Chapter 7

Financing Innovation

Carolina Rodríguez Rodríguez

Additional information is available at the end of the chapter

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Abstract

Financing innovation is the mechanism that allows public support for public or private innovation to compensate the inherent market failure of innovation activities. An insight of the main drivers and mechanisms of implementation at European level is provided.

Keywords: financing, innovation, market failure, public support, innovation policy

1. Introduction

Throughout history, innovations have been taken place with or without financial support from external sources, under the umbrella of specific research and innovation programmes or "out of the box". Socio-political and economic conditions have contributed to challenge innovation conditions to penetrate markets [1, 2].

This chapter is focused on financing innovation (non-technical military ones) in the European context, as the mechanism that allows public support for public or private innovation to compensate the inherent market failure of innovation activities. An insight about the current state of play of mechanisms to support systemic[1] and technological innovation is summarized through strategy, policy and implementation approaches to deal with the "funding gap" for investment [3, 4].

There is a large number of available mechanisms to promote public and private investment in research and innovation (from lower Technology Readiness Levels[2] to higher ones) to increase competitiveness at global scale [5, 6].

[1]Systemic innovation means completely redesigning the way a system works (for example, the health service), and achieving innovation across every part of it.
[2]Technology Readiness Levels (TRLs) are indicators of the maturity level (TRL 1 being the lowest and TRL 9 the highest) that provide a common understanding of technology status and address the entire innovation chain.

Public-Private Partnerships (PPPs), Joint Technology Initiatives, Public-Public Partnerships, Knowledge Innovation Communities, and InnovFin [7] (as access to risk finance) are some examples of innovation supporting schemes. Furthermore, collaborative research, innovation, coordination, and support actions promote cooperation not only between different kinds of entities (enterprises, universities, research centres, etc.), but also among countries and regions, with a view to approaching internationalization, globalization and competitiveness challenges [8].

2. Open Innovation

There are several challenges and needs at socio-economic level that may be tackled through innovation, on the basis of a collaborative and open approach [9, 10].

Regarding Europe's competitiveness, lower growth than its main competitors seems to be due to a productivity gap caused by lower levels of investment, and barriers to implement some kinds of innovation at practical level in all segments of society.

Concerning education, some 25% of European school children have poor reading skills, under a third of Europeans aged 25–34 have a university degree (40% in the US, over 50% in Japan), and European universities rank poorly in global terms—only 2 are in the world top 20. Therefore, the European institutions stand for a better knowledge economy with more opportunities to help people work longer and relieve the strain.

The five policy targets for the European Union (EU) in 2020 can be summarized as follows:

1. Employment: 75% of the 20–64 year olds to be employed.
2. Research and innovation: 3% of the EU's gross domestic product (GDP) investment.
3. Climate change and energy sustainability: greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than 1990, 20% of energy from renewables, and 20% increase in energy efficiency.
4. Education: reducing the rates of early school leaving below 10%, at least 40% of 30–34-year olds completing third level education.
5. Fighting poverty and social exclusion: at least 20 million fewer people in or at risk of poverty and social exclusion.

Coherently, challenges for smart growth include the combination of public and private investment levels (to reach 3% of EU's GDP, specifically) as well as better conditions for innovation. Digital agenda for Europe to create a digital market, Innovation Union refocusing on research and development, and youth on the move to help students for the future job market are the current main flagships.

Cooperation within regions, European Member States and Associated Countries, and other countries in a global context is a pillar of enhancing current capacities towards better results. The conceptual insights behind *Open Innovation*, *Open Science*, and *Open to the World* highlight

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actions to strengthen every link in the innovation chain. Reforming the regulatory environment (through Scientific Advice Mechanism, InnovRefit, Innovation Deals (IDs), and Policy Support Facility), boosting private investments in research and innovation, and maximizing impacts (through the seal of excellence for projects, simplification, etc.) are the three pillars of the strategy to foster Open Innovation (**Figure 1**).

