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]).

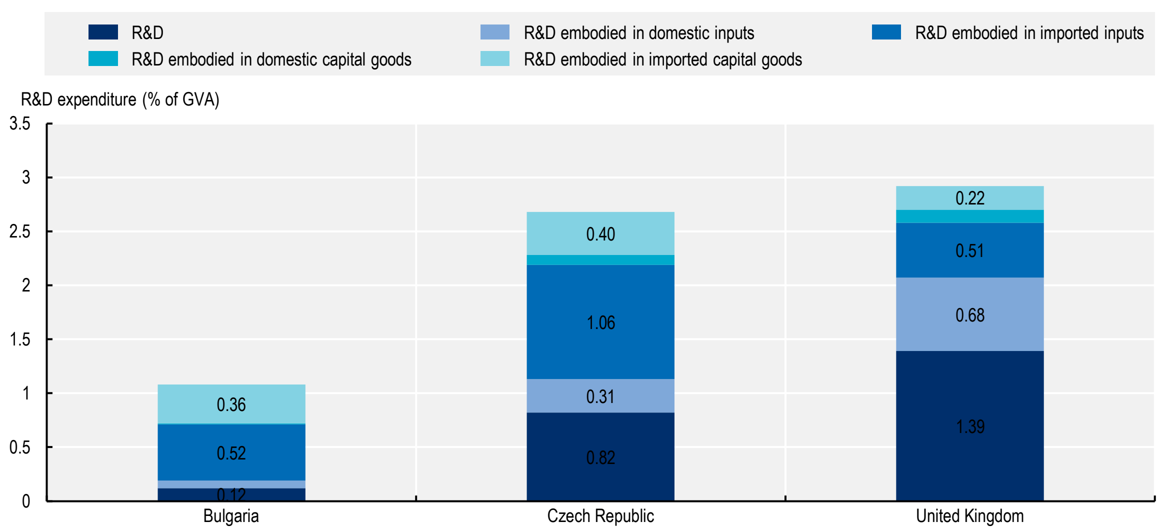
Traditional innovation indicators are not adapted to capture innovation in non-frontier regions. They are focused on technological capacities and perform well in capturing the type of innovation activity taking place in frontier regions, but not in any others. Traditional innovation indicators include 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]

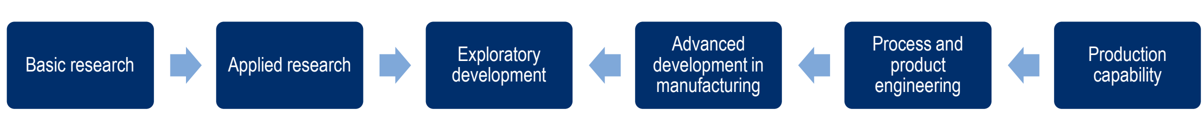
Even in places where there is academic excellence in some field, the question remains on how to create local links and commercialise ideas. For academics, the benefits of collaborating locally might be lower than finding partners in other parts of the country or even internationally. In many countries,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

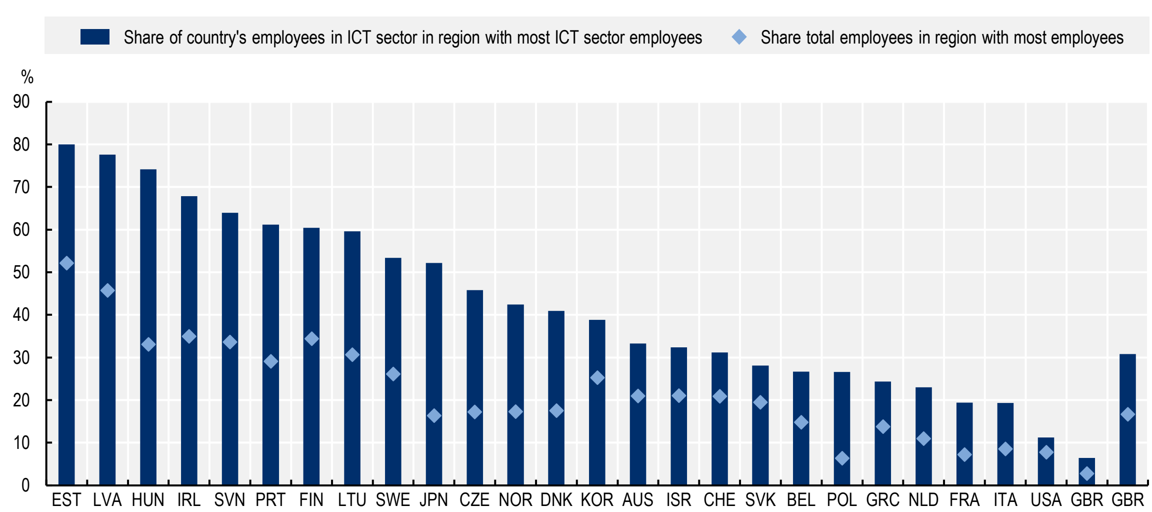
Funding for R&D is among the most common instruments in innovation policy and most countries have some form of targeted support with either sectoral or place-based targets. Norway has a place-based approach through Innovation Norway, which is jointly owned by national and subnational governments and 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.

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