Unleashing Innovation and Entrepreneurship in Europe

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People, Places and Policies

Report of a CEPS Task Force

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The Centre for European Policy Studies (CEPS) is an independent policy research institute based in Brussels. Its mission is to produce sound analytical research leading to constructive solutions to the challenges facing Europe today.

This report is based on discussions in the CEPS Task Force on "Innovation and Entrepreneurship in Europe: People, Places and Policies". The Task Force, chaired by José Manuel Leceta, was composed of authoritative scholars, industry experts, entrepreneurs, practitioners and representatives of EU and international institutions. The group met on five occasions during the second half of 2015. The views presented here do not necessarily coincide with the opinions of all the participants of the Task Force, nor were they explicitly presented by any of the participants (unless explicitly mentioned in this report). A list of participants, invited guests and speakers appears in Annex.

The views expressed in this report are those of the authors writing in a personal capacity and do not necessarily reflect those of CEPS or any other institution with which they are associated.

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LIST OF ABBREVIATIONS

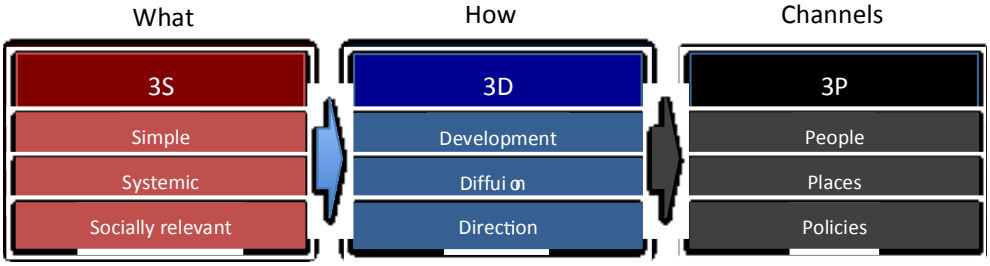
3D	development, diffusion and direction
3P	people, places and policies
3S	socially relevant, systemic and simple
arXiv	repository of electronic preprints, known as e-prints, of scientific papers in the fields of mathematics, physics, astronomy, computer science, quantitative biology, statistics, and quantitative finance, which can be accessed online
CDN	content delivery network
CERN	Conseil Européen pour la Recherche Nucléaire (European Organisation for Nuclear Research)
CODATA	Committee on Data for Science and Technology
COSME	EU programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises
COST	European Cooperation in Science and Technology
CUDOS	communalism, universalism, disinterestedness, originality and scepticism
DARPA	Defense Advanced Research Project Agency
DG	Directorate-General
ECB	European Central Bank
EFSI	European Fund for Strategic Investment
EIB	European Investment Bank
EIC	European Innovation Council
EII	European Industrial Initiatives
EIP	European Innovation Partnership
EIT	European Institute of Innovation and Technology
EP	European Parliament
ERA	European Research Area
ERA-NET	European Research Area Network
ERC	European Research Council
EUROSTAT	statistical office of the European Union
FET	Future and Emerging Technologies
FinTech	financial technology

FP	framework programme
GDPR	General Data Protection Regulation
GEDI	Global Entrepreneurship Index
GEM	Global Entrepreneurship Monitor
ICSU	International Council for Science
ICT	information and communications technologies
IMF	International Monetary Fund
INSEAD	Graduate business school in Fontainebleau, France
IoT	Internet of Things
IP	intellectual property
JPI	Joint Programming Initiative
JRC	Joint Research Council / Joint Research Centre
JTI	Joint Technology Initiative
K-12	a term used in education and educational technology in the United States, Canada, and possibly other countries, is a short form for the publicly supported school grades prior to college. These grades are kindergarten (K) and the first through the 12th grade (1-12).
KET	Key Enabling Technologies
KIC	Knowledge and Innovation Communities
LAMP	Linux, Apache, MySQL and PHP/Perl/Python
M2M	Machine-to-machine communication
MOOCs	massive open online courses
NASA	National Aeronautics and Space Administration
PPP	public-private partnership
R&D	research & development
R&D&I	research & development & innovation
R&I	research & innovation
RePec	Research Papers in Economics
RIS	Regional Innovation Scheme
RIS3	regional smart specialisation strategies
ROARMAP	Registry of Open Access Repository Mandates and Policies
SBIR	Small Business Innovation Research
SDG	Sustainable Development Goals
SME	small and medium-sized enterprise
STEM	science, technology, engineering and mathematics
STI	Science, Technology and Innovation
SWD	Staff Working Document
WEF	World Economic Forum

EXECUTIVE SUMMARY

This report provides the elements for the design of a streamlined and future-proof policy on innovation and entrepreneurship in Europe. It is the result of a collective effort led by CEPS, which formed a Task Force on Innovation and Entrepreneurship in the EU, composed of authoritative scholars, industry experts, entrepreneurs, practitioners and representatives of EU and international institutions. The group met on five occasions during the second half of 2015 (see the Annex for a list of the members and invited guests and speakers). The result of these deliberations is a set of policy recommendations aimed at improving the overall environment and approach for entrepreneurship and innovation in Europe and a new paradigmatic understanding of the role that innovation and entrepreneurship can and should play within the overall context of EU policy. These recommendations are based on a new, multi-dimensional approach to both innovation and entrepreneurship as social phenomena and to the policies that are meant to promote them. The figure below summarises our overall conceptual framework for innovation policy, based on a combination of three basic concepts identified in the Task Force:

- ***3S principles.*** Innovation policy should become more socially relevant, systemic and simple.
- ***3D criteria.*** Innovation policy should focus on development, diffusion and direction.
- ***3P pillars.*** Innovation policy should be centred on three channels: people, places and policies.



We present below a list of 55 policy recommendations that we formulated and disseminated in the course of the Task Force's proceedings. These are elaborated throughout this report (and repeated in the concluding chapter), grouped according to each of the three channels through which we advocate their implementation, i.e. the 3Ps: people, places and policies.

Recommended actions - People

1. Strengthen policy efforts to promote a variety of skills, including STEM education (science, technology, engineering and mathematics) and coding skills, starting in early school years throughout the EU-28.
2. Promote the inclusion of entrepreneurial skills, managerial skills, creativity and the ability to think outside the box as basic skills to be taught during school years and university.
3. Strengthen public-private cooperation to ensure the exposure of young European citizens to entrepreneurial role models and success stories to encourage emulation among youngsters.
4. Launch a systematic reflection on the security and flexibility needs of the future European job market, with a specific focus on employability, self-employment features and work-train-life balance for the coming years.
5. Promote open access to government-funded research and government-held data to boost data-driven innovation in Europe.
6. Foster legal certainty for data-driven innovation and more generally for text and data-mining activities, especially with respect to EU copyright and data protection laws.
7. Strengthen 'citizens' science' in Europe by creating effective platforms and calling on EU-funded research projects to involve citizens and adopt bottom-up approaches where possible.
8. Promote openness to foreign talent in all member states.
9. Develop guidance on regulatory flexibility to make regulation more conducive to innovation, implementing where appropriate the concept of 'permissionless innovation'.
10. Eliminate useless and redundant red tape, by distinguishing it from regulatory costs that generate benefits and help achieve policy goals.
11. Create one-stop-shops for entrepreneurs by consolidating contact points for access to EU and national funds and streamlining rules for financial and non-financial support.
12. Avoid creating perverse incentives with legislation, e.g. by creating rules that discourage scale-up.
13. Design policies to promote public-sector innovation at all levels of government, including innovation prizes and awards.
14. Promote and foster smart institutional design in innovation agencies and other relevant institutions.

15. Consider the creation of 'entrepreneurs in residence' and other fellowship and mentoring programmes to promote entrepreneurial thinking in institutions.
16. Promote successful role models and success stories more widely, in particular among students, especially among women.
17. Promote, at the local level, the participation of students from late school years and older in gatherings of entrepreneurs and start-ups.

Recommended actions - Places

18. Promote open science and data-sharing and the improvement of data quality and management.
19. Ensure that publicly-funded research communities: i) represent all aspects of basic and applied research, innovation, etc., ii) include stakeholders from various fields (not only one industry sector) and iii) become the main source of information for the drafting of innovation agendas and technological roadmaps.
20. Develop new performance measures for academia that encourage further valorisation of research.
21. Develop skills for open science and promote commonly agreed open science standards of research integrity.
22. Promote cooperation between public and private players in shaping and implementing legal rules for platforms.
23. Engage with platforms by seeking their cooperation on nurturing entrepreneurship, shaping university curricula and defining technology roadmaps to be used as a basis for future policies.
24. Develop initiatives on platforms at both European and national levels to encourage evidence-based research to inform policy.
25. Launch foresight activities to explore the future of the platform economy and its implications for policy and society at large.
26. Improve conditions for the platform economy by fostering investments in broadband, the Internet of Things (IoT) and Industry 4.0, by removing unnecessary regulatory barriers and by addressing market concentration and barriers to competition.
27. Preserve the open internet and the free flow of data, enhancing trust in the digital economy.
28. Reduce barriers to entry, e.g. red tape, growth, e.g. size-specific regulations, and firm exit/failure, e.g. penalising bankruptcy legislation, overly strict employment protection legislation.

29. Address regulatory incumbency: Policies often favour incumbents, e.g. R&D tax credits, some environmental regulations, subsidies that delay exit, visa rules.
30. Develop ecosystems through enhancing incentives and access to (risk) capital, developing networks (including the valorisation of research), mentoring of entrepreneurs and developing skills.
31. Complete the Single Market and reduce trade barriers, so firms can scale more easily across borders.
32. Promote scale-up culture through education and media, celebrate success of scale-ups and encourage entrepreneurs to share their success stories.
33. Initiate studies providing evidence on the impact of financial supply-side interventions.
34. Foster pan-European innovation ecosystems that connect diverse and disruptive talent across Europe, and stimulate local entrepreneurship ecosystems in regional policy.
35. Reformulate smart specialisation strategies to encompass coordination and acceleration across European borders and beyond.
36. Coordinate better the various funding mechanisms at EU level to ensure a sharper focus on innovation and entrepreneurship.

Recommended actions - Policies

37. Refocus policies for large and small to high-growth companies.
38. Promote healthy cooperation between existing and new business.
39. Establish a suitable balance between direct and indirect support schemes.
40. Facilitate intermediation in access to finance through increased transparency and accountability.
41. Complete the Single Market while pooling public procurement, including 'innovation deals'.
42. The European Innovation Council (EIC) should be sufficiently 'authoritative' to effectively advise governments on good practices to overcome barriers to growth and scale for start-ups.
43. Integrate systemic innovation with better regulation by refining the guidance on innovation impacts in the better regulation guidelines.
44. Align policymaking and better regulation to be in accordance with the EU's long-term impacts and objectives.
45. Set up mission-led platforms to inform policymaking at an early stage about impacts on innovation.

46. Strengthen the better regulation toolkit with more information and guidance on adaptive, experimental policymaking that favours systemic innovation.
47. Reformulate European added-value and focus EU support in interventions that make sense only at EU level, e.g. the European Research Council (ERC), the European Institute of Innovation and Technology (EIT) the Future and Emerging Technologies (FET) programme, etc.
48. Delegate collaborative undertakings like ERANETs, Joint Programming Initiatives (JPIs) and Joint Technology Initiatives (JTIs) to long-standing and experienced intergovernmental networks, such as Eureka, which aims to develop cooperation between SMEs, research centres and universities for industrial innovation, and COST (European Cooperation in Science and Technology) in particular.
49. Empower governments with enabling functions while embedding the European dimension fully in their programmes and agencies to create scale of policy.
50. Shift policy coordination away from project cooperation as this has shown its limitations and actually reached a plateau in recent years.
51. Structure a stable policy framework at European level consisting of two Councils and progressive consolidation of instruments around a limited number of agencies.
52. Link action on the ground for stronger institutions at regional and local level.
53. Consolidate and strengthen the role of research and innovation platforms as sources of policy inputs.
54. Streamline the role of the EIC and the Joint Research Council (JRC) in converting existing science and research into actionable policy recommendations.
55. Refocus REFIT (Regulatory Fitness and Performance Programme) exercises towards coherence with long-term goals.

1. INTRODUCTION: IS EUROPE IN THE GRIP OF AN INNOVATION EMERGENCY?

There has been no shortage of emergencies in the European Union over the past few years. From migration in the Mediterranean and the Balkans to Brexit, the eurozone crisis, the Greek crisis, the rise of populist movements and the decline of pro-EU sentiment, almost every key aspect of the Union has been placed under the spotlight and subject to unforeseen, sometimes rushed and messy policy changes. The perennial state of uncertainty that this has created has been at one and the same time cause and effect of Europe's relatively poor performance from an economic, social and environmental perspective, with sluggish growth being increasingly coupled with widening inequality, deteriorating social cohesion and growing unemployment, especially among younger generations. Among the most widely felt problems in Europe (and also in most other OECD economies) is the slowdown in productivity growth, which hampers Europe's chances to achieve long-term improvements in living standards.

The current stalemate is almost paradoxical, especially if one recalls that the current decade had started with a resounding commitment by EU leaders to achieve "smart, sustainable and inclusive growth" in the now-neglected Europe 2020 strategy launched by José Manuel Durao-Barroso. Six years down the road, the current President of the European Commission, Jean-Claude Juncker, denounced Europe's "existential crisis" in his relatively dismal State of the Union address in September 2016, which followed, inter alia, the shock caused by the Brexit referendum. Meanwhile, the EU project appears shaky when faced with upcoming game-changing events, such as the French, Dutch, German and (probably) Italian elections during 2017.

Innovation is clearly no exception in this landscape. Already a few years ago, calls to face Europe's "innovation emergency" came from very prominent political actors, as well as from industry.[1] Statistics and scorecards have shown

[1] See http://ec.europa.eu/research/index.cfm?lg=en&pg=newsalert&year=2011&na=na-090611. And see also E. Aho, J. Cornu, L. Georghiou and A. Subira (2006), "Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation

a gradual distancing of EU member states from leading countries such as the US, Japan and South Korea, with China slowly catching up with Europe in a number of dimensions of innovation.[2] Commissioners, politicians, scholars and industry representatives have taken action to denounce the meagre state of European innovation, pointing the finger at Europeans' lack of entrepreneurial skills and attitude, as well as at the existence of a plethora of regulatory obstacles to revamping both human and social factors of innovation.

International organisations such as the OECD (2012) have highlighted that the economic crisis that started in 2008 has negatively affected business innovation and research and development (R&D) in all countries. The World Economic Forum (2016) has observed that "European countries simply must fix their productivity problem to generate long-term growth" and that "in innovation and digitisation, Europeans often seem obsessed with data privacy and protection rather than grasping new opportunities". When looking at key innovation outputs, a report for the European Commission recently concluded that the EU performs at a similar level as the US, but is clearly outperformed by Japan; whereas in terms of employment in knowledge-intensive activities, the EU is outperformed by both the US and Japan.[3] The EU also appears to be slightly less technologically specialised than the US, Japan or South Korea. Other publications (Sachwald, 2016; Veugelers, 2015; Gill & Raiser, 2012) refer to various types of European deficits, in both research and innovation, linked to the comparative differences in Europe regarding young world-leading innovative firms and less knowledge intensive business sectors. And perhaps in a more balanced way, recent reports have mostly emphasised the EU's widening gap between laggards and frontier firms.[4]

Against this background, is there really hope for the European Union to improve its innovation performance and in turn increase living standards? In our opinion, it is not entirely correct to speak of an "innovation emergency" in Europe. Rather, as observed by, inter alia, the OECD in its report "The Future of Productivity", Europe faces a "diffusion deficit": in other words, technologies are developed and made available but very often do not adequately permeate society or do not gain sufficient market exposure due to a variety of factors,

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appointed following the Hampton Court Summit", European Communities, Brussels, January (http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf).

[2] See http://europa.eu/rapid/press-release_SPEECH-16-3043_en.htm.

[3] http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en. See also http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_research_and_development.

[4] http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/.

which often have to do with incumbency problems, inadequate regulatory regimes, or simply a badly designed policy mix (Ashford & Renda, 2016).

As authoritatively remarked by Dani Rodrik (2016): "The consequences of any innovation for productivity, employment, and equity ultimately depend on how quickly it diffuses through labor and product markets." In this respect, the roots and causes of Europe's innovation problem might be more multifaceted and systemic, but also, probably, less hopeless than often presented. This does not mean that the problem is in the pipeline or in 'technology transfer', rather the opposite: we argue that policies are not holistic, resulting in an insufficient flow of opportunities. Sadly, most European countries declare that they have holistic policies while, *de facto*, their implementation remains linear (Edquist, 2014).

All in all, Europe's innovation and entrepreneurship problems can be related to a variety of factors, which deserve a thorough analysis. Most importantly, the scholarly literature increasingly considers innovation and entrepreneurship as the result of a combination of skills and attitudes, platforms and exchanges and overall processes and policy. Neither innovation nor entrepreneurship can be described as a linear process but rather as an ecosystem (to borrow an often-abused term), which requires a multitude of concurring factors and interactions to fully realise its potential. In Europe, the innovation ecosystem is evidently and prominently represented by the Single Market, but entrepreneurship inevitably flourishes at a much more local level, whenever the right combination of ingredients allows for such development (Isenberg, 2011). Managing this 'tension' between local conditions and global ambitions is not easy for policy.

The difficulty arises from the fact that 'strong ties' in geographically close environments are key they but might be principally responsible only for incremental innovation, while 'weak ties' through global pipelines may bring about more radical innovation. Recently, Kuhlmann & Edler (2003) proposed three scenarios for the 'Europe of Knowledge', including "a vision of a centrally 'mediated' mixture of competition and cooperation between diverse regional innovation cultures and a related governance structure." One of the most evident problems generated by the proposed approaches is that on the one hand, innovation happens locally, which leads 80–85% of public funding for innovation being managed nationally or sub-nationally; on the other hand, competition is increasingly global, which requires policies that allow innovation to be scaled up and accelerated across markets. This, in turn, calls for policy interventions that are less national/local and increasingly trans- or supranational.

This report tries to provide elements for the design of a streamlined, future innovation and entrepreneurship policy in Europe. The report is the result of a

collective effort led by the Centre for European Policy Studies, which convened a Task Force on "Innovation and Entrepreneurship in the EU" in early 2015 and relied on the cooperation of the Madrid-based Insight Foresight Institute led by José Manuel Leceta (Chairman of the Task Force) and Totti Konnola (co-rapporteur of the Task Force). The CEPS Task Force was further supported by a scientific director (Andrea Renda, CEPS Senior Research Fellow) and another co-rapporteur, Felice Simonelli, CEPS Research Fellow.

The Task Force met five times between June and December 2015, and received input from many authoritative scholars, industry experts, entrepreneurs, practitioners and representatives of EU and international institutions (a list of all attendees and speakers is attached in an annex at the end of this report). The result was a set of policy recommendations that aim at improving the overall environment and approach for entrepreneurship and innovation in Europe; and a new paradigmatic understanding of the role that innovation and entrepreneurship can and should play in the overall context of EU policy. These recommendations are based on a new, multidimensional approach to both innovation and entrepreneurship as social phenomena and to the policies that are meant to promote them. This is presented below as a combination of a 3S, a 3D and a 3P approach.

1.1 Socially relevant, systemic, simple: Three principles for innovation and entrepreneurship policy in Europe

The CEPS Task Force agreed upon three key principles, which provide an important background for the remainder of the work. In a nutshell, the future EU policy for entrepreneurship and innovation should be tied to societal needs (i.e. to be socially relevant), systemic and simple. These principles can be summarised as follows:

- *Socially relevant.* Entrepreneurship and innovation are means, not ultimate policy goals.[5] This means that public policy, besides striving to create a suitable environment for entrepreneurship, should seek to encourage those entrepreneurial ventures and innovation efforts that address the outstanding societal challenges facing Europe. Policy-makers must seek to promote the type of entrepreneurship and innovation that can help

[5] This view was shared by several representatives of the Commission attending the Task Force meetings, who stressed the need to foster, e.g. growth and jobs via innovation. In this respect, Philippe Aghion presented empirical evidence confirming the role played by innovation in fostering long-term growth in advanced economies. In addition, Johan Schot and Jan Fagerberg emphasised innovation as a driver to introduce systemic changes and address societal challenges.

Europe solve its present and future challenges – e.g. youth unemployment, aging, stagnation – and contribute to solving challenges of a global nature, e.g. climate change, food security, water supply, etc.

- *Systemic.* Innovation is broader than industrial R&D. While R&D still plays a crucial role in many sectors, it is clear that other forms of innovation, such as social and user innovation, and new business models are just as important when it comes to addressing Europe's thirst for new solutions to outstanding challenges. This variety should also be reflected in the choice of innovation policy tools and entrepreneurial support schemes. Policy should look not only at all the actors but increasingly at their dynamic interconnections in the innovation and entrepreneurship ecosystem to ensure that they contribute to the emergence of a suitable and enabling environment for new ideas to emerge and diffuse throughout the economy.
- *Simple.* Entrepreneurs and innovators often do not have time and resources to dedicate to complex procedures and administrative requirements; the governance of EU and national innovation and entrepreneurship policies often does not offer the single points of contact and the multi-stakeholder platforms that entrepreneurs need to test their ideas and apply for funding, mentoring and support.

The consequences of these principles are far-reaching and also involve the way in which policy is designed and implemented at the EU and national levels. Many emerging societal challenges call on innovation policy to depart from academic disciplines, enabling technologies or sector-specific industrial policy, and to take a more systemic and transformative approach that crosses academic, technology and sectoral boundaries. Moreover, EU policy should enable experimentation and learning and avoid creating biases in favour of incumbent business models. This requires new approaches and adaptive regulation tools at all levels of government and the creation of policy spaces for testing new business models and services that can benefit end users, at the same time without lowering protection levels for consumers. Accordingly, EU policies and better regulation tools should include an adequate consideration of innovation and entrepreneurship from the genetic moment (foresight and ex-ante impact assessments) to the ex-post evaluation and feedback phases, e.g. in ex-post evaluation and REFIT.

The 3S (socially relevant, systemic and simple) approach to innovation policy would transform current policy approaches and provide new regulatory stimuli that are essential for entrepreneurship and innovation to flourish in Europe, which would be locally rooted but with global ambitions. How to achieve this goal should be the main concern of EU policy-makers in the coming years, starting from the revision of Horizon 2020 and the governance of EU innovation policy, from its

R&D-centric 'innovation policy' today to an enabling and holistic understanding of 'policies for innovation' (OECD, 2015).[6]

1.2 Development, diffusion, direction: Three criteria for innovation and entrepreneurship policy in Europe

Over the past few years, the understanding of innovation as a policy subject has followed new, important trends, in addition to the ones highlighted in the previous sections. Not only has innovation (and our understanding of it) become more multifaceted, systemic and open. The modelling of the interaction between players that compose the innovation system has also become more sophisticated, and the notion of ecosystem, rather than merely system, has been adopted (not without a degree of uncertainty and variance in definitions) to encompass, inter alia, the institutional and policy interrelations and constraints that characterise the life and activity of entrepreneurs and innovators, the proactive role of end users and the involvement of several players in innovation projects.

Scholars have increasingly argued that not all innovation exerts a significant impact on long-term policy goals such as sustainable development and growth. More in detail, there are innovative products, processes and services that contribute more than others to addressing grand societal challenges, such as climate change, water scarcity and, for Europe, unemployment and the needs of the ageing society. This has led to a growing emphasis on the so-called 'purpose' of innovation, which bears substantial relevance for innovation policy. As a matter of fact, both innovation and entrepreneurship should be approached in public policy as intermediate, not ultimate goals, and as such functional to social welfare in the long run. In particular, the diffusion of innovation and its widespread availability to end-consumers are as important as the innovation process itself.

The consequences of this shift in the approach to innovation as an essential element of a sustainable development strategy are far-reaching. As a preliminary set of remarks:

- *Innovation policy cannot focus only on product and process innovation* but rather on many forms, including social and organisational innovation. This leads some authors to refer, more generally, to "systemic innovation"

[6] It is worth stressing that the Commission is already moving in this direction. In fact, Horizon 2020 represented a breakthrough over past Framework Programmes: for the first time, in addition to the traditional support for research and development, the programme placed great emphasis on innovation and close-to-market activities.

(Mulgan & Leadbeater, 2013). The OECD recently observed that "social and organisational innovations, including new business models, are increasingly important to complement technological innovation".[7]

- *Innovation policy cannot focus only on the supply side*. Demand-side policies such as the strategic use of public procurement, policies that encourage the consumption of sustainable and innovative products, and policies that aim at improving the accessibility of innovative products (including education policy and even trade policy) are as important as traditional supply-side innovation policies such as R&D subsidies and tax breaks, patent law, or public funding of innovation and entrepreneurship.
- *Innovation policy is chiefly related not only to the development but also to the diffusion of new products, processes and services* (Freeman, 1994). Public policy in support of innovation (especially in Europe) should look beyond the so-called 'innovation deficit' to encompass the 'diffusion deficit' that prevents new technologies and business models from reaching the market or to become affordable for the majority of consumers. The recent Staff Working Document published by the European Commission on Better Regulation for Innovation-Driven Investment acknowledged the key role of public policy in removing obstacles to the commercialisation and diffusion of existing technologies, which lack a sufficiently large market in Europe (European Commission, 2015).
- *Innovation policy cannot rely exclusively on sector-specific industrial policy*, since this would not constitute the best approach to trigger those organisational, transformational, disruptive changes that often create innovation by displacing existing business models.[8] In short, innovation policy has to take a systemic view, not a sector-specific view. This is important also in order to avoid so-called incumbency problems, which emerge whenever policies crafted for a specific sector end up hampering disruptive innovation by empowering existing players and disadvantaging new entrants (OECD, 2015).
- *Innovation policy is increasingly in need of 'direction'* (Fagerberg, 2015), in addition to facilitation of private sector entrepreneurship, R&D investment and knowledge transfer. The direction element implies that governments steer innovation efforts towards emerging and urgent societal challenges. This is done, as a matter of fact, by the Horizon 2020 programme (in particular in setting up European Innovation Partnerships) and even more explicitly in the US Strategy for American

[7] www.oecd.org/sti/OECD-Innovation-Strategy-2015-CMIN2015-7.pdf, at 6.

[8] See http://ec.europa.eu/economy_finance/publications/economic_paper/2011/pdf/ecp438_en.pdf

Innovation adopted by the Obama administration and recently updated and relaunched in October 2015. This requires that governments choose to support those technologies that are more likely to bring social, economic and environmental benefits over time and to avoid creating biases or misalignments in their policies, which would disadvantage sustainable, systemic innovation.

- *Moreover, history and geography appear to be very important for a proactive innovation and entrepreneurship policy*. The literature on innovation and entrepreneurship ecosystems suggests that not every portion of territory can become equally innovative, and therefore the role of government should be to select those environments in which entrepreneurship can flourish more easily and strengthen the ties between the various players that populate those environments whenever possible. This finding is potentially in line with the 'smart specialisation' approach adopted in EU regional policy.

Most important, innovation policy is now focusing specifically on diffusion, for a number of reasons. First, while picking winners has been successful by governments promoting big science innovation (Mazzucato, 2014), institutions may often lack adequate knowledge of 'which winners to pick', and thus would not necessarily be able to choose the right technology on which to focus in order to accelerate deployment. For this reason, multi-stakeholder involvement should supplement governmental intervention. As reported by the OECD (2015): "The kinds of breakthrough innovations that can generate significant environmental benefits can come from fields as diverse as ICT, materials sciences and biotechnology." And within these areas, several options exist. Innovation policy can contribute to this challenge if governments invest in the skills possessed by civil servants and, most important, if the institutional framework for innovation includes transparent multi-stakeholder, mission-oriented R&I platforms that can convey technical information and technology forecasts to policy-makers.

Second, even if R&D were successfully promoted on a given technology, the market conditions for its uptake might not necessarily exist: in particular, not all innovative technologies are produced by incumbent players, and in most cases they imply a reshuffling of the *status quo* in a given sector. For example, many new business models in the energy or financial sector are not being adopted by incumbent players, who are typically less agile and more affected by sunk costs compared to new entrants; and in other cases, e.g. for smart grids, the need to cooperate with other players, e.g. telecoms, IT companies, could end up threatening the market position of the incumbent electricity companies, leaving them with little urge to move forward. In contrast, see Reinaud et al. (2016) for

documentation of incumbents that have become innovators/players in this innovation space.

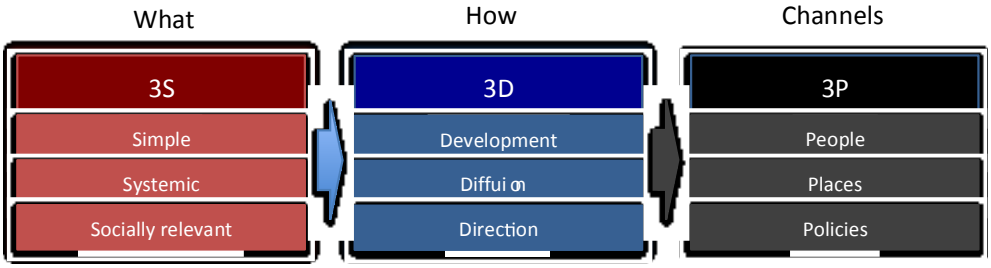
Third, lack of skills, collective action problems and path dependency in consumption habits are often major obstacles to the uptake (deployment) of disruptive technologies and business models. Lack of skills can emerge both along the value chain (for example, repairers may lack the skills needed to work on electric vehicles); collective action problems can emerge whenever technological uptake is favoured by interoperable standards, e.g. recharging stations for electric vehicles or hydrogen-powered cars. Finally, path dependency can emerge whenever the technological breakthrough requires changing long-term contracts and switching providers; changing the way in which a given service or product is used by residential customers; changing equipment; etc. All these conditions have to be part of an overall assessment of the measures that would be needed in order to facilitate the smooth, swift penetration of more sustainable technologies into the market.

All these problems deserve careful scrutiny in themselves and also for what concerns the role of the public sector, which is typically invoked whenever markets fail (as in the case of collective action problems). As observed, inter alia, by Mariana Mazzucato (2014), governments play a fundamental role in changing economic direction by creating and shaping markets, taking on risks at research and development stages and at stages of technological diffusion, by supporting manufacturing and commercialisation. Governments influence the direction of innovation when they manage training and educational institutions, produce information, set regulations, supply funds (with conditions attached), purchase goods and services, and set targets. The case of decarbonisation is no exception. There seems to be growing consensus on the need for strong public presence and direction, not just through regulation but also through systemic innovation policy, to lead the world towards long-term sustainable development.

1.3 People, places, policies: Three pillars of innovation and entrepreneurship policy in Europe

These basic principles (3Ss) and criteria (3Ds) presented above can be articulated based on a conceptual framework that relies on the interaction of three main pillars (our 3Ps): people, places and policies. For each pillar, the Task Force suggested a number of coherent policy recommendations. Figure 1 below summarises our overall conceptual framework based on the described 3Ss, 3Ds, 3Ps approach.