From a historical perspective at European scope, common research and innovation has been done since the Iron and Steel Community; from 1984, FP1 legitimized the expansion of research and innovation programmes beyond energy and information technologies becoming the Commission's industrial policy. Until FP6, just about cross-border research and development actions by the Commission were justified as having European Added Value. The Commission

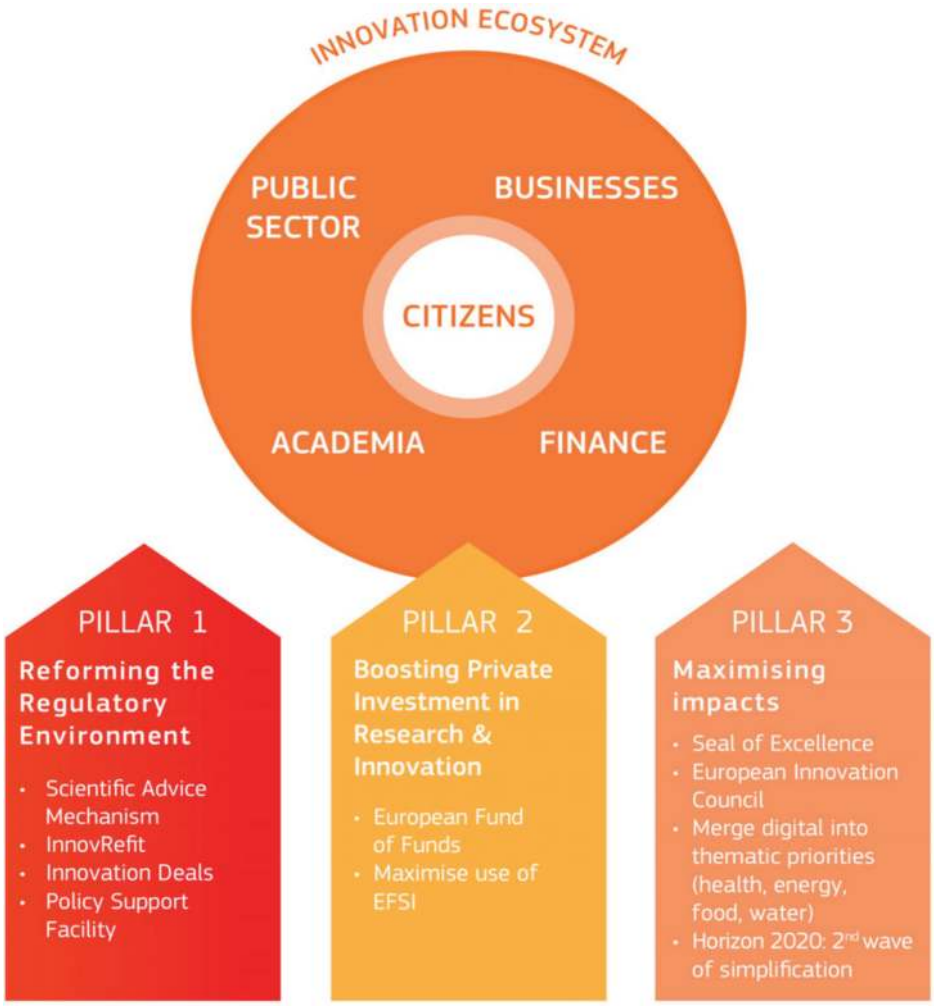

Figure 1. The European Commission's pillars to foster Open Innovation.

respected the subsidiarity principle and kept out of national research and innovation policy, however, the budgets kept increasing. From FP7, the agenda-setting function has become more explicit moving the focus of the FP from solving problems to seizing opportunities using this idea to tackle societal 'Grand Challenges' such as environment, ageing, and health.

Some authors identify different generation approaches linked to societal challenges:

- *First generation*: basic research; a policy for science. The linear model implies there is little need for coordination.
- *Second generation*: 'science policy' but actually the birth of innovation policy, more demand-led, industry-focused. Eventually, an understanding of the need for 'holistic' research and innovation policies and therefore a need for cross-sectorial coordination.
- *Third generation*: societal rather than industrial demands made of science. It requires large transitions and shifts in socio-technical systems. Coordination needed not only across sectors in research and innovation but among wider policies.

3. Mechanism of implementation

3.1. Horizon 2020: an overview

Apart from the national and regional, bilateral and transnational instruments for cooperation, the practical implementation measures to approach challenges at European level have a common main framework: Horizon 2020—the Framework Programme for Research and Innovation (2014–2020).[3]

The legal basis of different mechanism of implementation and instruments are described in the Treaty of the Functioning of the European Union (TFEU) and the Rules for Participation of Horizon 2020 and its three pillars (Excellence Science, Industrial Leadership, and Societal Challenges), which stand for a rather high degree of variability (in terms of target entities/institutions, degree of collaboration, timeframe of the actions, etc.) (**Figure 2**).

