

DERIVING NEW POLICY INSTRUMENTS FOR ATTRACTING RESEARCH & DEVELOPMENT & INNOVATION IN GLOBAL VALUE CHAINS TO EUROPE

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Abstract

In this paper, we discuss new policy instruments to improve the attractiveness of Europe for innovative activities. The case studies and interviews with company representatives collected on Global Value Chains (GVC) show a high interest in these new policy instruments. Since the companies analysed are active in different sectors and Research & Development & Innovation (R&D&I) Global Value Chains it is suggested that the policy instruments and options discussed will be linked with current and future sectoral initiatives organized in the frame of the Smart Specialisation Strategy. This gives numerous established and new actors from business, politics, science and society from different Member States, regions and cities but also actors from outside the EU the chance to develop bright ideas for new products, services, processes and work in a well-structured but also open-minded environment. In addition, this approach helps regions to develop systematically in new fields of innovation and industry which are appropriate for the region and their actors. This approach matches in a very good way with the new innovations labs which are currently very popular in companies highly active in R&D&I. These innovation labs have a highly experimental character. The same might be necessary for an ambitious policy to upgrade European GVC by shaping a process of engaging, anticipating, assessing and responding on an ongoing basis. Strengthening a proactive attitude among policy makers towards a proactive innovation policy is a soft but important instrument to speed up for a new industrial age in Europe.

Keywords: Innovation Policy, Industrial Policy, Innovations Labs, Global Value Chains

Introduction

The world economy has changed significantly during the past several decades, especially in the areas of international innovation activities and industrial organization. New features of the contemporary economy are for instance the globalization of innovation, production and trade. They have fuelled the growth of industrial capabilities in a wide range of developing countries

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and the vertical disintegration of transnational corporations (TNC). TNC are redefining their core competencies to focus on innovation and product strategy, marketing, and the highest value-added segments of manufacturing and services while reducing their direct ownership over 'non-core' functions such as generic services and volume production.

The European Commission stresses in a Communication of 2017 (2017a) "a new industrial age" with economic, societal and environmental transformations and technological breakthroughs (e.g. robotics, Internet of Things, artificial intelligence). These changes go along with automation, digitized manufacturing processes and the nature of work. Furthermore, industry is more and more integrated in Global Value Chains (GVC) with important service components. In this Communication it is suggested that the Member States, EU institutions and industry itself need important efforts "to maintain and reinforce Europe's industrial leadership." This means that it is for instance necessary to fill the missing links in relevant value chains. One important step is to facilitate the integration of European companies in GVC in Research & Development & Innovation (R&D&I) which are the essential drivers of industrial competitiveness. Besides this, missing links in value chains have to be filled with investment in a strategic way as demonstrated in the field of new batteries for smart mobility. In this Communication it is also stressed that there has to be a focus on "strategic value chains" in new technology which has to be well coordinated and financed by public authorities and industries from several Member States. In another recent Communication on "Strengthening Innovation in Europe's Regions" the European Commission (2017b) stresses the beneficial link between innovation and smart specialisation in the regions. The Smart Specialisation Strategy (S3) has the aim to encourage Europe's regions to identify their specific competitive advantages to better prioritise public research and innovation. Another important step is therefore to organise new forms of co-operation on an inter-sectoral level and across regions. This means GVC in R&D&I are an important additional element of S3 in Europe.

Upgrading industry in the EU by using policy instruments needs concrete instruments and mixed instruments. Otherwise there is the risk that the current industrial renaissance is just a flash in the pan. The policy tool box discussed in this article discusses special instruments and combinations of policy instruments e.g. for the appropriate development of human resources, efficient research and innovation infrastructures and absorptive capacities and the identification of needs of companies R&D and innovation linked with their existing and new GVC. Furthermore, this paper provides options on how public authorities on different levels can tackle new challenges for innovation and industry by organizing collaborative opportunities for innovation and industrial actors.

