Newcastle City Council is a partner in the City Futures Initiative but is not directly involved in all of the experimental projects beneath its umbrella. In some projects, the city council also serves a third role, that of facilitator or enabler, by providing expertise and urban branding.

Source: Morgan, K. (2018[2]), "Experimental governance and territorial development", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

Digital technologies play a major role in advancing networked governance

Digital technologies can make policy implementation more user-centric and facilitate interaction among local stakeholders. By bringing together local agents more easily, digital technologies can enable networked forms of policymaking. Technological developments also open up new possibilities to work with machine-readable information from government and the private sector – so-called open data – which is increasingly becoming an important instrument to break down information gaps across industries and replace intuitive decision-making approaches with data-driven ones (OECD, 2018[24]). A rising trend observed among OECD member and partner countries is using the constellation of policy stakeholders to crowd-source knowledge, promote new forms of partnerships and secure policy co-ownership and co-responsibility. For instance, the government of Mexico leverages open government data to promote transparency and involve citizens to collaboratively solve policy issues (Box 5.5).

Box 5.5. Open Data National Policy, Mexico

Mexico's Open Mexico Network is an open platform for co-operation for the entire public administration. The federal, state and municipal governments co-operate for sharing knowledge, tools and resources to facilitate the effective implementation of the Open Data National Policy.

The Open Data Infrastructure is a group of datasets prioritised by the federal government for release due to its potential contribution to national development goals. The group has been crucial to guide open data disclosure by public institutions.

The Open Data Squads (ODSs) provide technical and regulatory guidance and support from the centre of government to federal and local public institutions. The work of the ODSs has been instrumental to build capacities for data management (e.g. data production, exchange, publication and use) towards greater disclosure on the central portal.

Retos Publicos is an initiative providing incentives for application development. The initiative has been useful to connect developers with public institutions in order to foster collaboration around specific policy issues and sectors. As a result, web and mobile-based platforms and applications were developed by private sector organisations to improve public service delivery or to tackle asymmetries in citizen access to information.

Source: OECD (2018[25]), *Open Government Data in Mexico: The Way Forward*, https://dx.doi.org/10.1787/9789264297944-en; Mexican Government (n.d.[26]), *Open Data National Policy*, https://datos.gob.mx/; Reto México (n.d.[27]), *Homepage*, https://retomexico.org/ (accessed 23 September 2020).

The digital transformation of governance is helping avoid top-down assumptions about citizen and business needs by empowering them to engage with governments. Closer engagement with local agents can inform policymakers about bottlenecks to innovation, and foster collaboration in order to tackle local challenges in a user-driven approach. Estonia is a leading example of how government structures can interact with citizens much more closely through digital technologies, performing much better in this domain than many larger countries.

Box 5.6. Estonia's digital governance strategy

Since the 1990s, Estonia has made remarkable advances in information society development. The main drivers behind this include economic factors, the active role of the public sector, technological competency and socio-cultural factors. The telecommunications and banking sectors were the cornerstones of Estonian information society developments; they were also behind major initiatives dedicated to computer training and awareness-raising. Public sector initiatives have been also crucial in providing a favourable legislative environment, as well as launching necessary infrastructure projects and in implementing innovative e-services.

eGovernment in Estonia started as a long-term effort to develop a functional architecture that could serve as the basis for delivering a wide range of services. These include the Estonian electronic identification card, authorisation and digital signatures. Additional web portals offer the general public, civil servants and entrepreneurs almost 500 different e-services from the national and local governments. Citizens and entrepreneurs benefit immensely from this fully integrated system, as they do not need to complete long applications since all of their data are maintained in the system. Meanwhile, civil servants are freed up from inputting the data from paper documents or cross-checking

data on different databases, making the system a good example of how the government has simplified the payment system.

Some non-governmental organisations have strongly influenced public sector developments as well. A special case is the digital technologies used for e-residency. E-residency or "virtual residency" gives foreigners global access to Estonian e-services via a state-issued digital identity. The "virtual state" and "virtual residency" have features of nation branding and national reputation, which may help attract investment and create start-ups.

Source: Tsipouri, L. (2018[4]), "Fostering innovation in less-developed (with low institutional capacity)", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

The trend of using data to improve public sector performance is evident at the national and local levels of government. For example, in Bristol, United Kingdom, the project Bristol is Open is a collaboration among the local government, universities, local tech communities and the technology, media and telecommunications industry. The project is based on a joint venture between the Bristol City Council and the University of Bristol and draws upon the value of using digital technologies to facilitate multi-stakeholder collaboration and jointly address policy challenges. It promotes user-driven services and policies in the city. An initiative called the Bristol Approach was launched to support citizens working together to pinpoint the necessary knowledge, technology and resources to address problems in the city. Other national and subnational governments have also started to explore the potential of new technologies in improving the quality and efficiency of public service delivery through a bottom-up and engaging approach. However, capacity constraints – be they in terms of human, financial or infrastructure resources – remains a challenge for most governments, especially at the subnational level (OECD, 2019[28]).

The role of networks in regional innovation policy: The Entrepreneurial Discovery Process

Innovation-led regional development in Europe is based on the theory of smart specialisation and was conceived as part of the EC's reformed Cohesion Policy for the 2014-20 programming period. Smart specialisation is a place-based approach in which strategic areas for intervention are identified based on an analysis of the strengths and potential of the economy and an entrepreneurial discovery process (EDP) with wide stakeholder involvement. It is outward-looking and embraces a broad view of innovation including, but not limited to, technology-driven approaches supported by effective monitoring mechanisms.

The European Union (EU) Cohesion Policy supports innovation-led development through regional smart specialisation strategies (S3). With its total budget of EUR 80 billion for the 2014-20 programming period, it belongs to the world's largest regional innovation policy programmes. As a policy concept, smart specialisation was designed with a dual purpose in mind: i) to accelerate agglomeration processes by reducing duplicative regional investments in science and technology; and ii) to encourage regional players, especially regional governments, to stimulate the growth of new exploration and research activities, which are related to existing productive structures (Foray, 2014[29]).

At the heart of the S3 approach is a process of entrepreneurial discovery for innovation and growth (Foray, David and Hall, 2009[30]). The approach puts forth that successful entrepreneurship must combine knowledge about science, technology and engineering with a more fundamental understanding of the competitive dynamics of market opportunities, potential competitors and the financial, managerial and other inputs necessary to make an entrepreneurial venture success. Policy learning occurs through search and experimentation, initiated by the public sector, but strongly supported by entrepreneurs in the region (Asheim, 2012[31])

From the beginning, a commonly accepted definition of the EDP has been lacking (Capello and Kroll, 2016[32]). Bottom-up, firm-led participative processes through which priority areas for research, development and innovation investment would be defined appeared as central in earlier definitions. However, recent approaches argue that an EDP should be built with evidence-based analyses and through the combination of bottom-up and top-down processes that might initially establish fairly broad priorities (Kroll, 2015[33]). Nevertheless, there seems to be agreement that the EDP is meant to prioritise investment based on an inclusive and evidence-based process driven by stakeholder engagement and attention to market dynamics.