Among all, mechanisms of implementation can be divided into grants/subsidies, and loans, even if other schemes, as public procurement are also implemented. Collaborative projects (e.g. Research and Innovation Actions, and Coordination and Support Actions), Small and Medium Enterprise (SME) Instrument, Fast Track to Innovation, European Research Council grants (e.g. Proof of Concept), Marie Sklodowska-Curie Actions (to foster research career, with a number of typologies to create links to the innovation environment, like the Innovative Training Networks, or the international and inter-sectorial cooperation through the Research and Innovation Staff Exchanges) are some examples of the abovementioned variability.

The management of those schemes is a competence of the public administration itself, together with delegated *ad-hoc* institutions in some special cases.

[3]Horizon 2020 is the biggest EU Research and Innovation programme with nearly €80 billion of funding available over 7 years (2014–2020).

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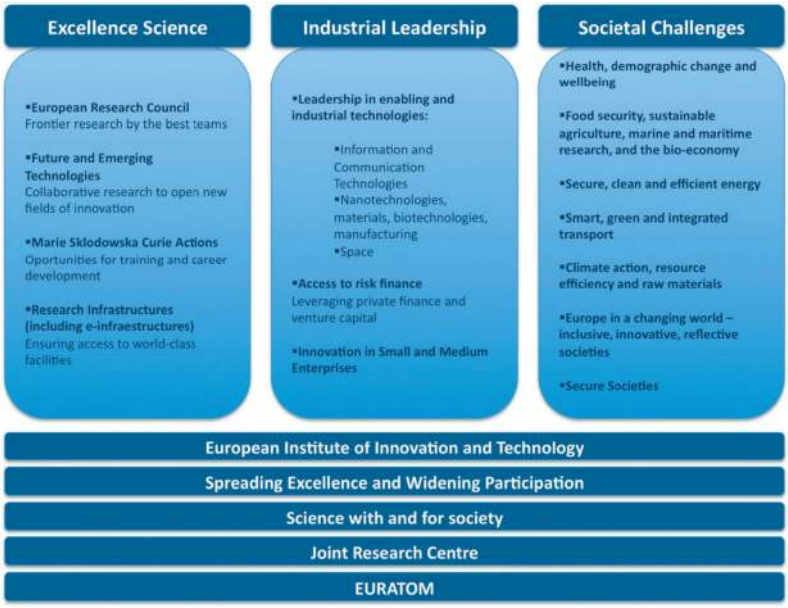

Figure 2. Horizon 2020 (2014–2020) main structure.

The TFEU also foresees the launching of new initiatives at any moment, after a positive assessment following the Better Regulation principles (e.g. new Art. 187 TFEU, namely Joint Technology Initiatives, or Art. 185 TFEU, as long-term Public-Public Partnerships for the execution of new integrated programmes).

3.2. Public-Private Partnerships

Contractual Public-Private Partnerships (PPPs) of strategic importance for the European industry were launched to leverage investments to be allocated through open calls for proposals, managed by the public administration itself. Their conceptual approaches are industry-driven to enable a long-term, strategic approach to research and innovation and reduce uncertainties by allowing for long-term commitments. Some of them are inspired by the Key Enabling Technologies, identified in 2009 to tackle societal challenges from a multiple industries' approach (on micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies) to bridge the well-known "Valley of Death" (from knowledge to market, and from science to production) (**Figure 3**).

Some thematic examples of PPPs are outlined below:

- Factories of the future towards high added value manufacturing technologies (clean, highly performing, environmentally friendly).
- Energy-efficient buildings towards a high-tech building industry to develop affordable breakthrough solutions at building and district scale.