Methodological approach

To examine the topic three methodological tools were used: a literature review, structured interviews and case studies. The literature review focused on obtaining a comprehensive and recent overview of the existing evidence on the interrelation between R&D&I localisation decisions and their impact on the home and the host countries. All references that have been used throughout the project can be found at the back of this document. References to company reports or websites of the firms that have been examined in the case studies have been removed in order to safeguard the confidentiality. Information from the desk research has been complemented with multiple interviews to obtain a more comprehensive assessment of corporate internationalization strategies, organizational processes and challenges. 10 companies have been selected for this purpose (see below). Structured interviews with company managers have also been complemented by interviews with external sector experts. 10 case studies at company level have been conducted, distributed across three of the most knowledge-

intensive sectors (with the highest overall R&D expenditures) of the European Union. These case studies enabled us to better understand the geographical and organizational patterns of corporate R&D and innovation (R&D&I) activities across GVC and their interactions with home and host countries' economies and policy initiatives. Additionally, the case studies enabled us to gain a better understanding of the locational drivers and barriers to improving the attractiveness of Europe as a location for R&D&I activities. The case studies have also shed more light on the competitive position of the European Union in strategic GVC.

A 'case' refers here to the entire GVC of a company's product (group). More specifically, this study has looked at R&D&I activities (both R&D and non-R&D) within the GVC. This GVC covers the sequence of operations going from early research activities to the marketing of the developed products. The value chain can also include external partner firms and (research) institutions when the company outsources activities or engages in collaborations. The selection of the 10 company cases was guided by the outcome of the literature review. It has been decided to focus on companies in the three industries with the highest R&D expenditures in Europe, in particular:

- Health (Pharmaceuticals & Biotechnology, Health Care Equipment), further specified to pharmaceutical companies (we examined 3 companies)
- Mobility (Automobiles & Parts, Airplanes, Public Transport), further specified to automobile companies (2 companies) and aerospace companies (2 companies).
- ICT (Technology Hardware & Equipment, Electronic & Electrical Equipment, Software & Computer Services, Fixed Line Telecommunication), further specified to ICT manufacturing and software (3 companies).

Other key criteria that have been taken into account for the case selection are:

- A well balanced mix of sectors (as indicated above) taking into account the technology level: pharmaceuticals – high tech, automotive and aerospace – medium-high tech and ICT manufacturing – high tech
- R&D intensity of the company – high R&D intensity
- Origin/nationality of companies – EU companies
- Geographical coverage (headquartered in the EU, but with dispersed GVC)
- Company type – established MNEs and fast growing firms
- Indication of recent noticeable trends with respect to location decisions.

For each case study, around 6 interviews were conducted, so a total of 60 interviews with business representatives, company managers and industry experts have been undertaken.

Results, discussion and implications

Rationale behind a policy to upgrade Global Value Chains

During the last years there has been an enormous increase in research literature on innovation and industrial policy. The highlights of this research are summarized in a number of most recent articles (e.g. Edler/Fagerberg 2017; De Marchi/Di Maria/Gereffi 2018; Martin 2016; Buciuni/Finotto 2016; Grilli et. al 2018; Dosso/Martin/Moncada-Paternò-Castello 2018). Concerning the rationale of innovation and industrial policy ("Why?") there are a number of

prominent arguments. One argument is that innovation policy is necessary because of market failure. This argument continues to be influential among policy makers and justifies funding basic public research (Edler/Fagerberg 2017). Other authors question that this approach is adequate justifying and guiding the design, financing and implementation of innovation and industrial policy (Mazzucato/Semienuk 2017). Another argument is that an effective coordination of innovation is necessary. Following this thinking innovation systems are strengthened to ensure positive impacts for business, society and regions. In addition to that, there is a prominent argument saying that there are strong tendencies to path dependencies in innovation with negative effects in the long run when change is needed (Edler/Fagerberg 2017). These needed changes can be supported by new forms of innovation and industrial policy, e.g. by open dialogues between established and new innovation actors and sectors in pro-active regions and across sectors (Nepelski/De Prato 2012).

When discussing innovation and industrial policy scientific studies point out that there are quite a number of relevant actors active in this field which have to be considered. Some observers describe this as a “diversity of key actors” (De Marchi et al. 2017). Companies [MNEs, SMEs, home-grown firms, foreign global lead firms], science societies, universities (also of applied sciences), business organizations, trade unions and the public authorities are just a few examples of relevant actors. Furthermore, these actors perform on different (or all) levels, e.g. international, European, national, regional and municipal. In addition to that, these different actors may have different objectives and incentives which are not necessarily explicit. Empirical research shows that there is mostly consensus between the key actors that innovation and industrial policy is needed (Mai 2014). One of the key questions the different innovation actors continue to discuss is to what extent public authorities should intervene and if the intervention should have an initiating or a supportive role. This discussion seems to be driven by fear (too high degree of globalization, deindustrialization) and hope (increasing employment, sustainability, new products and services) at the same time (Aiginger 2014). Besides this, innovation and industrial policy instruments play a major role. „Policy instruments are not tools that carry the same meaning in different contexts. Instruments are influenced by agents that implement them, by actors they are targeting and by time and space“ (Editorial: Innovation Policy: How can it make a difference? In: Industry and Innovation, 23 (2), S. 136). All case studies and interviews collected by the authors of this paper underline the above described arguments across all the studied sectors (pharmaceutical, automotive, aerospace and ICT).

