Report on the State of the European Innovation Union, including an analysis of the 34 commitments, and the working of the European Innovation Systems

Investigating the Impact of the **Innovation Union**

D9.4 | *Report on the State of the European Innovation Union, including an analysis of the 34 commitments, and the working of the European Innovation Systems*

Deliverable:	*Report on the State of the European Innovation Union, including an analysis of the 34 commitments, and the working of the Innovation Systems*
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Version:	Final
Quality review:	*Bart Verspagen, UNU-MERIT*
Date:	06/12/2018
Grant Agreement N°:	645884
Starting Date:	01/01/2015
Duration:	43 months
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645884.

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1. Introduction

The Innovation Union (IU) constitutes a set of measures or intentions to improve the innovation performance in the European Union. The 34 commitments span a large set of actors, conditions and interactions. Although not all aspects of it have to this date been implemented, it is useful to take some distance and evaluate the progress of the implementation of the IU, its strengths and weaknesses so as to take corrective actions. This was the task of Grant Agreement number: 645884 — Investigating the Impact of the Innovation Union (I3U). The evaluation was accomplished in three ways. First, each commitment was examined individually. Second, those commitments for which data and reliable parameters of their impact existed or could be estimated were introduced in the macroeconomic model NEMESIS so as to evaluate quantitatively the effects of the commitments as a whole on a number of economic performances. Third, the whole European Innovation System was examined in terms of its coherence, completeness and efficiency and the effect and effectiveness of the 34 commitments of the IU were examined within this holistic framework. This innovation system perspective was the object of workpackage 9, which is concluded in the present deliverable.

The paper is organized as follows. Section 2 explains the innovation system approach that adopted in the project and the workpackage in particular. Section 3 analyzes how the Innovation Union Commitments address the Innovation Systems that exist in Europe. Section 4 deals with the state of the European Innovation Systems in light of the evidence gathered from the I3U project, in particular also the other workpackages (1 – 8) in the project. Section 5 summarizes and concludes.

2. Conceptualizing Innovation Systems in Europe

2.1. Actors and actor roles

The approach to innovation systems that was adopted in workpackage 9 of the I3U project is based on the identification of actors in the system, and the definition of a number of typical roles for each of the actor types. This was elaborated in D9.1 and D9.3, and will briefly be summarized here.

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There are six actor categories: the higher education sector, public and semi-public research institutes (the institutes sector), private enterprises (firms), governments (policymakers), the finance sector including banks, and consumers. The first two of these traditionally have the role of knowledge generators, including both basic and applied knowledge. Firms are traditionally seen as the innovators, which both generates new knowledge, absorb it, and apply it in innovations that are put on the market. However, in a more modern view of innovation, universities and research institutes are also given a role in innovation, often interactively with firms.

Governments and policymakers have a facilitating function, stimulating the actions of other actors and steering their behaviour and resulting innovative output. Banks and the finance sector have a similar facilitating function, but limited to credit and funding, which are often seen as hampering factors in the innovative process. Finally, consumers are the receivers and beneficiaries of innovation, but are also seen as playing a role in directing innovation, or even in generating innovations and new knowledge.

Within each of these actor categories, we distinguish a number of typical actor roles. D9.1 introduced actor roles for firms, higher education institutes, the institutes sector, the finance sector, and consumers. D9.3 further developed the roles for the government or policy sector.

Four typical roles or modes of innovation are identified for firms. The role 'science-based' refers to firms that innovate through (their own) R&D activities, derive important information and knowledge from universities and research institutes, and whose collaboration is geared towards science-based knowledge. These firms are usually also heavily involved in innovation and devote large amounts of internal resources to it. The 'externally-sourced' mode of innovation refers to firms that use the acquisition of machinery, equipment and software, and the acquisition of external knowledge through for example licenses, and combine this with limited R&D activities. For these firms, innovation does not depend much on internal activities. The 'supply-chain driven' role refers to firms that use co-operation and interaction with suppliers of equipment, materials or components, or with clients, as a source of innovation. Finally, the 'low profile' role relates to limited innovation activities, generating mostly imitative innovations and relaying on arms-length knowledge sources such as fairs and exhibitions.

In the higher education sector, universities and other institutes for higher education are the actors. D9.1 distinguished two typical roles: research-driven universities and education-driven universities. The former type impacts on the innovation system by generating new

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knowledge, which is often used by science-based firms to innovate. Education-based universities mainly have an impact on the innovation system by supplying graduates with specific human capital and capabilities.

Concerning public research institutes two main roles are distinguished: research-driven and market-driven. Research-driven institutes are driven by technological goals and aims, and mainly attempt to generate new knowledge that may ultimately be used in innovation. Market-driven institutes work much closer to the market, and often for firms on the basis of a contractual relationship.

In the finance sector, the two typical roles are risk-taking funders and risk-averse funders. Risk-taking funders are venture capitalists and similar agents, who seek out promising firms with a large profit potential but also high risk. By investing in many of such firms, risk is diversified to some extent, but, more importantly, firms that would not be funded by risk-averse funders get an opportunity to develop. The lack of risk-taking venture capital is often seen as a European problem for innovation (also in the Innovation Union commitments). Risk-averse funders are more often found in the traditional banking sector.

For consumers, also two typical roles were distinguished: the early adopters, and the conservative buyers. The former group is prone to buy new products and thereby stimulate demand-pulled innovation, while conservative buyers are an impediment for this kind of innovation.

Finally, D9.3 distinguished two types of policy actors in the innovation system. Based on a qualitative assessment of innovation policy in European countries, the two roles we identified as (1) organizing, intense, with specific instruments, or (2) facilitating with more generic instruments. The first type of policymakers takes a central and active role in organizing the innovation system. This often involves making choices for specific sectors or technologies. The latter type of policy will limit itself to setting conditions, and, as a consequence only apply generic policy instruments.

With these actors and actor roles in mind, we will now proceed to define four dimensions of innovation systems that can be used to categorize the Innovation Union commitments (this will be done in section 3 below).