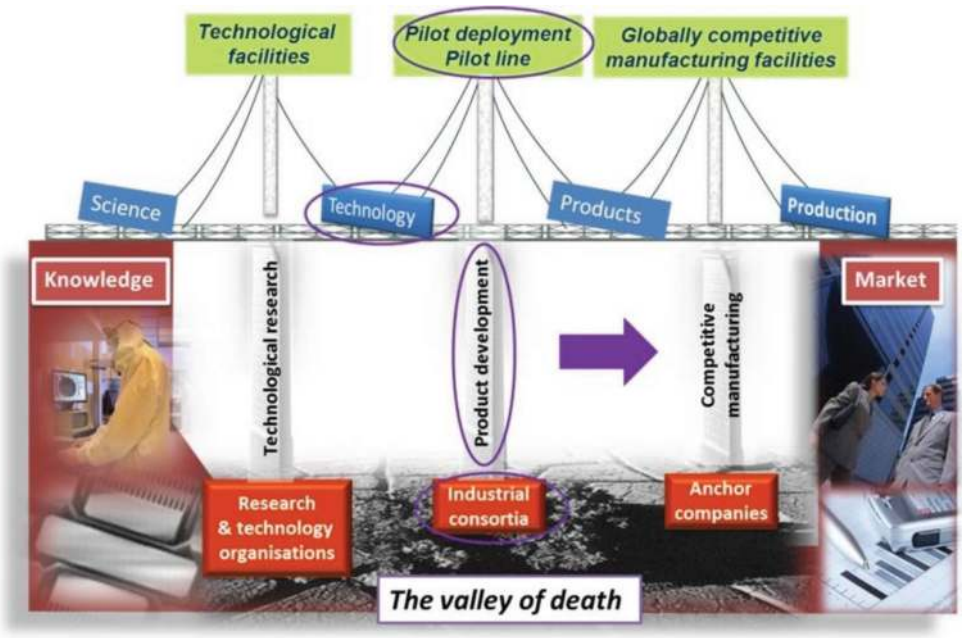

Figure 3. Valley of Death.

- Green vehicles to deliver green vehicles and mobility systems.
- Sustainable process industry to innovate in resource and energy efficiency enabled by the process industries.
- Photonics, bringing together all players from the European photonics sector and related activities including end-user industries and professionals.
- Robotics, teaming up of the robotics industry, research and academia.
- High performance computing.
- Advanced 5G networks for the future Internet.
- Cybersecurity to access innovative and trustworthy European solutions (information and communication technology products, services and software).

Joint Technology Initiatives aim at implementing Public-Private Partnerships in technological fields. The legal entities to implement them, Joint Undertakings, are industry-driven, as well as the calls for proposals. Meaningful examples are the following:

- Innovative Medicines 2 (IMI2) developing next generation medicines and treatments.
- Fuel Cells and Hydrogen 2 (FCH2) accelerating clean and efficient technologies in energy and transport.

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- Clean Sky 2 (CS2) developing quieter aircraft with less CO_2 emissions.
- Bio-based Industries (BBI) fostering greener everyday products and renewable natural resources.
- Electronic Components and Systems for European Leadership (ECSEL) boosting Europe's electronics manufacturing capabilities.
- Shift2Rail developing better trains and railway infrastructure that will drastically reduce costs and improve capacity, reliability and punctuality.
- Single European Sky ATM Research (SESAR) 2020 standing for a European Air Traffic Management system that will enhance the performance of air transport.

3.3. Public-Public Partnerships

Public-Public Partnerships allow European Member States and Associated Countries to draw up joint research and innovation programmes [11–13]. They target the highest level of integration of national programmes at scientific, management, and financial levels through long-term commitments [14, 15]. Dedicated Implementation Structures manage their calls for proposals for 7–10 years, in general. The Public-Public Partnerships launched under Horizon 2020[4] are the following:

- European and Developing Countries Clinical Trials Partnership 2 (EDCTP2) dealing with treatments for diseases within poverty environments.
- The European Metrology Programme for Research and Innovation (EMPIR) focussing on technologies to measure.
- Eurostars 2 provides support for high-tech SMEs.
- Active and Assisted Living Research and Development Programme (AAL) empowering the elderly and disabled to live safely in their own homes.
- Partnership for Research and Innovation in the Mediterranean Area (PRIMA) [16] on water and agro-food systems, with an important approach to equal footing in neighbourhood countries in the Mediterranean region in the future.

European Joint Programmes (EJP) and Joint Programming Initiatives (JPI) through ERA-Nets (COFUND) target alignment of national programmes within a timeframe of 1–5 years.