Various instruments – not either or but a meaningful combination

A review of recent literature shows that innovation and industrial policy consists of various instruments. The question arises what changes or combinations in policy instruments are necessary to meet the challenges Europe and its innovation actors are facing when coping with GVC in R&D&I in a new industrial age with numerous transformations and technological breakthroughs. Before we start discussing answers to this question it is beneficial to describe and to examine the different types of innovation and industrial policy instruments and how are they used by public authorities to influence innovation and industrial processes. This has to be done to explore the nature of instrument choice and design before mixes of instruments often described as policy mix (Borrás/Edquist 2013) or a meaningful combination are discussed in detail from a holistic or systemic perspective.

In a publication by the OECD published in 2012 it is concluded that the “effectiveness of a policy instrument almost always depends on its interaction with other instruments” (p. 156). In this publication it is also stressed that beyond “core innovation policies” such as science and technology and education other policies and instruments have to be taken into account. This

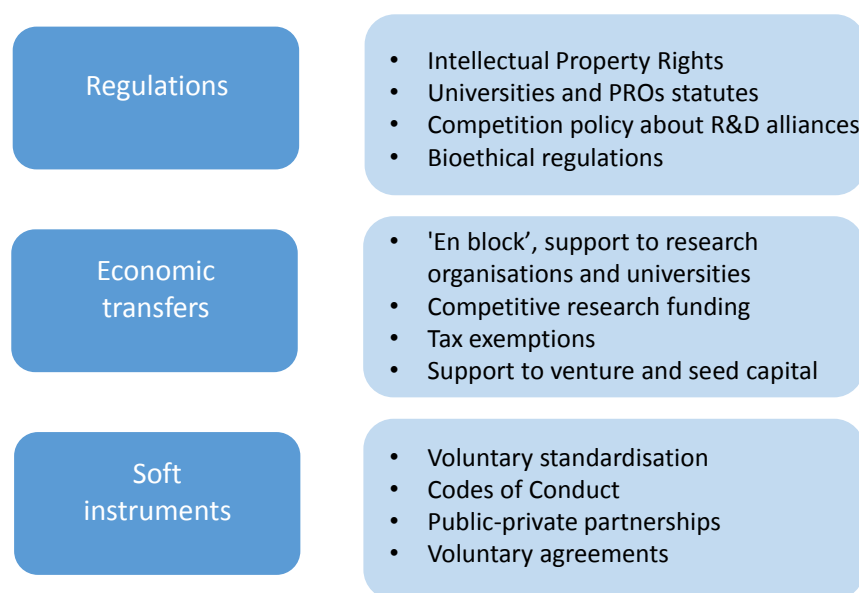
means for instance that taxation, competition laws and regulations play an additional prominent role. Besides this, it is suggested to keep in mind that there are different target groups, desired outcomes, funding mechanism linked with these instruments. In this paper the OECD distinguishes between

- supply side and
- demand side instruments

which are complementary.

An additional, more detailed distinction between policy instruments is available in the publication by Borrás/Edquist (2013, S. 1517) as shown in Figure 1.