Figure 1. Conceptual scheme of the book



The remainder of this book is structured as follows. The next section summarises the current understanding of innovation and entrepreneurship and their determinants, diffusion and impacts, based on contributions presented to the CEPS Task Force as well as recent academic literature. Then we present our 3Ps as the key components of a well-designed innovation and entrepreneurship strategy, with backing materials, data and case studies.

- The People section mostly deals with skills and entrepreneurship and reflects on the future needs that the job market must meet feature in order to put EU education policy under pressure to deliver radical change.
- The Places section looks at the various ways in which governments and private players can become vehicles of innovation and entrepreneurship and reflects on emerging patterns such as open science, open government and open innovation.
- The Policies section looks more specifically at two aspects: i) the EU policy process and the formation, implementation, monitoring and evaluation of the many rules that exert an impact on innovation and entrepreneurship, including the often-criticised 'precautionary principle' and the recently evoked 'innovation principle'; and ii) the ways in which existing EU policies can be reviewed in order to provide innovators and entrepreneurs with a streamlined, predictable and effective framework within which to test and market their ideas.

The final section concludes by summarising our main recommendations and outlining some avenues for future research.

2. INNOVATION AND ENTREPRENEURSHIP: PRELIMINARY DEFINITIONS AND EMERGING TRENDS

There have been various attempts to define innovation and entrepreneurship. One commonly used definition of innovation points at "the process by which individuals and organisations generate new ideas and put them into practice".[9] Alternative definitions that have been frequently used in the past decades are market-focused and customer-oriented, such as "a process by which value is created for customers through public and private organisations that transform new knowledge and technologies into profitable products and services for national and global markets";[10] or "creating or improving goods, services, or methods of production" (Van Schewick, 2009). Today, however, these definitions appear too narrow, especially if one observes the peculiar dynamics of innovation and their likely evolution in the coming years.

One of the most authoritative and pioneering scholars in this field, Joseph Schumpeter, used to define innovation way more broadly, as "the introduction of new goods…new methods of production…the opening of new markets…the conquest of new sources of supply…and the carrying out of a new organisation of any industry" (Schumpeter, 1934). Industrial economists tend to define innovation in terms of productive and dynamic efficiency, i.e. the ability of a society to push outwards the efficiency frontier by finding new ways to use existing resources, or creating new resources that can be added to the production mix.

Overall, there seems to be growing consensus on the fact that innovation, however defined, does not relate only to new products that come into the marketplace. Innovation may well occur in market processes and products but also outside the marketplace, including among end users and without the need for any R&D process. Innovation is more than science, which is not always needed and never enough. Against this background, defining and capturing

[9] White House, Strategy for American Innovation, 2011.

[10] This is the definition given by the Alliance for Science & Technology Research in America.

innovation becomes even more difficult today, as markets and forms of exchange change continuously, often departing from the traditional chain of innovative activities, which took place mostly in universities and large public or private labs.

Today, the most diverse forms of exchange are emerging, most often based on reciprocity and collaborative schemes, not on traditional market exchange (good examples being open source software, the collaborative economy, or distributed ledger models such as blockchain). In addition, innovation takes place inside and outside firms, through new mechanisms of collaboration such as open innovation chains and innovation hubs; moreover, users can be innovators just like big entrepreneurs are: some markets require significant R&D investment, others only a good dose of creativity and luck; industry clusters are moving online and becoming global, they do not need geographical proximity and they rather seek complementarities and synergies. Finally, the boom of data availability observed in the past few years – the so called 'big data' age – opens new windows of opportunities for designing innovative products and anticipating societal needs, which in turn disrupt existing models of innovation (McKinsey & Co., 2011).

In our view, adopting a sufficiently broad definition of innovation and its role in modern economies is essential for the design of effective innovation policy. Granieri & Renda (2011) propose a definition that encompasses two major elements: i) the creation of new value (including through the efficient reallocation of existing resources), which ii) contributes to progress.[11] The first element is to be intended in the broadest possible sense, thus leaving space for user-generated innovation, automated innovation, industrial R&D projects, public investment, etc. The second element simply states that a new product is to be considered innovative only to the extent that it contributes to social welfare in the long run, without depriving society of resources that could have been more usefully allocated elsewhere. In a nutshell, innovation's main features are allocative efficiency and progress.[12]

Economists and social scientists have devoted significant efforts to the understanding of the dynamics and phenomenology of innovation. Initially, scholarly efforts were mostly devoted to the analysis of the innovation process, with peculiar emphasis on what happens inside a given firm during such a process. One of the leading authors in the analysis of developing innovation

[11] To quote Professor Bijker, "While a new idea is a thought about something new or unique, and making that idea real is an invention, innovation is an invention that has a socioeconomic effect. Innovation changes the way people live."

[12] See R.J.R Peritz (2006). And by the same author, the forthcoming "The Political Economy of Progress".

process models, Roy Rothwell, distinguished between various generations of innovation process models. Below, we provide a brief description of these generations, also recently summarised in Renda (2016).

The first generation of innovation process modelling is called "linear technology push" and was widely used until end of 1960s. These models interpret innovation as a linear process, with research, development and the outputs of new successful products standing on the same level. The chronological alignment of each phase starts from research and encompasses pre-production, production, marketing and final sale.

The second generation is what Rothwell calls the "market pull model". This model reflects the fact that in the 1960s and 1970s innovation changed to include what was seen as a result of perceived customers' needs, sourced through market research. The needs and demands of the market determined the work of R&D departments in companies. As a result, during that phase many companies engaged mostly in incremental rather than disruptive innovation.

The third generation was characterised by the coupling of R&D and marketing (leading to the so-called 'interactive model') and refers to a period (the end of the 1980s) in which it became clear that neither technological push nor market pull strategies were enough to successfully handle the innovation process. The combination of technology push and market pull models was improved with the addition of feedback loops between science and innovation and labelled as the 'interactive model' of technological opportunities and the needs of the market.

Later, a fourth generation of innovation process models led to the identification of a more integrated, 'chained model' of innovation (Kline & Rosenberg 1986), characterised by the parallel use of integrated research teams and the involvement of the supplier and important customers. This generation of innovation clearly stands out from the previous one and models a stronger parallel process of innovation. Cooperation between research, development and production is enhanced, and horizontal collaboration, regardless of the company's boundaries, is also considered. Due to the constantly shortening product lifecycle, this generation of innovation process models include time as a strategic variable. The (chained) model represents a further step towards a comprehensive innovation process actively involving research and existing knowledge. This model demonstrates the necessity of integrating knowledge into the innovation process, where knowledge is not understood as a result of scientific activities, but rather as a result of interaction between the individual units of a company, the company itself and its environment. The novelty of this model lies mostly in the fact that the market represents both the beginning and the end of the innovation process, and knowledge is integrated in all phases of

the innovation process (though mainly in the research phase) and, therefore, considered a necessary prerequisite for innovation.

The fifth generation of innovation process modelling is characterised by the identification of system integration and networking as dominant features of innovation. This also entails much stronger interaction with external research facilities and cooperation in the marketing area. This model also emphasises the vertical linkages with suppliers and customers along the whole innovation process, e.g. suppliers are involved in the co-development of new products and/or share the technical systems used for it, and the horizontal linkages take place in a variety of forms (joint ventures, alliances, consortia, etc.). For these reasons the fifth model represents a first step in the emergence of distributed innovation. This generation also marks the transition towards a vision of innovation that is broader and more systemic than the one adopted in the previous four generations. As such, this model contains some elements than the subsequent open innovation models would capture more explicitly.[13]

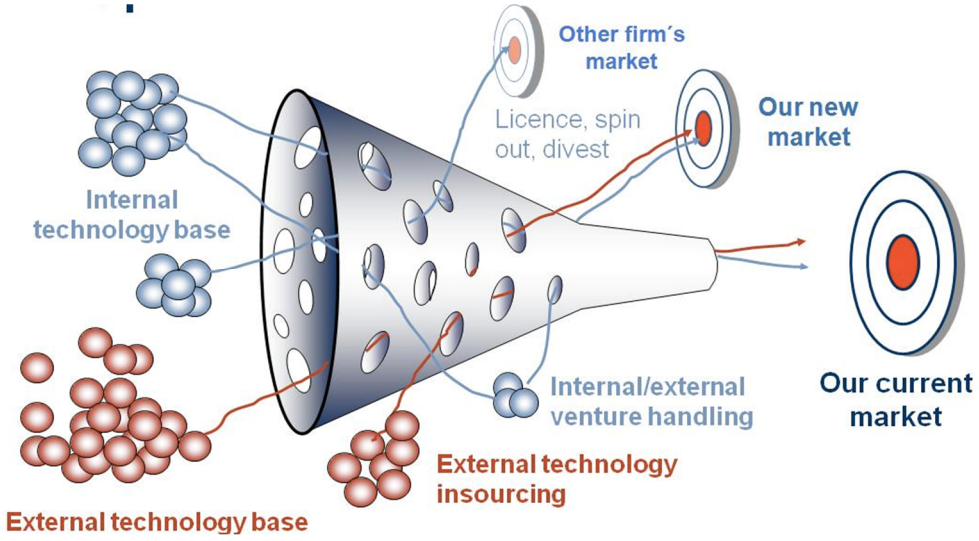
The sixth generation of innovation models is what is often termed open innovation, which implies, inter alia, the use of internal and external R&D sources; openness to external business models, a variety of IP generators and collaborations (SMEs, academics, etc.) and a proactive IP asset management. This is leading to an increase in the number of companies collaborating in innovative activities. In the words of Henry Chesbrough, the academic who coined the term, open innovation is a paradigm that assumes that firms use external ideas as well as ideas developed in-house, and internal and external paths to market, as firms look to advance their technology (Chesbrough et al., 2006). Open innovation is not only concerned with sourcing of external knowledge into the firm ('outside-in') but also with exploring new channels of revenue generation by granting usage rights (joint ventures, licensing or outright sale) of in-house developments to other firms ('inside-out'), "especially when the technology has future potential but is not part of the firm's core strategy" (OECD, 2008, p. 11).

While the original perspective of innovation primarily focused on research and development of firms, open innovation has outgrown this narrow view and today integrates different streams and perspectives (Gassmann et al., 2010). Chesbrough, Vanhaverbeke & West (2014) explain that open and closed innovation are to be understood as two extremes of a spectrum, along which

[13] As reported also by the OECD, "[T]he organisation of innovative activities (technological as well as non-technological) across firm boundaries is clearly on the increase, with more balance between internal and external sources of innovation...Industries such as chemicals, pharmaceuticals and information and communication technology (ICT) typically show high levels of open innovation." See OECD (2008).

most business models can be found. The spectrum they describe is a function of the extent to which in-house R&D is involved in product development. Figure 1 below shows Chesbrough's latest description of open innovation.

Figure 2. Chesbrough's description of open innovation



Source: Chesbrough, Vanhaverbeke & West (2014).

In its original definition, open innovation mostly related to large corporations, which could act as catalysts of innovation efforts by becoming purchasers and orchestrators of streams of R&D, which involved much smaller companies, whose agility and flexibility usefully complement the capacity and organisation of larger firms.

Since the emergence of the open innovation model, a number of trends have led to the emergence of even more distributed forms of innovation. Such trends include the following:

- ***Increasingly proactive user involvement.*** The emergence of open innovation as a dominant mode of generation of new market solutions in several sectors of the economy was just the beginning of a new trend, which has led to the gradual involvement of many actors along the supply chain as key contributors to idea generation and testing. This led at once to the gradual rise of the end user as a protagonist of the innovation landscape and to enhanced possibilities for organisational innovation as an important new phenomenon. Part of this emerging paradigm of innovation is the so-called 'user innovation' (Von Hippel, 1988, 2005). As explained, inter alia, by Henry Chesbrough, the difference between open and user innovation is that the user innovation model advocates a

decentralisation of innovation that changes the locus of innovation from firms to users and leads to the 'democratisation of innovation'.

In the user innovation model, innovation results from a collaborative and co-creation process, where users share tasks and the cost of developing innovative products and services, and then reveal their results. In other words, the motivation for innovation revolves around the concept of user utility gains rather than pecuniary returns. According to von Hippel (2013), users are firms or individuals that "expect to benefit from using a product or a service, in contrast to manufacturers that expect to benefit from selling a product or a service." Therefore, users who contribute to the development of the innovative product or service (users-innovators) will adapt the innovation to their specific needs. The user-innovators, although they freely reveal the innovation, will receive greater utility from the use of this innovation than free-riders, as the innovation may not completely fulfil the needs of the latter.

- ***Cumulative innovation.*** A specific case of user innovation, sometimes presented as a stand-alone category, is 'cumulative innovation' in which innovation is generated incrementally and collectively by a community of users that share similar values and are bound by formal or informal rules. The typical examples here are open source communities (Von Hippel, 2001) for software development and creative commons communities for content production and sharing. Often these communities emerge on a local scale due to geographical proximity; the advent of the internet, however, has made it possible to create global-scale communities and even industry clusters without the need for geographical proximity. In addition, the nature of information goods allows for easy versioning and reconfiguration, as well as incremental changes, which is a key feature affecting software and online content production.

  Importantly, users in this form of innovation may include both intermediate users (for example, users firms, downstream firms in the supply chain) and final users such as end consumers (Bogers et al., 2010; Berthon et al., 2006). User innovation is normally considered as an opportunity for innovating firms, as user creativity can be usefully employed in a co-creation process: however, in some cases user innovation can also threaten the firm, in particular for what concerns its intellectual property (Baldwin & Von Hippel, 2011). The consequences of a massive shift towards user innovation and co-creation, especially in some sectors or sub-sectors of the economy, e.g. at the application layer of the ICT ecosystem, are also potentially disruptive to the ability of firms to secure intellectual property protection.

- ***Social Innovation.*** Social innovation refers to new ideas, institutions and innovation processes that meet societal needs through new forms of civic participation and collaboration. The challenge of social innovation is to involve society in finding alternative and novel ways to face current societal challenges such as climate change, epidemics, increasing inequality and poverty. Social innovation often exploits internet network effects and internet collaborative power to harness the collective intelligence of communities in order to tackle these social challenges. Among the benefits of social innovation are the fact that "the involvement of users on a voluntary basis in the co-creation process reinforces people's recognition by their communities, increases motivation and commitment, and results in the development of more solid innovation practices" (Murray, Caulier-Grice & Mulgan, 2010). The ultimate goal of social innovation models is 'systemic innovation', which entails "fundamental changes to the social system, affecting many elements which shape society: e.g. social movements, business models, laws and regulations, data, infrastructures, and the development of new frameworks and new ways of thinking and acting". This definition is different from other existing definitions, which tend to portray social innovation as a "novel solution to a social problem that is more effective, efficient, sustainable, or just than present solutions and for which the value created accrues primarily to society as a whole rather than private individuals" (Phills et al., 2008); or as "new strategies, concepts, ideas and organisations that meet the social needs of different elements which can be from working conditions and education to community development and health — they extend and strengthen civil society" (OECD, 2011).

  Social innovation can take place within government, the for-profit sector, the non-profit sector (also known as the third sector), or in the spaces between them. Research has focused on the types of platforms needed to facilitate such cross-sector collaborative social innovation. Typical examples of social innovation are microcredit, e.g. the Grameen Bank, and the Indian frugal innovation model, which refers to innovative products and services that "seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption and disposal) with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards" (Tiwari & Herstatt, 2012b).
- ***Distributed co-creation.*** Recently, scholars have observed even more open forms of innovation, called "distributed co-creation". This practice mostly consists of organising R&D among a number of independent groups working in parallel and complementary streams of research and

composed of both providers and customers looking for tailored solutions. Once again, this will require a cocktail of new talents, researchers and users (often in constant online contact) as well as clear and transparent rules on revenue-sharing and IPR management. The peculiarities of this form of organisation and production are summarised by Yochai Benkler (2006: 100-101) in his description of granularity, as being an even more advanced form of modularity, allowing for micro-contributions to an ever-growing innovative product, the typical example being that of Wikipedia and the creative commons approach to content production. A number of companies have implemented co-creation strategies over the past few years, including notable examples such as LEGO and Threadless.[14] In the software sector, open-source platforms developed through distributed co-creation since the very beginning and ended up forming entire stacks of products such as the 'LAMP' (Linux, Apache, MySQL and PHP/Perl/Python), which have become standard components of the IT infrastructure at many corporations.

The resulting phenomenon is our seventh generation of innovation models: the so-called 'Open Innovation 2.0' model. In particular, Curley & Salmelin (2013) have brought together the concepts of open innovation, user innovation and social innovation in new a model they call Open Innovation 2.0 (OI2). The authors emphasise three main points:

- ***Co-opetition***, i.e. collaboration between competitors (Brandenburger & Nalebuff, 1996). This goes beyond joint ventures: interdependent competitors work together to find solutions and develop new products (mashed-up products of multiple concepts and ideas).
- ***The user as an integral member of the innovative process***. The user, the fourth element of the quadruple helix, intervenes earlier in the innovation process to experiment, even before the innovation reaches the pilot stage, and actively participates in the co-creation of new markets for innovation. According to the authors, the co-creative process embedded in the quadruple helix approach leads to a win-win situation, as users get the products and services they need, and the suppliers get scalable products and services. This allows immediate feedback on which innovation is successful and enhances the probability of success, speeding up the scalability and quickly dismissing innovation in unsuccessful areas.

[14] LEGO, for instance, famously invited customers to suggest new models interactively and then financially rewarded the people whose ideas proved marketable. The shirt retailer Threadless sells merchandise online – and now in a physical store, in Chicago – that is designed interactively with the company's customer base.

- ***Value networks and interdisciplinarity***. Intermediaries must connect value networks to form value constellations. They point out that interdisciplinary approaches must be taken that go beyond the traditional boundaries of disciplines such as ICT, chemistry, or mechanics, which should be mixed together.

The European Commission points to five main elements that define Open Innovation 2.0, to be intended as "a new paradigm based on a Quadruple Helix Model where government, industry, academia and civil participants work together to co-create the future and drive structural changes far beyond the scope of what any one organisation or person could do alone":[15] networking; collaboration (involving partners, competitors, universities and users); corporate entrepreneurship (enhancing corporate venturing, start-ups and spin-offs); proactive intellectual property management (creating new markets for technology); and research and development (achieving competitive advantages in the market).

In summary, models of innovation used in the literature have significantly evolved over the past few decades, along with the modes of innovation observed in reality. Needless to say, and as already mentioned above, open innovation has been strongly facilitated by the development of new networking technologies, and in particular by the internet and, inter alia, the versioning possibilities that the information economy has brought. In cyberspace, modularity and end-to-end communication have determined the emergence of entirely new patterns of innovation, such as open source software and creative commons. This stimulated both collaboration between programmers, distributed and collective creation of new products and also co-innovation between customers and creators, shifting the frontier of intellectual exchange and co-creation towards previously unattainable levels. Table 1 below summarises the main features of the seven models of innovation described in this section.

[15] https://ec.europa.eu/digital-agenda/en/growth-jobs/open-innovation.

Table 1. Seven generations of innovation process modelling

Generation	Period	Authors of fundamental ideas	Innovation model	Essence of the model
1	1950s-late 1960s		Technology push	Linear Process
2	Late 1960s-First half of 1970s	Myers and Marquis (1969)	Market Pull	R&D on customer wishes
3	Second half of 1970-end of 1980s	Mowery and Rosenberg (1979); Rothwell and Zegveld (1985)	Coupling model	Interaction of Different Functions; Interaction with research institutions and market
4	End of 1980s-early 1990s	Kline and Rosenberg (1986)	Interactive model	Simultaneous process with feedback loops; "Chain-linked model"
5	1990s	Rothwell (1992)	Integrated model	System integration and networks (SIN)
6	2000s	Chesbrough (2003)	Networking Model	Innovation collaboration and multiple exploitation paths
7	2010s	Chesbrough (et al.) (2014)	Open	Focus on the individual and framework conditions under which to become innovative

Source: Renda (2016), based on Kotzemir & Meissner (2013).

2.1 Defining entrepreneurship

Innovation requires entrepreneurs in the broadest sense of the word. A term thoroughly explored and researched by Austrian School economists, as illustrated by, inter alia, De Soto (2009), the concept of entrepreneurship implies creativity and capacity to organise knowledge in a way that generates innovative commercialised products.

The word "entrepreneurship" derives from the Latin term *in prehendo*, which means to discover, to see or to realise something (De Soto, 2009). Accordingly, entrepreneurs are defined as individuals who possess the ability to detect profit opportunity offered by the environment in which they operate. This is why the concept of entrepreneurship implies vigilance and alertness. De Soto (2009) defines the main characteristics of entrepreneurs as follows:

- Entrepreneurship always generates new information.
- Entrepreneurship is fundamentally creative, which means that any social maladjustment is embodied in a profit opportunity which remains latent until entrepreneurs discover it.
- Entrepreneurship transmits information.
- Entrepreneurship exerts a coordinating effect.
- Entrepreneurship is competitive.
- The entrepreneurial process never stops or ends.

Likewise, the OECD (2011, 2015) defines entrepreneurs as the principal actors in innovation, since they "bring about change in an economy by providing 'new combinations': new or improved goods, methods of production, markets, sources of supply of inputs, organisation of an industry, or management processes within a firm". Entrepreneurs are defined as opportunity identifiers (Kirzner, 1973, 1997), risk-takers (Knight, 1921); resource shifters (Drucker, 1985) and breakthrough innovators (Baumol, 2002).

In other words, entrepreneurs are the engine of a national innovation system. They are the main actors in charge of detecting potential opportunities for profitable innovation that matches existing, potential or future market demand. In doing so they combine available information and knowledge to produce and disseminate new information in the form of new products and possibilities for consumption and production. It is important to clarify that entrepreneurs can also be the end users of innovation. They do not need to be producers of knowledge themselves: they can use knowledge produced in universities, R&D labs and anywhere else to develop new products and services.

Of course, entrepreneurs have limited information: this means that the greater the contribution of other actors to the production and dissemination of knowledge and the creation of innovative skills, the easier it will be for them to perform their crucial task for the achievement of progress and prosperity within a national innovation system.

2.2 The innovation policy-industrial policy conundrum: Towards the quintuple helix?

The need to promote entrepreneurship and innovation that contributes to addressing societal challenges is reflected also in recent attempts to steer the direction of innovation through next generation industrial policy. Such industrial policy approaches, e.g. Industry 4.0 in Germany, embed the so-called quadruple helix concept and are based on enhanced collaboration between universities, entrepreneurs, business and government.[16] Any innovation policy intervention should be carefully aligned to industrial policy strategies. The nexus is provided by the so-called Smart Specialisation Strategy which aims at achieving knowledge-based transformation/development of the industrial/

[16] At a more micro-level, evidence suggests that the percentage of turnover that companies generate from 'novel products' is positively correlated to their collaboration activities with universities (Faems, Van Looy & Debackere, 2005). On the contrary, this kind of collaboration does not have any significant impact on turnover from 'improved products', which is positively correlated with collaboration activities with suppliers and customers (the civil society).

business texture of a region or nation. This strategy focuses on the strengths of the local ecosystem with an entrepreneurial approach and combines more entrepreneurs with more entrepreneurial approaches in research institutions and universities. Smart Specialisation should be supported by policy-makers at several levels (EU, national, regional). At these levels in particular, to link innovation and industrial policy within Smart Specialisation, four transformation models are envisaged:

- *Transition*. A new economic domain emerges from existing industrial commons, e.g. sustainable chemistry sector.
- *Modernisation*. Improvement of the efficiency and quality of an existing sector generated by the development of specific application of a general purpose technology, e.g. modernisation of traditional value chains.
- *Diversification*. Potential synergies materialising between an existing activity and a new one.
- *Radical foundation*. R&D and innovation creates new economic domains that were not previously attractive.

These possible policy options lead to important consequences for the mix of instruments that can be used by policy-makers to promote sustainable, systemic innovation. For example, public support for R&D, when well designed and accurately awarded, can make an important contribution to innovation.[17] Evidence suggests that subsidies have a positive effect on the level of R&D and on the innovation intensity of the recipient firms, and no significant crowding-out effects are registered (Debackere, contribution to CEPS Task Force, 2015).[18] Non-funded firms would have certainly invested more in R&D and innovation if they had received public support. In addition, there are very important

[17] The ratio between R&D and GDP in the EU is still at 1.9%, the worst figure in developed economies. Many stakeholders suggest looking at the quality of R&D investment rather than at a merely quantitative target; and many argue that an outcome indicator, not an input one, would be needed to reflect the effective progress of innovation in Europe. That said, investing in R&D is still an important driver of economic growth ("technological progress" is the third production factor explaining economic growth, together with labour and capital, Solow equation). See Konraad Debackere's contribution to the CEPS Task Force.

[18] Two main data sources: Mannheim innovation project (Community Innovation Survey for Germany) comprising all types of companies, including those that are not really involved in innovation. A set of 10-year panel data was adopted. The econometric analysis looked not only at public funds but also at internal investment, and no crowding out effect was registered. In addition, the private sector (including venture capital) is shifting to financing innovation (higher TRL) rather than R&D, so there might be not so much to crowd out when investing public money on R&D.

additionality and complementarity effects: in a nutshell, those firms that are funded by both national and EU sources invest more in innovation. Hence, there are neither any crowding-out effects between different sources of public support to research and innovation. EU funds are complementary to national/regional funds: this is also important for the future of innovation policy in the EU, since it is not always possible to aggregate and cumulate the funds available at different levels of government, nor is it always easy for would-be recipients.

Against this background, there seems to be room for deeper involvement of financial institutions in the overall innovation ecosystem, especially in the framework of the current EU Strategic Investment Plan.[19] In its contribution to the CEPS Task Force, the European Central Bank argued for a quintuple helix approach, which would involve also the financial sector as a key intermediary.[20] Several challenges are posed by this sector. For instance, ECB via the EFSI wants to trigger financial 'additionality' in R&D&I investment. Nonetheless, the question shifts to the risk profile of this kind of investment and risk acceptance in the financial sector. It is worth stressing that four major Belgian banks before 2008 were largely involved in private equity; today, as a result of Basel III, their involvement in private equity is close to zero. How to regulate the financial sector to foster innovation becomes then a very serious and important question. In the EU, venture capital is very limited; hence, the involvement of banks is still key and EU rules are probably not helping innovation flourish. In the same vein, looking at the national budget deficit, public funding might also be very limited due to current financial rules. Funding universities, research institutes or companies can clash with EU rules on budget deficits. This is a potential problem for EFSI, because mobilising additional investment in innovation might be less successful than expected. The fifth force in the quintuple helix is therefore as important as it is problematic in Europe. Various options are potentially available, including excluding innovation and R&D expenditure from the equation adopted to compute compliance with Maastricht parameters in the context of the European Semester.

Another key aspect of innovation and entrepreneurship is the possibility for entrepreneurs to take risks and experiment with possible solutions. Venture capitalists usually focus on business planning and this has a negative effect on the survival rate of funded start-ups. Start-ups need flexibility and greater room for experimentation rather than strict adherence to initial business plans. Hence, start-up programmes within the EU require room for flexibility ("Fail fast fail small").

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[19] https://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en.

[20] The key role played by financial markets as well as financial education was emphasised by several participants in the Task Force meetings.

2.3 Future technologies and the challenges for innovation policy – revolutionising ICT and society as a whole

This book is not specifically focused on information and communications technologies (ICT). However, when discussing innovation and its potential to contribute to emerging and future societal challenges, it is inevitable to mention ICT as both an enabler of innovative solution and the potential driver of emerging challenges for society, if not existential risks (Bostrom, 2016). In this respect, it is useful to recall that both ICT-producing and ICT-consuming sectors will be significantly reshuffled and revolutionised by the pervasive nature of new generation ICT. Already today, ICT (together with managerial competences) is a major component of Europe's productivity gap with the United States. The OECD, among others, has repeatedly stated that "from the mid-1990s, many countries, particularly in Europe, did not keep pace with the acceleration of productivity growth associated with rapid diffusion in ICT in the United States, and gaps in productivity levels between the US and other advanced economies started to widen again".[21]

Since Solow (1987), there has been a hectic debate on the impact of ICT on economic performance and, particularly, on productivity. Most firm-level studies show that investment in ICT is positively correlated with product, process and organisational innovation, as well as with productivity. The literature overall suggests that R&D mostly contributes to innovation in manufacturing, while ICT affects positively all types of innovation in services but not in manufacturing (Alvarez, 2016). Today, ICT represents a separate, ever-expanding, layered ecosystem which pervades more and more sectors of the economy every year. Such an ecosystem, as more specifically observed in Renda (2016), features a number of foundational, differentiating features that must be taken into account when crafting innovation policy.

These include Moore's law (according to which the number of transistors – the fundamental building blocks of the microprocessor and the digital age – incorporated on a computer chip will double every two years, resulting in increased computing power and devices that are faster, smaller and lower cost); modularity, which leads many industry players to converge on a single *de facto* industry standard (Bakos & Brynjolfsson, 1999; Shapiro & Varian, 1998); an end-to-end architecture, which implies the possibility, for every end user, to engage in communication and exchange information with every other end user; and the predominance of digital information goods, which feature endless replicability and non-rivalry in consumption, near-zero or zero marginal costs; plasticity and

[21] www.oecd.org/global-forum-productivity/library/The-Productivity-Inclusiveness-Nexus-Preliminary.pdf.

granularity. These foundational characteristics have determined the emergence of some of the features that are typically attributed to the ICT ecosystem by industry analysts.

- First, *R&D intensity and innovation rates tend to be greater than in other sectors.* This depends on a number of factors, including the acceleration in computing power (Moore's law); the possibilities for diffusion guaranteed by the common architecture (Metcalfe's law); and the possibilities for participation secured by the choice of open protocols, i.e. anyone can in principle develop a software or hardware that is compatible with existing internet protocols.
- Second, *innovation was initially largely incremental, due to modular architectural design* that followed 'big bang' inventions such as the computer chip and the internet protocol: this feature is however not as evident today due to the platformisation of the internet and the permeation of a number of economic sectors by new and disruptive business models (see below).
- Third, *product life cycles become increasingly shorter due to the acceleration of technological change*: several companies in the ICT ecosystem (and, to an even greater extent, the ones active at higher layers, such as operating systems, other middleware and applications) reportedly work on at least three successive generations of products (the current one, the next one and the one after that).
- Fourth, *the end-to-end architecture of the internet and the digital nature of information goods have led to the emergence of network effects and large economies of scale* in the ICT ecosystem: this, in turn, has led to the emergence of multisided platforms that are gradually changing the architecture of the network.

Based on these peculiarities, today a number of trends are affecting the ICT ecosystem. They include the following.

From the 'neutral' to the 'platformised' ICT ecosystem. As observed, inter alia, by Palacin et al. (2013) and by David Clark and K.C. Claffy (2014, 2015), this transition is now evident if one confronts the original (three-tier) model of the connectivity and logical layer of the ICT ecosystem with the emergence of vertically integrated platforms that make extensive use of traffic acceleration techniques and developed their own semi-walled gardens to improve their customers' experience and capture the bulk of the end users' attention. A company like Apple uses content delivery networks (CDNs) like the ones provided by Akamai to accelerate traffic to its FaceTime users; and at the same time hosts more specialised providers such as Netflix, which in turn use traffic acceleration techniques to enable video streaming services to subscribers

through a multitude of existing platforms (iOS, Android, public internet). A company like Spotify can be defined as a two-sided specialised platform (matching users with rights holders), but access to it mostly occurs through existing large platforms (iOS and Android). This phenomenon, often called "platformisation" of the ICT ecosystem, bears far reaching consequences for both innovation and innovation policy. In particular, understanding the economics of platforms is essential to understanding the direction and pace that innovation might take in various parts (layers) of the ICT ecosystem, as will be discussed in the next section.