2.2. Capabilities, interactions, obstacles and conditions

The approach in WP9 of the I3U project has been to conceptualize innovation systems mainly

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at the level of actors, e.g., firms, universities, and policymakers. In this deliverable, we extend this approach to include more explicitly the way in which these actors operate in the innovation system at large. This will enable us to characterize, interpret and analyze the 34 Innovation Union commitments that are the prime topic of the project.

Four major elements of the innovation systems will be used in our extension of the actor roles in D9.1 and D9.2: capabilities, interactions, obstacles and conditions. Of these four, capabilities are closest related to the actor roles. Capabilities refer to what actors are capable of doing, based on tangible and intangible assets that they possess. Knowledge is an important asset that is used by actors such as firms, universities, and research institutes to produce innovations. Thus, the amount and type of knowledge that actors possess is an important capability in the innovation system. We will discuss other capabilities below, when we address the way in which the Innovation Union efforts affect capabilities of the actors in the European innovation systems.

There is a large literature from many disciplines at many levels of aggregation on capabilities and related concepts such as competence and capacity and skills. Firms often tend to focus on what they are already capable of doing, where they have experience and skills (Smith 1999). This leads to 'core competences' that a firm can hold on to and expand based on experience, but is not easy to develop or switch to a new capability. In addition to 'core competences', Borras & Edquist (2013) find two other widely used concepts: 'dynamic capabilities', defined as a "firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997) and 'absorptive capacity'. The latter can be defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128). Carlsson et al. (2002) derive capabilities from the main features of innovation systems: "the capabilities of the actors to generate, diffuse, and utilize technologies" (Carlsson et al. 2002). They attribute capabilities to actors, and link the concept of bounded rationality to capabilities by stating that actors are rational but act under constraints of limited capabilities.

Nelson (1993) generalizes this to the idea that a "wide range of factors, organizations, and policies influence the capabilities of a nation's firms to innovate". The innovation systems literature broadly speaking point at the system level to the importance of relating the capability for technological change and the capability for institutional change (Freeman 1987; Nelson 2001). As Dopfer (2011) points out, agents are involved in activities at two levels: knowledge and operations. In the National Innovation Systems literature, not only technological and scientific knowledge and capabilities are addressed. Lundval (2007)

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mentions in his explanation of how the NIS concept has developed that one of the insight was that the different styles and mode of innovation and how firms organize themselves is important. As an earlier concept he refers to "NICS concept: "the National Innovation and Competence building System". Other ideas that helped have been: "the distinctions between information and knowledge, between "knowing about the world" and "knowing how to change the world" and between knowledge that is explicit and codified versus knowledge that remains implicit and tacit. (Lundval 2007, p.108). The most important capability at actor and system level according to Lundvall is the capability to learn and build competence.

Next to technological capabilities Fagerberg & Srholec (2008) distinguish and measure social capabilities of countries. The first also includes production capabilities. The latter concept is based on how Abramovitz (1987) has emphasized a range of capabilities that nowadays is often captured by being capable to govern, organize, educate, manage, regulate. 'Policy intelligence' is a notion that could be used for knowledge that make governments capable of producing 'policy innovations'. But we can also think of competencies of various levels of government that are arranged according to the subsidiarity principle that 'higher' levels of governance should not be leading, when national levels are more appropriate. In this respect the EU level has more competencies concerning science. Borrás (2011) also points at the organizational capacities in innovation policies ". She identifies three levels of policy learning and argues that their effects on innovation systems are related to specific capacities of the relevant organizations implementing change".

Interactions between the actors of the system are important for system performance (e.g., Mytelka and Smith, 2002). These interactions can take multiple forms, such as voluntary cooperation, market transactions involving goods or services that affect actors' capabilities, and technological spillovers of various kinds. These interactions can directly produce innovation outputs, e.g., a new product that is jointly developed by a firm and a public research institute, or may affect the capabilities of actors and thus have indirect effects in the system. According to Carlsson et al. (2002) "[o]ne result of interaction (feedback) among actors is that capabilities shift and grow over time, and therefore, the system configuration also changes". Also policy makers interact with other actors in the system, often with the aim to stimulate innovations or, indirectly, increase capabilities of the actors involved, e.g. in doing R&D (Nauwelaers and Wintjes, 2002).

The notion of obstacles refers to factors that hinder or oppose a free working of the system. This may include a variety of factors, both affecting innovation directly (e.g., privacy regulation that obstructs innovation by social media firms), or affecting interaction between

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actors. An example of the latter kind of obstacles is the existence of borders (both literal and metaphorically) that obstruct interaction and collaboration between researchers in Europe. The European Research Area, which will be analyzed in one of the Innovation Union Commitments below, is an example of a policy initiative aimed at removing obstacles in the innovation system. The working of obstacles in innovation systems has not been studied very intensely in the literature on innovation systems. Klein Woolthuis et al. (2005) state that "[h]ard institutional failures refer to the formal institutional mechanisms that may hinder innovation". Mohnen and Röller (2005) found that obstacles to innovation work differently for different phases in the innovation process. "The two phases of the innovation process, i.e. the probability of becoming an innovator and the intensity of innovation, are subject to different constraints. Interestingly, there seems to be a need to adopt a package of policies to make firms innovate, while a more targeted choice among policies is necessary to make them more innovative." Galia and Legros (2004) studied obstacles to innovation faced by French manufacturing firms. Using CIS2 data, they look at obstacles in postponed projects and in abandoned projects. Important obstacles are: costs, risk, skilled personnel and customer responsiveness.

Conditions are factors or circumstances present in the system that shape the aims and goals of the actors. Conditions may be imposed by some actors in the system, or they may be related to broad societal institutions. An example of the first kind of conditions is the notion of research excellence that is often imposed by funding agencies such as research councils, or the notion of market relevance that is imposed by policymakers on publicly funded research institutes. An example of conditions that are related to broad institutions is the system of protection for intellectual property rights through a set of instruments such as patents, copyrights and plant breeders rights. Conditions will shape both the type of output that is produced in the innovation system, and the amount of output. Nelson (2013) clearly links conditions with the aims and goals at the system level in the sense of the "the basic national objectives and conditions".

2.3. Innovation systems in Europe

Based on the empirically identified actor roles, D9.3 identified combinations of these roles that describe the actual national innovation system(s) in Europe. Four basic types of national innovation systems in Europe were identified.