Figure 1: Categories of policy instruments



These authors suggest three categories of instruments (a. regulatory instruments, b. economic and financial instruments and c. soft instruments) and point out that the three-fold division is most accepted in the literature on innovation policy instruments. In these categories (see Figure 1) there are quite a number of special instruments like competition policy about R&D alliances, tax exemptions or voluntary agreements. Borrás and Edquist observe that most of these instruments influence the development and diffusion of innovations from the supply side rather than from the demand side. From their point of view instruments focusing more on the demand side might have the advantage to redress specific types of weaknesses. And especially the new types of instruments – often called soft instruments – might be able to address different and new aspects of the innovation and industrial system challenged by a number of deep transformations and technology breakthroughs. Borrás/Edquist conclude that the design of the mix of instruments has to include ultimate objectives which support private organizations and companies in solving problems in the field of innovation they cannot solve on their own. Most recent research shows that successful innovation and industrial policies combining a whole set of policy instruments from all three categories discussed above have led to radical innovations. It has to be underlined that these policies have been more focussed on market shaping and creating through direct and pervasive public financing than on market fixing

(Mazzucato/Semienuk 2017; d'Andria/Savin 2018). This means instruments are changed and combined with other instruments to address new and sometimes “old” problems and challenges of innovation and industry. Public financing of innovation becomes even stronger as a strategic tool since it can help shaping and creating markets. Mazzucato/Semienuk stress three features when looking on public financing of innovation and the way it can shape and create markets

- investing along the entire innovation chain
- mission-oriented nature of agencies involved and
- their lead risk-taking role, independent of the business cycle.

This market shaping approach suggests that the usage of policy instruments must be “proactive and bold, creating directions, and transcending the role envisaged by market- or social system-fixing approaches” (p. 44). The properties of innovation in a new era of industry seem to be highly uncertain, cumulative collective, and with very long lead times (Grilli et. al 2018).

Well known scientists from North America (Wolfe 2017, 2016; Cantwell 2017) argue in a similar way but stress the point that only “substantial tax incentives or direct subsidies might be an inefficient use of scarce public resources” (Wolfe 2017, p. 11). Instead this instrument has to be combined with investments “in building a talent base and research capabilities” in selected regions (Wolfe 2017, p. 11) to attract investments by MNE in new R&D&I activities. Cantwell emphasises that globalization and national/regional specialisation are complementary and not conflicting. “From a locational perspective, international knowledge connectivity has become critical for sustained innovation and growth” (2017, p. 41).² Just recently, Owen (2017) published a paper on lessons from US innovation policy. From his view an important point is to avoid over-centralization in innovation policy. “In industries where technology is advancing rapidly and in uncertain directions, success generally depends on multiple sources, on initiative and innovation ... (and) new entrants are often better equipped to identify and exploit new lines of research” (2017, p. 31).

The case studies and interviews with company representatives collected for this article show a high interest in these new policy instruments especially in these of categories 2, “economic transfers”, and 3, “soft instruments”, for the usage in the pharmaceutical,³ automotive, aerospace and ICT sectors. The interviewees of all companies stress the existence of well-developed and connected industry clusters in Europe as a major advantage as well as the political stability and a quite good transportation infrastructure (except an appropriate charging infrastructure for e-mobility). Also they view a number of European public-private partnerships (PPP) like SPIRE⁴ as a positive factor. Furthermore, most of the interviewees are pleased with the system of well-established, reliable intellectual property laws and the academic excellence in quite a number of European regions. In addition to this, the interviewed companies stressed that a long history of R&D&I sites in Europe is a positive factor since the companies have a very good access to strong and existing networks and to knowledge clusters they can rely on.

Factors decreasing the attractiveness of R&D&I sites in Europe are – from the interviewees’ point of view – for instance that there is no central European research organization that stimulates and steers research (e.g. pharmaceuticals) or that companies do not find a one-stop-shop for information on public financial support in appropriate regions in Europe. For this reason

² Also other research shows that connectivity has been found as a critical factor in determining the attractiveness of a region (Somers 2016).

³ Some actors from the pharmaceutical sector also prefer a regulatory instrument for strengthening industrial property rights.

⁴ Sustainable Process Industry through Resource and Energy Efficiency.

the interviewees ask for more attention to red tape and bureaucratic processes. The Interviewees also indicated that the European academic research market is too fragmented, especially compared to the US. This has from there point of view two consequences:

- (1) It is more difficult to reach the critical mass in certain areas and
- (2) there is a duplication of research efforts since the market is less efficient.

From the interviewees point of view the S3 should partly reduce the duplication of research efforts but currently the strategy is not working properly. Another important factor for a decreasing attractiveness of R&D&I sites in Europe is that a number of companies interviewed for this study follow their customers for instance to China (e.g. automotive).