One of the major weaknesses of the EDP approach is its lack of regional connectivity. In some cases, the government has dominated the EDP process, leading to questions around whether regional search processes are including actors at the margin and whether the theory is put into practice. Promoting more engagement of regional actors and improving connectivity between agents will need to be considered to make sure that S3 are developed into effective and flexible regional strategies that are built on entrepreneurial dynamics (Radošević, 2018[3]). A key question is whether governments have the right governance mechanisms to build long-lasting broad partnerships with private sector actors. Arguably, the process of smart specialisation has been most successful in the Northern countries, e.g. Sweden, home to high-quality institutions and a long tradition of networked governance. Leveraging multi-stakeholder networks to identify future-oriented priority areas can however also work in moderately innovative regions. The Pomorskie region in Poland provides an example of a well-designed entrepreneurial discovery process within an environment that lacks a legacy of strong collaborative ties (Box 5.7). As a consequence, this was addressed in the EC proposals for the new Cohesion Policy in the post-2020 period where there is a specific focus on governance aspects of smart specialisation.

Box 5.7. The Entrepreneurial Discovery Process in Pomorskie, Poland

The Pomorskie regional government took a strong collaborative approach to the development of smart specialisation priorities through the entrepreneurial discovery process. Smart specialisation investment priorities in Pomorskie were identified largely through a bottom-up process entailing the following main steps:

- Step 1: An economic diagnostic of key regional strengths and weaknesses, accompanied by public consultation and the formation of partnerships.
- Step 2: A call for proposals to research and industry stakeholders for joint smart specialisation projects together with conference and workshop activities to stimulate proposals. This led to 28 proposals.
- Step 3: An initial assessment of proposals by a selection board composed of national and international experts and a public hearing. The selection took into account global trends, market potential, economic and technological potential, a domestic and international benchmarking, the proposed strategy and action plan, and the potential of the partnership. This led to a narrowing down to six specialisations and partnerships.
- Step 4: Final concepts were developed by the partnerships for expert assessment and recommendations. As a result, four smart specialisations were selected.
- Step 5: An implementation plan was set up for each specialisation, including its scope, aims and priority research directions.
- Step 6: Partnership agreements with priority access to EU funding were established for each specialisation, subject to renegotiation where needed.

The regional government is keeping these consortia active through continued workshops and peer-learning events. The process was also useful to learn about challenges that need to be overcome in the future to drive smart specialisation, notably a lack of data on locally emerging products and technologies to help identify potential smart specialisations and difficulties in maintaining the initial stakeholder engagement. New forms of economic policy governance in the form of project consortia and regional innovation platforms were developed to ensure long-term engagement of higher education institutions and businesses in S3 implementation.

Source: OECD (2019[34]), "Local entrepreneurship ecosystems and emerging industries: Case study of Pomorskie, Polandhttps://doi.org/10.1787/8fd63992-en.

Regional governments all over Europe have used the EDP more or less successfully to develop S3. However, even where the EDP successfully identified regional innovation strength, it remains focused on the policy search and discovery stage, suggesting a need for an additional mechanism to embed the role of networks in policy implementation. This is the role of learning networks.

Sustaining learning beyond the EDP: The role of learning networks

Learning is often a "by-product" of network activities, emerging, for example, through an exchange of views or shared attempts at problem-solving. However, it is also possible to see learning as the primary reason for building a network. The concept of a learning network can be defined as a formal mechanism purposefully built to support the practical learning of its members. These networks can reduce risks in experimentation because they provide an opportunity to engage in challenging reflection and to make use of peer group support. Examples of such configurations can be found in regional clusters, sector groupings, heterogeneous groups sharing a common topic of interest, user groups concerned with learning around a particular technology or application, and supply chain learning (Bessant et al., 2012[35]).

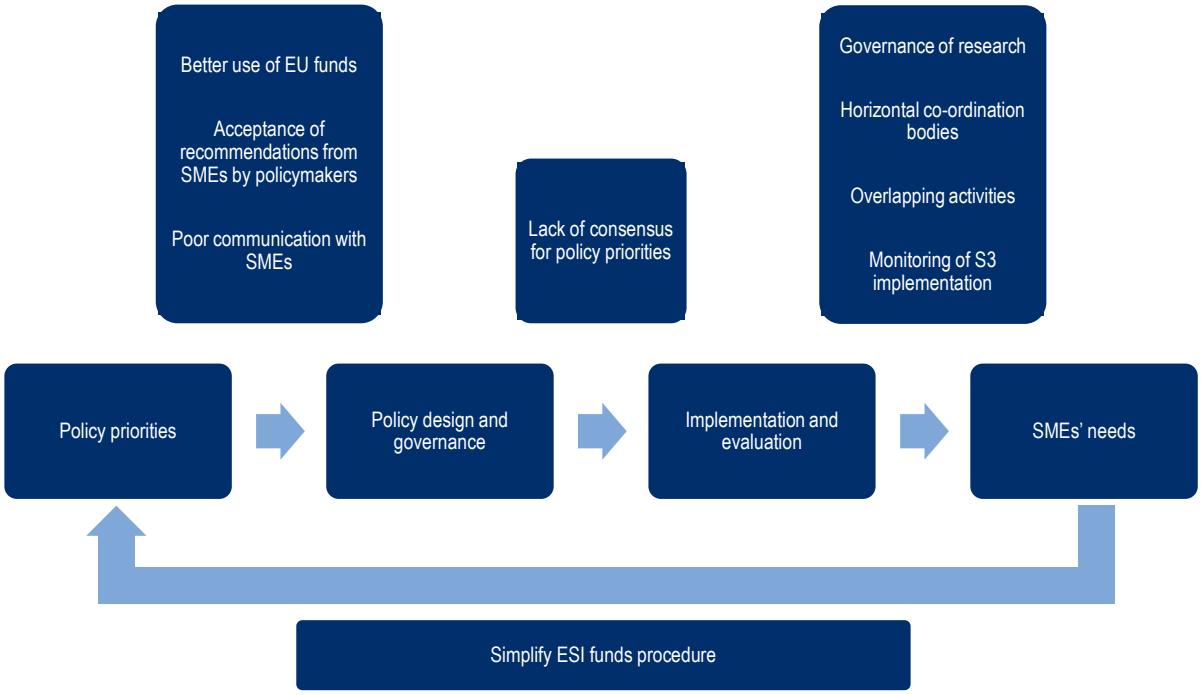
Formalising the approach and using learning networks as a governance and learning mechanism would significantly resolve contradictions between experimental innovation policy and the administrative requirements for conventional public policy. Learning networks can also help overcome some inherent weaknesses of the entrepreneurial discovery process. Often, the EDP is reduced to the design stage of policy, meant to identify regional areas with potential for innovation and growth. While the identification of priorities based on collaboration with the private sector is experimental in nature, the implementation of projects within these priority areas is mostly executed through programme-based calls rather than through strategic partnerships or "innovation platforms" of all key actors (Radošević, 2018[3]). Learning networks should include the following actors:

- *A network moderator* who manages and co-ordinates activities, people and time, matches learning needs with knowledge resources, and monitors the relationships between members.
- *Peer group facilitators* who assist groups of practitioners in their structured reflection. Facilitators are trained and accumulate experience over time.
- *Network members* are individuals representing an organisation.
- *Invited experts,* i.e. non-network members invited to participate in the network for a specific reason (such as the presentation of a topic) and a defined period.