'Strongly Developed' innovation systems are usually highly-developed in the general economic

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sense. Austria, Belgium, Denmark, Finland, Germany, the Netherlands, Slovenia, Sweden, and the United Kingdom are in this group. All parts of the innovation system are well-developed and perform strongly in an internationally comparable context. This group has a strongly innovative firm population at its core and various other functions that can work with this firm population. There are still differences within this group, as some countries have a particular emphasis on a certain actor role.

'Publicly policy-led' innovation systems is the characterization of the next group in which we find France, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta and Portugal. Innovation in the private sector (firms) is not developed particularly well in this group of countries, but public policy in the STI field is developed and active. Innovation therefore primarily becomes a public policy interest. As innovation intensity in the firm sector is "average", public policy initiatives have a potential impact of raising them to higher levels, but this depends on the effectiveness of policy.

'Developing' innovation systems as a third group includes Bulgaria, Croatia, Cyprus, Czech Republic, Hungary, Romania, Slovakia and Spain. Firms in these systems generally tend to have a role that is strongly dependent on external knowledge and competencies, such as supply-chain based innovation and external sourcing. Public policy is developed in a stronger way, which makes them also public policy-led. However, with the particular style of innovation in the firms sector in these countries, innovation policy must be more aimed at absorption in the private sector. Public policy in this group often runs through (semi-)public research in the institutes sector, while the university system tends to be weakly developed. In terms of the so-called technology gap theory (e.g., Fagerberg, 1994), the countries with these innovation systems can benefit from international technology diffusion, provided that their innovation systems provide absorptive capacity.

A fourth group of innovation systems can be characterized as the *'Lagging behind'*, including Estonia, Greece and Poland. In this type of systems firms tend to be either supply chain driven innovators or externally sourcing (as in the previous type), but public policy is weakly developed in a comparative perspective. Thus, public policy does not provide a strong perspective to stimulate innovation in the private sector in these innovation systems.

The conclusion is that innovation systems in Europe differ widely by country. It is the aim of this deliverable to analyze the impact of the 34 commitments of the Innovation Union on this diversity.

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3. How the Innovation Union Commitments address Innovation Systems

We will now proceed to analyze the 34 commitments of the Innovation Union in the context of the innovation systems approach that was outlined in the previous sector. For this purpose we will use information and results from the other work packages of the I3U project (WP1 – WP8), each of which has analyzed a specific subset of commitments. Our analysis in this section will be aimed at outlining which commitments address capabilities of actors, interactions between actors, obstacles found in the system, or conditions. We will also look at which kinds of capabilities, interactions, obstacles and conditions are addressed.

3.1. Capabilities

Errore. L'origine riferimento non è stata trovata. shows the capabilities of actors in the innovations system that are addressed by the 34 commitments (some split into sub-commitments) of the Innovation Union. Commitments that are not aimed at capabilities of the actors are excluded from the table. On the whole, the table shows that the Innovation Union commitments are intensively aimed at capabilities, and address a wide range of them. There are 15 (sub-)commitments in the table, and seven different types of interactions. Also, capabilities of all six actor categories are addressed by the commitments.

A second observation is that there is a diversity of capabilities addressed. All in all, the table distinguishes six kinds of capabilities, with several, such as “innovation” in fact consisting of a range of sub-capabilities. Research is a frequently mentioned capability, especially in the first 9 commitments covered in chapter three of the Innovation Union, which is about “Strengthening the knowledge base and reducing the fragmentation”. Research is a capability that is relevant in three actor categories: higher education, research institutes, and private enterprises. Often, a commitment that addresses research also addresses these three actor categories, but this is not always true (e.g., a specific focus on higher education and institutes, or on small and medium sized firms).
The other main capability category in the table is “innovation”, including “social innovation”. This points to a range of capabilities that enable actors to innovate. This may include design, marketing, human capital, and, in the case of social innovation, also social relations. Recognizing broad innovation capabilities detracts from an exclusive focus on research as an innovation capability, but also makes the policy commitments less focused.

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A third observation is that the policy commitments that aim for increased capabilities, mostly do not address all actors and actor roles. The capabilities of two types of actors are hardly addressed: Finance & banks, and Consumers. Capabilities of policymakers in government are also less addressed than those of the other three actor categories. Some commitments stand out in aiming for capabilities in a broader range of actors and actor roles. Increasing advanced ICT-skills for workers, for example, (commitment 3: promoting e-skills) is expected to be relevant for all actors and actor roles. The actions aimed at increasing scientific research capabilities address a fairly limited number of actors, and actor roles.

A fourth observation is that sometimes the addressed capability builds on existing (strong) capabilities, while in other cases the actions aim to increase capabilities of actors that are new to them, or where they lack capabilities. The latter is, for instance, the case in commitment 9, where we have labelled the concerning capability 'knowledge triangle innovation' because it concerns learning between capabilities in education, research and innovation. Actors are expected to train in how to absorb the output of other actors in the system.

If we focus more specifically on the actor roles within each actor category, we find that there are two major types of actions. On the one hand, we have actions aimed at a broad range of capabilities, and these, consequently, address multiple actor roles (usually they address all actor roles that we distinguish). For example, innovation capabilities at broad are relevant for all kinds of innovating firms: science-based, externally sourced, supply-chain driven and low profile. Similarly, ICT skills matter for both research-driven universities and teaching-driven universities, as well as for research- and market-driven institutes.

On the other hand, actions aimed at research capabilities address only specific actor roles in some of the categories, in particular science-based firm and research-driven universities. While these actions do not address the broad innovation system, they do provide in-depth attention to the crucial capability that research is in the innovation system.