3.4. Knowledge Innovation Communities

The Knowledge and Innovation Communities (KICs) are partnerships that bring together businesses, research centres, and universities. They allow new companies to be started and a new generation of entrepreneurs to be trained [17].

KICs are inspired in "knowledge triangle integration", as a coordinated process in which the diverse skills and competences are empowered to deliver new products, services and

[4]Under the FP7, BONUS was launched to tackle the key challenges of the Baltic Sea Region.

business models; equip students with the skills to become entrepreneurs; and create start-ups and accelerate the scaling-up of ventures. The current KICs are the following:

- Climate-KIC about climate change mitigation and adaptation.
- EIT Digital aiming at generating world-class Information and Communication Technologies.
- KIC InnoEnergy addressing sustainable energy.
- EIT Health focused on healthy living and active ageing.
- EIT Raw Materials towards sustainable exploration, extraction, processing, recycling and substitution.

The funding model stands for a public financial contribution to a maximum of 25% of a KIC's overall resources over the KIC's lifetime. The public administration financial contribution to the KIC is provided in the form of a grant for action, where the funding rate for the specific grant may be up to 100% of the total eligible costs of KIC added-value activities.

Each of the KICs operates in innovations hubs called 'Co-location Centres' across Europe to catalyse impacts within regions.

3.5. InnovFin (access to risk finance)

"InnovFin—EU Finance for Innovators" consists of integrated financing tools and advisory services to support investments from through a wide range of loans and guarantees. Financing is either provided directly or via a financial intermediary, most usually a bank. InnovFin has been developed in such a way to provide a series of integrated and complementary financing tools [7] (**Figure 4**).

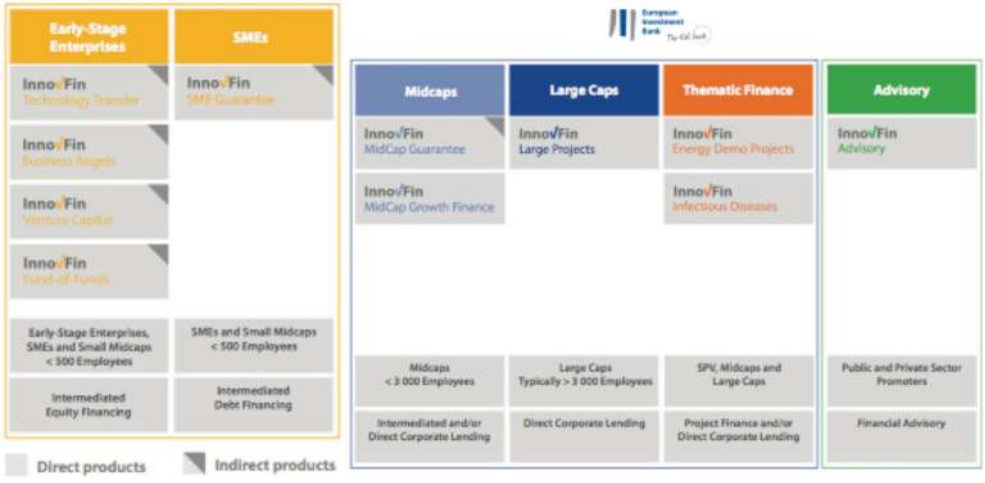

Figure 4. InnovFin product table.

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InnovFin builds on the success of the former Risk-Sharing Finance Facility developed under the seventh EU framework programme for research and technological development 7th Framework Programme (2007–2013) (FP7).

3.6. European Innovation Partnerships

European Innovation Partnerships (EIPs) are challenge-driven, focusing on societal benefits and a rapid modernisation of the associated sectors and markets. There is no budgetary provision for the outcome of their activities; however, their governance, with a high level group including public and private sector, the elaboration of the Strategic Innovation Agendas, and the calls for commitments has influenced the design of call for proposals and financial instruments (**Figure 5**).

3.7. Innovation Deals

One meaningful example to support innovation without financial support is the Innovation Deals (IDs). They aim at overcoming the regulatory environment, as already mentioned to swiftly address legislative obstacles, shortening the time between moment of inspiration and market uptake. If a rule or regulation is confirmed as an obstacle to innovations that could bring wider societal benefits, the deal will make it visible and feed into possible further action [18].