Learning networks can address two critical challenges of experimental innovation policy. The first challenge is ensuring a strategic fit between policy priorities and the private sector needs to create innovation policies that are appropriate and relevant. The second challenge is ensuring the operational fit between policy design and governance, and implementation and evaluation (Bessant and Tsekouras,

2001[36]). Learning networks can be deployed at different stages of the smart specialisation process and input into specific areas of the process (Figure 5.1).

Figure 5.1. Areas of potential implementation of learning networks in the smart specialisation process



Source: Radošević, S. (2018[3]), "Fostering innovation in less-developed and low institutional capacity regions: Challenges and opportunities", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

Learning by doing: Experimentation and evaluation

This section focuses on the role of "experimentation" in boosting innovation. Experimentation involves designing a portfolio of policies to solve problems in a variety of local contexts, monitoring and evaluating intermediate outcomes as rapidly as possible, and constant learning, feedback and adjustment (Wolfe, 2018[11]). Critical to the experimentation process is the recognition that policymakers can and should learn from failure. This approach supports multidisciplinary approaches to designing and implementing innovation policy and stands in stark contrast to the idea of universally-relevant policy packages.

Experimentation suggests that policymakers co-operate closely with private and non-governmental actors, which are often better placed than governments to identify barriers and areas for productive investment or policy action. It suggests involving agencies and actors on the margin of policymaking to limit capture by vested interests and to enable more creative and co-operative policies than those emerging from central agencies. Successful learning through experimentation is closely related to processes of networked and collaborative governance as described in the previous section.

What is experimental governance?

In a rapidly changing world, fixed rules written by a hierarchical authority are quickly rendered obsolete on the ground. The concept of experimental governance was developed as a response to the perceived failure of "command and control" regulation. Experimental governance has been defined as a "recursive process of provisional goal-setting based on learning from the comparison of alternative approaches to advancing

them in different contexts" (Sabel and Zeitlin, 2012[37]). It involves a multi-level process in which four elements are linked in an iterative cycle:

1. Broad framework goals and metrics are provisionally established by central and local authorities.
2. Local authorities are given broad discretion to pursue these goals in their own way.
3. As a condition for this autonomy, local agents must report regularly on their performance and participate in a peer review in which their results are compared to others who are using different means to the same ends.
4. The goals, metrics and decision-making procedures are revised by a widening circle of actors in response to the problems and possibilities revealed by the peer review process, and the cycle repeats.

Experimental governance enables a multi-level architecture, where the responsibility for policy design and implementation is distributed between different levels of government and special-purpose local institutions (e.g. private associations, joint local authority bodies, co-operation across national borders, public-private partnerships, etc.). In this architecture, it is up to the higher levels of government to set general goals and performance standards and to establish and enforce the "rules of the game". It is up to the lower levels to have "the freedom to advance the ends as they see fit" (Barca, 2009[38]).

Linking experimental governance to multi-level governance

The concept of experimental governance implies the decentralisation of power in the state system from ministries at the national level to local and regional levels of government, which are generally considered better positioned to build lasting and interactive relationships with firms and civil society associations in their respective regions (Morgan, 2018[2]). For this reason, experimental governance is closely linked to multi-level governance. It represents a new model of political architecture where political authority and policymaking influences are dispersed across the different levels of the state, as well as to non-state actors.

Effective multi-level governance arrangements are a necessary pre-condition to support the innovative behaviour of firms, sectors and clusters. Recognising the extent to which policy and decision-making are shared between levels of government leads to an appreciation of the importance of "absorptive capacity" for learning on the part of policymaking institutions and innovation support organisations.

State-sponsored experimentalism: Bottom-up models of innovation

Policymakers across OECD countries are supporting experimentation in regional innovation policy through different initiatives and programmes as part of their policy portfolios. Some governments have also started to support experimentation directly inside the government to devise more innovative services and develop technology. Policymakers are playing an increasingly active role as innovators in their own right, taking on the uncertainties of innovation through policy design, experimentation and implementation activities inside the government (Karo and Kattel, 2018[39]). For example, NESTA's Innovation Growth Lab and the EU's Joint Research Centre's Policy Lab have been supporting experimentation in innovation policy.[1] Many governments are also exploring how to create "safe spaces" for experimentation inside the public sector, helping civil servants at all levels of government deal with the uncertainty connected to experimentation processes, and sometimes giving them an explicit licence to fail (OPSI, 2017[40]). The following examples from Canada, Germany and Sweden demonstrate how novel approaches to innovation policy design, implementation and monitoring can support place-sensitive experimentation in innovation policy.

The Canadian approach: Combining policy tailoring with experimentation

In Canada, regional development agencies (RDAs) represent an institutional approach to delivering federal programmes to the different regions of the country. The RDAs have continuously evolved over the past four decades by taking on new roles and abandoning previous ones. They work closely with the provincial

governments in their regions to tailor programme structures to the specific needs of the regions. Unlike earlier Canadian bureaucratic structures that delivered programmes and services, the RDAs seek to be "change agents" in local innovation systems (OECD, 2011[41]).

In addition to managing traditional financial assistance instruments, RDAs play "softer" roles that are integral to facilitating innovation systems. These include supporting strategic planning and capacity building among firms and community organisations, addressing cultural or educational barriers to entrepreneurship and innovation, building regional knowledge through trends analysis and performance benchmarking and providing a portfolio of network-based "doing, using, interacting" relations among multiple local actors. The Federal Economic Development Agency for Southern Ontario and the Atlantic Canada Opportunities Agency provide examples of two agencies that successfully tailor their offerings to the relevant development history and regional innovation context. (Box 5.8).

Box 5.8. Facilitating innovation systems through regional development agencies, Canada

Federal Economic Development Agency for Southern Ontario

The Federal Economic Development Agency for Southern Ontario (FedDev Ontario) is helping to strengthen the region's leadership in AI through support to the Southern Ontario Smart Computing Innovation Platform (SOSCIP). SOSCIP is Canada's only advanced computing research and development consortium focused on industry innovation. It is composed of up to 17 members (post-secondary institutions and not-for-profits) and 6 innovation partners including multinationals like Unilever and IBM. SOSCIP provides a single point of contact for companies to work with world-leading researchers and advance computing platforms to solve their businesses challenges and drive economic growth.