Table 1 : Capabilities of actors in the innovation system that are addressed by the 34 Innovation Union commitments

	HEI	RI	Firms	Government	Finance & banks	Consumers
1.1. Training of researchers	Research	Research	Research			
2.2. Knowledge alliances for skill gaps	Innovation skills		Innovation skills			
3. Promotion of e-skills	ICT skills	ICT skills	ICT skills	ICT skills	ICT skills	ICT skills
4.1. ERA, International	Research	Research				

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	HEI	RI	Firms	Government	Finance & banks	Consumers
collaboration						
6. EU R&I programmes	Research	Research	Research			
7. SMEs in R&I programmes			Research			
8. European forum on forward looking activities				Foresight		
9. Set out EIT strategic agenda	Innovation	Innovation	Innovation			
24. Improve/increase the use of Structural Funds for R&I and Smart specialization	Research, Innovation	Research, Innovation	Research, Innovation			
25. post-2013 Structural Funds for innovation and smart specialization	Research, Innovation	Research, Innovation	Research, Innovation			
26. European social innovation pilot			Social Innovation	Social Innovation		Social Innovation
27. Public sector innovation scoreboard				Innovation		
29. European innovation partnership	Innovation	Innovation	Innovation	Innovation		
30. Attracting and retaining foreign talent	Research, Innovation	Research, Innovation	Research, Innovation			
33. Member States self-assessments R&I systems				self-assessments		

3.2. Interactions

The interactions between actors that are addressed by the 34 Innovation Union commitments are documented in **Errore. L'origine riferimento non è stata trovata.**. As was the case for capabilities, there is a large amount of actions that addresses interactions in the innovation system, as well as a variety of types of interactions. There are 19 (sub-)commitments in the table, and 15 different types of interactions. This makes the interactions category even slightly larger than the capabilities category and broader in range.

Research is an often-found interaction type, and like in the case of capabilities, this is aimed at a limited range of actor roles (research-driven universities, science-based firms). This type of cooperation addresses the innovation system at the level of in-depth interactive activities that are at the core of advanced technological cooperation. The same holds for the knowledge "triangle" interactions in the EIT commitment 9. This kind of interaction involves a large degree of research, but for some of the actors involved in this interaction, other activities

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apply. Research interactions generally face the same issue as already stressed in the capabilities group: they apply to a limited set of actor roles, such as research-driven universities and science-based firms.

There are two interactions in the table that are aimed specifically at skills, both general and specific to ICT. This addresses the education side of the system, with a role for higher education institutes that is different from the research role that they play in other interactions.

Specifically on the policy front, there are three commitments that propose actions for interaction between policy makers and a specific other actor category. For firms, there is commitment 17 on public procurement, which aims to stimulate demand-led innovation. In the institutes sector, commitment 8 asks for science-based policy, with input from the institutes sector, specifically at the level of the European Commission. Policy makers also figure in a number of other actions, in which a range of actors are targeted for multi-actor interaction (commitments 18, 26 and 31).

Consumers and the finance sector, which were the two actor groups least targeted in terms of capabilities, are also the least frequent categories in **Errore. L'origine riferimento non è stata trovata.**. Consumers are only addressed in broad actions aimed at a large range of actors, i.e., there are no specific actions for consumers (this was similar for the case of capabilities). The finance sector is addressed in terms of interactions specifically in commitment 12, which asks for (cross-border) matching of credit to innovative firms.

Table 2: Interactions between actors in the innovation system that are addressed by the 34 Innovation Union commitments

	HEI	RI	Firms	Government	Finance & banks	Consumers
2.2. Knowledge alliances for skill gaps	Skills		Skills			
3. Promotion of e-skills	ICT skills	ICT skills	ICT skills	ICT skills	ICT skills	ICT skills
4.1. ERA, International collaboration	Research	Research				
5. Research Infrastructures	Research	Research	Research			
6. EU R&I programmes	Research	Research	Research			
7. SMEs in R&I programmes	Research	Research	Research			
8. European		Policy		Policy		

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	HEI	RI	Firms	Government	Finance & banks	Consumers
forum on forward looking activities						
9. Set out EIT strategic agenda	Knowledge triangle	Knowledge triangle	Knowledge triangle			
12. Access to finance - Matching			Matching		Matching	
17. Innovative Public Procurement			Procurement	Procure-ment		
18. Eco-innovation action plan	Multi-actor	Multi-actor	Multi-actor	Multi-actor	Multi-actor	
19.1 Creative industries (CI)			Buyer-supplier			
21. Collaborative research and knowledge transfer	Research, transfer	Research, transfer	Research, transfer			
22. European market for IPR			IPR market			
26. European social innovation pilot	Virtual hub	Virtual hub	Virtual hub	Virtual hub		Virtual hub
28. Consultation social partners			Consultation	Consultation		Consulta-tion
29. European innovation partnership	Innovation	Innovation	Innovation	Innovation		
31. Cooperation 3rd countries	Cooperation	Cooperation		Cooperation		
32. Global research infrastructures	Cooperation	Cooperation	Cooperation			

3.3. Obstacles

Errore. L'origine riferimento non è stata trovata. documents the obstacles in the innovation system that are addressed by the commitments of the Innovation Union. As compared to the two previous categories, we have less actions that are relevant in this category: there are 9 (sub-)commitments in the table. In this collection, access is a recurring theme. We find actions aimed at access to research infrastructures (5) , research results (20), venture capital and finance more generally (10 and 11), and research programmes (7). Another, but smaller, recurring topic are legal obstacles, such as in the ERA action (4.1), and

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the venture capital and finance actions (10 and 11).

Table 3: Obstacles in the innovation system that are addressed by the 34 Innovation Union commitments

	HEI	RI	Firms	Government	Finance & banks	Con-sumers
2.1. University ranking	Identification					
4.1. ERA, International collaboration	Legal, funding	Legal, funding				
4.2. ERA remove obstacles for research mobility	Mobility	Mobility				
5. Research Infrastructures	Costs	Costs	Access			
7. SMEs in R&I programmes			Access			
10. Put in place EU financial instruments to attract private finance			Access to finance	Legal and state aid rules	Risk	
11. Access to finance- Venture capital			Access to foreign VC		Legal, fiscal	
14. Unitary patent			Costs			
20. Open access to research results	Access	Access	Access			Access

3.4. Conditions

The conditions of the innovation system that are addressed by the Innovation Union commitments are documented in **Errore. L'origine riferimento non è stata trovata.**. As was the case with obstacles, conditions are a relatively small, but still substantial, part of the Innovation Union: there are 12 (sub-)commitments in the table, which is just slightly over the number of the obstacles, but less that either capabilities or interactions.