Virtualisation and the cloud. With cloud computing, technology has made it possible for small companies to avoid buying or leasing hardware and downloading software and applications: these traditional transactions were replaced by "everything as a service", which led to enormous advantages both for individuals and businesses.

Openness and collaboration. Open source software is evolving and growing from the initial models of "copyleft" licensing, based on reciprocity and the voluntary commitment to refrain from claiming the exclusive right to commercially exploit a given invention, towards a variety of models, which include the making available of entire patent portfolios for free exploitation by users and small entrepreneurs. Openness has become an increasingly dominant paradigm in research and innovation, thanks to the internet evolution. Key examples include, in the public sector, the recent decision by NASA to make hundreds of patents available for free for developers;[22] and in the private sector, the decision by Google to open up its Android patents;[23] as well as the decision by Tesla's Elon Musk (later followed by other car manufacturers such as Ford) to open up for free the company's patent portfolio to external developers.[24] This example is being followed by governments: e.g. the US Open Government Plan is increasingly geared towards the diffusion of all information held by public administrations for use by researchers and individual citizens as users or contributors to innovative projects (Renda, 2016). Overall, this trend leads to the identification of a new strategy for the launch of innovative, disruptive platforms, which chiefly depends on making technical information available royalty-free to maximise diffusion and achieve first-mover advantage. A similar

[22] www.nasa.gov/press-release/nasa-offers-licenses-of-patented-technologies-to-start-up-companies/.

[23] http://techcrunch.com/2015/07/23/google-offers-to-sell-patents-to-startups-to-boost-its-wider-cross-licensing-initiative/.

[24] www.digitaltrends.com/business/ford-to-open-electric-vehicle-patents-news-pictures/.

strategy is being used by Toyota for the hydrogen car.[25] And needless to say, the open, collaborative economy is emerging in many more sectors than the often-mentioned taxi (Uber, BlaBlaCar) and hotel/accommodation (Airbnb) sectors.[26]

The data-driven economy. Another important trend is the breathtaking surge in the availability of data, coupled with the dramatic reduction in the cost of data storage and processing. The power of big data analytics, according to many experts, is yet to be fully discovered, especially if one considers that the overwhelming majority of data available for analytics (some say 99%) has been produced in the past two years; or, as others have observed, "the amount of data generated in two days is as much as all data generated in human history before 2003".[27] Big data applications encompass many sectors of the economy, but also many forms of innovation, including, increasingly, Open Innovation 2.0.

Connecting everything (the IoT revolution). Machine-to-machine communication (M2M) is an enabler for data-driven innovation in many industrial applications and services, including logistics, manufacturing and even health care. With at least 20 billion devices expected to be connected at the end of the decade, it is easy to recognise why M2M is considered an impending revolution, likely to connect the 'remaining 99%' of things and humans that have not yet been connected. Again, the Internet of Things (IoT) revolution will mean essentially an extension of the features of ICT (in particular, network effects, platformisation and re-intermediation) to many other sectors of the economy, even those that are typically characterised by more 'linear' models of innovation, e.g. automotive and more generally manufacturing.

Such a transition is likely to result in very important consequences for the industrial organisation of several sectors, especially due to the foreseen transition towards the so-called 'factory of the future'. This will imply a 'cocktail'

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[25] www.zdnet.com/article/toyota-pushes-hydrogen-fuel-cell-cars-with-open-patent-portfolio/.

[26] Owyang & McClure (2015) describe the ever-changing landscape of collaborative economy champions as now composed (based on the jargon used in Silicon Valley) of three Pegasus companies (Uber, Airbnb, Wework); a few Unicorns (Didi, LendingClub, Ola Cabs, HomeAway, Lyft, Instacart, Beepi, Blue Apron, Prosper, GrabTaxi, Thumbtack, BlaBlaCar, Etsy Tuja, Rocket Taxi); and Centaurs (Freelancer, Chegg, Rent the Runway, Postmates, Shyp, Inspirato, Circle, Hailo, RelayRides). The authors do not list the 'ponies', defined as companies with a capitalisation of less than $10 billion; and the hundreds of start-ups that have the legitimate ambition to join one of those other categories. Most likely, these companies will further proliferate in the coming years. The total capitalisation of sharing economy players calculated by the authors as of 24 October 2015 totalled $128.7 billion.

[27] www.uschamberfoundation.org/sites/default/files/Data%20Report%20Final%2010.23.pdf.

of many different technologies, including smart objects (the IoT), advanced and secure cloud computing for central data storage, infrastructure and frequencies for multi-tech, always-on connectivity (starting with 5G wireless communications, but including sensor infrared technologies and others, e.g. Bluetooth); advanced robotics; 3D printing; and of course big data analytics for optimised management of the supply chain. This will be coupled with granular business models that will enable mass customisation and real-time reconfiguration of the supply chain. In Europe, this trend has been accompanied by an ambitious strategy originated by Germany with its *Industrie 4.0* initiative launched in 2011, and is currently being scaled up at the pan-European level.

The internet of value. In emerging sectors such as FinTech, distributed architectures born thanks to the internet are reaching new levels of sophistication and are empowering unprecedented, disruptive innovation. One key example is the blockchain technology that backs all crypto-currencies such as BitCoin and empowers distributed processing of data, robust transaction verification and potential applications on a variety of platforms, including on virtual reality systems such as Oculus Rift or Google Cardboard. Among others, Taylor (2015) explains that both permissioned and unpermissioned blockchains have tremendous potential in fields such as smart contracts, virtual transactions, dis-intermediated mortgage and investment markets, and many more, creating what some commentators have defined as the "internet of value".[28]

Artificial intelligence and human-machine interaction. Last but not least, artificial intelligence (AI) is already becoming pervasive in many sectors. In the online environment, ChatBots are replacing humans and Microsoft recently announced the development of the first software that is more accurate than humans at speech recognition. Self-driving cars implement increasingly AI-powered software, prompting both the European Parliament and governments in Germany, the US and the State of California to actively work on regulations aimed at governing the moral decisions that AI will have to make.

These trends are very important for the future of the ICT ecosystem. But even more important is the fact that they are occurring simultaneously. The combination of disruptive innovation in network architectures, e.g. blockchain, new sensor and wireless communication technologies, e.g. 5G, nano-technologies, robotics and artificial intelligence is likely to create unprecedented possibilities for innovation, most often based on predominantly open standards and free/open source software, low entry barriers and completely innovative funding and management arrangements. In the next sections, we will take these trends into account when suggesting policy changes for the EU.

[28] www.finextra.com/finextra-downloads/newsdocs/The%20Fintech%202%200%20Paper.PDF.

2.4 The age of openness: Crafting a new role for government and citizens

2.4.1 Open science and citizen science: The emerging role of empowered citizens as drivers of innovation

Generally speaking, "open science" refers to an approach to research based on greater access to public research data, enabled by ICT tools and platforms, and broader collaboration in science, including the participation of non-scientists, and finally, the use of alternative copyright tools for diffusing research results. As reported by the OECD, "open science has the potential to enhance the efficiency and quality of research by reducing the costs of data collection, by facilitating the exploitation of dormant or inaccessible data at low cost and by increasing the opportunities for collaboration in research as well as in innovation".[29] Greater access to research data can also help advance science's contribution to solving global challenges by enhancing access to data on a global scale, e.g. in the case of climate change data.

The conceptualisation of open science goes back to the work of sociologist Robert Merton, who in the early 1940s laid down the foundations for the analysis of science and its role in society. Merton argued that science had developed norms of behaviour that cumulatively contributed significantly to the growth and quality of scientific knowledge: these norms were summarised in the acronym CUDOS (communalism, universalism, disinterestedness, originality and scepticism).

In 2003, economist Paul David first coined the term "open science", mostly as a way to highlight the contrast between norms in science and the tendency towards limiting the availability of information observed in the innovation world, where intellectual property has long been a prevailing way to incentivise the production of knowledge. Chesbrough (2015) observes that the internet age has led the "Mertonian" norms to find expression in new institutions that again create even greater volumes of knowledge that diffuse even more rapidly, a key example being open source software. In other words, as recalled by the OECD (2015), "open science is the encounter between the age-old tradition of openness in science and the tools of information and communications technologies (ICTs) that have reshaped the scientific enterprise and require a critical look from policy makers seeking to promote long-term research as well as innovation" (OECD, 2015: 9).

[29] www.oecd.org/sti/outlook/e-outlook/stipolicyprofiles/interactionsforinnovation/openscience.htm.

The key aspects of the internet age that have boosted the potential of open science are the digitisation of (increasing amounts of) information and the end-to-end internet architecture. Over the past two decades, the emergence of digital content compression technologies and the internet, with its end-to-end architecture, have determined a massive change in the way information is created, shared and distributed between end users. On the one hand, the digital nature of information has led to new forms of production, e.g. creative commons, open source software, and enabled new forms of versioning and reconfiguration of products, to such a significant extent that today the concept of "mass customisation" is conceivable only in, or thanks to, the ICT sector (Renda, 2016).

On the other hand, the end-to-end architecture of the internet has exponentially amplified the possibility for information goods to be produced, modified and disseminated: this is also due to the fact that digital goods can feature high fixed costs (in particular, R&D costs) but often very negligible marginal costs. Suffice it to think about the shift in music consumption and production that was enabled by digital technology coupled with the internet's end-to-end architecture. While the former technology already enabled new forms of production, e.g. through sampling, already before the advent of the internet era, the late 1990s witnessed the emergence of peer-to-peer file-sharing platforms that led to a major reshuffling of the music industry, e.g. Napster.

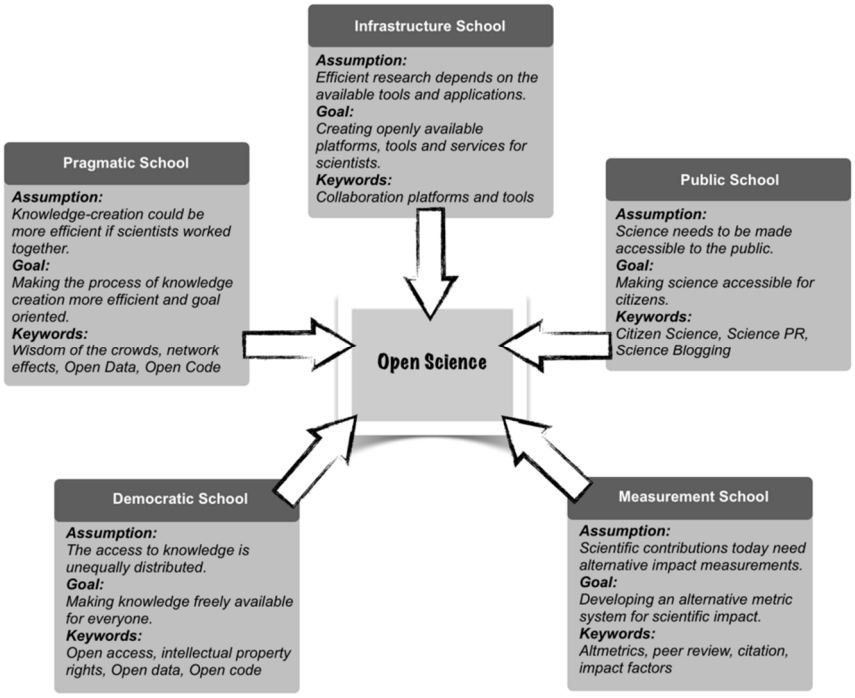
Furthermore, open science and collaborative creation have become gradually cheaper thanks to the mind-boggling reduction of computing and storage costs. The OECD, among others, reports a drastic fall in the cost of data storage costs between 1998 and 2012. In addition, the gradual increase in broadband connectivity and the fall in the costs of hardware such as 3D printers have made accessing and reproducing research results easier over time, potentially leading to what some authors already call the "democratisation" of science.

There are, however, other factors that can be said to have played a decisive role in the emergence of open science over the past few years. In particular, the decision by computer scientists such as David Clark and Tim Berners Lee to design and preserve the internet as a 'dumb' end-to-end network, as well as the decision by policy-makers to shield internet service providers from liability for the conduct of their users has certainly contributed to the development of the Web as an environment where information sharing could be possible and indeed became part of the overall 'netizen' culture. And needless to say, the fact that the internet was built on open, interoperable standards has been essential for this development.

That said, it would be misleading to state that open science is a well-defined domain. Fecher & Friesike (2015), in a recent literature review, define it

as "an umbrella term encompassing a multitude of assumptions about the future of knowledge creation and dissemination", and identify five open science schools of thought, as shown in Figure 3 below: the *infrastructure school* (which is concerned with the technological architecture), the *public school* (concerned with the accessibility of knowledge creation), the *measurement school* (concerned with alternative impact measurement), the *democratic school* (concerned with access to knowledge) and the *pragmatic school* (concerned with collaborative research).

Figure 3. Five schools of open science



Source: Fecher & Friesike (2015).

- Depending on the definition and perspective adopted, open science is today considered as incorporating at least six main sub-pillars (Majer, 2015):
- *Open data*, which implies that data and content can be freely used, modified and shared by anyone for any purpose.[30] This sub-pillar of open science can encompass both the requirement to keep data open for all government-funded research projects, but also more pervasive strategies aimed at opening up data in the possession of government agencies, as will be explained below (Tran & Scholtes, 2016).

[30] See http://opendefinition.org/.

- *Open source*, which entails that the underlying source code of data and content is made available and complies with a number of well-specified criteria and principles.[31]
- *Open methodology*, i.e. a methodology which has been described in sufficient detail to allow other researchers to repeat the work and apply it elsewhere.
- *Open peer review*, which aims at making peer review a collaborative process between authors and reviewers; it is about constructive criticism but with the goal of helping the authors to get published.[32]
- *Open access*. Content is made available for anyone to read without having to pay, and the related license allows secondary use such as text and data mining.[33]
- *Open educational resources*, i.e. high-quality, openly licensed, online educational materials that offer the opportunity for people everywhere to share, use and reuse knowledge. This ranges from sectoral repositories of free educational content to massive open online courses (MOOCs).

Today, there are numerous examples of successful open science initiatives at the global level including, inter alia, well-known repositories such as PubMedCentral in the life sciences, arXiv in physics, mathematics and computer sciences and RePec in economics; new initiatives such as PLOS One and BioMed Central; large institutes providing access to a wealth of data such as the Research Data Alliance, CODATA, ICSU, EMPL-EBI; private organisations adopting an open access policy such as the Wellcome trust, the Open Knowledge Foundation and the Bill and Melinda Gates Foundation; private start-ups such as figshare, and public-private partnerships such as SHOK (Strategic Center for Science, Technology and Innovation) and DIGILE[34] both of which are Finnish initiatives.

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[31] See https://opensource.org/osd-annotated.

[32] Watson (2015). The *British Medical Journal* gathered convincing evidence that open review did no damage to the quality of peer reviews; yet still they insisted that they introduced open peer review for "ethical reasons", believing that removing anonymity would help bring an end to the worst abuses of peer review and transform the entire process from one of judgment to one of open, scientific discourse. When reading these words, doesn't it make you wonder why peer review was ever anything else?

[33] A good solution are the 'living figures' introduced by F1000Research, which are data within papers that update in real-time as more data become available. Rather tellingly, F1000Research is an open-access publisher.

[34] DIGILE is a non-profit company operating between the public and private sectors in Finland with the goal of increasing know-how, developing the tools required by the internet economy and creating growth, jobs and new business.

More generally, the amount of data released by institutions such as CERN has led to collaborative efforts that have eventually generated scientific discoveries as important as the Higgs Boson, which was described in a publication that counts more than 6,000 authors.[35] Available studies confirm that increased accessibility of publicly funded research outputs can lead to significant additional benefits to society.[36]

Defining open science is, however, different from conceptualising the way in which governments can promote openness and knowledge sharing. There are compelling arguments, today for governments to try to harness the recognised potential of open data for economic development and growth.[37] And the

[35] See, for instance, Atlas Collaboration (2012), "Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC", *Physics Letters* B 716,1 (2012): 1–29. doi:10.1016/j.physletb.2012.08.020. As we shall see below, it is unclear at this point how helpful it is to each of the individual contributing scientists to be among the 6,000 authors, in terms of personal recognition and prestige. Merton's CUDOS implies scarcity in academic credit yields prestige and recognition. When such credit is distributed among 6,000 people, the social rewards to any one individual may be diluted.

[36] Rasmussen and Sheehan (2010) estimated that a public access policy mandate for US federal research agencies over a transitional period of 30 years may be worth approximately $1.6 billion and up to $1.75 billion if no embargo period is in place. Approximately $1 billion would benefit the US economy directly and the remaining amount would translate into economic spillovers to other countries. These figures would be significantly higher than the estimated cost of implementing open access archiving. JISC (2014) conducted a study on the economic impact of three UK data centres (the Economic and Social Data Service, the Archaeology Data Service and the British Atmospheric Data Centre), and estimated that the returns to investment of each of these three centres could be between approximately twofold and tenfold over 30 years.

[37] Two studies comissioned by the European Commission. In particular, Graham Vickery found that the size of the narrowly defined EU direct, "business as usual", public sector information reuse market was on the order of €28 billion in 2008 with an annual growth rate of around 7%. This was a conservative estimate, as it excluded domains where reuse was not a principal activity, as well as the value of government activities. The Vickery study also investigated the indirect benefits of open data, estimating aggregate direct and indirect economic benefits for the whole EU economy on the order of €200 billion in 2008, or 1.7% of the GDP of the EU as a whole. McKinsey estimated that, globally, seven sectors alone could generate more than $3 trillion a year – and up to $5 trillion a year – in additional value as a result of open data. Similarly appalling estimates came, for example, from the UK Shakespeare review of public sector information

international community has been particularly vocal in mandating that governments open up science and knowledge as much as possible.[38]

There are different ways in which an open science strategy can be promoted by governments:[39]

- *Open access to government-funded research.* This requires that all government-funded activities, including research and innovation projects, lead to openly accessible and reusable data. For example, in the United States, the National Institutes of Health was required to change its data access policies in 2007; the White House's Increasing Access to the Results of Federally Funded Research Executive Directive released in February 2013 directs federal agencies to develop plans to make the publications resulting from federally funded research freely available to the public within one year of publication and required researchers to better account for and manage the digital data resulting from federally funded scientific research with the goal of making these data publicly accessible as well (Mauthner, 2013). At the EU level, an open research data pilot has been launched within the context of Horizon 2020 and led to the publication of Guidelines on Data Management, the last version of which is dated 30 October 2015.[40] Already in 2007, the Council conclusions on information in the digital economy called upon member states to take steps towards an open access policy, but the landscape still appears heavily fragmented.[41]
- *A "whole-of-government" open data policy.* This implies that government-held data are made available to everybody for use, editing and dissemination. In June 2013 G-8 countries met to agree on the Open Data Charter, which specifies a number of principles that signatory countries are expected to comply with in the coming years, going way beyond open access. These include releasing open data by default in open and machine-readable formats (unless there is a compelling reason not to, such as national security or privacy concerns); ensuring high quality and quantity

[38] Article 27 of the Universal Declaration of Human Rights (1949), Article 15 of the International Covenant on Economic, Social and Cultural Rights (1966), and Article 15 of the UNESCO Universal Declaration on Bioethics and Human Rights (2005) all articulate the obligation to share scientific knowledge and the right to share in the benefits of scientific knowledge.

[39] See also McKinsey (2015), which observes that governments can act as providers, catalysts, users and policy-makers in this domain.

[40] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf.

[41] See the PASTEUR40A report at www.pasteur4oa.eu/.

of data; making data usable by all, including through standardised metadata, open licenses and other ways to ensure general accessibility; releasing data for improved governance and for innovation. The latter two commitments imply, more specifically, that government agencies share best practices on open data internationally, release certain "key data sets" specified in the charter and seek input from civil society, including for data sets considered "high value" by the charter, as well as engage with developer communities and fund open data start-ups.

- *A full-fledged open government strategy.* Even more ambitious, this endeavour does not only imply that governments open up their decision-making process to allow access by external stakeholders, e.g. through systematic stakeholder consultation, data releases, Freedom of Information Act requests, or merely go beyond the idea that government can use digital channels to communicate with citizens and provide access to public services as in what is often termed "eGovernment"; it also entails, most important, that citizens and civil society are empowered and allowed to provide early inputs into the shaping of public decisions and expenditure, e.g. participatory budgeting, thus realising the full potential of participatory democracy (Noveck, 2015).[42] In line with this view, Heller (2012) argues that open government includes information transparency, public engagement and accountability.
- *Policy-making in support of open science.* In recent years it has become clear that open science goes way beyond open access to publications or data; it includes many aspects and stages of research processes. Open science is a broader concept that also includes the interoperability of scientific infrastructure, open and shared research methodologies (such as open applications and informatics code) and machine-friendly tools. This approach to government support of open science entails adopting specific public policy measures to promote open data, access and standards also outside government. This includes, inter alia, the removal of legislative and regulatory obstacles to research activities based on text and data mining, the clarification of privacy constraints to the use of (big) data, the provision of incentives to universities, SMEs and larger companies for the creation of open platforms, promoting competition and collaboration on research ideas.

These approaches to openness can also be seen as presenting different degrees of complexity. As also acknowledged by the OECD (2015), a whole of government open data strategy can be way more difficult than adopting a

[42] http://thegovlab.org/open-government-whats-in-a-name/ provides a plethora of definitions of open government.

commitment to open access, due to a number of reasons that include problems related to the ownership of datasets; significant diversity of datasets in research (from excel tabs to large datasets collected by machines); problems in defining when a given dataset is ready to be released; confidentiality issues; security issues; lack of incentives in the academic community; missing infrastructure and skills; and lack of adequate and sustainable funding.

The emerging evidence on the economic importance of open science and data has led governments to increasingly focus on the development of *ad hoc* strategies to boost economic development and growth through openness. In order to achieve this result, it is essential that all the key actors and enablers of a vibrant open science environment be adequately involved and stimulated. More in detail:

- *Enablers* include, inter alia, the infrastructure developed to share articles or data, initiatives undertaken to develop an open science culture, amendments to the legal framework to make them increasingly open-science friendly or the development of the skills (demand and supply side) necessary for researchers to share and reuse the research outputs produced by others.
- *Actors* include researchers; universities and research centres; ministries and research funding agencies or public foundations; libraries, data centres and repositories; private scientific publishers; and businesses. In addition, as already explained, international and intergovernmental organisations, coupled with private transnational organisations, can play an essential role in promoting coordination across governments and an overall culture of open science across countries.

Both enablers and actors are important ingredients of an open science policy. Creating a wealth of data through mandatory publication of government-held information in open, machine-readable format can add significant value to the economy, but requires the existence of researchers who can reuse these data to build welfare-enhancing new business models and/or bring new, enticing products to market. This, in turn, calls into question the importance of education policy to create and promote the diffusion of skills related to data science. In addition, it requires that, for example, privacy and copyright legislation create no unreasonable obstacle to the elaboration and processing of data, as well as their use in innovative business models. Such innovative products and services will require an overall legal and economic environment that is conducive to entrepreneurship.

2.4.2 *Citizen participation in research: Citizen science and crowdsourcing*

The last frontier of open science in government involves the participation of citizens in the research process. The term "citizen science" was introduced in the mid-1990s by Rick Bonney in the United States and Alan Irwin in the United Kingdom.[43] It is a broad term, covering that part of Open Science in which citizens participate in the scientific research process. Such participation can take place in different ways: as observers or funders, in identifying images or analysing data, or providing data themselves. Bonney et al. (2015), without pretending to create a formal taxonomy, distinguish between four different forms of citizen science:

- *Data collection*, in which volunteers – who may or may not have any formal training as scientists – collect data that can be used in organised scientific research.
- *Data processing*, sometimes referred to as "crowd science", which often focuses on activities such as data transcription, categorisation, management and interpretation, e.g. mapping and classifying images from space, modelling the earth's climate using historic ship logs, mapping neurons in the human brain). For example, NASA is relying on 30,000 volunteers to map the sky and search for clues on the formation of the solar system.[44]
- *Curriculum-based projects*, typically developed in pre-college education (so-called K-12[45]) involve youth, supervised by educators or other adults, collecting and submitting data to a larger, 'parent' citizen science project, and are often are aligned to state and/or national science standards.

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[43] Some people equate citizen science with a movement to democratise science. This idea likely stems from the 1995 publication of Alan Irwin's book, *Citizen Science: A Study of People, Expertise, and Sustainable Development* (Irwin, 1995). The goal of citizen science espoused by Irwin is to bring the public and science closer together, to consider possibilities for a more active "scientific citizenship", and to involve the public more deeply in dialogue and decision-making around issues related to risk and environmental threat. Other people equate citizen science with public participation in scientific research, in particular, with members of the public partnering with professional scientists to collectively gather, submit or analyse large quantities of data.

[44] www.datainnovation.org/2015/10/getting-the-u-s-government-on-board-with-citizen-science/.

[45] K-12, a term used in education and educational technology in the United States, Canada, and possibly other countries, is a short form for the publicly supported school grades prior to college. These grades are kindergarten (K) and the first through the 12th grade (1-12). (If the term were used, '13th grade' would be the first year of college.)

- *Community science* projects involve data collection but typically seek to affect policy- or local decision-making for public health or conservation. Community science projects often are developed by members of the public who reach out to scientists for assistance. They may involve workshops for community members focused not only on data collection but also on how to speak to the media and public officials about scientific findings; how to use findings to influence land, air and water quality regulations and enforcement; and how to ask answerable research questions. Bonney et al. (2009) and Shirk et al. (2012) suggest that among citizen science projects, co-created projects may have the greatest potential to achieve a wide range of public understanding impacts. This is primarily because such projects typically involve participants not only in collecting data but also in developing research questions and designing research protocols, interpreting data and disseminating results. Also, many citizen science projects intertwine engagement in the science process with the goals of public engagement in governance and science-based decision-making in ways that Irwin (1995) envisioned two decades ago.

Most citizen science projects provide multiple benefits. For example, a 2015 synthesis of peer-reviewed literature describes the individual- and community-level impacts of volunteer environmental monitoring. Specific outcomes reported in peer-reviewed journal articles include "improved communication between government and local stakeholders, increased knowledge and changed attitudes among participants, better adherence to natural resource regulations by community members, and empowerment of local stakeholders."[46] Local stakeholders also became more engaged in ecosystem management and policy discussions, and the scientific literacy of participants grew. In addition, community-based monitoring or management led to improved relationships with the communities involved.

Governments are increasingly reverting to crowdsourcing and citizen science to solve complex research problems, which in turn allow for more rapid and effective solutions to public policy problems. Authoritative scholars recently observed that citizen science is becoming "nearly as big a concept as science itself" (Bonney et al., 2016). Citizen science associations are now becoming more organised, with chapters in many regions around the world.

At the same time, there is also criticism of the recurrent use of citizen science, particularly about the set-up of the projects, their output and quality, which calls for the improvement of standards and other criteria related to the performance of research that extensively relies on citizens' participation.

[46] www.whitehouse.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf.

2.4.3 *Open data, open government, open innovation: Missing links and trade-offs*

The previous sections have offered an illustration of the evolving concepts of open science and open innovation and related notions such as open data, citizen science, crowdsourcing and distributed innovation. What emerges is a rather blurred picture, characterised by a variety of definitions and overlapping concepts, some of which have a purely descriptive characterisation, whereas others can be given a more prescriptive value. Most important, it is essential to distinguish the phenomenology of open science and open innovation from the analysis of the public policy aspects of these phenomena, which are typically a narrower concept and present peculiar problems and challenges for governments. Below, a number of potential policy challenges and trade-offs are discussed.

First, as already mentioned, mere open access requirements represent only a tiny fraction of what governments can do to involve the private sector and stimulate innovation in the long run. It is therefore very important not to confuse open access with open science and at least to encompass in the latter concept commitments to open up government-held data, possibly in open machine-readable format, and incorporate in the open science concept also proactive policies aimed at facilitating 'absorption' on the private sector side, starting with citizens and SMEs. In this respect, other fields of government such as education policy and infrastructure policy, e.g. universal access to broadband, appear as essential elements of a whole of government approach to open science.

Moreover, and relatedly, a whole of government approach to open science should also include the evaluation and (if appropriate) review of those policies that directly affect access to and reuse of data. In this respect, sensitive policy fields include the clarification of access rights for citizens, private companies and civil society organisations, e.g. through the Freedom of Information Act; copyright laws, especially for what concerns the availability of exceptions for text and data mining and user-generated content; data protection laws, especially for what concerns data ownership and rules related to the liability of data controllers and processors; and more generally legislation on intellectual property, including patent law and trade secret law.

Furthermore, there seems to be an emerging conflict between the openness goals pursued by open science policy and the 'social bargain' on which innovation policy is based, in particular for what concerns patent laws. This conflict is reflected in policies aimed at stimulating the commercialisation of innovation in universities. For example, Caulfield et al. (2012) denounce the existence of conflicting incentives for university-based genomics researchers in many advanced economies. On the one hand, researchers are "told to

commercialize their research by patenting, licensing, and forming close partnerships with industry, which has particular skills, financial assets to facilitate the translation of knowledge into products, and objectives". On the other hand, "researchers are encouraged to share data and disseminate knowledge quickly (that is, to adopt an open science model) so as to foster scientific progress, meet humanitarian goals, and (again) maximize the impact of research". Against this background, what is the optimal level of openness that government should choose? And does it change across sectors? What instrument mix is most suitable to maximising social welfare?

These questions are particularly important since there seems to be a significant "clash of cultures" between science and innovation: such a clash of culture is reflected in the underlying values of the scientific and innovation communities. The fact that both communities are moving towards more open models should not suggest a complete convergence process. In science, openness is considered to expand the frontier of researchers, as it provides for an expansion of available channels for data collection and processing. Whole of government open data policies, even more than simple open access, maximise the availability of content that researchers and private companies can use to generate new science, contribute to existing products and design innovative products and business models based on a combination of big data, innovative ideas and managerial/entrepreneurial skills. This, however, does not automatically imply that an open science policy should be coupled with an open innovation policy, which mandates that all innovation is carried out in an open fashion.

This, in turn, leads to another important observation. Openness, *per se*, is to be considered as a means to greater progress and social welfare. This entails that removing the obstacles to open science and open innovation does not necessarily mean *mandating* open innovation. Rather, a whole of government open science policy can help entrepreneurs develop their innovative products and services thanks to the availability of greater amounts of data, further strengthened by the enormous amount of data created by end users themselves (as well as objects, in the IoT) on a daily basis. Whether this leads to the emergence of open, semi-open or closed business models on the market at any given moment in time is a completely different policy issue.