The IDs are inspired by the "Green Deal" Programme of the Government of the Netherlands, where a large number of Green Deals are proving to be successful in supporting the national Green Growth policy by providing regulatory clarity for innovative solutions. IDs take the form of voluntary cooperation between the European Union, innovators, and national, regional and local authorities.

One of the most relevant communications is "Closing the loop—an EU action plan for the circular economy". It explains the concept of Innovation Deals as "a pilot approach to help innovators facing regulatory obstacles (e.g. ambiguous legal provisions), by setting up agreements with stakeholders and public authorities".

Figure 5. European Innovation Partnerships.

4. Impacts

Important impact mechanisms may operate over extended time periods at policy/governance level. Both sorts of research and innovation are at various times needed [19].

Different mechanisms of implementation may lead to different types of impacts, from scientific/technological to economic impacts that can denote changes at the organizational and also national budgetary levels, and or cultural and societal impacts reflecting changes to mind-sets or behaviours.

The alignment of programmes through the creation of networks called "process impacts" can range from:

- policy-related or conceptual impacts when participation (e.g. in a Public-Public Partnership) changes the way a certain research area is perceived at policy level;
- connectivity impacts reflecting the collaboration of funding agencies or programme managers that can have a long-lasting effect;
- capacity building impacts in organizational and personal skills in international programme management for instance;
- attitudinal/cultural impacts reflecting a more positive or negative attitude towards transnational collaboration; and
- structural impacts relating to changes in institutions and structures in the national or European research landscape.

When analysing different programmes, those impacts are usually examined at project level. So, a common practice in the evaluation of research and innovation programmes reflects the notion that the impact of the whole programme is the aggregate impact of the component projects.

For example, in 2015, around 4500 transnational projects had been funded by the Public-Public Partnerships representing a combined investment of some €5 billion. Most of the networks, and the national funding organizations, have some forms of monitoring system for the projects that are spawned from Joint Calls but assessment of their economic, societal and/or environmental impacts is less common [20, 21]. Impacts by beneficiary (research organization, industrial organization, public administration, societal organization, and environmental organization) could be summarized as shown in **Figure 6**.

Type of Beneficiary	Outcomes	Intermediate Impacts	Global Impacts
Research organisation	new technology, new data/method, formal publications, patents	additional research income, commercial income, increased research capacity, spin-off businesses, enhanced reputation	new research trajectories, new solutions for socio-environmental challenges, economic spill-overs to industry
Industrial organisation	new product/service, new technical process, new organisational process, patent, improved capacities	increased turnover/profit, new jobs, protection of existing jobs, increased market share, geographic expansion	economic spill-overs to other businesses, new solutions for socio-economic challenges
Public service organisation	new methods/services, new organisational process	improved service quality, reduced cost of service delivery	improved health, safety, security and/or quality of life for citizens
Public administration	improved scientific evidence, new organisational process	improved governance, reduced administration costs, evidence-based policy making	improved economic, social and/or environmental impacts
Societal organisation	improved scientific evidence, improved services, improved capacities	increased influence	improved standards/regulations, improved quality of life
Environmental organisation	improved scientific evidence, improved services, improved capacities	Increased influence	improved standards/regulations, reduced environmental impacts

Figure 6. Outcomes, intermediate impacts, and global impacts by beneficiary.

The literature says research and innovation-society links focuses on direct effects as increasing in the stock of useful knowledge, supplying of skilled graduates and researchers, developing new instrumentation and methodologies, creating of networks and stimulation of social interaction. The solving capability is based on "spin-off" companies and the provision of social knowledge [22, 23].

A review from the Organisation for Economic Co-operation and Development (OECD) suggests there seem to be six kinds of impact mechanism to consider:

- Human capital development—which is not orthogonal to the other categories but tends to feed into them.
- Research-influenced changes in policy, agenda-setting.
- Industrial innovation (including innovation in services as well as products and processes).
- The improved exercise of professional skill, for example, in research-based improvements in medical practice.
- Tackling "grand" or societal challenges, that impede social and economic development or provide existential threats (e.g. climate change).
- The provision of improved public goods (and potentially the provision of associated state services).

At European level, there is an evolution of instruments and on-going exercises to deep on impacts [24, 25].

Author details

Carolina Rodríguez Rodríguez

Address all correspondence to: carolinardrd@gmail.com

European Commission – Directorate General for Research and Innovation, Brussels, Belgium

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