Originally established in 2012 with funding from FedDev Ontario and expanded with subsequent funding, SOSIP brings academia and industry together to accomplish life-improving research that has led to job creation in key emerging sectors. FedDev Ontario's most recent CAD 10 million investment in the Platform toward a CAD 84 million project is supporting the delivery of a three-year initiative to help small and medium sized enterprises (SMEs) working in emerging sectors, including business analytics, advanced manufacturing and cybersecurity sectors, adopt AI in their products and operations. The project aims to undertake collaborative projects with SMEs, commercialise new AI-driven technologies and foster the skilled talent pool of AI and data science-trained students and researchers in southern Ontario.

Atlantic Canada Opportunities Agency

The Atlantic Canada Opportunities Agency has major initiatives supporting business strategies and community development at geographic scales that connect functional regions rather than conform to jurisdictional boundaries. The inter-provincial Atlantic Innovation Fund invests in R&D and commercialisation to build industrial clusters that can anchor maritime innovation, including ocean technologies and environmental technology. At the same time, the agency supports community economic development through investments in sector associations and regional development bodies that organise collective action at "in between" scales, i.e. above individual municipalities and below the province.

Source: Wolfe, D. (2018[11]), "Experimental governance: Conceptual approaches and practical cases", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris; FedDev Ontario (2019[42]).

Canadian RDAs have a long history of successfully using experimental and innovative approaches in the design and delivery of policies and programmes. While the definition of experimentation for this purpose is open-ended, new and innovative approaches to policy can include: user-centred design, co-creation approaches to policy development with stakeholders, civil organisations and other governments, staged funding approaches to enable scaling, data analytics and modelling and investing in pooled funds that use these methods (Bradford and Wolfe, 2013[22]).[2]

The German approach: Place-based experimentalism through innovation clusters

Regional policy in Germany at the federal level and the level of the *Länder* increasingly involves distinct experimental features. At the federal level, the experimental approach is primarily implemented through regional competitions. Early examples of this approach include the Regions of the Future competition, the Active Regions competition, the InnoRegio competition, as well as the BioRegio contest of the early 1990s (Cooke, Uranga and Etxebarria, 1997[14]). This approach is designed in a top-down fashion but elicits bottom-up responses from a variety of regional and local actors.

With its Leading-Edge Cluster Competition (*Spitzencluster-Wettbewerb*, LECC) initiated in 2007, the Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF) is supporting innovation clusters in a nationwide contest for the first time. Fifteen cluster initiatives were selected in three waves. They received funding of up to EUR 40 million each for 5 years to support them on their way to becoming international leaders in their field of technology. This cluster support is meant to simultaneously improve the innovative performance of the regions selected and ensure that the funding helps cluster firms attain a leading international position in sectors or niches.

Cluster initiatives were formed through a bottom-up approach, which ensured a high level of participation by regional stakeholders during the launch of the cluster initiatives and their strategy development. Recent evaluations of the cluster support (Rothgang, Dehio and Lageman, 2017[43]) point out that the intensity of network co-operation increased in all clusters due to improved awareness of potential partners. Newly formed linkages also were formed to a substantial extent, even among actors that did not receive direct funding for a joint R&D project, indicating an additional mobilisation effect of the policy. To what extent this enhanced networking will have a long-term impact on successful innovation depends on whether the co-operation with local or supra-regional partners remains at a high level beyond the funding period and whether actors will be able to learn from each other. One of the Spitzenclusters that received considerable attention in the cluster and regional innovation literature is MicroTEC Südwest in Baden-Württemberg. It provides an interesting illustration of how adopting an experimental governance approach at the federal level reinforces efforts at economic diversification, regional innovation and greater collaboration by the *Land*. It also provides an example of how a cluster can sustain long-term innovation gains by embedding learning mechanisms in the cluster's design (Box 5.9).

Baden-Württemberg is notable for a dense network of research and higher education institutes, which has resulted in the highest level of R&D density, including patenting, of any state in the Federal Republic of Germany. A critical component of the RIS is the Steinbeis Foundation with its 400 centres located in regional universities that link the region with relevant federal policies to support innovation and clusters. Despite this rich endowment of research capabilities, the region has faced a number of challenges related to the extensive industrial restructuring that affected many parts of Germany and Europe in the 1990s. Following the recovery from the downturn in the second half of the decade, there was a growing perception that the region needed to diversify its industrial base away from traditional manufacturing strengths in the automotive and mechanical engineering industries. Attempts to diversify the economy led to government policies to support new software centres, centres for fuel cell technology and biotechnology parks, among other initiatives.

One of the mechanisms deployed by the *Land* to chart the way forward was the Future Commission Economy 2000, appointed in 1992. The commission was designed to lead a region-wide process of social

dialogue and consensus-building to help respond to serious competitive threats to its traditional core industries (automotive, machine tools, electronics) and to set the economy on a new trajectory emphasising emerging technologies. The process of producing this "dialogue-oriented market-based industrial policy" was mediated by a set of important state and non-state institutions in a manner corresponding to the form of collaborative governance. Major investments in new research infrastructure by the *Land* government followed from this effort, as well as a greater emphasis on initiating and supporting regional innovation networks.

Box 5.9. The MicroTEC Südwest Cluster in Germany – Learning by design

The MicroTEC Südwest "Spitzen" cluster, developed under the conceptual leadership of the Steinbeis-Europa Zentrum (SEZ) in Stuttgart, focuses on developing and implementing new products based on the development of new general-purpose technologies in miniaturised electronic systems in the fields of nano-, micro- or biotechnologies. It was one of 15 clusters selected in a national cluster competition. The cluster bid involved the participation of global multinational firms, such as Robert Bosch or Roche Diagnostics, as well as 350 other actors in the region, from universities and research centres to many SMEs. The research activities of the cluster organisation are focused on healthcare and mobility, as well as technology-related priorities to develop next-generation microsystems for future applications. Together they cover 25 research, technology development and innovation projects and 13 structural projects.

The cluster has a built-in decision-making process that supports learning and re-evaluation of projects. The cluster board and a strategy panel created a continuous learning cycle involving three main stages:

1. Stock-taking stage designed to review the cluster's position in the global context using evaluation, audit and benchmarking policy tools.
2. Forward-looking or longer-term perspective on the potential impact of the initiative that involves foresight and impact assessment tools.
3. An action-planning stage designed to develop roadmaps for the achievement of milestones for the project with specific actions to be undertaken.