Against this background, the history of the first two decades of the internet can shed some light on the value that openness has with respect to progress. Although an in-depth analysis of this issue would require a separate report, it is important to observe proprietary business models can prove very useful, especially for products that are in their infancy. These closed business models tend to be overtaken and replaced by more open models. This occurred, for example, in the case of IBM's first personal computer, later made more

modular to allow for competition and quality improvements over time; and Apple's iTunes-iPod-FairPlay business model that created the first legal store for music downloads a decade ago, now largely superseded by more open models such as streaming-based services that operate across platforms (Spotify, Apple Music). And even if open models are normally seen as more inclusive, the conclusion that open is always good, and closed (or semi-closed) always bad, should be resisted (Boston Consulting Group, 2011).

At a minimum, even if there seems to be little ground for mandating open innovation through regulatory measures, it is possible to observe that the market is spontaneously evolving towards larger use of open business models, thanks also to the enhanced possibilities that internet's end-to-end architecture and advances in connectivity and data compression allow. Beyond early-stage success stories such as Wikipedia or Linux, new examples include the decision by Google to open up its Android patents; and in emerging sectors such as FinTech, the blockchain technology that backs all crypto-currencies such as BitCoin, and that empowers distributed processing of data, robust transaction verification and potential applications on a variety of platforms, including on virtual reality systems such as Oculus Rift or Google Cardboard.[47]

In summary, it is essential to understand more deeply the links between open science and open innovation, as they appear to be less straightforward than it might seem at first blush. And not only governments must strive to manage trade-offs within the scientific community, as highlighted above; they should also clarify whether and to what extent an open science policy should be construed as 'viral', i.e. the openness requirement should apply to all subsequent uses of the information and data made openly available to third parties. Whatever decision is adopted in this respect, the resulting conflicts and trade-offs with other areas of policy ***should*** be adequately approached and discussed.

2.4.4 Prizes and awards: How government demands innovation

A major component of the open innovation agenda of many government is the increased use of prizes and awards as way to incentivise innovation.[48] Challenges and prizes have existed in the government sphere since the mid-

[47] Among others, Taylor (2015) explains the nature of blockchain and its potential. Both permissioned and unpermissioned blockchains have tremendous potential in fields such as smart contracts, virtual transactions, dis-intermediated mortgage and investment markets, and many more, creating what some commentators have defined as the "Internet of value", see www.finextra.com/finextra-downloads/newsdocs/The%20Fintech%202%200%20Paper.PDF.

[48] OSTP Blog (2015), "Accelerating the Use of Prizes to Address Tough Challenges", July.

2000s, especially in the United States but increasingly also in Europe. In the past five years, there has been an increase not only in the number of challenges and prizes but also in the size, complexity and sophistication of competitions. Current challenges reflect the diversity of opportunities: in the US, the Consumer Product Safety Commission is asking middle school students to enter a poster competition on carbon monoxide awareness, and NASA is seeking teams to build small spacecraft that can carry out operations near the moon and in deep space. More agencies are taking concrete steps to institutionalise challenge and prize activities: several agencies have dedicated prize leads, and a number of agencies are working on common contracting vehicles to cut down on operational costs. Enthusiasm has also grown through the Challenges and Prizes Community of Practice, which has over 600 members. The federal government increasingly uses cash prizes to promote innovation; these have been a great deal for taxpayers since the social benefits vastly exceed government funding costs.[49] The Defense Advanced Research Project Agency (DARPA) launched its first "Grand Challenge" in 2004; whoever could design a driverless car that completed a desert course fastest would win $1 million.[50] No car managed to cross the finish line that day and no one took home the prize money. But the challenge got brilliant minds focused on driverless technology. A decade later, Google is close to mastering the technology and most major automakers are working on their own driverless prototypes. Since then, there have been more DARPA-sponsored competitions involving humanoid robots and radio communications, among other fields.

Challenge.gov recently celebrated its five years of existence, during which it reportedly collaborated with more than 200,000 members of the public through more than 440 challenges on topics ranging from accelerating the deployment of solar energy, to combating breast cancer, to increasing resilience after Hurricane Sandy. Agencies have been increasing their use of prizes and challenges because they allow the government to pay only for results and increase the number and diversity of 'solvers' working on important problems. In the field of prizes and awards, the administration officials recently announced nine new challenges by federal agencies; expanded support for the use of challenges and prizes in the federal government; and 14 new challenges hosted

[49] The prizes are at most only a few million dollars, and the competition energises non-governmental researchers and entrepreneurs to tackle socially significant problems.

[50] A well-known example of a demonstration project is the Ansari X Prize, which was awarded in 2004. The Ansari X Prize was awarded to aerospace designer Burt Rutan and financier Paul Allen for being the first private team to "build and launch a spacecraft capable of carrying three people to 100 kilometres above the earth's surface, twice within two weeks."

by multiple non-governmental institutions which will, for example, improve screening for lung and breast cancer, improve the physical and brain health of 165 million children worldwide and improve our ability to treat spinal cord injury.[51] The May 2015 report to Congress on the Implementation of Federal Prize Authority for Fiscal Year 2014 highlighted that Challenge.gov is a critical component of the federal government's use of prize competitions to spur innovation. Numerous federal agencies have discovered that prizes allow them to:

- pay only for success and establish an ambitious goal without having to predict which team or approach is most likely to succeed,
- reach beyond the 'usual suspects' to increase the number of citizen solvers and entrepreneurs tackling a problem,
- bring out-of-discipline perspectives to bear,
- increase cost-effectiveness to maximise the return on taxpayer dollars and
- inspire risk-taking by offering a level playing field through credible rules and robust judging mechanisms.

[51] www.whitehouse.gov/sites/default/files/microsites/ostp/final_prizes_fact_sheet_100715.pdf.

3. PEOPLE: FOSTERING TALENT AND ENTREPRENEURSHIP TO UNLOCK EUROPE'S INNOVATIVE POTENTIAL

3.1 What skills? Looking for the right mix of competence, creativity, entrepreneurship

3.1.1 Problem

The current mix of competence displayed by the European labour force is not in line with the evolution of the market, which exhibits a fast industrial transformation and an ongoing polarisation, i.e. either low-skill or high-skill jobs will stay in the market). Moreover, Europe needs policy entrepreneurs and creative thinkers in public institutions, as well as large and small companies and civil society. The issue of intra-preneurship within firms and in public institutions is still insufficiently considered among European Union policy-makers.

3.1.2 Analysis

Education policy has become a public-private endeavour and a lifelong need. From a public policy perspective, school and university education must be carefully rethought to ensure that students are exposed to a new mix of competence through experiential learning. There cannot be enough emphasis on the importance of promoting STEM (science, technology, engineering and mathematics) and coding skills already in early school years, both areas in which countries such as the US have invested more resources than the EU-28 in recent years. In many parts of the world, the emergence of ICT as an enabling technology and the gradual expansion of the ICT ecosystem into other sectors, not just as ICT-using but as fundamentally ICT-powered, has led policy-makers to develop specific policies to promote STEM education even in early school years. Recently, in the US the Obama administration launched a $4 billion programme dedicated to computer science, and aimed at increasing access to K-12 computer science education by training teachers, expanding access to high-quality instructional materials and building effective regional partnerships. In the EU a recent report for the European Parliament highlighted "persisting skills

shortages in STEM fields in spite of high unemployment levels in many Member States".[52]

The European Commission has long denounced the emerging skills mismatch in Europe, referring to the slower pace of updating skills compared to updating technology: "skills development does not come about as fast as technological development, which is why we are faced with a paradoxical situation: although millions of Europeans are currently without a job, while companies have a hard time finding skilled digital technology experts. As a result, there could be up to 825,000 unfilled vacancies for ICT…professionals by 2020".[53] Notably, missing skills do not include only ICT-related technical skills, but also, and importantly, managerial skills, which themselves explain a portion of the productivity gap between the United States and Europe in ICT: both these skills sets are among the core entrepreneurial skills.[54] The full set of competence needed includes, inter alia:[55]

- *coding skills*, possibly to be introduced as early as possible in schools;
- *creative skills*, to be stimulated through dedicated programmes during primary, secondary and tertiary education;
- *science, technology, engineering and math (STEM) education,* in order to enable the application of ICT to a wide variety of sectors, from health care to energy, manufacturing, finance, etc.;
- *cross-disciplinary skills*, which require abandoning textbook-style education in order to instil students with enough basic knowledge and culture and advanced notions to be able to handle more than one discipline at once;
- *managerial skills*, which include basic entrepreneurship skills such as the ability to conceive a business plan or define a start-up and scale-up strategy for the first years of a new venture;
- *financial and accounting education*, in order to empower individual would-be entrepreneurs in their relationship with financial intermediaries;

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[52] www.europarl.europa.eu/RegData/etudes/STUD/2015/542199/IPOL_STU(2015)542199_EN.pdf.

[53] https://ec.europa.eu/digital-single-market/en/blog/here-how-we-will-improve-digital-skills-and-create-more-jobs-europe-0.

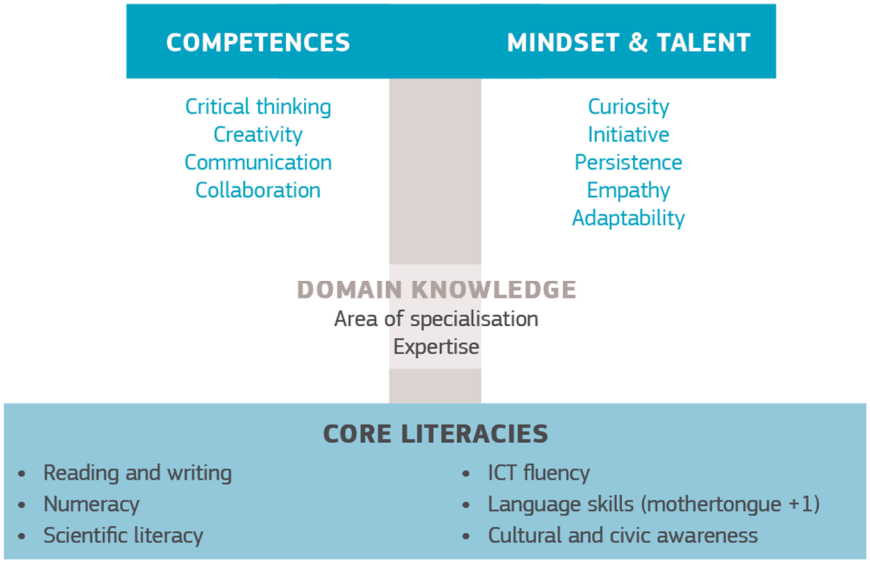
[54] http://eskills4jobs.ec.europa.eu/c/document_library/get_file?uuid=b69ba1d7-6db4-415d-82e4-ac4d700a38b8&groupId=2293353.

[55] For a more detailed description of coding, creativity, cross-disciplinary, managerial and entrepreneurial skills, see https://ec.europa.eu/jrc/en/research-topic/learning-and-skills.

- *leadership and team-working skills*, for example, the 2014 European Schoolnet e-Skills Manifesto introduced the INSEAD skills pyramid, which organises e-skills into literacy and basic skills at the bottom, occupational skills in the middle and global knowledge economy skills at the top. The manifesto also states that not only programming skills but e-leadership skills – that is, the combination of ICT skills and leadership skills – will be in high demand in the future.

The European Political Strategy Centre recently posted a similar analysis of key skills, displayed in Figure 4 below.

Figure 4. Skills and resilience needed in a world of change



Notes: The vertical bar of the T refers to the expert knowledge and experience in a particular area or discipline/field. The top of the T refers to the ability to collaborate with experts in other disciplines and a willingness to use the knowledge gained in areas of expertise other than one's own from this collaboration.

Source: EPSC (2016), based on the T-Skill framework.

All these skills must be developed and constantly updated. On the one hand, the school system must be rethought to accommodate all these skills and competence from the early years of education onwards. And workplace, lifelong learning should embrace this multifaceted skill set to ensure that the European labour force is 'fit for purpose'. Moreover, the acceleration of the pace of technological progress will increasingly require that beyond the work-life

balance, the work-train balance of individuals is also adequately taken care of.[56] Lifelong learning then must be rethought to mirror the need for a constant evolution and update of the skills available in the labour force. Possible policy actors to be involved include schools (including, most importantly, retraining and empowering teachers), government administrations and businesses themselves.

More specifically, important efforts must be made to improve the availability of e-skills; the effectiveness of current policies, including the ones comprised in the Entrepreneurship 2020 Action Plan and the ones managed under the Digital Agenda, could probably be improved through enhanced coordination with existing initiatives, e.g. EIPs, KICs, and research projects funded under Horizon 2020. To be sure, Europe needs a major reflection on the future of jobs, which capitalises on the first steps made with the 'Grand Coalition for digital jobs', now replaced by the 'Digital Jobs and Skills Coalition', which brings together Member States and stakeholders, including social partners, to pledge action and to identify and share best practices, so that they can be more easily replicated and scaled up.[57] Education is a fundamental driver of ICT uptake and competitiveness and must be broadly intended to include a high-quality university system, widespread e-skills and digital literacy among both firms (in particular, SMEs) and citizens.

Needless to say, skills and computer literacy are needed also from a user's perspective, in order to ensure the uptake of new technologies. And these skills are increasingly subject to obsolescence in the ICT sector, as a consequence of shorter product life cycles and rapid innovation rates. A high quality secondary and tertiary education constitutes a fundamental ingredient of the so-called 'knowledge triangle': in fact, when universities produce skilled graduates and high quality basic (ICT) research, and the legal and business environment offers the chance to translate such research into applied research and innovative products, the whole sector can profit from a more dynamic flow of ideas and cross-fertilisation in innovation. In a recent study, Osborne & Frey (2013) showed that as much as 47% of existing jobs are at risk of computerisation in the coming years (see Figure 5 below). A recent report for DG Employment also highlights the challenges that this trend will create for the labour market in

[56] In this spirit, the e-Skills Manifesto 2014 by European Schoolnet argues that the 'educate then work model' is becoming less relevant as the turnover of skills accelerates, markets become more volatile and the linear one-way path from education followed by lifelong work is exchanged for an increasingly two-way interaction between learning and working.

[57] See https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition.

Europe;[58] and researchers from Bruegel have applied the framework created by Osborne and Frey to European data, showing results that are even more worrying, with 54% of jobs on average being at risk of computerisation. Even more recent work by James Bessen (2015) shows that the ongoing technological revolution is more likely to create a skills shortage than a job shortage: a finding that points at the education system as responsible for creating the required skills, with the required speed.

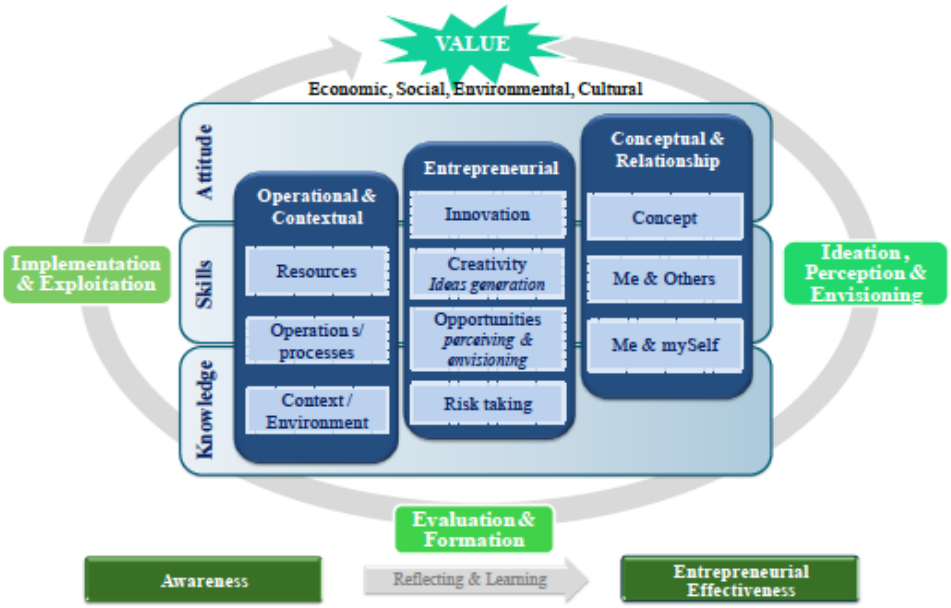
In this respect, it is clear that the challenges that are already perceived today will only become more pressing in the coming years. Evidence from global markets suggests that many industrialised countries do not compete anymore on low salaries, but rather on the availability of reliable authorities, world-class infrastructure and, most important, a highly educated and skilled workforce. This is why relaunching Europe's objectives in higher education is key to Europe's future innovation and employment policies. As shown in recent research performed at the JRC, this may require fundamental changes in the way learning occurs both at school and university and over the course of an individual's life (see, inter alia, Redecker et al., 2011; Kampylis et al., 2015), and this in turn requires a new framework for entrepreneurial competences (Komarkova et al., 2015). Figure 5 below shows the mix of entrepreneurial competence developed by Komarkova et al. (2015).

The private sector is increasingly decisive in the promotion of skills. Large companies have become key players in this field, with various models and approaches emerging. Examples collected by the CEPS Task Force include the following:

- Google provides services (mail, docs, etc.) that enable collaboration. These tools are easily and cheaply available to entrepreneurs, thus reducing time and costs to set up a company. The company also provides instruments and mechanisms for exchanging knowledge. People need to meet each other to transform ideas into business. Google invested in a number of campuses and established 'partnership' spaces (such as "The factory" in Berlin). There, Google engineers interact with start-uppers and potential entrepreneurs. This allows both knowledge increase and transfer. It is also a good occasion to recruit new entrepreneurs. Being in contact with entrepreneurship is important for fostering emulation.
- Google provides capital and invests in innovation through Google Venture. The role of acquisition in innovation systems is crucial. The acquisition provides an exit strategy for entrepreneurs and an opportunity to look at how large companies work, especially when acquisition leaves the management and workers at their place at least for a while.

[58] For a survey of the literature, see http://epthinktank.eu/2015/05/11/tackling-long-term-unemployment-in-the-eu/.

Figure 5. Summary of entrepreneurial competence



Source: Komarkova et al. (2015: Figure 23).

Google also contributes directly to the formation of digital skills. Google trained 700,000 Europeans by the end of 2015 and is on track to reach one million by end of 2016. It is building a Europe-wide training hub to support businesses anywhere in Europe to get training online. Google also launched a project in Spain with 21 universities based on online courses; students can choose the course that is most suitable to them.

- Telefonica fosters innovation via an open innovation scheme where several tools are open to use by partners. All those companies that do not have financing and time to develop these tools can leverage them. In particular, Telefonica deployed a worldwide network with different initiatives and programmes to support talent. Open innovation in large corporations must have KPI and can go beyond corporate social responsibility and generate new business opportunities. Within this context, Telefonica manages: i) programmes to encourage entrepreneurship, e.g. a talent programme to help students reach the labour market; ii) acceleration programme, e.g. business digital accelerator, mainly focused on Latin American countries; iii) investment aimed at helping select business to scale up and go international. Telefonica has been following this open innovation approach for 10 years and invested some €650 million.

- Orange is very active in keeping their workers' competence up to date and retraining them to help them understand new market needs. Orange also needs new talents to move forward. One of the most important needs is to find people skilled in customer experience, because innovation needs to be customer friendly. Start-ups launching new ideas in customer experience are very important players for Orange. Working with digital entrepreneurs hence allows Orange to attract new generations, even when they are not really interested in a job in a large company.
- Amway is still a family-owned company, 50 years from its foundation and even now that the company is worth $11 billion. Amway encourages people to be entrepreneurial. Its associates create micro-business at the pace they want. Individuals can learn skills (Amway also provides training) and use them. In Amway's early days, training was only organic (learning by doing). Nowadays, it provides formal training programmes. Helping and supporting people is not just a 'corporate social responsibility', it can be a business model in itself. Amway supports entrepreneurial skills and activities. A new programme is now aiming at individuals over 50. Amway trains people from every type of background in terms of education and skills, age, gender and employment history.

3.1.3 Recommended actions

- *Strengthen policy efforts to promote a variety of skills, including STEM education and coding skills during early school years throughout the EU-28.*
- *Promote the inclusion of entrepreneurial skills, managerial skills, creativity and the ability to think out of the box as basic skills to be taught during school years and university.*
- *Strengthen public-private cooperation to ensure the exposure of young European citizens to entrepreneurial role models and success stories in order to generate emulation among youngsters.*

3.2 The future job market: Facing the challenge of helping everyone reinvent themselves

3.2.1 Problem

Technological evolution and the economic downturn are creating substantial tensions and persisting unbalances in the European job market, which must be addressed by EU policy-makers. Given increases in productivity and increased computerisation of skills, as much as 80% of jobs that exist today will not exist

10 years from now (according to the OECD); while new ones will be created, the number and nature of the new jobs is very difficult to predict.

3.2.2 *Analysis*

The current interplay between existing labour regulations and current market conditions is unsustainable. ECB Chairman Mario Draghi recently denounced the fact that Europe's economies are rigged to protect older workers at the cost of new employees and that "the side-effect is that young people are stuck with lower-paid, temporary contracts and get fired first in crisis times. That also means that employers are reluctant to invest in young people, so the incomes of this generation stay lower over their lifetime." What is even more worrying is that structural conditions are poised to make this situation worse as markets continue to evolve (especially towards the internet of things, artificial intelligence and Industry 4.0). EU institutions should face this challenge through smart and adaptive policy-making, such as:

- *More flexible labour markets are to be welcomed, but flexicurity is a composite word*: without security, flexibility can only result in lower levels of protection, which mostly work to the detriment of younger workers.
- *The effects of unemployment are widespread and* include possible repercussions on consumption and levels of demand, which in turn reverberates on the conditions for innovation to spread through the market, and on social cohesion. The situation for young people is made worse by the current deflationary spiral in Europe.
- *Due to technological evolution, in the future a reduction in working hours and a relative increase in average hourly salaries might be required*, to reflect the increase in productivity and the need to ensure that the entire population has a chance to be employed. This, in turn, means that labour policy should be fine-tuned to facilitate employment, avoiding deterrent effects created by overly cumbersome tax wedges on labour income.
- *Employability requires an update in the competence and skills available to young and older individuals* who actually or potentially belong to the work force (see above).
- *The acceleration in technological evolution will soon require a different 'work-train-life' balance*, with employees not only in need of protection for the balance between personal life and working hours, but also between working and retraining, which in many sectors is likely to become a growing need.

3.2.3 Recommended actions

- *Launch a systematic reflection on the security and flexibility needs of the future European job market, with specific focus on employability, self-employment features and work-train-life balance needs in the coming years.*

3.3 The age of openness and people: From citizen science to the attraction of talent

3.3.1 Problem

As science and innovation models become gradually more open and distributed, access to large swaths of data and the proactive involvement of citizens in science, innovation and public policy becomes essential. But public policy at the EU level seems hardly equipped for this transition, considering the widening identification of citizens with European institutions and an 'ever closer Union' project. The level of openness of the EU is limited also when it comes to attracting talents from other countries: most EU member states appear hostile to foreign researchers.[59]

3.3.2 Analysis

Openness is an emerging paradigm in all aspects of research, innovation and policy. In the United States, the Obama administration has invested heavily in promoting access to government-funded research, in ensuring the release of data possessed by public administrations, and in opening up government to more bilateral, proactive and constant cooperation with citizens and civil society. In the private sector, open innovation has become a dominant paradigm, even more as the ICT sector permeates many other industries. While new technologies increasingly gain diffusion with the help of open patent strategies, e.g. Tesla, Toyota and NASA, in cloud computing and big data analytics open source software and entire 'stacks' of open hardware and software are coming to dominate the scene, lowering entry barriers in an unprecedented way. The European Commission has recently adopted a new "open science, open innovation, open to the world" strategy capturing the vision of Commissioner Moedas. It is important that this strategy be reinforced to include the release of

[59] Difficulties in attracting talent, especially from outside the EU, also affects EU companies as confirmed by Kumardev Chatterjee (European Young Innovators Forum), Nicholas Davis (World Economic Forum) and Lenard Koschwitz (Allied for Startups) during meetings of the CEPS Task Force.

data in the possession of public administrations, and the creation of channels for communication and cooperation with stakeholders and citizens.

The role of people, again, is essential for research and innovation not only in performing different functions but also to build up the synapsis beyond 'institutional cooperation'. *Citizen science can lead to very important discoveries at very low cost for government, and can foster social innovation. But the regulatory framework has to be compatible with this trend*: currently, lack of legal certainty on key activities such as text and data mining (in copyright law), scope and breadth of the unitary patent, a rigid framework for data protection (the new GDPR) and conditions for open access to government-held data create limits to the possibility for Europe to harness the potential of citizens as an engine of innovation and development.

As already mentioned above, *suitable infrastructure and adequate literacy and numeracy skills can further empower citizens as drivers of growth.* This calls for even more urgent actions on these two fundamental dimensions. But skills and talent are not only found in Europe; attracting talent from abroad can prove essential to restoring Europe's growth path, and *too little is being done in most member states to open up the doors of academia and industry to non-nationals.*

3.3.3 Recommended actions

- *Promote open access to government-funded research and government-held data to boost data-driven innovation in Europe*
- *Foster legal certainty for data-driven innovation and more generally for text and data mining activities, especially with respect to EU copyright and data protection laws.*
- *Strengthen citizen science in Europe by creating adequate platforms and calling on EU-funded research projects to involve citizens and adopt bottom-up approaches where possible.*
- *Promote openness to foreign talent in all member states.*

3.4 'Permissionless' innovation and smart policy: Making room for entrepreneurs

3.4.1 Problem

Europe, on average, displays relatively low levels of entrepreneurship. Creating an environment that is conducive to entrepreneurship is a complex, multifaceted endeavour, which involves all actors of the innovation ecosystem and policy stakeholders. Increasingly, the legal system is recognised as a key driver of a

risk-oriented culture, which lies at the basis of entrepreneurship. Europe also needs entrepreneurial policy-makers, as the fundamental role of the public sector is to realise things that individuals alone cannot make happen.

3.4.2 Analysis

Legal rules shape the context in which entrepreneurs test their ideas, and their willingness to take risks to realise them also contributes to showcasing a culture. Too often, the legal system acts as an obstacle rather than a facilitator and driver of entrepreneurship.

- *Bankruptcy laws* often do not give a second chance to an entrepreneur, and this is a serious problem since failure is an inherent element of entrepreneurial activity.
- *Several sector-specific laws contain an inherent bias in favour of incumbents*. This can happen in many ways, e.g. when the law establishes strict entry conditions, or is implicitly tailored towards a given business model or a given pattern of service provision. In other cases, laws require that new entrants – often small companies – meet very stringent requirements in order to start operating, which discourages entry. And finally, some laws simply leave almost no room for experimentation with new business models, often due to their extremely prescriptive nature.
- *Many laws and expenditure programmes at the EU and national levels impose unnecessary red tape*. Many practitioners and entrepreneurs addressed the CEPS Task Force to advocate a simplification and consolidation of the 'access points' to EU funding, especially since most applicants are micro-firms of individual entrepreneurs.
- *At the same time, often legislation does not encourage scale-up by differentiating the treatment of small versus larger firms, nor new versus established firms, this being even more worrying as new entrants are responsible for a significant share of breakthrough innovations*. Firms that want to grow by hiring more employees and expanding activities could be discouraged by the prospect of a changing legislative framework and being subject to more stringent requirements.
- *Increasingly, policy-makers in some countries are discovering the value of legal systems and business models that allow for 'permissionless innovation'*: this is still not the case at the EU level, and it would be essential both to creating entrepreneurs and in related fields such as financial intermediation (see below). One good example is the 'regulatory sandbox' initiative of the UK Financial Conduct Authority and the recent 'innovation deals' launched by the European Commission modelled on the Dutch experience with green innovation deals.

3.4.3 Recommended actions

- *Develop guidance on regulatory flexibility to make regulation more conducive to innovation, implementing where appropriate the concept of permissionless innovation.*
- *Eliminate useless and redundant red tape, by distinguishing it from regulatory costs that generate benefits and help achieve policy goals.*
- *Create one-stop-shops for entrepreneurs by consolidating contact points for access to EU and national funds and streamlining rules for financial and non-financial support.*
- *Avoid creating perverse incentives with legislation, e.g. by creating rules that discourage scale-up.*

3.5 Intra-preneurs: Unleashing innovation in large companies and public administrations

3.5.1 Problem

Public administrations and large companies are, of course, composed of people. The importance of promoting a more entrepreneurial and creative attitude in both settings is often overlooked in the debate on EU policy. This should change.[60]

3.5.2 Analysis

Both large companies and the public sector are important players in the innovation ecosystem. Their coexistence and cooperation with entrepreneurs, smaller companies and educational institutions is key to creating a vibrant setting for innovation. However, very often mainstreaming a more innovation-oriented attitude inside these entities can be difficult, as they lack the agility and the risk-taking attitude that is needed to support, favour and nurture new ideas. Problems identified in the literature range from path dependency and structural difficulties in changing business model, e.g. due to specialised competence, to behavioural biases such as the familiarity trap, the maturity trap and the propinquity trap (Deloitte, 2015).

In a setting in which large companies play a major role in driving and orchestrating innovation, as occurs in the EU-28, ensuring that intra-

[60] During the kick-off meeting of the CEPS Task Force, Professor Martin Fransman argued that creating a culture of innovation within large organisations is crucial to spurring innovation.

preneurship is adequately promoted is essential. Public policy, however, can only encourage the private sector to do so through constant dialogue and initiatives that favour competition and the constant disequilibrium that characterises competitive, dynamic markets. On the contrary, public sector innovation is an open wound in many member states, where the relatively low quality and scant dynamism of public administrations can put sand in the engine of innovation. After all, as already observed in the introduction to this report, the public sector plays a decisive role in steering and coordinating innovation efforts; having innovation-hostile civil servants may fatally undermine this role if the system rewards those avoiding mistakes rather than those trying something unconventional.

Policies to promote public sector innovation and creativity include initiatives to mainstream innovation at all levels of government, use of innovation prizes and awards for civil servants and other incentives, reliance on academics and entrepreneurs as mentors of civil servants, e.g. entrepreneurs in residence, increasingly frequent in leading city halls in the US, such as in Los Angeles and New York), and the creation of innovation labs inside public administration, e.g. the 2015 US Innovation Strategy). Emphasis on citizen science and open innovation platforms is also conducive to a more outward-oriented, creative public administration. Finally, institutional design of smart innovation agencies can be an important factor in modernising the relationship between the public and private sectors and fostering a thriving innovation ecosystem.

3.5.3 Recommended actions

- *Design policies to promote public sector innovation at all levels of government, including innovation prizes and awards.*
- *Promote and foster smart institutional design in innovation agencies and other relevant institutions.*
- *Consider the creation of 'entrepreneurs in residence' and other fellowship and mentoring programmes to promote entrepreneurial thinking in institutions.*

3.6 Leading by example: Europe needs new role models and success stories

3.6.1 Problem

Lack of entrepreneurship in Europe can lead to fewer future would-be entrepreneurs. Attempts to highlight success stories in Europe and beyond are being made, but they should be strengthened, also at the local level, in order to create the right conditions for entrepreneurship ecosystems to flourish. Women should receive special attention, as the lack of role models is particularly serious for them.