Regulation is the most often addressed condition. We find this in terms of regulations over state aid for R&D (13), patents and IPR in general (14 and 23), and regulation in general (15). While some of these actions have a pre-determination in the direction of diminishing regulation or regulatory pressure on firms and other actors, it is also often the case that the nature of the regulation is at stake. This is, for example, the case with commitment 23, which calls for reviewing existing IPR regulations with the aim to foster competition.

Table 4: Conditions in the innovation system that are addressed by the 34 Innovation Union commitments

	HEI	RI	Firms	Govern-ment	Finance & banks	Con-sumers

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	HEI	RI	Firms	Govern-ment	Finance & banks	Con-sumers
1.2. Employment conditions for researchers	Employment	Employment				
2.1. University ranking	Multi-dimension ranking					
5. Research Infrastructures	Excellence (ESFRI)	Excellence (ESFRI)	Excellence (ESFRI)			
11. Access to finance-Venture capital					Fiscal, cross-border	
13. Review State aid framework for R&D and innovation	State aid	State aid	State aid	State aid		
14. Unitary patent			IPR protection			
15. Screening of regulatory framework			Regulation	Regulation		
16. Standardisation		Standards	Standards			
19.2 EU design leadership board			Design excellence			
23. Safeguard rules for IP	IPR agreements	IPR agreements	IPR agreements			
24. Improve/increase the use of Structural Funds for R&I and Smart specialization				S3 as pre-condition		
34. New indicators and monitoring				Indicator		

3.5. The system view

Together, **Errore. L'origine riferimento non è stata trovata. – Errore. L'origine riferimento non è stata trovata.** cover all 34 Innovation Union commitments in their entirety. In terms of the actor categories, higher education institutes are addressed by 23 of the (sub-)commitments, the institutes sector by 22 (sub-commitments), the [private enterprise sector by 29 (sub-)commitments, the public policy sector by 15 (sub-)commitment, the finance and banking sector by 5 (sub-)commitments, and consumers by 4 (sub-)commitments. Although these simple counts do not necessarily reflect the actual policy effort (e.g., in terms of resources devoted), it is clear that while the four first-mentioned categories are well-reflected, this is less so the case for the other two categories, especially consumers. In terms of four main action groups (capabilities, interactions, obstacles and conditions), 22 (sub-)commitments address only one action group. Eleven (sub-)commitments address two

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of these groups, and 3 (sub-)commitments address 3 groups.

On the whole, we may therefore conclude that the 34 Innovation Union commitments together indeed constitute a systemic approach to stimulating innovation in Europe. They address the system as a whole, i.e., all actors, actor roles, and system dimensions.

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4. The State of European Innovation Systems

4.1. Degree of implementation

All in all, one may safely conclude from deliverables D1.3 – D8.3 of this project that the commitments of the Innovation Union have to a considerable degree been implemented and yielded the desired effects. Some examples are as follows.

The training of young researchers and improvements in the employment conditions in public research institutions are supposed to increase the human capital of researchers, attract researchers and hence increase the productivity of graduates in research and in the business sector. Some empirical evidence has been found to support these hypotheses. Positive correlations between placement in the rankings and number of students enrolled have been found. The development of e-skills is supposed to increase the productivity of researchers and of labor in the business sector and the communication between actors of the innovation system, which is also what the data show.

International research collaborations increase the availability of top researchers and the flow of knowledge across countries. Likewise, the international mobility of researchers facilitates knowledge exchange. We observe, indeed, a positive correlation between mobility of researchers and scientific productivity. European research infrastructures create network externalities and enable research collaboration across different countries, regions, sectors and technology fields. This is also what users of the European Research Infrastructure report, whatever the group of innovation system they belong to.

The evidence shows that SMEs that receive public support for innovation are more likely to increase their innovation expenditure, to introduce new products on the market and to increase their turnover and level of employment. The European Institute of Technology is supposed to integrate scientific progress with entrepreneurial and creativity skills. Knowledge and Innovation Communities (KICs) have the mission to create golden triangles between education, research and business, teaching not only to produce ideas but also to commercialize them. Indeed, we can notice an increase in the number of innovations coming from the KICs, the number of start-ups created, the number of business ideas incubated and the number of new graduates from EIT labelled programs.

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In order to overcome some of the financial market failures in innovation, the EU Commission has over the years introduced a number of policies: InnovFin, European Venture Capital (EuVECA) Funds, the Startup Europe initiative and the Enterprise Europe Network (EEN), and a revision of the General Block Exemption Regulation (GBER). Econometric analyses found a positive effect of these financial sourcing mechanisms on private R&D.

Tests of the efficacy of regulation have been performed in two European Innovation Partnerships: EIP-Water and EIP-Raw Materials. Empirical evidence points to the positive effect of present and anticipated regulations on eco-innovation. Standardization stimulates innovations by disseminating new knowledge, reducing uncertainty about future technological developments, ensuring compatibility and interoperability of component technologies and by increasing the expected scale of returns from innovation. The experience in Germany shows that firms do not abandon an innovation project because of standards. Pre-procurement and public procurement for innovation can channel demand towards new products and thereby stimulate innovation. Empirical results show a positive correlation between them and innovation.

Cooperation in research between private firms, but also between firms and research organizations and universities increases the productivity of research and the incentive to undertake frontier research because of cost and competence sharing. Empirical studies have confirmed the positive correlation between collaborative research and R&D and innovation output. European Innovation Partnerships (EIP) were established in collaboration with stakeholder communities to encourage innovation and solve global challenges. The initiatives created linkages among innovation actors, facilitated knowledge spillover and promoted connectivity and collaboration among stakeholders.