The learning process includes the broad participation of public and private actors who are asked to share knowledge from global sources with actor/region-specific knowledge. The aim of the learning process is not only to contribute to the success of the cluster initiative itself but also to transform it into a smart innovation system that continuously monitors the cluster's competitive environment, assesses its progress toward its goals, builds local competencies and capabilities and reassesses the methods used to achieve its objectives.

Source: Morgan, K. (2018[2]), "Experimental governance and territorial development", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

The Swedish approach: Public sector innovation labs

Governments are increasingly turning to public sector innovation (PSI) labs for new approaches to policy design and the delivery of public services. PSI labs are created to deal with the growing complexity of policymaking in an era of accelerating social and technological change (McGann, Blomkamp and Lewis, 2018[44]). Most of these labs apply a user-focused, cross-sectoral approach to policy design as a means of driving innovation across a wide spectrum of policy domains. Their way of operating stands in stark contrast to the silos and hierarchies of the conventional public sector.

In Europe, more than 60 labs were in operation in 2016 (Fuller and Lochard, 2016[45]). In a survey of 35 of these labs, around one-third were established at a municipal level, suggesting that PSI labs are just as likely to be launched by cities and municipalities as by national governments (Puttick, Baeck and Colligan, 2014[46]). For over 60% of the labs covered in the survey, the primary source of income was self-generated from project-based funding, closely followed by direct budget transfers from the sponsoring government department. A key feature of the labs surveyed was a strong skills mix. They bring together heterogeneous teams of researchers, designers, and stakeholders to discover and analyse problems from different angles and they employ people from backgrounds generally new to the public sector from fields such as design, anthropology, ethnography, social geography, as well as political science, sociology and communication.

The primary role of PSI labs is to become effective catalysts for systemic change and to ensure that public policy is becoming more data-driven and evidence-based. To date, the catalytic role of PSI labs has been constrained by two main factors: their short lifespans and the fact that they operate removed from everyday reality. The Swedish innovation agency, Vinnova, has sought to better anchor the concept of PSI labs into everyday policymaking through the introduction of reality labs (Box 5.10).

Box 5.10. Promoting experimentation in the public sector through "reality labs" in Sweden

Since 2011, the Swedish innovation agency Vinnova has been experimenting with a number of concepts to support public service innovation. The "innovation sluices" programme aimed at creating organisational structures that would support ideas from public servants and help turn them into reality. This concept was then turned into testbeds, which are policy labs testing new solutions in a controlled environment through interaction with external stakeholders. The reality lab takes the testbed lab one step further by applying the principle of testing to the frontline. Instead of testing imagined solutions in a testbed, "reality labs" are created where policy is implemented, such as at the clinic or in the classroom where healthcare or education is delivered.

Vinnova has funded 15 labs through an open call. The agency requires innovation labs to focus on a technology or need-based area, for example medical technologies for elderly care or digitalisation of the railway sector. Although no prescription exists as to what a PSI lab is required to do, Vinnova has identified seven principles to ensure the success of each lab:

1. The lab performs experiments in the organisation's core business.
2. It expresses a special focus of interest that is specific but at the same time with broader applicability beyond the local context.
3. The market of the focus of interest is well known and there is an ambition to communicate the results.
4. The experimentation process is open to other stakeholders with possibilities to participate.
5. The applicant is building an organisation for testing and experimentation with high potential to survive after the funded project is over.
6. An integrated policy strategy exists from the start, including an understanding of what policies apply in the area of focus and how to change or influence them.
7. A clear view exists on how to utilise digital services.

Source: NESTA (2017[47]), "'Reality Labs': Evolving the public sector innovation lab", https://www.nesta.org.uk/blog/reality-labs-evolving-the-public-sector-innovation-lab/ (accessed on 6 November 2019).

Subnational worlds of experimentation

National-level initiatives may command most attention when it comes to innovations in governance but it is at the subnational levels where new forms of experimental governance have been pioneered. This is due in part to the success of the well-established paradigm of RIS but also to the manifold forms of innovation that are increasingly taking place at the level of cities and the still under-exploited innovation potential in local public administrations.

Regional innovation systems: The S3 challenge

RIS are based on relationships that interact in the production, diffusion and use of new and economically useful knowledge (Asheim, Grillitsch and Trippl, 2016[48]). Many of the basic ideas of the RIS approach like the place-dependent nature of innovation, the importance of inter-organisational networks for generating and exploiting knowledge and the integrity of governance mechanisms inform smart specialisation strategies. The smart specialisation concept as dominated regional policy in the EU since its introduction in 2014 as an *ex ante* conditionality for receiving financial support from the EU structural funds.

The S3 approach demonstrates that innovation is a place-dependent as well as a path-dependent process. Policy responses need to accommodate the specific conditions of each region rather than being derived from a “best practice” policy template. Regional innovation policy design will depend on the type of region in question. This led to the creation of a highly influential regional typology framework that distinguishes between the organisational thinness of peripheral regions, the lock-in problems of old industrial regions and the internal system fragmentation of highly diversified metropolitan regions. To address the diversity of these place-based challenges, the most important policy priority is to abandon a “one-size-fits-all” mindset and embrace a more granular approach that respects the specificity of places (Boschma, 2015[49]).

Many of the key features of experimental governance are intrinsic to the S3 policy process. Both are based on a partnership between public sector agencies at the regional level and private actors in the corporate sector, thus requiring an element of collaborative governance to succeed. The principles of the S3 approach require that it must involve a set of outcome indicators to monitor and track progress made towards meeting the objectives established in the entrepreneurial discovery process (see the preceding section). This means incorporating a diverse group of regional stakeholders in the design, delivery, monitoring and policy evaluation aspects of a programme. The co-ordination of policy systems across the regional, national, supranational and European-wide levels is also essential and calls for a strong degree of multi-level governance in its implementation.

A potential weakness in the S3 approach is that it presumes the existence of strong regional institutions and associated governance mechanisms (McCann and Ortega-Argilés, 2015[50]), which might not always be present. A growing body of literature in regional economics and evolutionary economic geography documents the close association between the quality of governance institutions in a region and its level of economic performance (Rodríguez-Pose, 2013[51]; Iammarino, Rodriguez-Pose and Storper, 2019[52]). The question it raises for the S3 process is whether it makes heroic assumptions about the state of governance, particularly in lagging regions that are most in need of its potential benefits. Recent research on the nature of new path development in RIS, which is what the S3 approach is designed to generate, argues that lagging regions may be deficient in the precise types of organisations and institutions that are most needed for the approach to succeed (Marques and Morgan, 2018[53]).

The implementation of an experimental governance approach in RIS might depend on institutional innovation for new path creation (Sotarauta and Suvinen, 2018[54]). A case study of Tampere, Finland, concluded that the process of new path creation depends on new economic opportunities being shaped by entrepreneurial actors from a range of sectors. In the process, actors acquire new ways of viewing the economic situation of their cities or regions and use this to construct new economic opportunities. Over time, the new sets of institutions or organisations created become rooted in the region and can unlock a

range of new economic opportunities, thereby embedding the learning process that was triggered through experimentation with entrepreneurial actors.