3.6.2 Analysis

Emulation and inspiration are key factors in entrepreneurship. Scholars such as Daniel Isenberg have shed light on the need for a collective mindset oriented towards entrepreneurship, and the role that role models and success stories can play in this respect. The European Commission has started to work in this area relatively recently, with Commissioner Kroes and with the Startup Europe programme. New associations of start-ups and young entrepreneurs, coupled with gatherings such as the Startup Weekend, are bringing success stories closer to would-be entrepreneurs, enabling forms of mentoring and advice by those who have succeeded for those who still strive. Often institutions are absent from these privately organised meetings, and this should change: entrepreneurs and innovation are an EU concern and should be for public stakeholders as well; it is thus essential that entrepreneurs do not see EU and national institutions as far from their core interests. The more public administrations are populated by creative thinkers and dynamic intra-preneurs, the easier making such contact will be, and the easier it will be for public policy to steer innovation towards societal needs.

Role models and success stories are particularly needed for women, who represent the majority of Europeans but less than a third of the entrepreneurs. Fewer female entrepreneurs means fewer success stories, and this in turn can lead to even fewer female entrepreneurs in the future. European Commission efforts should be stepped up to promote entrepreneurship among women, as female creativity and entrepreneurial potential are an under-exploited source of economic growth and jobs that should be further developed. Similarly, public and policy entrepreneurs could be publicly acknowledged through prizes and awards.

Again, the promotion of role models and the creation of an overall favourable environment for entrepreneurship aspirations can only be achieved with the help of the private sector, from start-uppers to unicorns and established

companies wishing to promote entrepreneurship skills in their smaller contractors and service providers. It requires also the participation of secondary school and university students in gatherings of entrepreneurs. All this should be done at the local level: scholars and academics suggest that entrepreneurship ecosystems are essentially local phenomena, and should be treated as such in EU multi-level governance.

3.6.3 Recommended actions

- *Promote successful role models and success stories more widely, in particular among students and women.*
- *Promote, at the local level, the participation of secondary school and university students in gatherings of entrepreneurs and start-ups.*

4. PLACES: COLLABORATION SPACES AND PLATFORMS AS DRIVERS OF INNOVATION AND ENTREPRENEURSHIP

4.1 Coupling pan-European innovation ecosystems with regional entrepreneurial ecosystems

4.1.1 Problem

Two perhaps central structural problems that European Innovation Policy has to address are the fragmented policy landscape on the one hand and the substantial innovation gap with other world leaders (the US in particular) on the other. The scholarly literature shows that these problems are largely explained, respectively, by the absence of enabling ecosystems and the few innovative world-leading firms rooted in the Old Continent. In addition, regional policies for innovation and entrepreneurship have found unprecedented common ground under diverse and growing pressures to deliver competitive advantage (Vanthillo & Verhetsel, 2012).

In European policy this is clearly reflected in the current cohesion policy. For the programming period 2014-20, structural funds of approximately €100 billion have been earmarked for research and innovation and largely coordinated through 'smart specialisation strategies' and cluster collaboration. Innovation and entrepreneurship policies are increasingly considering regional aspects and physical proximity for radical breakthrough innovations, for instance initiatives such as the Regional Innovation Scheme (RIS) put in place by the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT), ERA Chairs, COSME, etc. However, further focus and coordination is needed to avoid overlaps and maximise the potential of innovation-driven entrepreneurship. Also, cities and their districts have not been addressed sufficiently as potential hubs.

4.1.2 Analysis

Stakeholder networks or physically anchored clusters can be directed to accelerate innovation through interconnected hubs working closer together, not

necessarily locally. Moore (1993) applied the notion of 'ecosystems' to complex configurations of agents, making an analogy between the business ecosystems[61] and the biological ecosystems observed in nature.[62] Both biological and business ecosystems involve interactions between diverse agents and their evolving roles over the succession of analogous stages of emergence, expansion and maturity. Such a system can also be characterised as complex and adaptive to their broader environmental conditions (Richter et al., 2014). Ács et al. (2014) consider that the "National System of Entrepreneurship is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures."

Elsewhere, Russell et al. (2011) define the concept of innovation ecosystem to entail: "the inter-organisational, political economic, environmental and technological systems of innovation through which a milieu conducive to business growth is catalysed, sustained and supported. An innovation ecosystem is a network of relationships through which information and talent flow through systems of sustained value co-creation." To build the bridge between these two streams (the one on entrepreneurship and the other on innovation), we define the entrepreneurial innovation ecosystem as "the dynamic, inter-organisational, political, economic, environmental and technological milieu of interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives knowledge and value creation towards the allocation of resources through the creation and operation of new ventures."

Herein, we define a pan-European entrepreneurial innovation ecosystem as one that connects local ecosystems across Europe (see also Pombo-Juárez et al., 2016). How can entrepreneurship be nourished, beyond education and legal reform? While the literature on innovation systems and later ecosystems has emerged over the last four decades, the literature on entrepreneurship ecosystems (verbatim, in the definition given by Isenberg) is younger. The former literature is chiefly based on the quadruple helix and how to nurture each link and interaction within that context; the latter is not entirely different, especially when it comes to choosing the geographic location to create such an ecosystem, based on the availability of specific actors such as universities,

[61] Further to business ecosystems (Moore, 1993), this relates to efforts in conceptualising innovation (Russell et al., 2011) and entrepreneurial ecosystems (Ács et al., 2014; Mason & Brown, 2014).

[62] The biological ecosystem 'community' emerges with relatively few pioneering plants and animals and expands through increasing complexity until it becomes stable or self-perpetuating as a mature community. The 'engine' of succession, the cause of ecosystem change, is the impact of established species upon their own environments (Odum, 1969).

infrastructure, and a good installed base of knowledge and industry: however, it appears to be more local, more operationally defined, and linked to specific social interactions, e.g. emulation, creation of a positive mindset towards entrepreneurship.

Taking stock of recent discussion on innovation and entrepreneurship, we can consider a number of aspects that should be streamlined for actionable policy:

Clusters and smart specialisation: At the crossroads of innovation studies, regional development and strategic management literature, since the seminal work of M. Porter in the 1990s, cluster theory has guided regional innovation and economic policies with a focus on developing regions as part of industrial value chains.

Michael Porter's clusters theory focused on frequently observed concentrations of interconnected organisations including suppliers, service providers, universities, trade associations and so forth whereby "proximity leads to shared advantages through the aggregation of expertise and specialized resources" (McDonald et al., 2007) and thus explains the structure of certain industrial concentrations around the world.

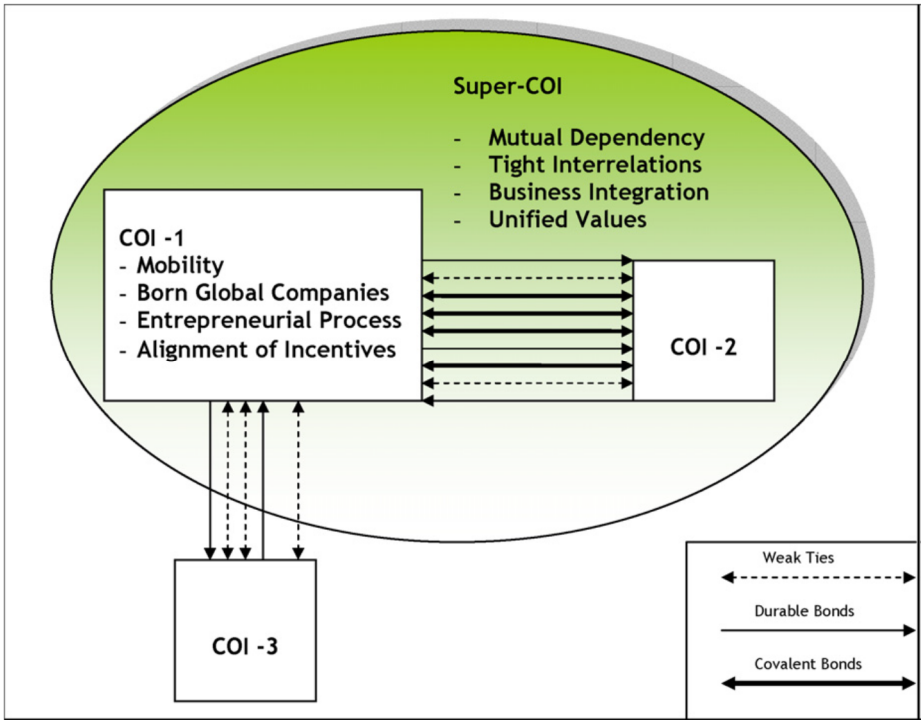
In the 'clusters of innovation' (COI) coined by Engel & del-Palacio (2009) and diagrammed in Figure 6, "[O]ther agglomeration benefits dominate, defined not by industry specialisation, but by the stage of development and innovation" to explain "why new and apparently unrelated industries have emerged in specialized clusters, already existing…as well as how new technology clusters…have emerged so rapidly and robustly in indigenous environments, attracting large concentrations of venture capital…accelerated through interactions with other clusters".

More recently has emerged the concept of smart specialisation (Foray & Goenega, 2013), which departs from central planning and considers measures building on local resources, competence and entrepreneurship to address international opportunities in order to develop regions. In particular, the widespread adoption of 'regional smart specialisation strategies' (RIS3) makes it possible to explore synergies between regional and innovation policies. European regions have specific assets that are required to deploy public-private partnerships to catalyse talent and creativity. Regions' interest is reasonable as entrepreneurship is a 'contact sport' which requires suitable spaces combining both knowledge and appetite for innovation into learning by doing.

Quite clearly, a new geography of innovation and entrepreneurship is emerging where regional ecosystems play an increasingly important and visible role. This is so as co-location enables both the formal and informal meeting of talent and knowledge in places where people want to live and which can be

reached easily (see East Berlin, East London Tech City or Boston Innovation Districts). This is consistent with the fact that within complex systems, to capture not just direct but also indirect outcomes, it is best to focus on processes.

Figure 6. COI (clusters of innovation), NCOI (network of COI), super COI, and the linkages among COI



Source: Engel & del-Palacio (2009).

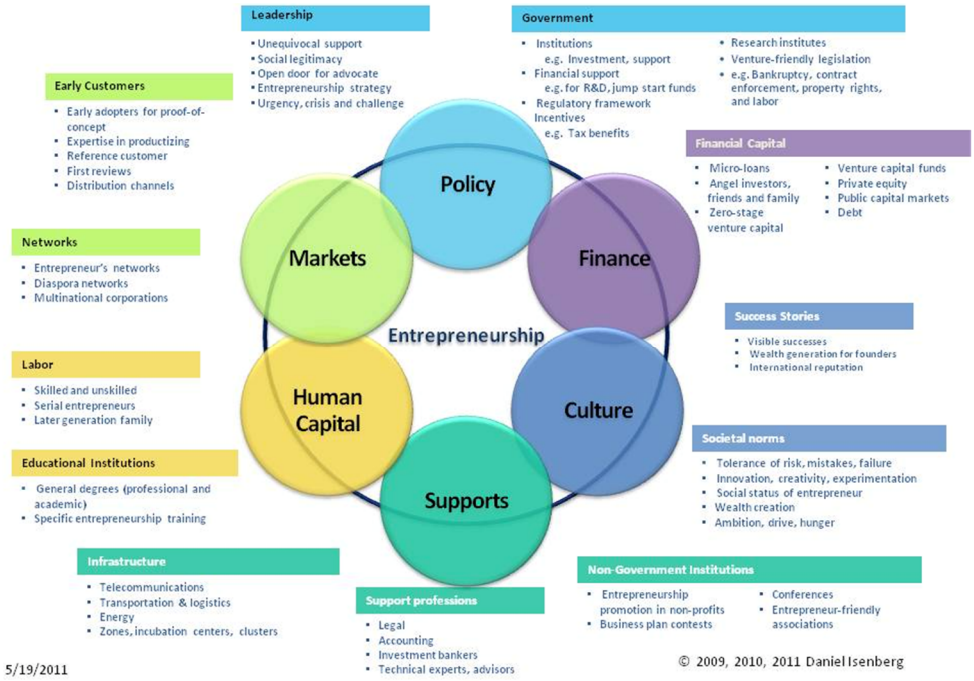
4.1.3 Innovation systems vs. entrepreneurship ecosystems

Although entrepreneurship and related topics have gained the attention of academics since the early contributions of Joseph Schumpeter, the measurement of entrepreneurship and the analysis of systemic conditions that favour entrepreneurship have been subject to significant efforts only recently. As remarked by Bogdanowicz (2015), significant efforts were made in particular by OECD and EUROSTAT (Entrepreneurship Indicators Programme, EIP) to lead to a consensual definition of entrepreneurship, a structured perspective on the determinants of entrepreneurship and on its economic and social impacts. Likewise, there is now a large body of surveys, analysis and research on data included in the Global Entrepreneurship Monitor (GEM) and the Global Entrepreneurship Index (GEDI), but current measurement efforts still fall short

of adequately capturing systemic factors such as the impact of entrepreneurship on innovation, and the role of 'intra-preneurship'.

Some of these systemic aspects are currently being factored into a nascent literature on entrepreneurship ecosystems, which is linked to the innovation systems literature by a peculiarity: the focus specifically and explicitly on the systemic factors that foster entrepreneurship.[63] In the literature, a variety of definitions of entrepreneurial ecosystems can be found. Isenberg (2010) defines them as a set of individual elements – such as leadership, culture, capital markets, and open-minded customers – that combine in a complex way to stimulate entrepreneurship. According to Isenberg (2010, 2011), the key to sustainable entrepreneurship lies in the specific combinations of the elements of an entrepreneurial ecosystem, as diagrammed in Figure 7.

Figure 7. Isenberg's entrepreneurship ecosystem



Source: Isenberg (2011).

[63] Models of entrepreneurial ecosystems have focused so far on "Entrepreneurial Personality" (Valdez, 1988), the "Entrepreneurial process" (Gnyawali & Fogel, 1994), and "Elements" and "Evolution" (Neck et al., 2004).

According to Isenberg, an entrepreneurship ecosystem consists of six domains which in turn comprise further elements: 1) politics, including leadership and government, 2) finances, 3) culture, including entrepreneurial success stories and social norms, 4) infrastructural, professional and non-public support, 5) human capital, including education and personnel and 6) markets, consisting of networks and early customers. For a healthy entrepreneurial ecosystem each of the six domains should be available in the region and be entrepreneurship-friendly. However, there is no easy path towards a sustainable, fully functional entrepreneurial ecosystem that is at the same time innovative. The creation of an entrepreneurship-friendly environment will be extremely difficult in particular if there is no explicit political support of and no high social and/or political priority on entrepreneurship.

At the crossroads of managerial business ecosystems and policy-driven innovation systems literature, and consequently in both private and public spheres, we can find diverse forms of initiatives around the globe that build ecosystems for incubating and accelerating start-ups and scale-ups. It is especially this locus of ecosystems that has fuelled the great increase in theorising and experimentation on the best possible conditions for radical and disruptive innovation and high-growth entrepreneurship. Entrepreneurial ecosystems emphasise 'shared values', mobilising resources and collective attitudes, and being driven by people and co-creative spaces in particular (Engel & del-Palacio, 2009).

In a broad sense, an entrepreneurial ecosystem refers to the actors and the environment affecting the rise and diffusion of entrepreneurship at the 'glocal' level. It encompasses a group of firms, including start□ups, individual and institutional investors, e.g. venture capitalists, banks, business angels, informal individual investors, universities and other knowledge creating institutions, and one or more coordinating entities, such as firm incubators or accelerators and local policy agencies. While these actors derive substantial benefits, in terms of scale economies as well as entrepreneurial flexibility, from being embedded in an efficient ecosystem and so share broadly similar general goals associated to its development, their specific interests may well diverge. For instance, entrepreneurs and individual investors may have intrinsic motivations and private benefits which are not shared by other actors, while local development often is the primary objective of local policy-making bodies. This divergence of objectives renders governance issues crucial.

The rise of new start-ups and start-up ecosystems around the world has recently reached its highest level to date. For instance, the 2012 Startup Ecosystem Report argues that countries and cities are shifting from service□ based economies to being driven by a new generation of lightning-fast software and technology□rooted business organisations. Thereby it is becoming widely

recognised that entrepreneurial ecosystems are inherent drivers of innovation and new business energy and power. Successful entrepreneurial ecosystems usually foster the long□term view, process□structure recombination across boundaries, and entrepreneurial dynamics to shore up communities of entrepreneurs and investors who share the aspiration to cultivate each other's talent, creativity and network support. Therefore, effective governance of the relations between the different agents involved in entrepreneurial ecosystems clearly has practical relevance for fostering long□term growth.

4.2 Intervention logic

Europe has a long standing deficit in technological intensity of business compared with that of the US, which some authors point to as one of the key explanatory factors of the EU 'innovation gap'. Creating the conditions for the Old Continent to successfully create companies in sectors of mid- and high-tech is crucial to ensuring their sustainable, long-term competitiveness. Likewise, Europe generates on average more spin-offs than the US does, but it is necessary to identify and overcome barriers to growth.

Both companies and universities are evolving in their strategies to make innovation happen. On the business side, from procuring technology to collaborating, firms are increasingly exploring new modes through corporate entrepreneurship, using venture capital funds and acceleration schemes beyond more established models of intra-preneurship (idea competitions, alliances, etc.). Similarly, universities are evolving in their third mission, well beyond traditional TTOs including professional branches (IP group, etc.) and venture funds.

We need to define open and distributed models of innovation, link it to the "open science, open innovation, open to the world" motto currently used by Commissioner Moedas, encompassing a 'holistic' view of innovation policy (Edquist, 2015) by 'walking the talk', i.e. emphasise not only the theory but also the practice of 'policies for innovation' across the board (Pilat, Contribution to CEPS Taskforce, 2015) and contrast it with the emerging pragmatism of the EFSI, and much more.

Depending on the case, entrepreneurs can find their way into one or more of these communities. It is very difficult to predict which initiatives will succeed: as in biological ecosystems, while the strength of the ecosystem or a given species might be measured, it is more difficult to foresee the success at the level of individuals – life evolves within the system's conditions, in the form allowed by it, and with a degree of selection and randomness. Still, it may be possible to identify and foster measures that develop the vibrant ecosystems in various dimensions such as culture, talent, knowledge creation and diffusion, finance, governance and market access.

4.2.1 Towards the governance of entrepreneurial innovation ecosystems

In the last four decades governance has become a prominent issue for scholars in management, economics and finance. However, ecosystems, and notably the interaction between the different agents that operate within them, have peculiarities that have received much less attention by scholars interested in governance issues. It is an open question whether and to what extent the consolidated body of knowledge relating to both internal governance mechanisms, e.g. the board of directors, and external governance mechanisms that discipline managerial behaviour, e.g. the market for corporate control, in large established firms can offer useful insights into the governance of ecosystems, or whether and to what extent we need new models and theoretical frameworks. While an audible plea for more integration between entrepreneurship in ecosystems and governance issues exists in business practice, we have neither consolidated a body of enquiry nor developed one or more encompassing interpretative frameworks that coherently address the theme of entrepreneurial ecosystems governance. In particular, the dual role of governance mechanisms as monitoring and resource-competence enhancing mechanisms deserves a closer examination.

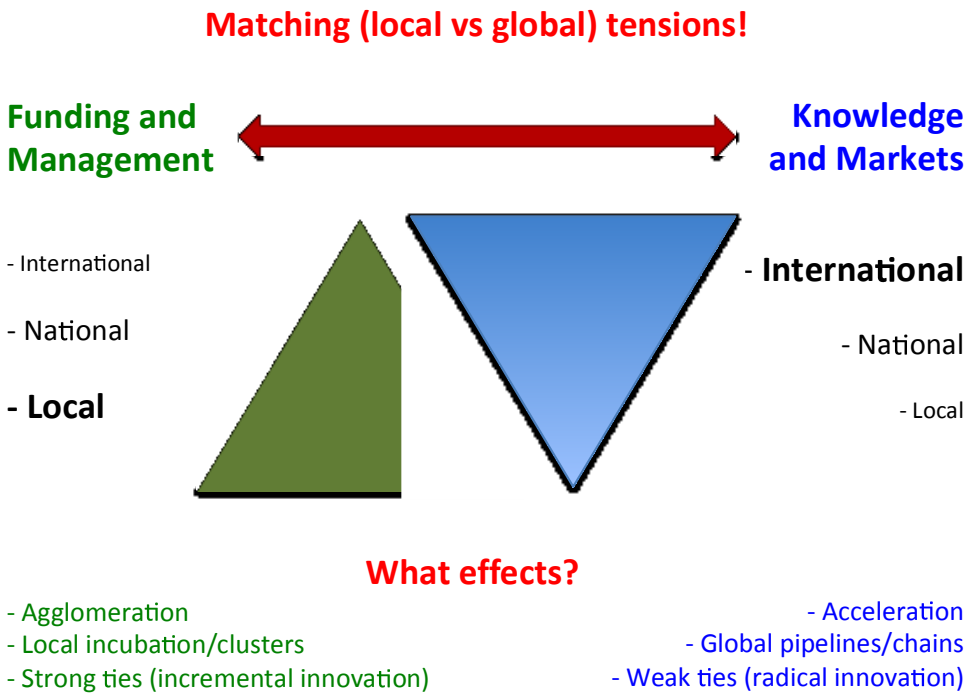
OECD (Pilat, contribution to CEPS Taskforce, 2015) finds evidence that the creation of new businesses on the one hand and the creation of 'favourable conditions' on the other is not enough to secure growth. The literature stresses the importance of relational structures, agents, ecosystems and agencies able to experience and learn in the field but with global ambitions.

To date, no one has found the formula to generate a vibrant ecosystem. Rather, most of the success stories are presented as a 'still picture', as an ideal location: Silicon Valley, Singapore, Israel, etc. The literature is silent on the time dimension, however. But a recipe doesn't just list ingredients, it indicates proportion and order: tacit knowledge in its purest form. We have some clues. One is that talent is key to a vibrant ecosystem. And all success stories incorporate an international dimension from the start.

The fundamental question remains regarding the best possible architectural model for reconciling local versus global dynamics, partnership composition and level of integration. Regarding local versus global knowledge dynamics, we know that 'strong ties' in geographically close environments are key but might be principally responsible for incremental innovations, while 'weak ties' made possible through global pipelines may bring about more radical innovations. The results also highlight that the roots of the latter, namely, that greater innovative capacity lies in the combination of firm, inter alia, size, share of foreign ownership and sector) and culture, e.g. the level of open-

mindedness of managers e.g. However, the trade-off and balance between local roots and global ambitions remains a matter for governance and management.

Figure 8. Tensions between local and global dimension for innovation and competition



Source: Leceta et al., forthcoming.

But what are the consequences for EU R&I and entrepreneurial policies?

- First, there is a need for consolidation of the various communities and spaces offered by the EU: KICs, EIPs, EPs, JTIs, etc. They simply multiply transaction costs and reduce opportunities for entrepreneurs. Here we could bring in EIC developments and pooling of national funds (EUREKA, JPIs, ERA-NETs, etc.).
- Second, there is a need to ensure that publicly funded research communities (i) represent all aspects of basic and applied research, innovation, etc., (ii) include stakeholders from various fields (not only one industry sector), and (iii) become the main source of information for the drafting of innovation agendas and technological roadmaps which can later inform innovation policy for sustainable development.

- Outside innovation policy, there seems to be little need for intervention on private platforms, which seem to be developing in a way that stimulates open innovation in the long run. That said, platforms could become very important allies of government in enforcing rules and promoting entrepreneurship in a variety of fields.
- Changing the current culture in research from a 'publish or perish' ethos to open science and data sharing can be promoted through awareness raising, training and education, incentives and reward systems and monitoring. Open science also requires improvements in data quality and management, appropriate infrastructures and funding considerations and awareness of legal issues covering intellectual and industrial property rights and security issues (ERAC, 2016).

Consistent with the innovation policy challenges for the 21st century in general and for Europe in particular, a paradigm shift is needed: the EU needs to move away from the current emphasis of EU-level interventions principally through transnational collaborative projects (in R&D) and toward fostering pan-European entrepreneurial (innovation) ecosystems whereby the European 'added value' in knowledge-based partnerships and interventions would be more about connecting diverse and disruptive talent rather than plurinational and balanced consortia. The long-standing need to reduce the fragmentation of the European R&D landscape in order to narrow the innovation gap may find a new policy discourse with co-creation spaces and people-driven innovation. Moreover, regions, cities and/or their districts should be acknowledged as the natural bedrocks of innovation-driven entrepreneurship policies targeting scale-ups in particular.

Such developments would require regional coordination and acceleration across European borders and beyond, engaging not only innovators and entrepreneurs, but also the wider set of leaders from different ecosystem sectors for training, alignment and planning. At the European level, analysing support measures and initiatives could provide improved understanding of their intersections and potential synergies and complementarities but also of possible blind spots and new rationales for global approaches of potential scale-ups. This would allow further connections with other European initiatives aimed at creating – in addition to talented and willing individuals – a successful innovation and entrepreneurship ecosystem.

4.2.2 Recommended actions

- *Foster pan-European innovation ecosystems that connect diverse and disruptive talent across Europe, and stimulate local entrepreneurship ecosystems in regional policy.*

- *Reformulate smart specialisation strategies to encompass coordination and acceleration across European borders and beyond.*
- *Improve coordination of the various EU-level funding mechanisms to ensure greater focus on innovation and entrepreneurship.*

4.3 Enabling knowledge flows, open science and data-driven innovation

4.3.1 Problem

The widespread 'publish or perish' ethos in research requires urgent change, by acknowledging the contribution academia can make to Europe's long-term and sustainable prosperity and well-being. In addition, access to government data is often limited to specialised entities managing the data, mainly due to privacy concerns. Yet public data has huge potential for data-driven innovation.

4.3.2 Analysis

Open science is a global phenomenon and many countries outside Europe, such as Japan, research funders, such as the United States National Institutes of Health, and private foundations, such as the Bill and Melinda Gates Foundation, are also developing open science initiatives. In 2015 the European Commission drafted policy actions to support the development of open science in Europe, and Japan was clearly influenced by European developments. The United States has in turn been developing open data policies at institutional levels since 2003.

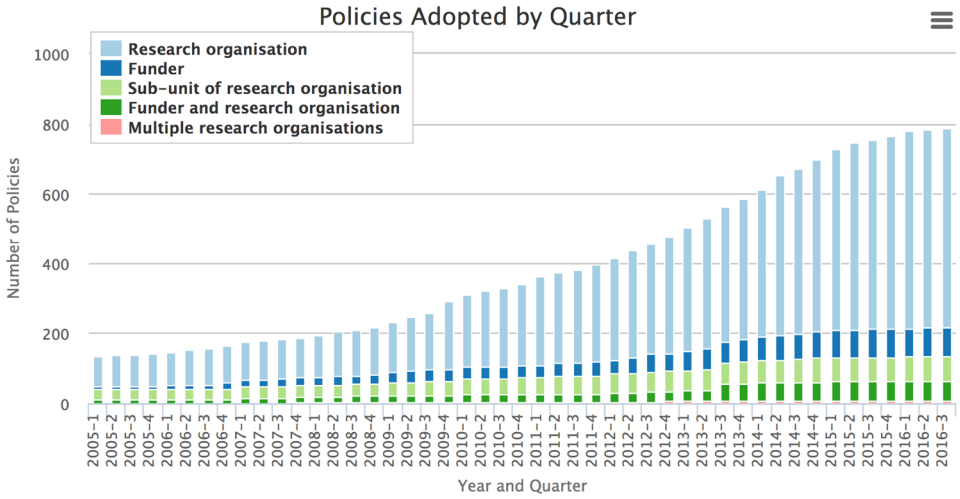
In general terms, the discussion on broadening the science base and on novel ways to produce and spread knowledge gradually evolved from two global trends: open access and open source. The former refers to online, peer-reviewed scholarly outputs, which are free to be read, with limited or no copyright and licensing restrictions, while open source refers to software co-created without any proprietary restriction on its accessed and use (European Commission, 2016b).

Open science is shifting from the standard practices of publishing research results in scientific publications towards sharing and using all available knowledge at an earlier stage in the research process. Open science is to science what Web 2.0 was to economics: allowing end users to be producers of ideas, relations and services and in doing so enabling new practices and relationships and leading to a new modus operandi for science. For instance, during the Human Genome Project, which began in 1990, data was widely shared among the scientific community involved in the project while at the same time a moratorium on proprietary publishing was maintained in order to encourage

optimal collaboration. Because of this openness, the human genome was sequenced in less than 15 years.

The Registry of Open Access Repository Mandates and Policies (ROARMAP) charts the growth of open access mandates and policies globally. There has been a steady increase between 2005 and 2016 in the number of registered policies adopted by universities, research institutions and research funders that require or request researchers to provide open access to their peer-reviewed research articles by depositing them in an open access repository (see Figure 9).

Figure 9. Number of registered policies globally that require open access



Source: ROARMAP.

Academia needs new performance measures that drive research development. Apart from the impact factor, Web-based metrics for measuring research output, popularised as "altmetrics" since 2010, have recently received a lot of attention: some measure the impact at article level, others make it possible to assess the many outcomes of research besides articles (data, presentations, blog posts, collaborative research and mentions in social media, etc.). Researchers engaging in open science increasingly expect their work, including intermediate products such as research data, to be better rewarded or taken into account in their career development. Vice versa, the use of open data will require appropriate codes of conduct requiring, for example, the proper acknowledgment of the original creator of the data (European Commission, 2016b). Open science and data sharing can be promoted through awareness raising, training and education, incentives and reward systems and monitoring at different institutional levels. Open science also requires improvements in data

quality and management, appropriate infrastructures and funding considerations, and awareness of legal issues covering intellectual and industrial property rights and security issues (ERAC, 2016).

Box 1. Entrepreneurial universities

As explained by Alberto Tejero Lopez (CAIT, Technical University of Madrid) to the CEPS Task Force, in 'traditional universities', innovation is only a byproduct of teaching and research. This approach may impinge on the entire innovation ecosystem, as there is no fertile ground for start-ups and innovation. In 'entrepreneurial universities', innovation becomes a target. Spin-offs and start-ups as well as IP are objectives rather than byproducts. In this context, professors are incentivised to work on applied research and students can be involved in projects and generate new ideas.

A remarkable example of a 'entrepreneurial university' is the Lappeenranta University of Technology in Finland, which relies on the Traiblazer strategy to "train the next generation of entrepreneurial problem solvers". More specifically, this strategy addresses three main global challenges (clean energy, clean water and sustainable entrepreneurship) with a specific action plan aiming, inter alia, to: i) increase the number of research-based spin-offs; ii) embed entrepreneurial learning in all degree programmes; iii) launch a minor in entrepreneurship for all students; iv) support extracurricular activities and involve students; v) increase cooperation with businesses; vi) encourage student and staff mobility to enterprises; vii) fund entrepreneurship activities; viii) reward staff for entrepreneurial activities; and ix) encourage staff entrepreneurship. The entrepreneurial and innovative potential of the Lappeenranta University of Technology is constantly monitored through the "HEInnovative" tool created by the European Commission in cooperation with the OECD.[64]

Open science, however, does not mean "free science". It is essential to ensure that intellectual property is protected before making knowledge publicly available. This will safeguard subsequent attraction of investment that can help translate research results into innovation. Furthermore, in order for the benefits that could be derived from new text and data mining tools, techniques and technologies to be fully developed for better science, the legal uncertainties across different fields of law, in particular copyright and database rights, need to be addressed (European Commission, 2016b).