The company representatives prefer proactive instruments for bridging the gap between high-level research and a suitable education plus an adequate infrastructure thus strengthening the training of highly skilled young academics at universities and skilled workers at vocational schools for instance in the areas of ICT, Big Data, Robotics, Life Sciences and New Materials to upgrade Global Value Chains in R&D&I in Europe. From their point of view the education system should focus more on STEM (science, technology, engineering, mathematics) profiles. The shortages of STEM profiles in some regions (also in Western Europe) will become a major issue in the coming years. This was stressed especially by companies active in the ICT sector. A number of interviewees made the point that there is a worldwide trend towards more multidisciplinary/multi-sector collaborations. The EU should stimulate and support these projects more since they are essential for the further industrial modernisation of European industry.

In general, the interviewed companies' representatives indicated that they need a more tailored instrumental approach. They prefer categories 2 and 3 of policy instruments. This means economic transfers and soft instruments are preferred. But they also stressed that their companies would not give up their R&D&I locations in Asia and North America in the short run because the location decisions usually have at least a medium character except they are focused on a highly open research and innovation in so-called innovation labs which operate for a limited time defined before starting the activity

These innovation labs go beyond traditional R&D and have a highly experimental character. Most of them have an open and collaborative innovation approach ("thinking out of the box with internal and external experts in established and new innovation fields") and they are user/client-driven or focused on lead users. Their infrastructure is characterized by the real and the virtual world. Furthermore, quite a number of them integrate a socio-economic perspective in addition to a technology perspective (e.g. Tönurist et al. 2015; Van Goolen et al. 2014). According to the interviews collected for this study these innovation labs are either established in the headquarters of the companies or they are coordinated by the R&D and innovation hubs of the headquarters.⁵

Highly skilled employees in Asia and the US are from the interviewed companies' point of view eager and flexible to develop new (and radical) ideas for future products, services and processes. Besides this, the interviewees point out that these young people also have in

⁵ There are already some good practices on innovations labs in Europe like the Smart Industry programme in the Netherlands, <https://www.smartindustry.nl/english/>.

addition to their subject-specific skills grounded skills in ICT which is an advantage when for instance working in digitally connected crowds (“crowdworking”).⁶

Higher labour costs in Europe are a challenge for a few interviewees from companies. Others point out that the stability of labour contracts and of labour relations in Europe is a positive factor even if the costs for labour are currently higher than in Asia.⁷ In some interviews it was also stated that more stringent labour regulations and less flexible labour markets (especially compared to the US) reduce companies’ flexibility in R&D&I. Unlike the OECD in its newest scenarios (2017b) the case studies and interviews collected for this paper do not show clear signals that Global Value Chains R&D&I have lost momentum in the chosen sectors in the short run. Indeed, especially the activities with the highest strategic value stay are done close to the headquarters of the companies which were analysed for this study. This means that usually foreign R&D&I activities are not crowding out the domestic ones.

Concise policy tool box – ambitious policy to upgrade short term or medium/long term

Policy challenges to upgrade European GVC in R&D&I, in particular policies that help to target market failures⁸ regarding the innovation activities across GVC have been discussed already in section 3 of this report. Upgrading industry in the EU by using policy instruments needs concrete instruments and mixed instruments. In this section an outline of options to adjust current instruments and mixes for EU industrial and R&D&I policies with regard to new GVC and the identification of regional R&D&I priorities is provided in a concise policy toolbox. While doing this it has to be kept in mind that most R&D intensive companies (pharmaceutical, automotive, aerospace and ICT sectors) analysed in this study are clearly driven towards regions with strong technological capabilities, strategic assets and/or a quite large market demand which quite often is met by own production sites in these regions or countries. Furthermore it has to be borne in mind that there is a strong trend towards collaborative R&D and open innovation networks in the companies interviewed.⁹

The following policy tool box shows special instruments and combinations of policy instruments e.g. for the appropriate development of human resources, efficient research and innovation infrastructures and absorptive capacities and the identification of needs of companies R&D&I linked with their existing and new GVC. Besides this, the outline based on the case studies on companies of the studied sectors (pharmaceutical, automotive, aerospace and ICT) and interviews done for this study provide options on how public authorities on different levels can tackle new challenges for innovation and industry by organizing collaborative opportunities for innovation and industrial actors.