However, the actions that are connected to the 34 commitments of the Innovation Union have various degrees of implementation. Knowledge alliances and partnerships between business and higher education (commitment 2.2) are stronger in the Nordic and Central European countries as a result of national characteristics, regulations and cultures. Retaining and attracting international talent (commitment 30) is only partially implemented. As D1.3 reports, “the share of high-skilled third country migrants in the total workforce is still quite low among EU economies”. The European Venture Capital (EuVECA) Funds (commitment 11) are marketed in all 28 EU countries but the funds come from only 15 of them. The unitary European patent (commitment 14) has not been implemented yet. Pre-procurement and public procurement (commitment 17) are slowly taking up in H2020. Member States are slow

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in introducing the corresponding European directives. Few firms so far participate in procurement tenders. There is still a lot of heterogeneity in Technology Transfer Offices in Europe (commitment 21). Currently, the market for technologies (commitment 22) is not yet sufficiently developed, slowing down technology trading and licensing. The reasons are a lack of market safety, information asymmetries and other uncertainties which drive up transaction costs, and the valuation of technologies. The private market for online matching platforms has still not converged to a dominant business model. Regarding the greater use of the Structural Funds for innovative projects (commitment 24), it turns out that in general in the 2007-2014 Multi-annual Financial Framework the Member States plan to reduce the proportion of the Structural Funds devoted to R&D and innovation. Inclusive innovation (Commitment 28) is still at an early stage of implementation, even though some important first steps have been taken. The implementation failure here is the result of various deficiencies, such as the lack of a clear formulation, the insufficient information of the social partners about their role, the autonomy of the social partners plus their highly fragmented organizational structure at the EU level. Scientific cooperation projects with third countries (commitment 31) are mostly bilateral. An interim evaluation of Horizon 2020 shows that third-country participations declined when compared to FP7.

4.2. Closing and widening the innovation system

With all this information, it is possible to provide an assessment of how the commitments work in the European innovation system, or rather, the collection of European national innovation systems. This is an important goal of this deliverable, and we will draw on the above analysis and other results in D1.2 – D8.3 to arrive at such a conclusion. The key questions in this respect are whether the different innovation systems that we distinguished in earlier deliverables (in particular D9.3) are addressed by the Innovation Union commitments in a balanced and homogenous way, and what is implied by the Innovation Union commitments for their future comparative development.

To answer these questions, we note that in the series of deliverables D1.3 – D8.3, there are two main sets of conclusions. On the one hand, some of these deliverables conclude that the commitments that they analyzed are unequally aimed at the innovation systems that are found in the European Union, and hence that there will be a tendency for these systems to develop at differential rates as a result of this commitment. This may either lead to convergence of innovation systems, i.e., when weaker systems are more positively affected by the commitments or policy actions, or to divergence, i.e., when the stronger systems are more

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positively affected. On the other hand, there are commitments or policy actions that affect all innovation systems in the European Union across the board, and are therefore not expected to lead to either divergence or convergence between innovation systems in Europe.

There are 13 commitments policy actions for which the deliverables D1.3 – D8.3 have pointed to a potential for diverging European innovation systems, in particular between the strongly developed innovation systems in Europe on the one hand, and the developing or lagging behind innovation systems on the other hand (commitments 1, 2, 3, 4, 5, 6, 7, 10, 11, 14, 21, 30 and 31). The general mechanism at work in these policy actions is that the Innovation Union commitments tend to have effects mainly in terms of the actors in the system that are already strong performers, such as science-based firms, or good research-driven universities. By stimulating activities of those actors, the weaker innovations systems (developing or lagging behind) are not much affected, simply because they contain few of those actors, while the strongly developed innovation systems are positively affected. This kind of tendency is especially prone in cases where the policy action is aimed at research capabilities or research interactions in the innovation system. The discussion of **Errore. L'origine riferimento non è stata trovata.** and **Errore. L'origine riferimento non è stata trovata.** already pointed to this possibility, by noticing that these kinds of policy actions are targeted mostly at a limited set of actor roles, and that these roles are found mostly in the strongly developed innovation system.

For example, university rankings (commitment 2.1) may increase the gap between the two extreme systems of innovations because the most developed innovation systems have a greater capacity to be highly ranked and thereby to outperform even more the countries in least developed innovation system. For commitment 1.1, D1.3 concluded that there are noticeable increases in the number of PhD students in the European Union, but that these increases are mostly visible in the countries with a strongly developed innovation system. For commitment 4.1, the conclusion reached in D1.3 was that although the European Research Area offers opportunities to all researchers from all countries, these opportunities are more often taken by researchers from countries with a strongly developed system. It thus seems that other countries lack a minimum level of absorptive capacity that is needed to enable them to benefit from the European Research Area. Researchers get attracted to the most developed innovation countries (commitment 5, researchers' mobility). For commitments 5 (research infrastructures) most of the money goes to participants from strongly developed systems. Lagging countries find it hard to participate in such international research collaborations, where excellence tends to collaborate with excellence. Regarding commitment 6 (EU research programmes). D2.3 (p. 25) concluded that "FP7 funding is concentrated in

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actors coming from economies classified in the "European Innovation Scoreboard 2017" (European Commission, 2017) as either innovation leaders (IL) or strong innovators (SI); same for the number of participants. Therefore, it can be hypothesized that one negative aspect of the FP7 programme is that it contributes to the innovation divergence within the EU." A dichotomy still exists between old (EU15) and new (EU13) member states in terms of participation and success rates in SMEs receiving funding (commitment 7), although there are some exceptions like Estonia, Slovenia and Cyprus, who outrank the EU15 after controlling for size, number of researchers and national R&D investment. The total financing provided under the risk sharing scheme (RSFF), InnovFin and the European Venture Capital Funds was unequally allocated across countries: the funding went mainly to firms belonging to the most developed and public-policy led innovation system. Similarly the amount of R&D financing coming from abroad was also concentrated in a few countries, but here it went partly to firms in the developing innovation system category. International collaborations (commitment 31) are on the rise, but only countries in the most advanced innovation systems are heavily involved in international scientific collaborations (in terms of scientific publications and the share of non-EU doctoral students).

There are also commitments and associated policy actions that are not specifically aimed at research capabilities or interactions, but still are likely to contribute to divergence in the Innovation Union because these policies are conditional on being innovative in the first place. One example of this is commitment 15 (screening of regulatory frameworks), where D4.3 (p. 44) concluded that "the implementation of C15 and the resultant more coherent and conducive regulatory frameworks are expected to induce effects that differ across European Innovation Systems (EISs): in the presence of strong private and public innovation capabilities, a more conducive regulatory framework should have the strongest innovation-enhancing effect among members of the Strongly developed EIS."