Cities as innovation spaces

Establishing a culture of innovation whereby cities are encouraged to experiment, take risks and learn from failure is a key enabler and driver to innovation. An OECD/Bloomberg survey on innovation capacities in cities (OECD, 2019[28]) has found that more than three-quarters of the 89 cities surveyed have funding schemes dedicated to supporting building innovation capacity, mostly coming from municipal budgets but also other sources, such as external (non-public) funding and national government budgets. Most innovation efforts are tailored to improve service delivery (e.g. for emergency services, housing, mobility and social services), to improve internal government operations (e.g. streamlining budget processes and workflows and fostering inter-agency co-operation) and to improve resident quality of life (e.g. health and job outcomes).

The important role of major metropolitan areas as national engines of growth (OECD, 2015[55]) and carriers of political weight (OECD, 2019[12]) has led to increased experimentation with city governance structures. The most prominent examples of experimentation in metropolitan governance involve the larger cities in each country, for example:

- In France, the 2013 Law on Metropolitan Areas provided for differentiated governance in Aix-Marseille, Lyon and Paris that included governance structures with their own taxing powers and entailed a shift of competencies from regions and departments.
- In Italy, a 2014 reform ended two decades of gridlock over territorial restructuring by creating a new legal structure for the introduction of differentiated governance in ten major metro areas – Bari, Bologna, Florence, Genoa, Milan, Naples, Reggio Calabria, Rome, Turin and Venice – and four additional cities in special regions – Cagliari in Sardinia as well as Catania, Messina and Palermo in Sicily.
- In the UK, the Core Cities have been the chief beneficiaries of a series of City Deals that devolved certain powers to city-regions in exchange for their agreement to meet certain economic goals and to be governed by directly-elected metropolitan mayors (OECD, 2019[56]; Waite and Morgan, 2019[57]).

Beyond the metropolitan level, experimentation in governance arrangements is visible at the individual municipal level as well. A prominent example comes from Denmark, where municipalities were granted exemptions from government rules in order to test new ways of carrying out their service delivery tasks, a policy experiment knows as the Free Municipality Initiative. This experiment is being evaluated in order to form the basis for potential future legislation on de-bureaucratisation for all municipalities. The concept of free municipalities continued in an adjusted form until 2019 and is being extended to more municipalities (OECD, 2017[58]).

Monitoring, evaluation and learning through experimentation

The notion of policy experimentation is linked to learning. By definition, an experiment is set up in order to learn something or to discover if something works or is true. Therefore, government approaches, which are “trying something new”, can only be perceived as policy experiments once the systems and processes required to learn from them are also put in place. This includes a timeframe with clear limits or checkpoints. A date at which the results are assessed and a decision is made on whether to continue the experiment, adjust it, scale it up or discontinue it.

Despite the many benefits of experimentation, policy organisations often find it difficult to apply (Breckon, 2015[59]). Two of the most common barriers to embedding learning in policymaking are: i) the commitment

to and capacity for learning by monitoring in public sector bodies; and ii) the degree of autonomy and discretion provided to subnational governments.

Building monitoring and evaluation commitment and capacity

Some of the most common barriers to a commitment to learning about what works, where and why are political, relating to the policy cycles or to competing political priorities, for instance, the pressure to make policy decisions before rigorous evidence emerges. In addition, policymakers may believe that their views are correct and do not feel they need better evidence on their programme's impact. Fear of negative results from monitoring and evaluation as well as a lack of knowledge or insufficient skills to conduct robust monitoring and evaluation are additional barriers (OECD, 2017[58]). Related additional barriers are budgetary constraints and missing organisational processes and structures. The 2017 Fraunhofer survey found that commitment to monitoring and evaluation remains low in regional innovation policy: while two-thirds of respondents claimed that their region had some monitoring system, only half of those had the capacity to track S3 priorities in an informed way (Kroll, 2018[60]).

Embedding a culture of experimentation across economic ministries and innovation agencies takes time. It requires raising awareness of the value and feasibility of policy experimentation and identifying early champions within governments. The Finnish experimental model is a leading example of monitoring, evaluating and learning through experimentation (Box 5.11)

Box 5.11. The Finnish experimental model

Experimental Finland is a policy framework for experimental policy design that was developed by the Finnish Prime Minister's Office in 2015 and incorporated into the strategic government programme. Its aim is to allow public policy design and delivery to become more experimental. The Finnish model is a combination of both top-down and bottom-up approaches, allowing for broader "strategic experiments" such as the universal basic-income experiment and rapid grassroots experiments.

The Finnish experience successfully changed the policymaking culture, making it more evidence-based and open to risk-taking. Learning through experimentation is on the rise in the Finnish public sector, supported by a number of initiatives:

- The digital platform Place to Experiment was created to provide funding, experimental cocreation space, and for gathering and sharing lessons from different small-scale experiments.
- Small-scale experiments of EUR 3 000-EUR 10 000 per experiment are funded under 3 themes: the circular economy, AI and digital workforce skills in social and healthcare.
- Randomised controlled trials (RCTs) and nudging have been supported. Civil servants have been offered training sessions on how to conduct RCTs and an expert panel has been launched to support these experiments across different units.
- Guidelines have been created concerning how to revise legislation to enable experimentation. This is especially relevant where existing laws are preventing experiments. A report on social experiments' ethics and legal perspectives was prepared for this matter.
- Strategic experiments are evaluated and inform guides for civil servants on the importance of conducting and supporting experiments.

Source: Experimental Finland (n.d.[61]), *Homepage*, https://kokeilevasuomi.fi/en (accessed 13 April 2020).

Helping public administrations set up first small trials makes it easier for them to build internal coalitions to undertake larger and more impactful experiments. It is also important to get the resulting evidence used and successful programmes scaled up. Lastly, change needs to be sustained until it becomes part of the norm, which means that it becomes institutionalised in processes, instruments and budgets. The French organisation La 27e Région provides an example of a small-scale low-budget organisation that accompanies public administration and disseminates knowledge on the "how to" of PSI.

Box 5.12. La 27e Région – A lab to transform public policies in France

La 27e Région is a French organisation that aims to build core government capacity in experimental public policy design through applied training with regional public administrations and the provision of written guidelines. To this end, it mobilises the capabilities of multidisciplinary teams composed of designers, idea generators and social scientists from many fields (ethnography, sociology, participant observation) and engages in ground-level actions, including do-it-yourself projects and adult education actions.