The more nuanced goals linked with this policy toolbox to upgrade European GVC in R&D&I are the following

- better usage of worldwide available knowledge for improving competitiveness, employment and education in Europe and its regions and (new) sectors;
- higher constant Foreign Direct Investment in European regions;

⁶ When discussing this point it has to be kept in mind that there are some large differences between Asia and the US. While more basic research will be performed in the US, more applied research will be conducted in Asia. Besides this the interviewed companies are confronted with a growing shortage of employees with skills in these fields in the EU.

⁷ Important to state is that it is relatively compared to Asia and not the US. Labour costs in some highly populated cities in Asia are however also rising rapidly (e. g. Beijing, China, and Seoul, South Korea).

⁸ Market failures can range from asymmetrical information, public goods to external effects.

⁹ Pharmaceutical companies are more inclined to implement measures to safeguard their knowledge when the host region is characterized by weak intellectual property rights.

- strengthening of international partnerships und co-operative projects to strengthen European GVC;

When the instruments of the policy tool box to upgrade GVC in R&D&I in Europe is described in Figure 2 and 3 a distinction between short term and medium/long term instruments and options is suggested. Figure 2 shows a number of instruments which fall into three categories (regulatory, economic and financial, soft as discussed in section 3). Option 1 (see figure 2) combines 3 short term instruments which are of low costs. Option 1 is of low cost since for activities like matchmaking events and studies just very limited resources are needed. Option 2 (see figure 3) combines 5 short term instruments which are of medium costs. Option 2 is of medium cost because EU actions, programmes and initiatives discussed here usually have a medium time horizon. Depending on the resources available Option 1 and 2 could be combined.

Figure 2: Policy instruments for an ambitious short term policy: Option 1

Instrument	Regulatory	Economic and financial	Soft
Support of systemic forward looking vision in GVC R&D and innovation, e.g. by studies, events for learning			
Identify key value chains in R&D and innovation in new areas, e.g. by studies, interviews and expert discussion			
Supporting of matchmaking events on different levels			

Source: VDI Technologiezentrum

Figure 3: Policy instruments for an ambitious short term policy: Option 2

Instrument	Regulatory	Economic and financial	Soft
Strengthening and expanding cooperation between major innovation, research and industrial actors in fields of specialization and inter/cross-sectoral innovation			
Improving cross-border value chains in Europe (and possibly with developing countries by using virtual ways of cooperation)			
Supporting Platforms and hubs for new thematic partnerships in breakthrough thematic areas like industrial robotics, smart mobility or smart data			
Synergy of investment between private and public sector on different levels (International, European, national, regional, local)			
Strengthening a proactive attitude among policy makers towards a proactive innovation policy			

Source: VDI Technologiezentrum

Figure 4 shows a number of medium/long term instruments which also fall into three categories (regulatory, economic and financial, soft as discussed in section 3). Option 3 combines 3 instruments which are of medium costs. Option 3 is of medium cost because EU actions, programmes and initiatives discussed here usually have a medium time horizon. They are in general more costly than the ones in Option 2 since more resources are needed for instance for the infrastructure in education, training and new technology.

Option 4 (see figure 5) combines 4 instruments which are of high costs. Option 4 is of high cost since the instruments discussed here are long term. The actions etc. could not be stopped short term. Also the experimental character would be much more limited compared to the other options.

Depending on the resources available Option 1 and 2 could be combined to reach positive results with low/medium resources operating on an experimental base like innovation labs. Option 1 and 2 could be short-term or medium-term stopped while the loss of resources would be quite limited. In addition to this, a combination of all 4 options might be possible if quite some resources are available. But if all these instruments fail the loss of resources would be very high. The advantage of options 1 and 2 is that – being used in an experimental way – they costs would be relatively low if the instruments do not provide the results expected. If options 3 and 4 do not provide the results expected the costs are very high. A less costly but pragmatic mix of short term and medium/long term instruments would be combining Option 2 and 3.

Figure 4: Policy instruments for an ambitious medium/long term policy: Option 3

Instrument	Regulatory	Economic and financial	Soft
Organize impetus events for new innovation networks in breakthrough areas			
Bridging between excellent research and specific training and education programmes at universities, vocational schools and primary and secondary education system			
Investment in educational infrastructure and new technologies (e.g. universities)			

Source: VDI Technologiezentrum

Figure 5: Policy instruments for an ambitious medium/long term policy: Option 4

Instrument	Regulatory	Economic and financial	Soft
Capital investment well-co-ordinated and linked with the societal grand challenges (e.g. EIB and EFSI) and creating and shaping new markets)			
Supporting R&D and innovation on the ground			
Supporting Leadership in key innovations			
Creation of an innovation culture linked with sophisticated integration (migrant workers)			