[64] The European Commission and the OECD have joined forces to support higher education institutions with the creation of the self-assessment tool HEInnovate, which facilitates the assessment of an HEI in a systematic way, opening up discussion and debate on the entrepreneurial and innovative nature of higher education institutions (for further details see https://heinnovate.eu).

Determined governmental action can unleash unprecedented sources of experimentation and innovation, while regulation can foster creative approaches by diverse new entrants. There is a need to ensure that publicly funded research communities: i) represent all aspects of basic and applied research, innovation, etc.; (ii) include stakeholders from various fields (not only one industry sector); and (iii) become the main source of information for the drafting of innovation agendas and technological roadmaps, which can later inform innovation policy for sustainable development. Here foresight practitioners can provide relevant support. In the European Commission's policy cycle, foresight is a participatory process that comes at an early stage, to engage and consult stakeholders well before decisions are taken or priorities set. Foresight activities can and should be carried out to specifically support the development of proposals for the Framework Programme and its biannual work programmes.

At the European level the Open Science Policy Platform advises the European Commission on the development and implementation of cross-cutting issues concerning open science. Furthermore, the establishment of a European Open Science Cloud under the Digital Single Market Strategy could help to make relevant research data searchable, accessible, interoperable and reusable vis-à-vis all European researchers. The Cloud will bring together existing and emerging data infrastructures to create a virtual environment for all European researchers to store, manage, analyse and reuse data. The Commission is also setting up an Open Science Monitor, which will identify, quantify and assess the quality of all the ongoing trends in open science (European Commission, 2016b).

Despite new online tools, such as social networks for research, e.g. ResearchGate, there is a low degree of awareness and adoption of the most innovative tools, such as collaborative writing tools or blogs for researchers. It is also important to encourage the inclusion of non-institutional participants, in other words, the general public, in the scientific process. Citizen science is "scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (Oxford English Dictionary, 2014). Initiatives such as Galaxy Zoo and Zooniverse have shown that it is possible to get hundreds of thousands of people to help with scientific research (European Commission, 2016b).

All young scientists in Europe should have the necessary skills and means to be open scientists, and all publicly funded research in the EU should adhere to commonly agreed upon open science standards of research integrity (European Commission, 2016b).

4.3.3 Recommended actions

- *Promote open science and data sharing and the improvement of data quality and management.*
- *Ensure that publicly funded research communities: (i) represent all aspects of basic and applied research, innovation, etc.; (ii) include stakeholders from various fields (not only one industry sector); and (iii) become the main source of information for the drafting of innovation agendas and technological roadmaps.*
- *Develop new performance measures for academia that encourage further development of research.*
- *Develop skills for open science and promote commonly agreed upon open science standards of research integrity.*

4.4 Platforms foster collaboration and entrepreneurship: Policy-makers should engage with them, not fight them

4.4.1 Problem

Companies adopting open innovation models (and especially multisided platforms) play a growing role in nurturing entrepreneurship, transferring knowledge and skills, creating an entrepreneurial mindset and orchestrating innovation, especially but not exclusively in the digital economy. Currently, EU legislation is uncertain as regards the role of platforms, which end up often being subject to contrasting policy pressures: on the one hand, neutrality advocates would propose treating them like 'dumb pipes', whereas others would want them to be increasingly responsible and accountable for their social impacts. There is an urgent need to develop and engage in adaptive governance with platforms for learning about and combining adequate institutional frameworks.

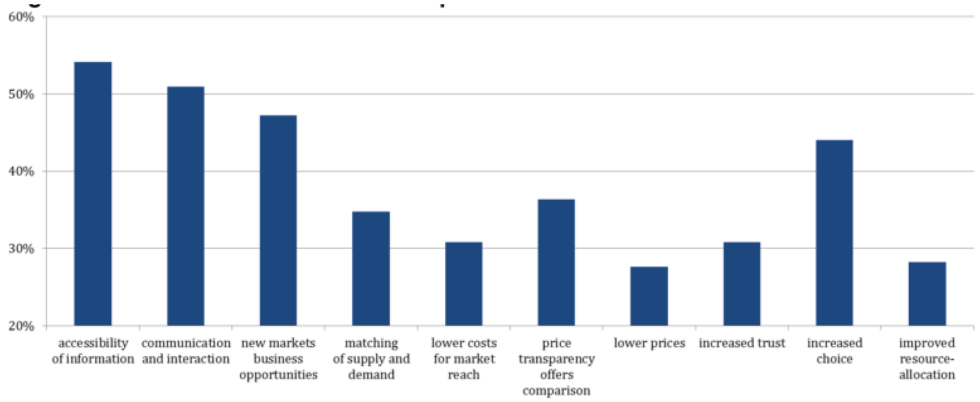
4.4.2 Analysis

Open innovation enables partners, including both customers and suppliers and even competitors, to broaden the horizon of established business in order to optimise the production and application of useful knowledge. European regions host medium-sized and large companies in scale-intensive sectors that can benefit particularly from open innovation with new firms (start-ups and spin-offs): utilities, networks, logistics, services, etc. This is one of the emerging trends at international level which can help modernise traditional business models and sectors.

Multisided platforms and open innovation models go hand in hand in the digital economy, and are permeating many other markets such as finance,

energy, real estate, automotive and many more. In this context, alliances, knowledge transfer and mentoring between platforms and smaller companies often become win-win situations. In fact, in many circumstances, platform competition imposes on rivals the urge to create and promote as many applications as possible to attract end users, and vice versa. In general, the platforms suggest major potential for benefitting society (Figure 10).

Figure 10. Perceived benefits of digital platforms



Source: Public Consultation: Regulatory environment for platforms, online intermediaries, data and cloud computing and the collaborative economy, 2015 (European Commission, 2016c).

The evolution of the debate on platforms at the EU level has been difficult and bumpy over the past few months. The temptation to impose neutrality obligations (in the form of non-discriminatory behaviour and "mere conduit" rules) is contrasted with the need for responsible cooperation and the enforcement of a growing array of rules, from e-commerce to copyright to counterterrorism, defamation, parental control and data protection. In consideration of (i) the important role that large companies and platforms can play in the promotion of entrepreneurship and innovation at all levels, as well as (ii) of their almost inevitable role as partners of public authorities in securing the promotion of public policy goals, it seems important that EU policy-makers realise the need for deep and constructive cooperation between public and private players in shaping and implementing legal rules. This can result in a more suitable environment for entrepreneurs (who, incidentally, seem to trust large intermediaries and platforms more than they do public institutions). Harmonised rules at EU level, such as the recently adopted General Data Protection Regulation and the Network and Information Security Directive, are important to facilitating growth and rapid scaling up of innovative platforms. Online platforms are subject to existing EU rules in areas such as competition,

consumer protection, protection of personal data and single market freedoms which would benefit from coordination in support of the platform economy.

Future regulatory measures proposed at EU level should foster the innovation-promoting role of platforms and address clearly identified problems relating to a specific type or activity of online platforms in line with better regulation principles. For instance, for the moment the collaborative economy is a good example where rules designed with traditional and often local service provision in mind impede online platform business models (European Commission, 2016d).

Despite limited European proactive policy efforts, a number of industries have experienced creative destruction triggered especially by digital platforms and their ecosystems (Evans & Gawer, 2016). Herein, both the empirical evidence and the emerging literature on digital platforms and the explosive growth of their owner companies are attracting wider interest (Evans & Gawer, 2016; Accenture, 2016).

While rapid transformations have on the one hand created multibillion-dollar platform businesses with a global presence and on the other ruined incumbent industries, their wider impact on society at large can be considered mixed (European Commission, 2016d). The observations of how digital platform businesses are generating growth and shaking both the capital markets and the real markets are getting the attention of policy-makers, e.g. the recent communications of the European Commission (European Commission, 2016d) and at the national level, for instance the reports for the Finnish Government (Halén et al., 2016). Eloranta & Turunen (2016) observe that to govern digital platforms, complexity should not be reduced, but rather embraced. Herein, Autio & Llewellyn (2013) relate the notion of 'ecosystem' to platforms by referring to platform-centred ecosystems that comprise the core and the periphery.

Both business leaders and policy-makers are perplexed by the governance of digital platforms. Platform businesses search the balance between control and openness to optimise the exploitation of their current assets and the exploration of new innovations to ensure future competitiveness (Könnölä & Unruh, 2007; Gawer, 2014). In terms of policy-making, the extant platform endeavours are mainly aimed at patching existing development trajectories provided by markets, e.g. European Commission (2016). The policies fit with platforms that are built on mechanistic paradigms, striving for industry architecture control. Market and systems failures resulting from too much control by some dominant players are addressed with existing policy measures. Regulation is slow and societal 'consensus' is difficult to match with dynamic and complex platform requirements. Sometimes, temporal monopolies may be good for innovation but their impacts are broad, multisided, cross-sectoral and difficult to regulate due

to information asymmetry (Bauer, 2014). In particular, the policies struggle with adaptive digital platform ecosystems[65] that share common schemata between stakeholders, entail emerging properties and resilience, and require policy approaches that also align with and adapt to complexity rather than reduce it. Unwanted impacts of policy measures in complex systems is the rule rather than exception.

Anttiroiko et al. (2014) discuss platform governance that reflects the environment of power shared among interdependent actors faced with 'wicked' problems – for example, complex financial, security and environmental issues – that cross organisational boundaries. Such an approach to governance offers a framework for supporting policy informatics, which is supposed to bring changes notably on two fronts: first, technology can replace structure as a means of control by employing technological rather than bureaucratic gatekeepers or facilitators; and second, the platform approach has the capacity to increase the flexibility and responsiveness of public organisations involved in governance processes (Wachhaus, 2011). The concept of 'connected governance', in turn, builds upon interoperability that enables public agencies to share and integrate information using common standards (Dais et al., 2008).

4.4.3 Recommended actions

- *Promote cooperation between public and private players in shaping and implementing legal rules for platforms.*
- *Engage with platforms by seeking their cooperation on nurturing entrepreneurship, shaping university curricula, and defining technology roadmaps to be used as a basis for future policies.*

4.5 Europe must courageously speed up a platform economy

4.5.1 Problem

Europe is lagging behind in the platform economy. A platform strategy differs from a product strategy in that it requires an external ecosystem to generate complementary product or service innovations and build positive feedback between the complements and the platform. While Europe has emerged as a major consumer of platform services, it has generated relatively few platform companies. In 2015, the Center for Global Enterprise surveyed the world's 176

[65] This also holds true for other types of ecosystems, such as those of innovation (Russell et al., 2011) and entrepreneurship (Autio, 2015; Mason & Brown, 2014).

most significant platform companies, defined as those exceeding a market valuation threshold of $1 billion. Only 27 of the 176 most significant platform companies (15%) are from Europe, collectively representing a little over 4% by market value (Evans & Gawer, 2016). Platform ecosystems are gaining ground through the digitisation of products, services and businesses. The importance of platforms is closely linked to the concept of network effects. The more products or services it offers, the more users it will attract. Scale increases the platform's value, helping it attract more complementary offerings which in turn brings in more users, which then makes the platform even more valuable. While the lack of European platform companies is concerning, Europe is also lacking evidence for policy formulation to address properly related aspects such as implications for employment conditions, competition law, regional development and entrepreneurship, for instance.

4.5.2 Analysis

Digitisation-driven market complexity and turbulence is prevailing in most industries. Companies seek help beyond their organisational boundaries by externalising both innovation activities and operations (Chesbrough, 2012). Cooperation involves large networks of stakeholders, including competitors. Consequently, the unit of analysis for organising business changes from a firm to a business ecosystem (Moore, 1993).

Across various studies in organisation, strategy and product innovation research, the notion of "digital platform" has gained considerable traction when addressing such managerial challenges of digitisation (Gawer & Cusumano, 2014). There is as yet no generally accepted definition for the digital platform, as the research has progressed simultaneously in different research streams. The different lines of work are still relatively weakly cross-referenced, further complicating the formation of a common conceptual basis. The literature streams merely agree that, in the abstract, the platform consists of slowly changing core components, rapidly changing complementary components, and the interfaces between them.

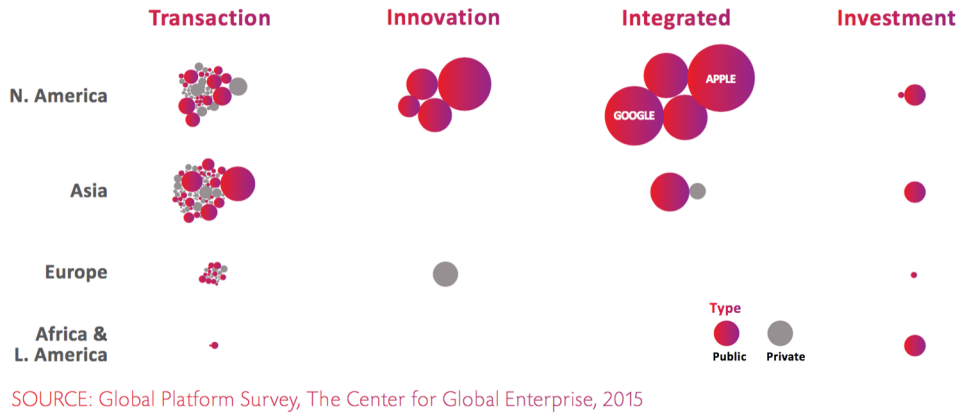
Platform ecosystems are gaining ground through the digitisation of products, services and business processes, and in the process are reshaping the global landscape. Platform companies contribute significantly to the economy. They have driven up productivity in multiple ways. Evans & Gawer (2016) separate platform companies into four types:

- Transaction platforms. A transaction platform is a technology, product or service that acts as a conduit (or intermediary), facilitating exchange or transactions between different users, buyers, or suppliers.

- Innovation platforms. An innovation platform is a technology, product or service that serves as a foundation on which other firms (loosely organised into an innovative ecosystem) develop complementary technologies, products or services.
- Integrated platforms. An integrated platform is a technology, product or service that is both a transaction platform and an innovation platform. This category includes companies such as Apple, which has both matching platforms, such as the App Store, and a large third-party developer ecosystem that supports content creation on the platform.
- Investment platforms. Investment platforms consist of companies that have developed a platform portfolio strategy and act as a holding company, active platform investor or both.

The total value of these platform companies exceeds $4.3 trillion, which demonstrates the size and scale that platform companies have achieved in recent years. While Asia has a larger number, the value of platform companies in North America is collectively much larger. North America has over 72% of the value compared to 22% for Asia. Surprisingly, while Europe has emerged as a major consumer of platform services, it has generated relatively few platform companies. Only 27 platforms (15% of the total surveyed) hail from Europe and collectively they represent a little over 4% by market value (Evans & Gawer, 2016).

Figure 11. Platform companies by type



Note: Each bubble represents a company sized by market capitalisation as of 1 December 2015.
Source: Evans & Gawer (2016).

Similar to any high growth firm, emergent single digital platform businesses, however, can be tricky targets for policy-makers, as it is difficult to

pick the future 'winners' based on the publicly available information and past performance. Increasingly scholars suggest focusing on the promotion of innovation and entrepreneurial ecosystems rather than hand-picked individual companies. However, despite the transformative potential of platform ecosystems, current policies addressing platforms within the market and system failure paradigms attempt to optimise the benefits and mitigate the downturns (European Commission, 2016d). Such market and system failure approaches are more useful for describing a steady state situation in which public policy aims to put patches on existing development trajectories provided by markets, but not to dynamically create and shape new trajectories (Mazzucato, 2016). In order to harness the disruptive potential of the platform economy for societal transformation and direct such developments towards societally beneficial pathways, these need to become an integral part of governance rationales.

The managerial literature on platforms has gradually evolved from mechanical optimisation of the one-sided platform infrastructures to federation and coordination of evolving and adaptive digital platform ecosystems of agents with diverse roles and ambitions (Gawer, 2014). These dynamic and evolutionary perspectives have not yet, however, captured sufficient attention in policy.

The latest developments in platform research emphasise the organisational and evolutionary perspective. So-called 'industry platforms', 'platform organisations', 'service platforms' and 'engagement platforms' refer to the platforms' are not limited to leveraging external innovation or matching supply with demand but extend to all business processes, creating overlapping and nested structures consisting of many organisations.

The system evolves organically and cannot be totally controlled by any party. In stable environments this would result in performance deficiencies, but in rapidly changing markets, the benefits in terms of rapid adaptation outweigh the potential process performance losses. Good case industries for these platform types are, e.g. smartphone application ecosystems and open source software products.

However, while the European Commission is examining the impact of platforms and preparing guidelines for policy, especially within the frameworks of the sharing and collaborative economy, to date Europe lacks evidence-based research on platforms to inform policy. It is urgent that both European and national level initiatives fill this gap and help transform Europe from a reactive to a proactive mode of developing the platform economy. At first glance, outside innovation policy, interventions on private platforms should be cautious, especially when the platforms seem to be developing in a way that stimulates open innovation in the long run. That said, platforms could become very

important allies of government in enforcing rules, and just as key in promoting entrepreneurship in a variety of fields.

The recently adopted strategy to digitise European industry (European Commission, 2016a) identifies a series of measures that help to advance these ambitions. They include investment in world-class data and computing infrastructure for science and innovation, with an estimated investment of €50 billion of public and private funds to upgrade Europe's digital innovation capacities. There are also measures included in this package for a streamlined approach to standardisation that aims to foster the necessary cross-border and cross-domain interoperability.

A number of ongoing initiatives in the research arena and other specific funding actions already aim to help the emergence of innovative platform-based ecosystems. These include the provision of high-speed internet access across the EU-11 and support for open service platforms. In this context, the Commission could start a reflection on how to shape the future internet as a powerful, open, user-centric, interoperable platform ecosystem, in particular with the support of Horizon 2020. Finally, projects such as the Startup Europe initiative provide advice and funding, thereby promoting opportunities for start-ups to experiment and scale up.

In sum, Europeans need to take a proactive stand in developing the platform economy, for instance by fostering investment in broadband, the IoT and Industry 4.0, removing unnecessary regulatory barriers, addressing market concentration and barriers to competition, preserving the open internet and the free flow of data, and enhancing trust in the digital economy. The platforms transform the economy, with diverse implications for society that need to be better understood. Europe needs to actively develop its own platforms and ensure that their spillover effects will benefit society.

4.5.3 Recommended actions

- *Develop both at European and national levels initiatives for evidence-based research on platforms to inform policy.*
- *Launch foresight activities to explore the future of the platform economy and its implications for policy and society at large.*
- *Improve conditions for the platform economy by fostering investment in broadband, the IoT and Industry 4.0, by removing unnecessary regulatory barriers and by addressing market concentration and barriers to competition.*
- *Preserve the open internet and the free flow of data, enhancing trust in the digital economy.*

4.6 More scale-ups are urgently needed!

4.6.1 Problem

'Born global' mindsets and connections are critically important for the renewal of the economy and the success of any innovation policy. The recent efforts across Europe have paid considerable attention to the creation of new start-ups, while less attention has been given to scale-ups, i.e. firms that have more than 10 staff and grow more than 20% per year (OECD, 2007). According to Isenberg & Onyemah (2016), such firms have the highest spillover effects (inspiration, capital, taxes, expertise and job creation). They also have the advantage of being selected naturally and able to show new growth in 6 to 12 months. Typically, 10-20% of existing stock is able to kick-start growth that translates into capital efficient use of funds. Maximising the potential of scale-ups to stimulate the economy has become imperative for entrepreneurial policy.[66]

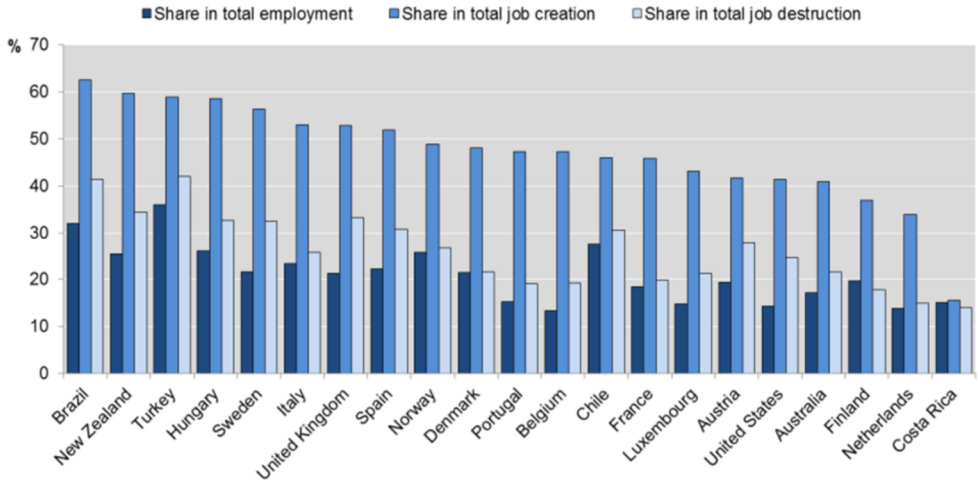
4.6.2 Analysis

The ongoing debate about a future European Innovation Council is rightly focused on radical innovations and scale-ups, as these are real problems facing Europe's innovation policy. While the scale-ups and their ecosystems are increasingly considered important for the economy, they also are considered difficult targets for policy. It is difficult to identify scale-ups, when the findings on scale-ups are diverse and their growth can be inconsistent. Even the source of financing does not ensure that the firm will grow into a scale-up and, more important, that the high growth will be maintained over time (Moreno & Coad, 2015). Nevertheless, OECD has concluded that young firms (thanks to their growth) are key to economic growth and employment (Figure 12).

Despite the difficulties of identifying scale-ups for direct policy measures, the rationale remains to develop measures that enhance the odds of generating new scale-ups and their sustainable growth. Herein, attention is given to the context. The promotion of scale-ups across Europe requires the alignment of different policies as well as specific support measures in different levels of governance and dimensions of ecosystems (Figure 13).

[66] At the CEPS Task Force, Nicholas Davis (World Economic Forum) pointed out substantial differences in growth rates between US and EU companies, which reflect 'scaling-up' problems for EU players. Similar evidence was presented by Dirk Pilat (OECD).

Figure 12. Young firms contribute disproportionally to job creation in all countries



Note: The graph shows the share of young firms (less than six years old) in total employment, total gross job creation and total gross job destruction, respectively. Data cover manufacturing, construction and non-financial business services. Figures for Chile are preliminary. Owing to methodological differences, figures may deviate from officially published national statistics.

Source: OECD (2016).

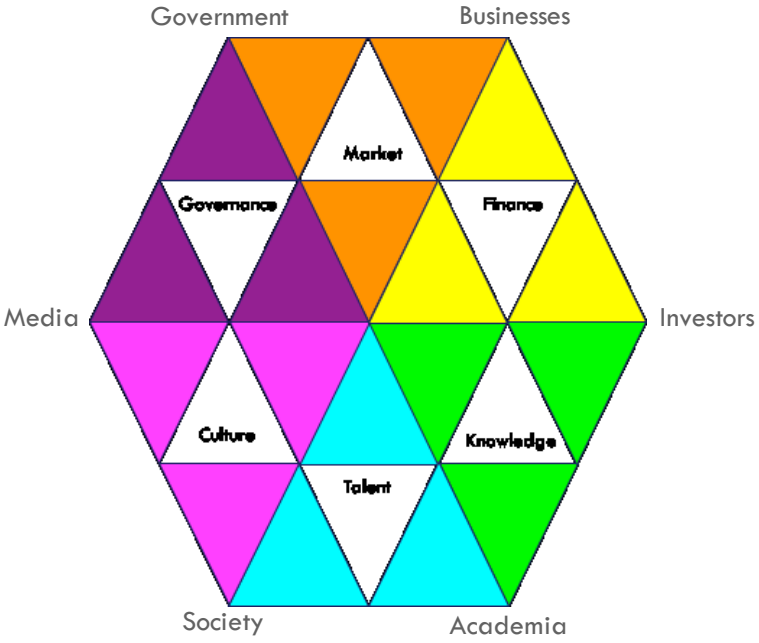
To enable experimentation and firm growth, it is pertinent to reduce regulatory barriers to entry, e.g. red tape, growth, e.g. size-specific regulations, and firm exit/failure, e.g. penalising bankruptcy legislation, overly strict employment protection legislation.[67] Policies that favour incumbents, e.g. R&D tax credits, some environmental regulations, subsidies that delay exit, visa rules, etc., should be revisited.

Banks have been less willing to provide loans as a result of the financial crisis. Meanwhile, venture capital firms have become more risk adverse due to pressures on the industry and have focused on later stage investment. Angel investors have become more visible and active through groups, syndicates and networks but also face challenges.

Capital market 'failures' arise mostly due to information asymmetries. While it can be argued that a financing gap is not a market failure, a number of governments have chosen to intervene based on broader objectives. The majority of OECD countries have had grants, loans and/or guarantee schemes in place for many years. A number of OECD member countries have also put tax incentives in place. There has been an increase in the use of equity instruments in OECD countries, but the focus has shifted from government equity funds investing directly to more indirect models such as co-investment funds.

[67] This recipe was presented by Dirk Pilat (OECD) at the CEPS Task Force.

Figure 13. Key dimensions and stakeholders of entrepreneurial ecosystems for high growth firms



Source: Insight Foresight Institute (2016).

These approaches seek to leverage private investment, and a number of OECD countries are experimenting with different incentive structures. While supply-side interventions have increased, there is little evidence of the impact of these instruments and whether or not they crowd out private investors. A mix of public and private venture capital funding may have a positive impact, but further analysis is needed (Wilson, 2015).

Specific programmes such as incubators, accelerators, business angel networks and matchmaking services have become increasingly popular in OECD countries. Human capital development can focus on both entrepreneurs and investors, although the focus is typically on entrepreneurs.

The development of financial markets and exit opportunities, whether through IPOs on a stock exchange or mergers and acquisitions by other firms, directly influences the development of seed and early stage financing. Bankruptcy regulations, labour market restrictions and other framework conditions also impact firm dynamics as well as the creation, financing and growth of innovative firms. Regulatory barriers and administrative burdens on high growth firms can directly hinder their performance and access to finance. In particular, securities legislation and more stringent capital requirements on

institutional investors could reduce the supply of investment in venture capital from banks, pension funds and insurance companies (Wilson, 2015).

Policy interventions should not be seen in isolation but as a set of interacting policies. A systems approach is needed which covers both supply- and demand-side intervention, framework conditions and especially policy measures that ensure policy learning. In particular, cities and their districts can implement strategies that build on the local understanding of the specific dynamics of start-ups or scale-ups and their ecosystems at hand. To avoid counterproductive policy measures, it is pertinent to engage with the ecosystem actors in learning processes that shed light on bottlenecks and possible actions needed from diverse perspectives.

Furthermore, innovation and entrepreneurial ecosystems need to be strengthened for innovative firms, e.g. through enhanced access to (risk) capital, network development, mentoring of entrepreneurs, skills development, etc. The efforts to complete the Single Market and reduce trade barriers has to be taken forward so firms can scale more easily across borders (see also "Ideas for Policy" below) (Pilat, contribution to CEPS Task Force, 2015). Scale-ups also need a supportive culture that can be promoted through education and media, by celebrating the success of scale-ups and engaging entrepreneurs to share their success stories.

4.6.3 Recommended actions

- *Reduce barriers to entry, e.g. red tape, growth, e.g. size-specific regulations, and firm exit/failure, e.g. penalising bankruptcy legislation, overly strict employment protection legislation.*
- *Address regulatory incumbency: Policies often favour incumbents, e.g. R&D tax credits, some environmental regulations, subsidies that delay exit, visa rules.*
- *Develop ecosystems through enhancing incentives and access to (risk) capital, developing networks (including development of research), mentoring of entrepreneurs, developing skills.*
- *Complete the Single Market and reduce trade barriers, so firms can scale more easily across borders.*
- *Promote scale-up culture through education and media, celebrate success of scale-ups and engage entrepreneurs to share their success stories.*
- *Initiate studies providing evidence of the impact of financial supply-side interventions.*

5. POLICIES: HARNESSING THE POTENTIAL OF REGULATION TO PROMOTE INNOVATION AND ENTREPRENEURSHIP

5.1 Beyond access to finance: Activating public demand

5.1.1 Problem

Building vibrant ecosystems through holistic innovation policies requires a number of interconnected and interdependent dimensions and interventions (Isenberg, 2011; Edquist, 2014). Among them, access to finance and access to markets figure prominently in the quest for action to overcome barriers to growth as indicated by business and entrepreneurs.

Access to finance is still one of the key problems facing EU entrepreneurs and innovative firms, particularly small and new businesses. On the other hand, in Europe, venture capital is still relatively underdeveloped; the banking system is still providing insufficient credit to entrepreneurs and innovators, despite repeated quantitative easing programmes by the ECB; and new channels such as crowdfunding, FinTech and online lenders are still in their infancy, and often hindered by existing EU and national laws.[68]

Market access can be eased through demand-side innovation policies to increase the uptake of innovations in society. Demand is a major potential source of innovation, yet the critical role of demand as a key driver of innovation is yet to be recognised in EU policies. Public procurement could play significant role in innovation policy strategies at the EU level and in a range of European countries, and this has been affirmed repeatedly (Aho, 2006). While both national and European constituencies have taken up experimentation programmes to spur demand for innovation, they are far less developed than supply-driven policies, which are implemented widely in the US.

[68] Regulatory barriers to FinTech and crowdfunding were highlighted by Oliver Gajda (European Crowdfunding Network) at the CEPS Task Force.

Indeed, public sector entrepreneurship (Leyden & Link, 2015) through cross-departmental schemes such as SBIR concerns both public finance and procurement. Sponsored firms receive early support and access to the federal system of procurements. This has no equivalent at the European level; the European Commission has developed an 'SME instrument' which basically concerns funding and regards size as the determining factor instead of the age of the candidate firm, which as we have pointed out above would be a much better indicator. In the European context, funding and procurement are not associated, although the budget for the SME instrument is compiled, as in the US, from a distributed number of sources (departments and federal agencies in the US, DGs in the European Commission context).

5.1.2 Analysis

Financial support is one of the key ingredients of successful entrepreneurship and innovation. In Europe, the picture is still quite fragmented. Berlin and London have made impressive progress in attracting venture capital, often thanks to the intermediation and active involvement of large companies (especially from the ICT sector). But venture capital is not a silver bullet solution to Europe's innovation and entrepreneurship problems; it is typically very local and provides funding at relatively late stages of a company's life. Seed money is often provided by other means: for example, in the US crowdfunding has already overtaken venture capital and is proving very useful in providing early-stage financial support for innovative ideas and business models.