The initiative currently carries out three major strands of action:

- *Térritoires en Résidence (Territories in Residence):* Started in 2009, this is the first programme developed by La 27e Région. Within the programme, a multidisciplinary team spends three separate one-week periods with a neighbourhood organisation, a school or a community centre. The purpose of the activity is to question the operation of the entity from the standpoint of its beneficiaries in order to propose concrete improvements. An evaluation conducted after the first 12 projects helped refine the methods and communication channels for future projects.
- *La Transfo*: From 2011 through 2014, La Transfo was conducted in partnership with four pilot regions of France: Bourgogne, Champagne-Ardenne, Pays de la Loire and Provence-Alpes-Côte d'Azur. Over a period of up to two years, the team of residents worked with civil servants, elected officials, citizens and the entire administrative "ecosystem" on a specific topic, to test the public innovation function, including its methods and team, and its inclusion in mainstream policymaking.
- *Les Éclaireurs* (Foresight): This collaborative foresight tool developed by La 27e Région is meant to imagine the public service offer of tomorrow. By highlighting where a problem lies, the team helps identify the tools, methods and processes which public authorities can employ in the future.

Source: La 27e Région (n.d.[62]), *Homepage*, http://www.la27eregion.fr/ (accessed 14 April 2020).

Ensuring sufficient autonomy and discretion, and supporting asymmetric decentralisation

Although the experimental model makes a powerful case to create space for local innovation, questions remain about how much real authority is enjoyed by the local level when it comes to innovation policy and to what extent hierarchical structures have been replaced by networked forms of governance. Particularly in less-developed cities and regions of centralised and unitary states, such real power transfer might not have occurred.

Experimentation and learning by doing at the subnational level can be supported through asymmetric decentralisation, where selected subnational jurisdictions are treated differently from their territorial peers on economic, political or administrative grounds. However, asymmetric decentralisation carries costs and benefits. Potential benefits are linked to the fact that institutional and fiscal frameworks can be better aligned with local capacities and may be better attuned to local needs, thus favouring experimentation. As

regards the potential costs, asymmetric decentralisation can exacerbate inter-regional inequalities (OECD, 2019[56]).

Decentralisation has been an important international trend in governance for more than 70 years and remains high on the political agenda of many OECD countries. While the degree of decentralisation is difficult to measure and compare, OECD fiscal databases and other relevant sources have shown that decentralisation is still on the rise in many countries (OECD, 2019[56]). Data from the Regional Authority Index (RAI) also show that 52 out of 81 countries experienced a net increase in decentralisation in the years 1950-2010 and only 9 experienced a net decline (Marks, Hooghe and Schakel, 2008[63]).

Asymmetric decentralisation arrangements help drive experimentation because they allow policies to go through a testing phase. Developing a new product or service without going through an R&D phase involving market research and user testing will likely lead to failure. Designing policies should also go through similar phases before implementation. Such an "R&D phase" for policies helps better understand the problem being addressed and allows for larger user engagement in the policy design and implementation phases. In addition, policy "crash tests" can avoid large policy disasters, by experimenting them in small pilots before scaling them at large. The five RIS testing pilot projects in the Canadian province of Newfoundland and Labrador are an example of regional innovation policy testing (Box 5.13).

Box 5.13. Newfoundland and Labrador testing pilot projects, Canada

The province of Newfoundland and Labrador in Canada introduced an innovation policy scheme following experimental governance approaches based on a series of five RIS testing pilot projects. The projects were designed to identify unique characteristics and assets in different economic sectors in five regions of the province and improve their innovation capacity.

Once the testing pilots succeed in identifying promising avenues for new growth paths, regions can attempt to pursue investments on a larger scale. The pilots connect knowledge capabilities and resources of a wide group of stakeholders, fostering greater collaboration among local agents, creating linkages and providing support in the areas not only of R&D but also of innovation and technology adoption. The policy design has distinct stages involving:

- Identification of the unique characteristics and assets of the specific economic sectors in each region, highlighting regions' competitive advantage.
- Creating partnerships among regional stakeholders and developing a vision of what is possible for each sector in each region.
- Help in identifying new international markets for the region's products, overcoming information and knowledge gaps in the region.
- Focus on the areas of specialisation where regional businesses have the potential to innovate and disseminating the benefits of that innovation across the region.

The Newfoundland RIS testing pilots are designed in a model of networked governance. Each RIS pilot is overseen by steering committees that vary in form across the regions. The primary responsibilities of the steering committees are assessing the competitive strengths of each region (including strengths, weaknesses, opportunities and threats [SWOT] and competitive analyses that can generate a regional profile) and establishing a shared vision for pursuing the identified potential growth paths.

Source: Wolfe, D. (2018[11]), "Experimental governance: Conceptual approaches and practical cases", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

Policy learning in less-developed and remote regions

Trying out new processes and instruments in regional innovation policy can be particularly difficult in the context of less-developed regions with large institutional deficits. Within the EU, these regions are located mostly in Belgium, Bulgaria, Italy, Romania and Spain, and are at risk of being stuck in a "low-administrative quality, low-growth trap" (Morgan, 2018[2]). These regions are often in the greatest need for additional innovation support. However, their weak absorptive capacity keeps them from making full use of such support.

Less-developed regions often face low levels of co-operation and weak administrative capacity

Less-developed regions are often characterised by low levels of co-operation between public and private actors. Establishing collaborative arrangements between actors, for example governments, firms and universities, in a framework of strategic interactions is a major challenge, especially in regions with little or no tradition of collaborative agreements. However, such interactions are critical for regional development ensuring "policy learning" about changing local opportunities and bottlenecks and external solutions with the potential to work locally (Marques and Morgan, 2018[53]). The absence of such collaboration can also mean that funds made available in these regions through regional development programmes are more likely to be absorbed by public sector higher education institutions (HEIs) that may have the capacity to use them but may be poorly connected to the private sector actors with insights into the regional growth potential.

A second issue concerns the quality of public administration in these regions and whether public sector organisations have the administrative capacity to successfully implement processes of learning and monitoring. The institutional quality in low-growth regions is estimated to be just 63% of the EU average, while in low-income regions it is just 57%. However, this also varies significantly from just 12% of the EU average in Campania (Italy) to 26% above the EU average in Alentejo (Portugal) (World Bank, 2018[64]). Policy learning only works well when the quality of institutions at the regional level is high. However, institutional weakness in terms of both governance and capacity is one of the defining features of lagging regions, whether they are low-growth regions or low-income regions. In addition to relying on certain learning mechanisms that are better suited for regions where institutional capacity is less developed, there are measures that national governments can use to support capacity building. Asymmetric decentralisation, for example, allows governments to tailor responsibilities to local capacities. Responsibilities can then iteratively increase as capacity rises (Morgan, 2018[2]; OECD, 2019[56]). National innovation policy can provide targeted support to lagging regions. Such support can, for example, include co-ordinating and promoting learning across regions within the same country via physical or web-based platforms for exchange.