Source: VDI Technologiezentrum

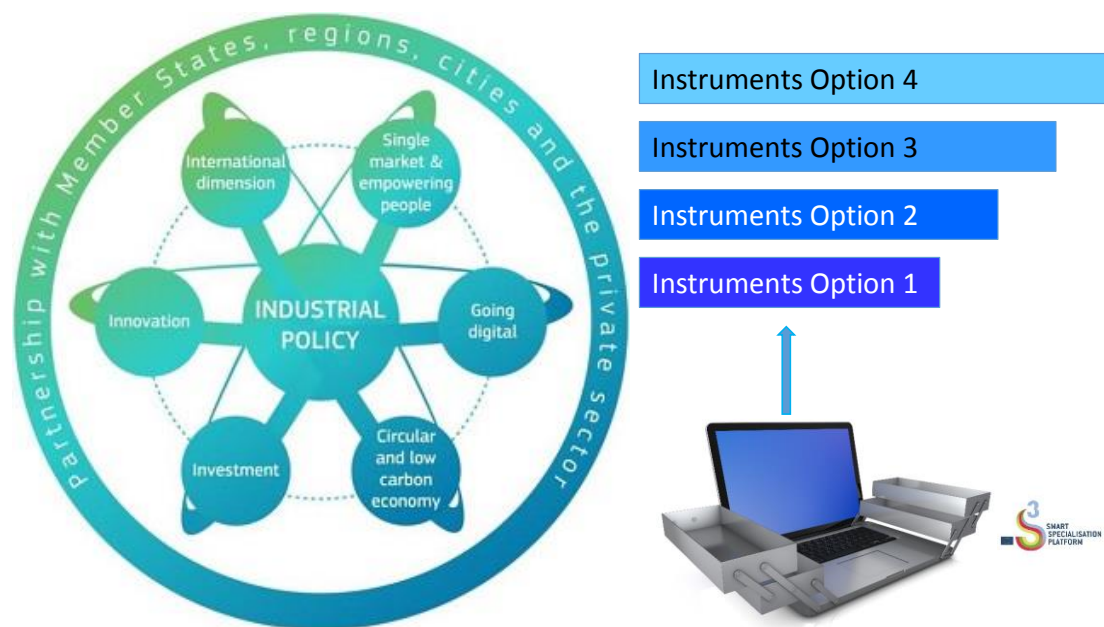
As described in a recent Communication by European Commission (2017b) for a renewed industrial policy strategy efforts on the European level have to be matched by national and regional reform efforts. There is a need to join forces behind a holistic and comprehensive strategy for industrial competitiveness linked with the policy tool box and the options of policy instruments discussed above (see Figure 6). Quite a number of these instruments are already used in a systematic mix on the national/regional level.

Germany, for instance, decided to start the Industry 4.0 initiative on the national level a few years ago. New forms of cooperation between large, medium and small enterprises from different sectors and politics, science and trade unions cooperate in a close way and are part of almost all the instruments discussed in this section. The goal is to create new products, services, processes and work. Today this initiative is on the one hand active in cooperation with actors in the German Bundesländer and in regions and on the other hand on the international level and in Europe. There are a number of efforts to transform/transfer excellent results from research on

the digital transformation of industry into the field of education and training. There are not only for instance so-called digital training factories at some Universities since 2015 but also the German Bundesland Baden-Württemberg started to establish similar training factories at vocational schools in 2017. In a nutshell, all instruments especially soft, economic and financial ones are used in a coordinated way with a lot of experimental and flexible character. Another interesting example where excellent research is transformed into good education and training can be found in Toronto Canada. Within a quite short period the Metropolitan Toronto developed by a good combination of innovation and industrial policy instruments into a well-known cluster for life sciences and ICT. In this cluster innovation culture is linked with a sophisticated integration of migrant employees (Wolfe 2017; 2016).