The commitments or policy actions analyzed in D1.3 – D8.3 that point to convergence of European innovation systems are less frequent. In particular we find 7 commitments where the analysis in the deliverables reaches a clear conclusion that the weaker innovation systems are more positively affected than the strongly developed systems. These are commitments 9 (EIT strategic agenda), 16 (standards), 18 (Eco-innovation action plan), 19 (Creative industries), 22 (market for patents and licenses), 23 (safeguarding rules for IPR) and 25 (smart specialization).

As an example of a converging tendency, we may quote D4.3 (p. 107): "the implementation of Eco-Innovation Action Plan (commitment 18) focusing on innovation towards sustainable

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development is expected to exert different effects across the different European Innovation Systems (EISs) … and have the strongest effects in the weaker EISs, such as the Developing and Lagging-behind EISs, where innovation and public policy-making capabilities are weaker, in general, and where capability-enhancing initiatives also have the strongest effects". Another example is the development of a market for patents and licenses (commitment 22). As D5.3 reports (table 5.2), the major beneficiaries here would be countries in the developing EIS, as these countries rely on complex technologies, which require complex licensing structures, and therefore "this is more an opportunity for catch-up through international knowledge diffusion for developing and lagging behind ecosystems than for more developed ones". One condition, however, is the presence of absorptive capacity. Likewise the revised guidelines on horizontal standardization agreements and technology transfer agreements and the Block Exemption Regulations for research and development reduce the legal uncertainty and make technology transfers more efficient than before. As D5.2 concludes "While firms in strongly developed and publicly-led innovation systems may have been adversely affected by the new regimes, the opposite may hold for firms in developing and lagging behind innovation systems". The European Creative Industries Alliance is found to have had positive and significant effects for the public-policy led and the lagging behind groups of countries. And finally, smart specialization is likely to have the largest impact in the countries belonging to the developing and lagging innovation regimes.

It is interesting to note that the commitments with a converging influence almost exclusively address interactions between actors or conditions of the system. It thus seems that interactions and conditions are particularly useful policy targets in terms of convergence inside the Innovation Union, while especially policy actions aimed at capabilities of actors seem to be leading to divergence. By focusing more explicitly on the capabilities of actors in lagging or developing innovation systems, this tendency could certainly be reversed, but in the current Innovation Union, capabilities of advanced actors seem to be more often targeted.

A final word is in order about the commitments 24 and 25, which deal with the role of the Structural Funds in the European innovation system. By their very nature, the Structural Funds are aimed at cohesion, i.e., convergence between different parts of the European Union in terms of socio-economic living standards. By linking the Innovation Union to the Structural Funds in commitments 24 and 25, the cohesion aim also became part of the Innovation Union. As the analysis in this section has shown, there are, however, a number of clearly diverging tendencies that result from the policy actions that are connected to the Innovation Union commitments. This may indeed be in the very nature of innovation, in which firms and other actors compete on the basis of knowledge and other inputs into innovation. Given that these

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diverging influences have been identified, it is especially interesting to look at the effects of commitments 24 and 25 on cohesion.

The analysis in D6.3 pointed to a number of policy actions in these commitments that are clearly aimed at increasing cohesion. However, while those elements are clearly present, it was also the case that their actual impact was not sufficiently visible yet. The analysis in D6.3 and the workpackage 6 in its entirety did not yield any clear-cut evidence that the inclusion of Innovation Union objectives and policy actions has led to an identifiable impact on cohesion in the European Union. While more research using better data may yield a more conclusive evidence base in the future, it also seems commendable to re-assess these policies and possibly re-formulate them, so that better results may be obtained in terms of convergence between European innovation systems.

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5. Conclusions and Summary

Our conclusions relate to two main topics: the nature of the European innovation systems, and the consequences of this for the development of innovation in Europe; and the nature and progress of the policies that are part of the 34 Innovation Union Commitments that were analyzed in the I3U project. We summarize these conclusions below, while a number of more specific recommendations (often at the level of individual commitments) are elaborated in Box 1.

As developed in D9.3, the European Innovation System (EIS) is characterized by four types of regimes:

- Strongly developed (strongly developed in a general sense; all parts of the innovation system well developed and competitive): *Austria, Belgium, Denmark, Finland, Germany, the Netherlands, Slovenia, Sweden, and the United Kingdom*;
- Public-policy led (active science & technology & innovation policies but not so well-developed private sector; overall good performance): *France, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta and Portugal;*
- Developing (depend strongly on external knowledge; weak performance, but public policy important for advancing the system): *Bulgaria, Croatia, Cyprus, Czech Republic, Hungary, Romania, Slovakia and Spain*;
- Lagging behind (depend strongly on external knowledge; weak performance, weak public policy initiatives): *Estonia, Greece and Poland*.

It has been shown that, while some of the commitments allow the countries in the developing and lagging behind groups to catch up with those in the most advanced innovation group, a majority of the commitments tend to increase the innovation divide within the European Innovation System (EIS). This rising gap between European countries in matters of innovation capacity and performance may be inevitable if the Union as whole wants to keep pace with the progress in the rest of the world, but it may also be an issue of concern for European policy makers. A tradeoff may exist between efficiency in innovation and equality in the distribution of inputs and returns of the innovation process.

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The analysis of the effects of the 34 commitments of the IU has also uncovered a number of weaknesses that should be examined in more detail. First, there is a high fragmentation of research along country boundaries and, going with it, a lack of transparency and duplication of research efforts. This is most visible with university-industry alliances (commitment 2.2), research infrastructures (commitment 5), inclusive innovation (commitment 28) and KICs (commitment 9). Heterogeneity exists because of different national priorities, regulations and overlapping societal challenges. Second, to perform an accurate evaluation of some of the commitments of the IU, the micro data needed are simply lacking. Either the concepts are not clearly defined as for social innovation (commitment 26) or the goals are set clearly but the appropriate data have not yet been collected as for the promotion of e-skills (commitment 3), public procurement by Member States (commitment 17), the European Creative Industries Alliance (commitment 19), the open access (commitment 20), the trade in technologies (commitment 23), and scientific cooperation with third countries (commitment 31). Third, there may be conflicts between the European Community and local or sectoral interests. For example, the European Innovation Partnerships (EIP) were established in collaboration with stakeholder communities who were incentivized to come up with their own research and join forces in the implementation of the jointly set targets. The implementation was somewhat problematic because the communities had not put money aside to finance these activities and because the EIP gradually shifted to satisfy the sectoral interest. In the end, innovation was no longer the primary drive.