At the same time, in the US and even more so in China, IT companies provide a valid alternative to the currently stalled banking loans market: from Alibaba to PayPal, from WeChat to Amazon and the Funding Circle, the lending market is filling gaps that traditional banks are not able to fill in the current market situation. Finally, online platforms themselves provide digital entrepreneurs with various forms of financial and non-financial support, e.g. mentoring, access to a variety of free services, etc. All these developments can potentially lead to easier access to finance for entrepreneurs in Europe; however, a number of legal and regulatory restrictions, coupled with a relative lack of transparency and accountability on the side of new platforms, are standing between the *status quo* and a more prosperous future.

Starting with national operations, first in the UK, and then with 'fund of funds' jointly operated with a number of states (Spain, Turkey, etc.), the European Investment Bank (EIB) has established itself as the *de facto* broker for publicly facilitated venture capital and other kinds of support. Risk Sharing Finance Facilities sponsored by the European Commission have also been added through the Seventh Framework Programme and Horizon 2020, including a window for SMEs intermediated by national banks. Looking ahead, the EIB aims

to launch a European 'fund of funds' within the Horizon 2020 timeframe, facilitated by the strong support of Commissioner Moedas.

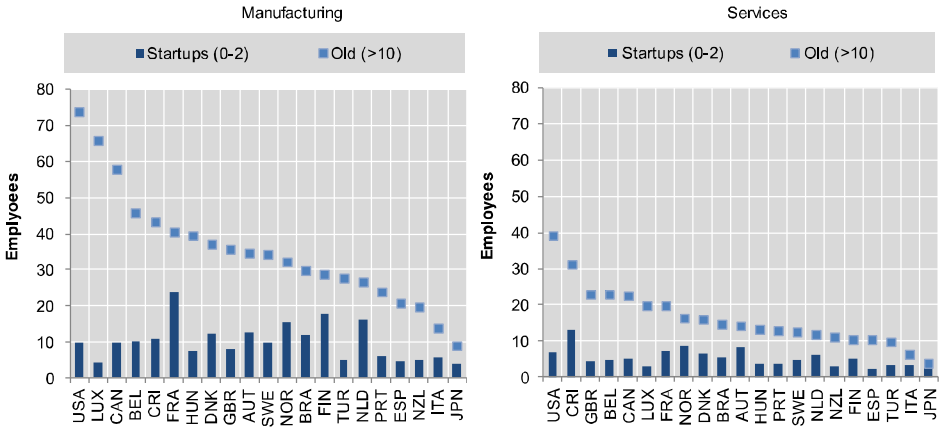
Concerning demand-driven innovation, policy measures can involve legislation that increases consumer confidence in innovative products, safety regulations, standards or public procurement. Creating effective links between demand-side and supply-side tools can improve the efficiency of the innovative system. This is a difficult task for both EU and national policy interventions, as competences are dispersed. An interesting recent case is the new Swedish Innovation Council created in February 2015 under the auspices of the prime minister, with a focus on innovation rather than on research (for which there is another council in Sweden), which is successfully addressing functional public procurement for innovation (Edquist, 2016).

In particular, to exert a wider impact, the pooling of public procurement for innovation and market access needs to be addressed at the national level and also overall at the European level: 'innovation deals' recently launched by the European Commission might spur innovation where it is currently hard to come by or impossible due to regulation (see below for a more detailed analysis). Such deals are inspired by the Dutch administration's experience with 'green deals', and the 'circular economy' would serve as pilot domain at EU level.

Such efforts are welcome because they go beyond less focused attempts to associate innovation with regulation, e.g. European Innovation Partnerships (EIP), whose impact has been relatively negligible. Interestingly and fortunately, the ongoing debate about the likely set-up of a European Innovation Council (EIC) has stressed the importance of regulation to spurring certain forms of innovation in Europe. The debate rightly focuses on the insufficient number of breakthrough scale-ups (Science&Business, 2016) and related regulatory action.

Last but not least, the EIC should also establish a strong and authoritative advisory function with EU and national governments, with insights from successful European entrepreneurs and innovators themselves, thus helping overcome barriers to growth in general and helping scale up start-ups in particular. In so doing, the EIC could tackle issues regarding demand and context, which are traditionally neglected by the innovation policy portfolios of both most member states and EU institutions. This would contribute to mobilising action in areas that require more than funding, procurement and innovation-friendly regulation in particular.

Figure 14. Average size of start-ups and old firms in manufacturing and services



Note: The figure reports the average size of start-up firms (from 0 to 2 years old) and firms more than 10 years old, over the available years. See source for country-specific details.

Source: Criscuolo, Gal and Menon (2014) and OECD DynEmp Express Database, April 2015, www.oecd.org/sti/dynemp.htm.

Box 2. ICT vouchers

One instrument that is being successfully tested by the European Commission to facilitate innovation by small enterprises is represented by the so-called 'vouchers' for value-added ICT services.[69] The European Commission created vouchers (valued at up to €10,000) for SMEs to innovate by investing in digital technologies in order to increase competitiveness and enhance growth prospects. The instrument promotes ICT uptake in established companies or by entrepreneurs located in regions where the voucher scheme is deployed. ICT services can be provided by private companies or public institutions at the market price. The implementation of the instrument will be entirely 'regional'. Each region is called on to identify the need for innovation support for business and the implementing body of the voucher scheme, and to tailor the scheme to specific local needs. The voucher scheme needs to be streamlined and administrative/transaction costs should be kept very low. The vouchers often imply the cooperation and approval of regional authorities, e.g. in Murcia a ICT voucher for improving internal processes and implementing e-commerce solutions was approved by the regional innovation agency). Once it has obtained the approval, the SME consults the service provider (among a selected list of 'reliable' providers) and the service is provided. The SME pays for the service with the voucher (the voucher does not cover the entire value of the service). The service provider gives the voucher to the innovation agency with a justification and payment is made to the service provider.

[69] Ann Branch's presentation at the CEPS Task Force.

This is only one among several tools. As structural funds are national/regional, the determination to use such tools to implement policies is local. Aside from recommendations on tools and their use, the Commission cannot decide. The regions have a full range of policy options (besides vouchers), and their decisions are based on strategies for spending social funds. The European Commission can steer, but not implement, such strategies.

5.1.3 Conclusion

Great societal challenges constitute a relatively new field of attention for EU innovation policy introduced within the new Horizon 2020 context (Georghiou et al., 2008). Access to finance and markets need to be leveraged by innovation policies that are holistic and pervasive while also taking advantage of Europe's social model.

The EIB is well positioned to tap innovative sources of finance in cooperation with EU, national, regional and local stakeholders, in order to develop the right mix of capillarity for beneficiaries and boost the contribution of its operations to excellence in research and innovation.

Increased transparency and accountability are necessary conditions for the EIB to be perceived not only as the natural but also as the actual facilitator at EU level.

Regarding regulation, the EIC could and should advise regulators in order to make certain forms of innovation possible in Europe. This would help meet public demand for innovation, by increasing the visibility of good practices at EU level to overcome barriers to growth (Leceta et al., forthcoming).

5.1.4 Recommended actions

- *Integrate systemic innovation with better regulation by refining the guidance on innovation impacts in the better regulation guidelines.*
- *Align policy-making and better regulation to the EU's sought-after long-term impacts and objectives.*
- *Set up mission-led platforms to inform early-stage policy-making on innovation impact.*
- *Strengthen the better regulation toolkit with more information and guidance on adaptive, experimental policy-making that favours systemic innovation.*
- *Facilitate intermediation in access to finance through increased transparency and accountability.*

- *Complement the Single Market by relying on a more strategic use of public procurement, and using 'innovation deals' to promote efficient compliance.*
- *EIC advisory function should provide good practice advice to governments in order to overcome barriers to growth and scale for start-ups.*

5.2 Reframing policy for established versus new firms (rather than large versus small firms)

5.2.1 Problem

Sadly, one often finds too many 'mechanistic' discussions about policy instruments, while policy emanates from strategy and strategy from vision; on the other hand, there is too often a clear disconnect between innovation policy-makers' intentions and actual implementation. It is thus time to rethink innovation policies through co-creation spaces, rather than through instruments too often focused on funding and innovation linearity (Edquist, 2014). Innovation is much more than R&D and both require much more than public funding, and we know that science is never enough, and sometimes not even required, for successful innovations.

Regrettably, most innovation policy interventions focus on R&D even though most European governments claim their innovation policies and strategies are holistic (Edquist, 2014). At EU level, most policy interventions foster public-private partnerships between academia and businesses, including SMEs. This is questionable for two reasons. On one hand, preferred partners for business in R&D differ across sectors and countries; on the other, when it is a question of inter-firm collaboration, policies favour consortia that involve both large and small businesses.

Collaboration with academia is useful to science-based innovation and specialised suppliers, less so to scale-intensive and supplier-dominated sectors (Pavitt, 1984). On the other hand, focusing on firm size rather than age is suboptimal for policy (Mazzucato, 2013), because "most of firms start small, but most small firms are old" (Coad et al., 2014). In the wake of the crisis, widespread awareness of and appetite for new, more experimental innovation models of innovation is emerging, coupled with evidence that disruptive innovative models can displace long-established firms. More and more voices from the World Economic Forum, the OECD and the International Monetary Fund (IMF) are calling for new policy interventions, replacing emphasis on cooperation between large and small partners with more focused efforts between established (both large and small) and new ventures.

5.2.2 *Analysis*

Debunking the myth of the role of the state and focusing on the real issues (Mazzucato, 2013) are pre-requisites. Regarding corporate ventures and entrepreneurship, for instance, emerging trends such as FinTech and digitisation of manufacturers (Industry 4.0) could very well point to some sort of 'European way' to use venture capital, associating new firms with established businesses. Indeed, Europe does not lack national champions, network operators, utilities and service providers with global footprints, but their competitiveness is at stake and requires radically open and more disruptive sources of innovation. Why is this? Because their traditional revenue sources will not necessarily grow, quite the opposite, in fact: traditional business models in 'extractive industries' are increasingly exposed to and eroded by international competition from new entrants. On the other hand, sustainability is not guaranteed either (as evidenced by Veugelers, 2009), since the average knowledge and technology intensity of European firms is lower. Hence, Europe is right to want to narrow the innovation gap both for what concerns disruptive innovation (particularly market-creating innovative models);[70] and radical innovation (based on new breakthrough technologies); and also targeting both start-ups and older firms.

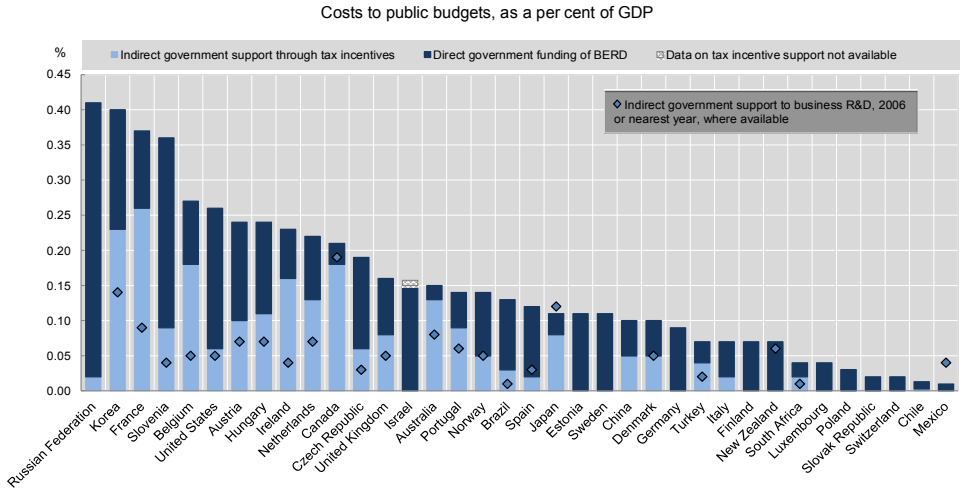
Big firms need to digitise, transform their business and reinvent themselves from the inside out. For that to happen, new forms of collaboration between the established firms (either large or small) and new (start-ups and spin-offs) is a rather unexplored area for policy, though it was recently advocated by WEF (2014). Vice versa, new firms can find 'launching partners' among established firms, helping them grow and accelerate market uptake by exploiting their global business footprints. Suitable arrangements need to be established to secure balanced and thus sustainable alliances, particularly for what concerns IP (WEF, 2015). More widely, governments also need to evolve from the policies of older generations, as too of them focus on (not necessarily new) SMEs on the one hand, and foster partnerships between (not necessarily established and new) large and small firms on the other.

Interestingly, the OECD (as of 2015) is now advising governments to stop supporting only established companies and to also and more resolutely support newcomers and to achieve balance between direct and indirect aid. Evidence shows that direct aid is more effective for launching innovation in companies that have yet to innovate, while direct aid 'builds loyalty' in companies that are already innovating, especially larger ones (Pereiras & Huergo, 2006). Another

[70] According to the 2016 WEF technology pioneer list, only six out of the top 30 companies are European, while 21 come from the US. Also, Europe is home to only 19 'unicorns' (start-ups that have reached a market valuation of over €1 billion) and their combined value is less than half the current market value of Facebook.

advantage of direct aid is the directionality to meet major challenges. In summary, a suitable balance between direct support measures and indirect support measures (tax incentives) should also be achieved, as new/small and established/large firms do not benefit equally from them.

Figure 15. Direct government funding of business R&D and tax incentives for R&D, 2012 and 2006



Source: OECD R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and OECD, National Accounts and Main Science and Technology Indicators, 15 December 2014. Direct funding estimates for Brazil based on national sources.

More recently, regarding the focus on tax incentives for R&D, IMF (2016) finds that "tax preferences should target new firms, not small ones", arguing that preferential tax treatment of small firms should be avoided; it may actually hurt growth by creating a 'small-business trap' as a result of the higher taxes firms would face once they cross a certain size threshold. Well-designed tax relief for new firms can promote entrepreneurship and innovation.

5.2.3 Conclusion

Overall, there seems to be a surprisingly unanimous opinion among international organisations that innovation policies require a different focus. Maybe the crisis brought about a much needed shift from more widespread generic public-private R&D-focused innovation policy to more targeted but transversal and contextual policies for high-growth potential.

Indiscriminate interventions for cooperation between large and small firms require more targeted partnerships between existing and new firms,

whereby the former may provide the scale and the latter the disruptive potential.[71]

In such a context, a suitable balance needs to be established between direct and indirect support schemes in consideration of their different implications.

5.2.4 Recommended actions

- *Refocus policies for large and small to high-growth companies.*
- *Promote healthy cooperation between existing and new businesses.*
- *Establish a suitable balance between direct and indirect support schemes.*

5.3 Set up a simpler division of labour for multilevel innovation policy in Europe

5.3.1 Problem

Progress toward establishing a European Research Area[72] in particular, and achieving the Lisbon and Barcelona objectives more generally, require radical policy shifts (Veugelers, 2014). However, in the past years the structure of the Framework Programmes for research has remained too rigid, and the strict application of principles such as subsidiarity and competition law still limits the EU's ability to engage with public-private platforms to promote research and innovation.

The question is: Why does Europe still need to invest in 'getting public and private partners together'? They know themselves enough already, and through such public-private partnerships (PPP) the EU may risk sponsoring the reputation of the given partners more than it does the actual excellence of the projects. A different notion of European added value is needed; it should denote competition at European level and not the geometry of collaboration projects *per*

[71] In the context of the CEPS Task Force, Nicholas Davis (World Economic Forum) argued that collaboration between large companies and SMEs/young entrepreneurs can be built on three pillars: i) empowering (setting strategy to foster collaboration); ii) educating (fostering proficiency in management of collaborative innovation); iii) enabling (stable legal and regulatory framework and developing infrastructures to support collaborative innovation).

[72] Representatives of European universities as well as the Italian National Research Council have confirmed that the European Research Area is far from being completed, and this undermines EU research and innovation capacity, especially when compared to other global players such as the US, Japan and China.

se; national governments could then embrace transnational collaboration as part of their national programmes and interventions, including structural funds which would help new member states to better position themselves.

5.3.2 Analysis

Now, after 35 years of EU Framework Programmes, more focus is needed to translate knowledge into action. Also, decisive normative efforts are urgently needed in order to encompass policy action commensurate with the challenges of our time. There is an apparent dichotomy in discourse and practice, focusing on either macro-level policy-setting (government and governance) or micro-level performance (firms and entrepreneurs).

As the need for policy experimentation becomes more acute, the 'meso level' efforts of learning innovation agencies and programmes (Breznitz & Ornston, 2013; Chesbrough, 2012) will play a very different role: from 'funding and coordinating' (Lepori, 2011) to 'facilitation and orchestration' (Clarysse et al., 2015; Chesbrough, 2012). These are some of the key words in this new era of entrepreneurial ecosystems (Mason & Brown, 2014; Isenberg, 2011) and global clusters of innovation (Engel & del-Palacio, 2009).

All over the world, an emerging wave of entrepreneurs, technological advancements and venture capital investment are co-creating radically new innovation models through new business-like vehicles for policy delivery in shaping entrepreneurial ecosystems, e.g. KICs of the EIT and mediating university-business structures such the IP Group in the UK. Also, firms are reverting more and more to open innovation schemes such as IP licensing, academic partnerships, open-source platforms and venture capital investment. Corporate and university ventures are among the fastest-growing strategies (Dushnitsky & Lenox, 2005; Napp & Minshall, 2011; Sahaym et al., 2010).

In the quest for the most effective schemes for adapting to this new business reality, learning is key not only to implementing programmes but also to make smarter interventions in terms of efficiency and impact. The results will help governments evolve from 'managing current systems' (top-down) to helping 'shape new ecosystems' (bottom-up), with more focus on knowledge dynamics and value generation. Policy experimentation of this sort could help operationalise more successful and holistic policies and to scale them up.

Mutual learning among agencies, policy-makers and the research community provides a good basis for further developments. Successful local ecosystems (Silicon Valley, Israel, Singapore, etc.) demonstrate that entrepreneurial talent and global ambition are key constitutional and cultural foundations. This section thus focuses on what policies can again make Europe a continent of entrepreneurs and innovators.

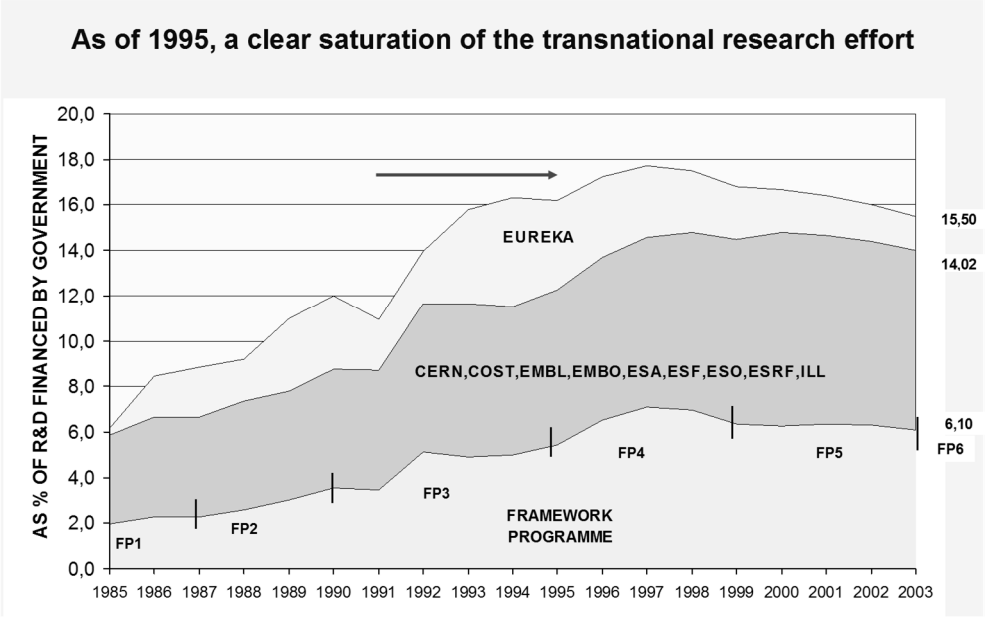
Past policy reviews have stressed the importance of policy coherence (León et al., 2008), in particular for the following dimensions:

- Horizontal coherence: coherence of R&D and innovation policies across sectors, ministries, departments, directorates, etc.
- Vertical coherence: coherence of R&D and innovation policies across governance levels, e.g. between EU, national and regional.
- Temporal coherence (dynamics): coherence of R&D and innovation policies over time, and predictability of policy changes.

As we approach the review of Horizon 2020 and discussions on setting up a European Innovation Council (EIC), these same dimensions help us formulate conclusions and recommendations:

- From a horizontal perspective, the number of instruments with the FP7 and Horizon 2020 has reached a peak, and many commentators and stakeholders stress that policy experimentation should now end, and all these instruments should now be consolidated.
- From a vertical perspective, notwithstanding experimentation, the relative weight of programmes coordinated at European level has not evolved significantly (see Figure 16 below).
- Policy experimentation at EU level has not always led to learning, because more and more instruments are added to the whole set-up.

Figure 16. Historical evolution and relative weight of transnational R&D vs. total public R&D funding in Europe



Source: Mustar et al. (2006) cited by Deubner (2007).[73]

5.3.3 *Conclusion*

In view of the above, there is a clear need for consolidation of the various communities, instruments and spaces offered by the EU Horizon 2020: KICs, EIPs, EIIs, JTIs, etc. Notwithstanding their experimental merit and interest for given stakeholders and participants individually, the whole set together multiply transaction costs and reduce opportunities for entrepreneurs in the

[73] No data are publicly available for the more recent history of the Framework Programme. However, EUROSTATS has started to produce "R & D budget statistics - transnationally coordinated research" with data from 2012 in a third round of experimental data collection (http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_budget_statistics_-_transnationally_coordinated_research#Data_sources_and_availability) from which basically three conclusions are drawn, confirming that coordination has stagnated recently: i) "On average, about 3.8 % of EU Member States' R & D budget was directed to 'transnationally coordinated research' in 2010"; ii) "The share of countries' R & D budget directed to 'transnationally coordinated research' decreased slightly in 2010 compared to 2009"; iii) "Framework Programme instruments for coordinating national R & D programmes and other Europe-wide R & D programmes are a major driving force for transnationally coordinated research activities."

periphery – precisely those who can make disruptive innovation happen well beyond existing or sustained innovation approaches.

We thus argue that a new paradigm is needed for EU-level policy whereby the Commission would adopt a more strategic role by focusing only on things it can make happen, such as ERC, EIT, FET, etc., while progressively delegating collaborative undertakings, such as ERANETs, JPIs, JTIs, etc., to longstanding and experienced intergovernmental networks, such as Eureka (for business-led, collaborative R&D) and Cost (for academy-led collaborative R&D).

Infidel frontier-research is the aim of ERC, on top of existing scientific infrastructures and laboratories (ESFRI), while the EIT aims to shape pan-European ecosystems for people-driven innovation. The ongoing debate about a future European Innovation Council (EIC) is rightly focused on scale-ups, as these pose the real problems facing Europe's innovation policy.

From the above, a possible multilevel division of labour emerges for existing schemes and network structures whereby a radically simplified architecture for multilevel policy would be advisable in the longer run as follows:

1. Governments principally responsible as enablers and funders, certainly for human capital and capacity building, including basic infrastructure (education, regulation, etc.).
2. Intergovernmental level, pooling together nationally funded programmes, the largest share by far of public support in Europe, whereby transnational collaboration is not established at EU-level but embedded in nationally funded programmes, and projects with:
    - EU-sponsored 'public-public partnerships' and 'public-led R&D cooperation' with business clusters around COST, progressively including 'Joint Programming Initiatives';
    - EU-sponsored 'private-private partnerships' and 'private-led R&D cooperation' with academia, clustered around Eureka, progressively including 'Joint Technology Initiatives'.
3. Longer-run EU/community level policy support interventions are substantiated in a new interpretation of 'European added value', namely, 'the added value which comes from competition at EU level' (Luukkonen, 2014, citing the Commission Communication 'Europe and Basic Research' (European Commission, 2004), which justified the establishment of the ERC), thus replacing the traditional interpretation of 'European added value' as a synonym of transnational collaboration (Muldur et al., 2006).

5.3.4 Recommended actions

- *Reformulate European added value and focus EU support on interventions which make sense only at EU level, such as ERC, EIT, FET, etc.*
- *Delegate collaborative undertakings such as ERANETs, JPIs, JTIs, etc., to longstanding and experienced intergovernmental networks, Eureka and Cost in particular.*
- *Empower governments with enabling functions while embedding the European dimension fully in their programmes and agencies to create scale of policy.*
- *Shift policy coordination away from project cooperation, as this has shown its limitations and actually reached a plateau in recent years.*

5.4 Europe should embark on transformative but simpler innovation policies

5.4.1 Problem

The current division of labour in the European landscape is far too complex, with regional, national and transnational institutions and programmes, whereby coordination unfortunately is often the responsibility of the actual beneficiaries of funded projects (Granieri & Renda, 2012). Efforts to attempt a higher degree of policy coordination at EU level through project coordination have also shown limitations (see ERANETs, JTIs, JPIs, etc.), as evidenced by data collected by EUROSTAT on 'transnationally coordinated research' since 2012.

Notwithstanding the above, with very notable exceptions such as the ERC, the paradigm for EU-level interventions remains that of promoting transnational collaboration in R&D (and not necessarily impact); collaboration, essentially an instrument, has become a goal in itself, neglecting its ultimate aim of creating value and impact. The proliferation of too many well-intentioned EU-level instruments, as indicated above, has further complicated the overall fabric, both for policy-makers and participants. It is time for a simplified and stable policy framework.

5.4.2 Analysis

It is high time for a more critical review of the effectiveness of demand-side versus supply-side policies introduced at the EU level. Such a review should consider to what extent new policies actually match contemporary ways of production and exploitation of knowledge well beyond traditional R&D-based model innovation 'within firm': open innovation and disruptive innovation in particular (JIIP, 2015).

The character of sustaining and disruptive innovation is quite distinct and, similarly, policies fostering them should also be adapted (see Table 2 below). In particular, public policies for innovation need to be much more entrepreneurial by coupling experimentation with healthy evaluation as a source of learning by doing. The debate on the introduction of an 'innovation principle', complementing the 'precautionary principle' in all EU legislation, reflects this duality, i.e. by doing the right thing one can simply fail, both in business practice and policy-making.

Table 2. Sustaining vs. disruptive innovation

Sustaining Innovations	**Disruptive Innovations**
Better	Different
Premium price	Low price
Next-generation	Good enough for now
Leap forward	Lead down
Complicated	Simple

Source: Adapted from Christensen (2004).

This report advocates a transformation of policies for innovation and entrepreneurship if Europe wants to find its approach and place in an increasingly competitive and complex knowledge world. Obviously, a fundamental change is always more challenging than adding additional layers to the already complex innovation policy landscape that characterises Europe. On the other hand, many new instruments address given stakeholder groups, e.g. rather than reforming the FP to make the whole more business friendly in order to attract firms, large ones in particular; JTIs were put in place precisely to attract such participants. The same is happening with other stakeholders (research for researchers through the ERC, small grants for SMEs with the new SME instrument, etc.), which may result in further policy fragmentation. We argue that rather than targeting given stakeholders in isolation, policies should focus on the right dynamics, e.g. addressing the absence of young leading innovators (Veugelers, 2009) may require a policy intervention to activate latent potential, but the whole ecosystem also needs to be changed to make not just start-ups but also scale-ups a more frequent phenomenon on the Old Continent.

With the emergence of societal challenges as a focal point of policy interventions in Europe, compared to the persistence of mission research in the US, the EU has gained a sense of purpose beyond fostering the competitiveness of European industry (the theoretical logic of the FP in the early days) or shaping the European Research Area (more recently since the Lisbon strategy). With this

opportunity, however, there may be a risk of populating the landscape with too many instruments. Among them, 'Knowledge and Innovation Communities' (KICs) are actually contributing to the coordination of programmes following a 'business logic', resulting in a significant leverage factor; at times, €1 of EIT funding leverages €3 of national and regional funding. Therefore, KICs have the potential to become 'professional brokering' structures for the coordination of meeting 'societal challenges'. And if the multilevel coordination could be facilitated by existing intergovernmental networks (Cost and Eureka – see previous Recommendation), the European innovation fabric could be made much simpler and more easily accessible with the ERC and EIT as operational/infrastructure providers (frontier research and innovation hotspots) coupled with the EIB and EIC as more fluid investors leveraging finance and ventures.

Table 3. Summary challenges and responses for European-level interventions

Established EU-level policy paradigm: transnational collaborative projects	
Structural innovation policy problems	European underperformance explained by
• Fragmentation	• Absent enabling ecosystems
• Innovation gap	• Few innovative world leading firms

Source: Authors' own elaboration.

5.4.3 Conclusion

The mindset change that is so often preached to entrepreneurs is equally relevant to policy-makers and public authorities. After so much policy experimentation at EU level, it is time to create an overarching and stable institutional framework whereby:

- To capture tacit nature of knowledge and wisdom, two councils (ERC and EIC) should be tasked to create an interface between R&I and policy-making, critically contributing to including roadmaps in future impact analysis and solving emerging policy problems, such as the need to amend legislation to incorporate new technological developments or to encourage efforts in basic or applied research to address long-term societal challenges. In particular, the new EIC should promote regulatory, policy and funding coherence.
- On the more operative front, a limited number of agencies, e.g. the EIB and the EIT, would be called on to launch and orchestrate challenge-led, streamlined platforms where research, development and demonstration are tackled for specific societal challenges in a multi-stakeholder fashion, open to new entrants, new technologies, new business models and

citizens. There would be only one such platform for every emerging societal challenge, with cooperation across platforms in case of overlapping issues.

- Widespread action on the ground by stronger, open and dynamic institutions should address innovation and entrepreneurship at the regional and local level. These institutions should be designed to include intra-preneurs and exchange ideas and practices with the private sector, securing high-level commitments. At the same time, they should aim at creating suitable environments for entrepreneurship to flourish, and as such involve citizens, academia, civil society, small and large, new and established companies to harness the potential of local knowledge and talent and its combination within smart specialisation.

Compared to the US, the EU needs fewer anecdotes and more persistence. Policy coordination through project participation has its limits (the current approach); coherence is needed regarding approaches through orchestration at EU level of interventions and strengthening the European dimension within national programmes (see previous Recommendation regarding empowering Eureka and Cost with, respectively, industry-led and academy-led collaborative undertakings and partnerships currently sponsored and managed by the Commission).

Let's insist: transforming is not adding. Europe should now consolidate what it has learned from policy experimentation, get its approach to innovation right for what makes sense at national and EU level (ERC, EIT, EIC and EIB) and then simply keep it simple.

The EIC should not just be another supply-side intervention; rather it should have regulatory power to enact a policy of 'one in, two out' for existing instruments. If the art of painting is about adding textures and pigments, and sculpture about finding the soul by removing matter, the Europe of tomorrow needs more sculptors than painters.

Owing to the turmoil currently affecting the EU in the short term (refugees, the euro, etc.), vision is more than ever an essential characteristic for leadership. Many long-term challenges facing Europe (climate, security, etc.) can only be met through innovation in the broadest sense: collective improvement.