Another interesting approach for a renewed industrial and innovation policy to upgrade GVC in R&D&I has been started by the Bertelsmann Foundation who has given impetus for a discussion on the role of cultural diversity for innovation in Germany which is linked with the question how refugees and migrant workers can help to improve economy and society (Bertelsmann Foundation (2017). Recent research studies on diversity and innovation show mixed results on this question. Some of the studies come to the general conclusion that diversity has a positive influence on innovation (e.g. Mir-Babayev 2017; Ozgen et al. 2013). Other recent studies point out that the ethnic background might play an important role and that an improved innovation level can be empirically observed when well educated ethnic groups from Asia participate in innovation activities (Gompers/Wang 2017; Brixy et al.). These first results show already that there does not seem to be an easy answer to this question. Very interesting is that the companies which were interviewed for this article pointed out that quite often there is a quite high degree of cultural diversity for instance their teams working in innovation labs with a highly experimental character.

Figure 6: New forms of industrial policy linked with a policy toolbox (short/medium/long term)



Source: VDI Technologiezentrum based on European Commission (2017) and photo by Fotolia / Thomas Jansa

Recent research on innovation and industrial policy stresses the need of an intelligent governance of policy instruments and measures. Scholars like Edler/Fagerberg (2017, p. 15) make the case for four governance principles. These are anticipation, participation, deliberation and transparency. From their point of view these principles are necessary to ensure that societal preferences and concerns are taken into account in R&D and innovation processes and policies. Kuhlmann/Ordonez-Matamoros (2017) argue that in addition it is necessary to discuss failures of innovation governance from the past to better understand opportunities of today. One very important governance problem in the field of innovation and industrial policy is that there is still a lack of concern of the international dimension of R&D and innovation. These policies are quite often still organized on the national and/or regional level and not like for instance newly established innovation labs of companies on an international level. To get around this problem it is worth it to think about linking the international dimension with a strategy already existing.

Since the companies analysed for this paper are active in different sectors and Global Value Chains it is suggested that the policy instruments and options discussed here will be linked with current and future sectoral initiatives organized in the frame of the Smart Specialisation Strategy (S3). This gives numerous established and new actors from business, politics, science and society from different Member States, regions and cities but also actors from outside the EU the chance to develop bright ideas for new products, services, processes and work in a well-structured but also open-minded and inter-sectoral environment. This can/should be done across regions and in an inter-sectoral way. Like in the innovation labs of companies an experimental character is a major factor. Experimental innovation approaches for a new industrial era have to be accompanied by innovation and industrial policies which also create a positive mind-set for R&D and innovation in business and society. Besides this, such an approach helps regions to develop systematically in new fields of innovation and industry which are appropriate for the region and their actors thinking beyond traditional limits and borders. This approach matches in a very good way with the new innovation culture in other parts of the world like Asia and the US which are currently very popular for companies highly active in R&D&I.

Conclusions

In this article a policy tool box for the upgrade of the EU industry in Global Value Chains in R&D and Innovation is discussed on an empirical basis in four sectors (pharmaceutical, automotive, aerospace and ICT). It emphasizes on four options of combined new instruments which move beyond the current European, national, regional and sectoral policy instruments and mixes of policies. For pragmatic reasons the options outlined have to be linked in the beginning with one concrete policy strategy. This strategy is S3 including cross-sectoral initiatives in matchmaking, education and financing.

In a world economy that has changed significantly innovation labs and innovation cultures have a highly experimental character in highly innovative companies. The same is necessary for an ambitious policy to upgrade European GVC in R&D&I by shaping a process of engaging, anticipating, assessing and responding on an ongoing basis. Strengthening a proactive attitude among policy makers towards a proactive innovation policy is a soft but important instrument to speed up for a new industrial age in Europe and it is not very costly.

Besides this, it is important to stress that the Industry 4.0 innovation and industrial policy initiative stands already for an outstanding example for the use of combining different policy

instruments and options successfully (e.g. creating new products, processes and services based on the EU's industrial strength). The importance to transfer research results into the education system not only at the academic level but especially for non-academics has increased considerably. There is a real need for good vocational training to have regional skillsets of production workers who now need IT skills and process knowledge.

Such an approach or similar ones could also be used for finding new combinations of trends at large level (e.g. tourism and renewables) and integrate them via a process involving all stakeholders at the local and regional level, especially companies and also citizens and knowledge creators. In this respect, also from the policy side thinking out of the box is highly important. This includes the combination of flexible instruments for experimentation in a new era of EU innovation and industrial policy that has shifted from the orthodox top-down approach to a bottom-up approach. This would connect very well to the future-oriented trends of fragmented innovation processes across the companies' Global Value Chains and regions.

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