An additional problem is that policy learning and adaptation works only when regional elites are sufficiently committed to making it work. This commitment needs to include a change in perception of monitoring and evaluation from being a compliance tool to becoming a learning tool. Shifting to a model of diagnostic monitoring would perceive monitoring as checking on progress in order to facilitate problem-solving by all actors instead of using it as a threat of punishment for bad performance or an incentive for good behaviour (Sabel and Zeitlin, 2012[37]).

Some learning mechanisms might be particularly suited for less-developed regions

Given the additional limitations to policy learning in lagging regions, greater attention needs to be paid to the underlying conditions of institutional capabilities and regional culture. A critical part of institutional capabilities is the administrative capability required to implement and co-ordinate processes of experimental discovery (Morgan, 2018[2]). For these co-ordination capabilities to compensate for a weak

regional culture of collaboration, public sector agencies must establish the conditions and institutions under which private sector actors can learn to engage with the public sector and each other. The successful implementation of learning through experimentation rests on building stronger collaborative and networked governance.

The inability to engage in trust-building exchange and collaboration often reflects the absence of a tradition that values the connection of public sector agencies to economic actors in the private sector. A range of incentives that encourage all parties to maintain involvement can support exchange and collaboration. In a first step, small, repeated experimental interactions based on the entrepreneurial discovery progress may prove effective as a mechanism for getting all involved stakeholders to work together and facilitate institutionalised learning (Gertler and Wolfe, 2004[65]). Several institutional mechanisms can be applied to foster co-operation beyond the entrepreneurial discovery process. Learning networks (see the previous section), where communities of practice form across diverse stakeholder groups in various sectors of the economy, can help to build a common basis of knowledge and understanding that fosters trust and collaborative governance. Another institutional mechanism that has been proposed in response to these challenges is diagnostic (problem-solving) monitoring, which focuses on the type of activities a region engages in and is more suitable for lagging regions or countries. This approach involves a high level of experimentation in discovering new paths or domains of economic development. It introduces the notion of the Schumpeterian development agency (SDA) as an agency with the mandate and ability to undertake small-scale experiments, correct errors and learn from its mistakes. While this type of agency is deemed to be suitable for application in lagging regions, most of the examples provided come from small, open, emerging economies, such as Finland and Israel (Dutz et al., 2014[1]). Table 5.1 provides an overview of the strengths and weaknesses of these learning mechanisms.

Table 5.1. Policy learning mechanisms for lagging regions

Approach	Strengths	Weaknesses
Smart Specialisation Entrepreneurial Discovery Process (Foray 2015)	- Stakeholder engagement through structured consultation process but confined to the design stage	- Broad-based engagement does not always lead to adaptation and learning - EDP might reflect existing power and discourse structure
Learning networks	- Ensures that learning goes beyond the policy design stage - Feedback is an essential mechanism of experimentation which requires constant adaptation	- Requires the ability and willingness of public sector entities to lead and engage in change - Requires specific institutional setup
Diagnostic (problem-solving) monitoring	- Allows for experimentation	- Requires SDA

Source: OECD compilation based on Morgan, K. (2018[2]), "Experimental governance and territorial development", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris, and Radosevic, S. (2018[3]), "Fostering innovation in less-developed and low institutional capacity regions: Challenges and opportunities", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 22 June 2018, Paris.

In addition to learning within the region, supranational and international organisations are potential sources of institutional support for regional authorities. For example, the regional development agency (RDA) in Northeast Romania has been able to implement a bottom-up consultative policy strategy in challenging circumstances, having learnt substantially from support from the EC and the Joint Research Centre. Northeast Romania is one of the poorest regions in the country and has proved to be one of the most proactive in terms of mobilising all possible institutional capacity it possessed. The challenge for the RDA was all the greater because a linear model of innovation dominates the national innovation system in the country. Universities receive priority attention in terms of investment but remain substantially disconnected

from the private sector, with only a limited amount of technology transfer between the two and relatively few spin-offs. Northeast Romania has been able to contribute to more and better connections between the public and private sector (Box 5.14).

Box 5.14. S3 Multi-stakeholder engagement, Romania

Romania received special attention under the EU Lagging Regions project. The project was partly managed by the Joint Research Centre's S3 Platform in Seville because of the weak institutional support for S3 in Romania.

The proactive RDA in Northeast Romania benefitted from an internal policy learning process and strong support from the EC through the Lagging Regions project. A detailed analysis of local industrial sectors with the potential to form competitive clusters was undertaken. Six industrial sectors were identified with existing agglomerations that showed potential for further development, as well as nine existing clusters. The analysis concluded that the greatest potential lay in reconfiguring traditional industries in several sectors, as well as the potential for new sources of regional economic development in several emerging sectors.

The S3 was formulated based on the SWOT analysis undertaken by the RDA. The strategy included the existing regional potential for technology transfer, the position of regional industries in existing GVCs, a public consultation conducted between 2013 and 2016, and potential linkages with existing European and national policy priorities for innovation. The resulting vision for 2022 for the northeast region focused on promoting sustainable development in six vertical sectors: agri-food, biotechnologies, textiles and new materials, health and tourism, ICT and the environment. In addition to the sectoral focus that was adopted, several horizontal policy priorities for action were also spelled out, including developing the innovative competency of the younger generation in the region, support for innovative companies, initiatives to promote clustering of regional firms and technical assistance for the implementation of the strategy.

Northeast Romania represents a case where working in an institutionally thin and underdeveloped context did not impede setting processes that included key features of collaborative governance. The RDA linked the existing public administrative structures in the region to other elements in a quadruple helix model: the education system, firms and organisations in the economic system and civil society. The resulting process explicitly incorporated three elements of collaborative governance – consultation, engagement and collaboration – to formulate a common strategy and action plan.

Source: Wolfe, D. (2018[11]), "Experimental governance: Conceptual approaches and practical cases", Background Report for an OECD/EC Workshop Series on Broadening Innovation Policy: New Insights for Regions and Cities, OECD, 14 December 2018, Paris.

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Notes

[1] See https://ec.europa.eu/jrc/en/scientific-tool/tools-innovation-monitoring.

[2] It is too early in the process to find concrete examples of how this directive is being operationalised with respect to economic development programmes; the major RDAs are all contributing to the emergence of new cluster organisations funded by the federal government's Supercluster programme.

Broad-based Innovation Policy for All Regions and Cities

This publication summarises the main findings of a series of high-level expert workshops, organised with support by the European Commission, to deepen the understanding how OECD countries can move towards a broad-based form of innovation policy for regions and cities. Weaknesses in technology and knowledge diffusion are weighing on productivity growth and innovation in OECD countries, particularly in firms that are distant from the technological frontier (global or national). This in turn weakens their capacity to meet future challenges and undermines inclusive growth.

This report examines where current tools for innovation policy are too narrowly focused, targeting mainly research and development as well as science and technology-based interventions. It seeks to help empower firms to benefit from global trends and technological change, in order to better adapt to the different capacity and innovation eco-systems across regions and cities.

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