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Box 1 – Specific Recommendations

The analysis in this deliverable as well as many other deliverables (in particular the third deliverables of workpackages 1 – 8) has yielded insights that lead to specific recommendations on the implementation of the Innovation Union. These can be summarized as follows.

Recommendation 1 – Looking at convergence and divergence of European innovation systems

Some of the Innovation Commitments are likely to lead to divergence in terms of innovation capabilities, either because of the very nature of the commitment (e.g., because the implied policy is targeted at innovation leaders), or because the commitment is implemented in various degrees in the different member states of the EU. This leads to the following recommendations at the commitment level (C1/ C3/ C4/ C5/ C6/ C10/ C11/ C13/ C14/ C18/ C30):

There are a number of commitments that are especially important in the parts of the EU that are lagging behind in terms of innovation (e.g., the developing and lagging-behind innovation systems identified in the project). Strong implementation of these commitments in these weaker parts of the EU will lead to stronger convergence and cohesion. However, there are no specific policy measures aimed at strengthening the implementation of these commitment in the weaker parts of the EU. Such a strengthening could be achieved by explicitly linking these commitments to Commitments 24 and 25, which are concerned with the use of the Structural Funds for innovation purposes. This holds specifically for Commitment 1 (training of researchers and improving employment conditions of researchers), Commitment 3 (e-skills), Commitment 4 (European Research Area, ERA), Commitment 5 (research infrastructures), Commitment 6 (research and innovation programmes), Commitment 10 (financial instruments to attract private finance), Commitment 11 (attract venture capital), Commitment 13 (review state aid frameworks), Commitment 14 (unitary patent), Commitment 18 (eco-innovation), Commitment 30 (attracting foreign talent). For some of the commitments (1, 3, 4, 5, 6, 10, 11, 18) in this list that require significant investment of resources, we recommend that their implementation is specifically linked to the Structural Funds, with financial resources from the Structural Funds made available for such implementation. For the commitments in the list that do not depend crucially on investment of resources (13, 14, 30), we recommend a specific revision of the policy aimed at making it

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more effective in countries with weaker innovation systems.

Recommendation 2 – Better monitoring commitment implementation and outcomes

The analysis for some of the commitments has been severely hampered because of serious limitations in available data. Sometimes, this is due to the nature of the commitment, e.g., because it does not provide clear aims and goals so that measurement is difficult, and sometimes this is due to absence of (publicly available) datasources. More attention should be given to making available relevant data, leading to the following recommendation for specific commitments (C7/ C12/ C16/ C17/ C19/ C22/ C23/ C31):

New key indicators need to be developed to measure important dimensions of the policy commitments. Existing datasources are often aimed at measuring "how much" rather than at "how well". This holds for Commitment 7 (SMEs in research programmes – we can measure the quantity of such participation, but not the quality of it), Commitment 12 (access to finance – the commitment asks for better matching but this is not sufficiently quantified), Commitment 17 (public procurement – hardly any data exist), Commitment 19 (creative industries and design), Commitment 22 (European market for IPR – there is a specific need for databases stemming from other sources than the patent offices), and Commitment 31 (cooperation with third countries – we can measure the quantity of such cooperation, but not the quality of it).

Also, the availability of micro data on firms or other agents is often crucial for proper monitoring of policy. Without sufficiently rich (number and type of variables) and longitudinal micro data, causality (i.e., whether the policy really makes a difference) is often impossible to establish. This holds for Commitment 7 (SMEs in research programmes), Commitment 16 (standardization – this needs in particular data combining information on standards, innovation and performance), Commitment 19 (creative industries and design), and Commitment 23 (safeguard rules for IPR).

Recommendation 3 – Adjustment and intensification of policy measures

The analysis in the project yielded specific conclusions about potential adjustment of the policies implied by the Innovation Union commitments, or about their intensification. At the commitment level, this leads to the following recommendations (C7/ C8/ C11/ C15/ C17/ C18/ C20/ C21/ C26/ C27/ C28/ C29):

In Commitment 7 (SME participation in research and innovation programmes), the new FP9 can build on the successful implementation of this commitment in previous Framework

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Programmes, by continuing the specific attention to SME participation, and by devoting a larger amount of resources to this end. Also, better coordination of EU-level and national policies in the topic of this commitment is called for. In Commitment 8 (forward looking activities), wider dissemination of policy and foresight papers, especially from the JRCs would make the policy more efficient. In Commitment 11 (access to finance – venture capital), a stronger emphasis on diffusion and implementation across the EU of the InnovFin instrument is called for. For Commitment 15 (screening of regulatory frameworks), a continued effort at more implementation vigor is recommended from the analysis, since implementation has not been complete in any member state. For Commitment 17 (public procurement), an effort to spread awareness and use of the public procurement tool is necessary. In Commitment 18 (eco-innovation), more attention to the demand side, e.g., by measures aimed at changing the consumer's mindset are called for. In Commitment 20 (open access publishing), more attention is needed to the receivers' side, e.g., measures aimed at absorptive capacity in SMEs. For Commitment 21 (collaborative research and knowledge transfer), a number of policy reforms have already been suggested by previous literature, e.g., aimed at increasing the resources available for Technology Transfer Offices (TTOs) and strengthening their role in general. For Commitment 26 (social innovation), the analysis showed a general lack of coordination of policies and even a common working definition. Social innovation may have a potential for positive change, but it needs to be targeted in a more comprehensive and coordinated way. In Commitment 27 (public innovation), the decision to not implement a public sector innovation scoreboard should be followed up by new and systematic initiatives to monitor and foster innovation in the public sector. For Commitment 28 (social partners), a general lack of implementation was observed, and a recommendation for clarifying the goals and aims of this commitment can be given. For Commitment 29, a refocusing towards activities targeting genuine frontier innovation would increase the effectiveness of the policy. For Commitment 32 (global research infrastructures), the MERIL database could be developed into a comprehensive and up to date source of information.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645884.