Table 4. A potential strategic innovation framework

Sustained Innovation = higher unit prices; users ask for this kind of innovation	Competence enhancing	Product/Process Innovation	KET (Key Enabling Technologies)
	Competence destroying	Radical/Breakthrough Innovation	ERC (European Research Council)
Disruptive Innovation = lower unit prices; users do not ask for this kind of innovation	In the same market	Customers consume something similar or from this industry	FET (Future Emerging Technologies)
	In different markets	Customers do not consume, since they lack either the capital or necessary knowledge	EIT (European Institute of Innovation and Technology)

Source: Adapted from Vazquez-Sampere (2006), Instituto de Empresa Business School course, unpublished.

5.4.4 Recommended actions

- *Structure a stable policy framework at European level consisting of two councils and progressive consolidation of instruments around a limited number of agencies.*
- *Link action on the ground for stronger institutions at regional and local level.*

5.5 Europe should align policies with innovation and long-term sustainable development goals

5.5.1 Problem

In recent years, there has been a very lively debate on the possible role of regulation as an obstacle to, or a driver of, innovation. Traditionally, regulation has been seen as an obstacle to innovation, especially since it increases red tape, raises barriers to entry by dictating compliance with regulatory requirements, and, by inserting pro-incumbency biases in the functioning of the market, makes it tougher for innovative business models and new products to attract demand. But reality is very different: in many circumstances, well-designed regulation can trigger innovation and steer it towards meeting societal challenges.

5.5.2 *Analysis*

Since the 1970s, work at MIT coordinated by Nicholas Ashford has shed light on the relationship between regulation and innovation. At the EU level, studies for the UK NESTA and later for the European Commission (Pelkmans & Renda, 2014; Renda, 2016) have contributed to a better understanding of this relationship. Since then, better regulation has become increasingly acknowledged as a potential driver of innovation at the EU level. The European Commission also adopted a very interesting communication on better regulation for innovation-driven investment in December 2015, which considered regulation from this exact angle. Later, proposals such as the adoption of an innovation principle and the launch of 'innovation deals' were adopted during the Dutch presidency of the EU.

All in all, however, it is still unclear how these aspects of better regulation will be reconciled with the overall methodology that is being used to scrutinise new proposals and evaluate existing legislation in the EU. Similarly, the link between better regulation and long-term goals (in particular, long-term societal challenges) appears weak at best. It would be very important, in the coming months, to devote more efforts towards making better regulation a true engine of innovation by linking EU rules to the EU's long-term goals.

Key aspects of regulation that affect innovation are stringency, time, flexibility and certainty (Pelkmans & Renda, 2014). *Stringency* relates to how difficult and costly it is for firms to comply with new regulatory requirements using existing ideas, technologies, processes and business models. The amount of *time* that a regulation gives to the targeted stakeholders to comply with the regulatory requirements is essential to stimulating innovation, but timing is a double-edged sword: too little time might discourage innovation and generate an unsustainable increase of compliance burdens, while too much time might crystallise innovation efforts due to the lack of pressure to meet the requirements.[74] Flexible, performance- or outcome-based regulation stimulates innovation more than purely prescriptive regulation does, provided that it is coupled with adequate monitoring and enforcement (see, inter alia, Coglianese,

[74] BERR (2008) and Centre for International Economics (2006) discuss specifically the timing of standardisation. The message is that standardisation should occur neither too early nor too late to stimulate and encourage innovation. An early standard can kill alternatives, e.g. the GSM standard for mobile communications, creating more intra-standard competition. If the standard is imposed too early, this can generate an undesirable lock-in effect, which leaves society trapped in a suboptimal standard. Similarly, the selection of a rigid, non-scalable standard can inhibit both incremental and disruptive innovation, and as such is highly damaging to social welfare and progress.

2015). Also, uncertainty has been found to act as a driver and an inhibitor of innovation, depending on the circumstances.[75]

Today, four main trends can be observed with respect to the use of better regulation tools to foster innovation: the adoption of an 'innovation principle' in the ex-ante impact assessment process; the proposed creation of a European Innovation Council (EIC); the consideration of possible ways to foster 'innovation-driven investment' through better regulation; and within this framework, the introduction of a non-legislative approach termed 'innovation deals', to tackle regulatory obstacles to innovation. Below, we briefly describe these three new proposed arrangements.

The innovation principle was proposed in 2013 by a group of industry representations, think tanks and large companies' CEOs, and was enthusiastically advocated as a necessary change in the EU policy process.[76] Its aim is to ensure that "whenever policy or regulatory decisions are under consideration the impact on innovation as a driver for jobs and growth should be assessed and addressed".[77] One of the key concerns voiced by the signatories is the negative effect that increasingly risk-averse legislation is having on European innovation; that said, the innovation principle is said to be complementary to the precautionary principle. The innovation principle is also said to be open to "anyone who is interested in promoting an 'innovation friendly' and environmentally responsible regulatory environment in Europe", which potentially makes it consistent with long-term decarbonisation objectives, which appear to be the only responsible way to tackle environmental issues today.

The innovation principle was articulated in a more comprehensive way over the past year, as exemplified in a recent monograph.[78] In addition, it was recently endorsed by the Competitiveness Council conclusions of the Dutch

[75] Ashford et al. (1985) claim that "although excessive regulatory uncertainty may cause industry inaction on the part of the industry too much certainty will stimulate only minimum compliance technology. Similarly too frequent change of regulatory requirements may frustrate technological development." More generally, it is fair to state that whenever innovation requires large investment in R&D, the absence of reasonable stability or certainty in the regulatory framework can significantly hinder innovation. Our case study of competition rules applied in the e-communications sector below can contribute to shedding some light on this aspect of uncertainty.

[76] Initially 13 CEOs in 2013, which increased to 22 one year later. The 22 CEOs sent a letter to President Juncker upon his election.

[77] See www.riskforum.eu/uploads/2/5/7/1/25710097/innovation_principle_one_pager_5_march_2015.pdf.

[78] See www.riskforum.eu/uploads/2/5/7/1/25710097/monograph_innovation_principle.pdf.

presidency, and described in some more detail by a new note of the European Political Strategy Center (EPSC, 2016). That said, the methodology behind the innovation principle is still not very detailed, whereas methodological quality would be a decisive factor for the usefulness of adding yet another test to the already quite complex ex-ante impact assessment process.

At first glance, it seems that impacts on innovation, as with all economic, social and environmental impacts, do not need a dedicated test in the impact assessment process. At the same time, however, having a dedicated screen for innovation could 'force' administrations to address innovation impacts when appraising new policies or evaluating existing ones. Ashford & Renda (2016) advocate the adoption of a 'sustainable development test' – aimed at assessing the impact of proposed regulatory interventions in terms of progress along indicators of sustainable development, and thus through multi-criteria analysis – which would probably be more useful than an innovation principle for the simple reason that innovation is a means, not an end, for policy-makers. In addition, any innovation-related test that is relevant for sustainable development and decarbonisation should avoid any incumbency constraint and be open to systemic, disruptive innovation. But we share a number of the concerns voiced by the proponents of the innovation principle, in particular, the lack of a focus on coherence in the current better regulation agenda (in particular with respect to Europe 2020 goals), and the lack of a framework for using scientific and technological inputs in policy-making.

Finally, it may well be that the EU suffers equally or more so from a diffusion deficit, rather than from an innovation deficit.

At the end of 2015, the European Commission published a Staff Working Document, "Better regulation for innovation-driven investment at EU level", that outlines a relatively new approach to better regulation, more oriented towards innovation.[79] The document, initiated by DG Research and Innovation and endorsed by Commissioner Moedas, goes a long way towards acknowledging the potential role of better regulation as a driver of innovation. In addition, the document acknowledges the systemic nature of innovation and its role in addressing societal challenges. Among the problems highlighted by the document (which widely quotes a previous CEPS report by Pelkmans and Renda) with respect to the existing regulatory framework, some are particularly relevant for the purposes of this report. First, the Commission services highlight cases in which the regulatory framework i) is *de jure* or *de facto* prescriptive in technology choice and discourages different solutions and new entrants; ii) establishes a level of stringency which is inconsistent with available cost-

[79] See https://ec.europa.eu/research/innovation-union/pdf/innovrefit_staff_working_document.pdf.

efficient technology, hence delaying investment and deployment of solutions or iii) allows too-frequent changes in standards that may also limit the incentive for investment if a technology is relatively recent. Driverless cars are among the examples mentioned.

Second, the Commission cites cases in which the regulatory framework is not sufficiently innovation-friendly due to i) lack of interoperability of the regulation across sectors and cases in which rules block cooperation and the development of open innovation based on multi-technology sourcing; ii) cases in which regulations that are technology specific are not adapted in a timely way to technological progress or iii) cases of inconsistencies between regulations, which give rise to legal uncertainties and unnecessary additional compliance costs. Among the examples mentioned in the document, the most relevant for the purpose of this paper is related to energy-efficient buildings. The document identifies a number of pieces of EU legislation that would have to be reviewed to boost innovation in the sector, including a recast of the Energy Performance of Buildings Directive (2010/31/UE), a review of the Construction Products Regulation (305/2011) and of the Energy Efficiency Directive (2012/27/UE), plus the evaluation and review of the Eco-Design Directive and the Energy Labelling Directive.

Third, the Commission identified cases in which the implementation of innovation-friendly regulations can also discourage investment and limit the marketing of innovative products, when: i) legislation is not uniformly or not appropriately implemented across member states; or ii) European and national legislation duplicates, overlaps or is not fully consistent or repetitive controls and authorisation procedures are maintained. Here, too, examples include relevant areas for decarbonisation such as eco-design for resource efficiency, energy-efficient buildings and electric vehicles.

Finally, the Commission document identifies some areas in which there are regulatory gaps that might affect innovation, especially by creating fragmentation that could hamper the emergence of innovative products. Examples include again road vehicle automation, and also low-carbon hydrogen in transport.

This document is, in our opinion, a Commission initiative that offers a promising perspective on the policy alignment initiatives that could be achieved at EU level. We strongly endorse the overall approach adopted by the document, and further encourage the Commission to pursue its efforts with a view to promoting systemic innovation, not simply by listening to incumbent stakeholders but to permanent, multi-stakeholder platforms that would engage in backcast (or double backcast) exercises to offer policy-makers input on what set of measures would be needed to stimulate systemic innovation to the benefit of long-term decarbonisation. The problem remains, however, that incumbents

may not adequately represent future disrupting innovation more likely to be generated by new entrants displacing incumbents' technologies.

In the same Staff Working Document, the European Commission also announces that it would pilot so-called 'innovation deals', and indeed a first pilot was launched through an open call for expressions of interest in June 2016.[80] The Commission has clarified that these deals would be a new way to address EU regulatory obstacles to innovation in an open and transparent manner, in the form of voluntary cooperation between innovators, national/regional/local authorities and Commission services to better achieve EU policy objectives. In addition, innovation deals are being piloted as one of the actions under the Circular Economy Action Plan. An important feature of innovation deals is that they seem to be destined for specific cases in which legislation must be clarified or interpreted but not amended. They are, in this respect, presented as a tool for addressing cases in which legislation is difficult to interpret for new players, but never as a way to change EU or national law.[81]

In a companion paper for the European Commission, DG Research and Innovation, Renda (forthcoming) analyses more closely the virtues and possible challenges of such an instrument, by also looking for equivalent experience in the US (in particular, in so-called 'negotiated rule-making', negotiated implementation and negotiated compliance; see Ashford & Caldart, 1999). Based on this past experience, while innovation deals might end up becoming an important tool for the clarification of EU legislation and the removal of 'perceived obstacles' to innovative product and service offerings, there are greater concerns about the suitability of innovation deals for systemic innovation addressing long-term decarbonisation. To mitigate such concerns, it is essential that innovation deals are not underpinned by a belief that 'less is more", and that 'clarification' of regulation should always mean red tape reduction and slashing of regulatory requirements in the name of innovation. On the contrary, as we have amply demonstrated in earlier research, regulation often has a positive impact on innovation, and certainly a clearer regulation, other things being equal, is better than an obscure one. But this does not mean that less regulation should be the objective in innovation deals. Similarly, the red tape rhetoric, also originated in the Netherlands (according to which reducing administrative burdens by 25% would lead to remarkable GDP increases) was not confirmed empirically after years of experimenting with the Standard Cost Model.

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[80] See https://ec.europa.eu/research/innovation-deals/index.cfm?pg=home.

[81] "To offer a pragmatic, flexible and transparent approach to timely address innovation obstacles to trigger growth and jobs whilst fully respecting EU law, without derogating from the existing legislative framework."

Second, the likely nature of innovation deals makes them potentially ill-suited for more disruptive, systemic innovation. Due to their negotiated nature innovation deals might suffer from an 'incumbency' problem, and as such would lend themselves more easily to incremental innovation rather than substantial market reshuffling. Adequate control and monitoring by EU institutions would thus be essential to ensuring that incumbency problems do not exert a disproportionate influence on the way innovation deals are handled.

Third, and relatedly, the governance of innovation deals should be clarified in a number of aspects: How will innovation deals be selected? Where would the applications originate (REFIT stakeholder platform)? Would there be multi-stakeholder advisory boards to avoid incumbency problems? Would the Regulatory Scrutiny Board advise on their implementation and compatibility with existing regulatory frameworks? How would trust be built and nurtured, and what arrangements will be in place to sufficiently avoid adverse selection problems (offering an easy way out to firms that cannot comply with legislation for reasons related to their own inadequacies)? In addition, there are important questions over how to offer legal certainty (guidelines on selection, due process, time horizon, monitoring of compliance, evaluation); how to ensure technology neutrality and avoid the incumbency problem; and how to deal with multi-level governance, especially for what concerns the powers of the European Commission to request clarifications in national and local legislation.

Since it seems clear that it will be member state authorities that will have to report on their implementation and results, it is still unclear how innovation deals are going to work, in a context in which communication between the EU and national levels is not always effective and rapid. The involvement of all levels of government should also be accompanied by the involvement of all relevant stakeholders. A weak rule of law in specific member states should also be taken into account. Overall, it is important to offer more certainty as regards the scope of the instrument. If the innovation deals are only related to possible "clarification, enhanced guidance, existing flexibility and/or demonstration of the innovative solution" (see the SWD of 15 December 2015), then it is also important to clarify that their use is not going to be a 'magic bullet' solution that will bring Europe back to growth, let alone sustainable development. If anything, it would be a sign of greater attention given to possible obstacles to innovation disseminated throughout the 'downstream phase' of EU legislation, i.e. the delivery and enforcement phases. The reasonable expectation is that most of these obstacles will be found in national legislation; that said, it is not clear whether the Commission's attempt to clarify or streamline national legislation will be well received by member states, or if it will be seen as a wild card for the Commission, which will lead it to go *ultra virus* and bypass other EU institutions to recommend and *de facto* impose regulatory changes on member states. All in

all, innovation deals might prove useful in specific circumstances, but will have to be accompanied by a much more ambitious, whole-of-government effort to promote systemic innovation through policies that have in mind swift action for shorter goals, consistently with a longer-term view of societal well-being.

All in all, the best way to adopt a better regulation agenda that fits the EU's purpose would be to tie better regulation to the long-term needs of EU citizens and industry. The current better regulation guidelines, as revised in May 2015, are among the best examples of integrated guidelines for evidence-based policy-making worldwide. At the same time, they still place insufficient emphasis on issues such as policy coherence, long-term impacts, risk analysis, adaptive policy-making, systemic innovation and sustainable development. In this respect, the following changes could be contemplated to improve the extent to which better regulation can become more conducive to policy alignment for the long term.

- The **baseline option** adopted as a basis for major new policy initiatives could be inspired by long-term sustainable development pathways, possibly in a way that is made consistent across policy areas. A first attempt in the direction of common baseline options across Directorates General of the European Commission was made by the Joint Research Centre, but so far this idea has not been fully translated into the practice of impact assessment in the Commission.[82]
- The overall **methodology for the selection of the preferred policy option(s)** for major new initiatives (corresponding to so-called 'primary legislation' in national legal systems) should make use of multi-criteria analysis, where criteria should reflect long-term societal challenges and should be measured by means of dedicated indicators. Such indicators could extensively borrow from the existing well-established literature on indicators of sustainable development, and should be refined and made more EU-specific with the help of mission-led platforms and the EIC (see above, steps 1 to 3).
- The **role of innovation** should be subject to more careful analysis in the better regulation guidelines, as recently evoked also by the Council conclusions of the Dutch presidency. However, accounting for systemic innovation does not mean leading Europe on a deregulatory path. On the contrary, the guidelines could devote more attention to the role of policy learning and experimentation by offering guidance on so-called 'adaptive policy-making', or "planned adaptation";[83] and to the consistency of

[82] See http://publications.jrc.ec.europa.eu/repository/bitstream/JRC94069/lb-na-27019-en-n%20.pdf.

[83] See e.g., McCray et al. (2010). And more recently, IRGC (2015).

prospective policy impacts with long-term sustainable development. Possible ways to make policy more flexible and adaptive include: (i) the use of regulatory sandboxes and other experimental approaches to allow for the ongoing monitoring of the market and social impacts of innovative techniques; (ii) the incorporation of technology roadmaps and the opinion of multi-stakeholder platforms as input for the policy-making process, to ensure that innovative, welfare-enhancing technologies are adequately represented in policy processes and outcomes; (iii) the ongoing monitoring of policy impacts, including through open government techniques.

Box 3. Is the EU more cautious than the United States?

One of the most often quoted differences evoked in the debate over the innovation-friendliness of the US and EU legal systems is the alleged existence of a more precautionary approach to regulation in Europe, which would act as a constraint on innovation by inhibiting the risk-loving behaviour typical of entrepreneurs, and shutting the door on innovative products for fear that they would cause harm. This approach has been extensively quoted in areas such as environmental standards, health and safety, chemicals, etc. One authoritative scholar, David Vogel, has concluded in a widely read book that the EU has gradually come to overtake the US in the area of risk regulation over the past three decades, mostly by bringing in a more precautionary approach to regulation. The issue of the precautionary approach is so heavily felt in Europe that a broad debate has emerged on the need to incorporate an 'innovation principle' in EU policy-making.

Against this background, it is useful to reflect on a number of open questions, which too often receive standardised, not carefully pondered answers.

First, *the statement according to which the EU legal system follows a more precautionary (some would say, anti-innovation) approach does not appear to be fully substantiated in practice*. While Vogel (2010) and others have reported this trend based on a limited number of specific, selected cases, a 10-year research effort culminating in the publication of a thorough report (Wiener et al., 2011) found that reality is much more complex, and there are important cases in which US regulation is much more precautionary than the EU's. Examples include the US standards on particulate matter (so-called 'PM2.5'), which are much more stringent than in Europe, and are also more strictly enforced. More generally, the authors have expanded the number and diversity of qualitative case studies to risk connected to food safety (genetically modified foods, beef hormones, mad cow disease), air pollution, climate change, nuclear power, tobacco, chemicals, marine and terrestrial biodiversity, medical safety, terrorism and precaution embodied in risk information disclosure and risk assessment systems.

In addition to detailed case studies, they also presented a broad quantitative analysis of specific precaution based on a sample of 100 risks drawn from a dataset of nearly 3,000 risks from the 1970s up to 2004 in both the United States and the EU. The results suggest that the degree of precaution exhibited in European and American risk regulation is very similar: averaging across the 100-risk sample in a 35-year period, there are 36 risks that show greater US precaution and 31 risks that show greater EU precaution. In the quantitative analysis the authors find no difference between the relative levels of precaution.

Second, *there is not strong evidence in the literature confirming that the precautionary principle can harm innovation*. Ashford & Renda (2016) survey existing wisdom in this field and argue that in many cases, precaution coupled with adequate stringency, appropriate timing and overall quality or the legal rules is a very important stimulus for innovation, especially of the type of innovation that more directly contributes to addressing specific societal challenges.

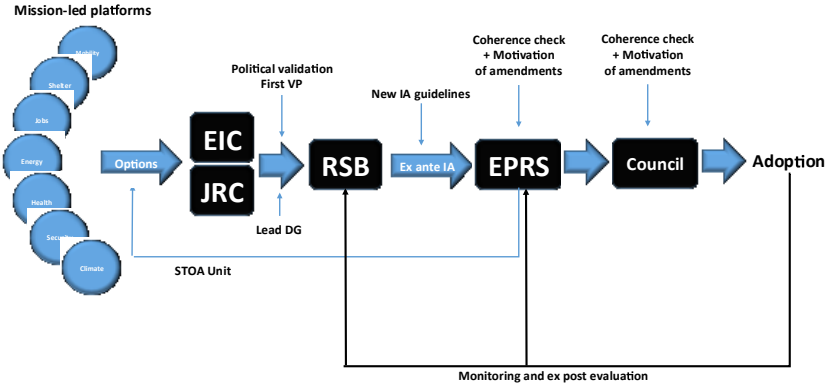
Third*, the overall effect on innovation of legislation in the field of risk regulation must be appraised in a more comprehensive way, in particular accounting for the enforcement and compliance phases*. Simply comparing the text of the rules makes very little sense, if one does not account for the incentives that follow; perhaps the clearest example is the existence of completely different litigation and enforcement systems in the US and the EU: a rule that is apparently more flexible and lenient in terms of ex-ante controls, e.g. US legislation on chemicals, as opposed to REACH, might end up being more effective thanks to the threat of opt-out class-actions fuelled by lawyers paid through contingency fees, and seeking punitive damages with the help of relatively favourable access to evidence rules. In Europe, the absence of a strong litigation system (no opt-out and in many countries not even opt-in collective litigation; no contingency fees; no punitive damages; high cost of access to evidence in court) implies that, once ex-ante regulations were relaxed, very little means would remain to incentivise virtuous conduct on the side of regulated businesses.

Accordingly, it is fair to state that there is insufficient evidence in support of revisiting the precautionary approach as an obstacle to innovation. In a recent speech, Commissioner Moedas announced the introduction of the innovation principle but contended that "this does not mean that there is anything wrong with the precautionary principle. Quite the opposite. If the precautionary principle is understood correctly, it should support innovation".[84] The judgment must thus be made on a case-by-case basis: existing literature only confirms that it is bad regulation (including badly enforced regulation), not the precautionary approach, that can stifle innovation. Once this myth is dispelled, of course it remains to be seen if certain regulatory practices in the US foster innovation more than the homologous EU ones.

[84] See Commissioner Moedas's speech, "Better Regulation for Innovation", 26 May 2016 (https://ec.europa.eu/commission/2014-2019/moedas/announcements/better-regulation-innovation_en).

Below, we show a variant of the proposed reorganisation of the EU policy process proposed by Ashford & Renda (2016), limited to the formation of policies phase.

Figure 17. A reorganised policy process in the EU



Source: Elaboration on Ashford & Renda (2016).

A recent report for the European Commission (Giovannini et al., 2015) also advocated alignment of science and technology policies with the aspirations of the 2030 Agenda, and recommended the following three key avenues for change: (i) switching the focus, reorienting mindsets and behaviours towards sustainable development, reframing the EU's science and technology challenges, and refocusing from technology transfer to building innovation capacity; (ii) strengthening partnerships, enhancing engagement with developing countries in existing EU instruments, engaging all stakeholders (especially the private sector), developing tailor-made international STI initiatives; and (iii) 'walking the talk', addressing causes of implementation gaps, ensuring domestic integration of the SDGs in/with science, technology and innovation policies, improving policy coherence, building up opportunities to benefit from the 'data revolution', and setting up monitoring, evaluation and assessment tools.

5.5.3 *Recommended actions*

- *Consolidate and strengthen the role of research and innovation platforms as sources of policy inputs.*
- *Streamline the role of the EIC and the JRC in converting existing science and research into actionable policy recommendations.*
- *Refocus REFIT exercises towards coherence with long-term goals, including in particular Sustainable Development Goals.*

6. CONCLUSION: A WINDOW OF OPPORTUNITY

The European Union will likely experience a continuing period of turbulence during 2017, after a 2016 characterised by important events such as Brexit and the election of Donald Trump in the US. Political instability might not help Europe reframe its long-term commitments, especially if short-term challenges are not met. This report, however, has shown that a major effort would be needed to ensure that Europe does not miss the opportunities that are offered by ongoing socio-technological transitions. In particular, the parallel evolution of technologies such as broadband connectivity, big data analytics, network virtualisation, artificial intelligence, IoT and human-machine interaction call for a major effort to restructure EU policies in a way that favours socially relevant innovation and create a simpler, comprehensive policy environment in which entrepreneurship can flourish. This requires major interventions in various fields, and a more general refocusing and realignment of EU policies towards sustainable development fostered by innovation and entrepreneurship.

The European Commission has taken action to ensure that EU policy is not an obstacle, and becomes a key driver of innovation. This requires both procedural and substantive changes to the way the EU acts and regulates, and, at the same time, a multi-level effort towards promoting an integrated, dynamic single market. In this report, we have explored a subset of the elements that will be needed to help restore Europe's innovation potential. They were organised within a framework that can be summarised as follows:

- ***3S principles:*** Innovation policy has to become more socially relevant, systemic and simple.
- ***3D criteria***: Innovation policy should focus on development, diffusion, and direction.
- ***3P pillars.*** Innovation policy should follow three channels, i.e. people, places and policies. Below, we report the list of recommendations that we have disseminated throughout the work of the CEPS Task Force, and that are listed above for each of the three "Ps" we have identified in this report.

Recommended actions - PEOPLE

1. Strengthen policy efforts to promote a variety of skills, including STEM education (science, technology, engineering and maths) and coding skills, starting in early school years throughout the EU-28.
2. Promote the inclusion of entrepreneurial skills, managerial skills, creativity and the ability to think outside the box as basic skills to be taught during school years and university.
3. Strengthen public-private cooperation to ensure the exposure of young European citizens to entrepreneurial role models and success stories to encourage emulation among youngsters.
4. Launch a systematic reflection on the security and flexibility needs of the future European job market, with a specific focus on employability, self-employment features and work-train-life balance for the coming years.
5. Promote open access to government-funded research and government-held data to boost data-driven innovation in Europe.
6. Foster legal certainty for data-driven innovation and more generally for text and data-mining activities, especially with respect to EU copyright and data protection laws.
7. Strengthen 'citizens' science' in Europe by creating effective platforms and calling on EU-funded research projects to involve citizens and adopt bottom-up approaches where possible.
8. Promote openness to foreign talent in all member states.
9. Develop guidance on regulatory flexibility to make regulation more conducive to innovation, implementing where appropriate the concept of 'permissionless innovation'.
10. Eliminate useless and redundant red tape, by distinguishing it from regulatory costs that generate benefits and help achieve policy goals.
11. Create one-stop-shops for entrepreneurs by consolidating contact points for access to EU and national funds and streamlining rules for financial and non-financial support.
12. Avoid creating perverse incentives with legislation, e.g. by creating rules that discourage scale-up.
13. Design policies to promote public-sector innovation at all levels of government, including innovation prizes and awards.
14. Promote and foster smart institutional design in innovation agencies and other relevant institutions.

15. Consider the creation of 'entrepreneurs in residence' and other fellowship and mentoring programmes to promote entrepreneurial thinking in institutions.
16. Promote successful role models and success stories more widely, in particular among students, especially among women.
17. Promote, at the local level, the participation of students from late school years and older in gatherings of entrepreneurs and start-ups.

Recommended actions - PLACES

18. Promote open science and data-sharing and the improvement of data quality and management.
19. Ensure that publicly-funded research communities: i) represent all aspects of basic and applied research, innovation, etc., ii) include stakeholders from various fields (not only one industry sector) and iii) become the main source of information for the drafting of innovation agendas and technological roadmaps.
20. Develop new performance measures for academia that encourage further valorisation of research.
21. Develop skills for open science and promote commonly agreed open science standards of research integrity.
22. Promote cooperation between public and private players in shaping and implementing legal rules for platforms.
23. Engage with platforms by seeking their cooperation on nurturing entrepreneurship, shaping university curricula and defining technology roadmaps to be used as a basis for future policies.
24. Develop initiatives on platforms at both European and national levels to encourage evidence-based research to inform policy.
25. Launch foresight activities to explore the future of the platform economy and its implications for policy and society at large.
26. Improve conditions for the platform economy by fostering investments in broadband, the Internet of Things (IoT) and Industry 4.0, by removing unnecessary regulatory barriers and by addressing market concentration and barriers to competition.
27. Preserve the open internet and the free flow of data, enhancing trust in the digital economy.
28. Reduce barriers to entry, e.g. red tape, growth, e.g. size-specific regulations, and firm exit/failure, e.g. penalising bankruptcy legislation, overly strict employment protection legislation.

29. Address regulatory incumbency: Policies often favour incumbents, e.g. R&D tax credits, some environmental regulations, subsidies that delay exit, visa rules.
30. Develop ecosystems through enhancing incentives and access to (risk) capital, developing networks (including the valorisation of research), mentoring of entrepreneurs and developing skills.
31. Complete the Single Market and reduce trade barriers, so firms can scale more easily across borders.
32. Promote scale-up culture through education and media, celebrate success of scale-ups and encourage entrepreneurs to share their success stories.
33. Initiate studies providing evidence on the impact of financial supply-side interventions.
34. Foster pan-European innovation ecosystems that connect diverse and disruptive talent across Europe, and stimulate local entrepreneurship ecosystems in regional policy.
35. Reformulate smart specialisation strategies to encompass coordination and acceleration across European borders and beyond.
36. Coordinate better the various funding mechanisms at EU level to ensure a sharper focus on innovation and entrepreneurship.

Recommended actions - POLICIES

37. Refocus policies for large and small to high-growth companies.
38. Promote healthy cooperation between existing and new business.
39. Establish a suitable balance between direct and indirect support schemes.
40. Facilitate intermediation in access to finance through increased transparency and accountability.
41. Complete the Single Market while pooling public procurement, including 'innovation deals'.
42. The European Innovation Council (EIC) should be sufficiently 'authoritative' to effectively advise governments on good practices to overcome barriers to growth and scale for start-ups.
43. Integrate systemic innovation with better regulation by refining the guidance on innovation impacts in the better regulation guidelines.
44. Align policymaking and better regulation to be in accordance with the EU's long-term impacts and objectives.
45. Set up mission-led platforms to inform policymaking at an early stage about impacts on innovation.

46. Strengthen the better regulation toolkit with more information and guidance on adaptive, experimental policymaking that favours systemic innovation.
47. Reformulate European added-value and focus EU support in interventions that make sense only at EU level, e.g. the European Research Council (ERC), the European Institute of Innovation and Technology (EIT) the Future and Emerging Technologies (FET) programme, etc.
48. Delegate collaborative undertakings like ERANETs, JPIs and JTIs to long-standing and experienced intergovernmental networks, such as Eureka and Cost in particular.
49. Empower governments with enabling functions while embedding the European dimension fully in their programmes and agencies to create scale of policy.
50. Shift policy coordination away from project cooperation as this has shown its limitations and actually reached a plateau in recent years.
51. Structure a stable policy framework at European level consisting of two Councils and progressive consolidation of instruments around a limited number of agencies.
52. Link action on the ground for stronger institutions at regional and local level.
53. Consolidate and strengthen the role of research and innovation platforms as sources of policy inputs.
54. Streamline the role of the EIC and the JRC in converting existing science and research into actionable policy recommendations.
55. Refocus REFIT exercises towards coherence with long-term goals.

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