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EVALUATION

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REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Ex-post evaluation of Horizon 2020, the EU Framework Programme for Research and Innovation

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Abbreviations

AAL	Active Assisted Living
CCI	Cross-cutting issue
CEF	Connecting Europe Facility
CIP	Competitiveness and Innovation Programme
COSME	EU programme to improve competitiveness of enterprises (2014-2020)
CS	Case study
DG	Directorate-General
ECA	European Court of Auditors
EESC	European Economic and Social Committee
EF	European fellowships
EFSI	European Fund for Strategic Investments
EIC	European Innovation Council
EIT	European Institute of Innovation and Technology
EJP	European Joint Programming
EMPIR	European Metrology Programme for Innovation and Research
ERA	European Research Area
ERC	European Research Council
ERICs	European research infrastructure consortia
ESIF	European Structural and Investment Funds
ERDF	European Regional Development Fund
ESS	European Spallation Source
EU	European Union
FET	Future and Emerging Technologies
FP	Framework programme
FTE	Full-time equivalent
GACD	Global Alliance for Chronic Diseases
GDP	Gross domestic product
GloPID-R	Global Research Collaboration for Infectious Diseases
IA	Innovation actions

IF	Individual fellowships
IOI	EU innovation output indicator
IPR	Intellectual property rights
IRDiRC	International Rare Disease Research Consortium
ITN	Innovative training networks
JPIAMR	Joint Programming Initiative on Anti-Microbial Resistance
JRC	Joint Research Centre
JU	Joint undertaking
KIC	Knowledge and Innovation Communities
KPI	Key performance indicator
LEIT	Leadership in Enabling and Industrial Technologies
MORE	Mobility of Researchers in Europe
MSCA	Marie Skłodowska-Curie actions
NMBP	Nanotechnologies, advanced materials, biotechnology and advanced manufacturing and processing
PRIMA	Partnership for Research & Innovation in the Mediterranean Area
PRC	Private for-profit entities (excluding higher or secondary education bodies)
RIA	Research and innovation actions
R&I	Research and innovation
RI	Research infrastructure
RISE	Research, innovation and science expert group
SC	Societal Challenges
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises
SoE	Seal of excellence
SwafS	Science with and for society
SWD	Staff working document
SEWP	Spreading excellence and widening participation
TFEU	Treaty on the Functioning of the European Union
TRL	Technology readiness levels

VC	Venture capital
UN	United Nations
WHO	World Health Organization

Glossary

Term	*Meaning or definition*
Administrative data	Data collected by government entities and agencies in the course of their regular activity for administrative purposes, such as to keep track of project payments.
Applicant	Legal entity submitting an application for a call for proposals.
Application	The involvement of a legal entity in a proposal. A single applicant can make several applications in different proposals. A single proposal can include several organisations and, therefore, several applications.
Associated countries	Association to Horizon 2020 is governed by Article 7 of the Horizon 2020 Regulation. Entities from associated countries can participate under the same conditions as those from EU countries. A country becomes associated to Horizon 2020 through an international agreement. Associated countries and territories in Horizon 2020 were: Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia, Turkey, Iceland, Norway, Switzerland, Armenia, Georgia, Israel, Moldova, Tunisia, Ukraine, and the Faroe Islands.
Background and foreground IPR	Background patents, i.e. patent (or other IPR) applications that are inputs of research rather than outputs, i.e. for which no causal link can be established with the support received by the programme (e.g. IPR applications reported by participants but filed before the start of the Horizon 2020 project. Foreground patents (or other IPR) are those filed after the start of the project that are genuine outputs of project research.
Causality	The sufficient link from one factor or event, the cause, to another factor or event, the effect.
Citation Distribution Index (CDI)	The citation distribution index is the sum of the weighted share of each decile of a distribution of publications, ranked by citation count (i.e., the 1st decile includes the 10% least-cited publications, the 10th decile includes the 10% most cited publications). This indicator is also normalised by year and by subfield of science. The CDI is normalised to 0 (i.e., the world average). A score above 0 indicates a level of performance above average, while a score below 0 indicates the opposite.
Close-to-market actions	Type of action under the Horizon 2020 Programme. They funded activities intended to produce plans, arrangements or designs for new, altered or improved products, processes or services, including: prototyping, testing, demonstrations, pilots, large-scale product validation and market replication.
Contractual public-private partnership (cPPP)	Structured public-private partnerships that have direct input into the preparation of work programmes in areas of major industrial significance. They develop roadmaps for research and innovation activities. There are currently eight partnerships: Factories of the Future, Energy-efficient Buildings, Green Vehicles, Future Internet, Sustainable Process Industry, Robotics, Photonics and High Performance Computing.
Control group	A group that is suitable for comparison with the group of units that were subject to a given policy. For more information, see Annex 2.

Coordination and support action (CSA)	An action consisting primarily of accompanying measures such as standardisation, dissemination, awareness-raising and communication, networking, coordination or support services, policy dialogues and mutual learning exercises and studies, including design studies for new infrastructures. This may also include complementary networking and coordination activities between programmes in different countries.
CORDA (and eCORDA)	CORDA stands for Common Research Datawarehouse. It is the internal repository of Research & Innovation data gathered from EU research and innovation framework programmes. eCORDA stands for External COmmon Research Datawarehouse. It contains data on projects and proposals.
Correlation	Association between two variables. The establishment of a reasonable correlation between variables does not imply the establishment of a causal effect.
Counterfactual impact evaluation (CIE)	Refers to statistical procedures to assess the effect of a policy measure and gauge the degree to which it attained its intended consequences. For more information, see Annex 2.
Cross-cutting issues	In Horizon 2020: 1. The development and application of key enabling and industrial technologies as well as future and emerging technologies 2. Areas relating to bridging the gap between discovery and market application 3. Interdisciplinary and cross-sectoral research and innovation 4. Social and economic sciences and humanities (used interchangeably with social sciences and humanities, SSH) 5. Climate change and sustainable development 6. Fostering the functioning and achievement of the ERA and of the flagship initiative 'Innovation Union' 7. Framework conditions in support of the flagship initiative 'Innovation Union' 8. Contributing to all relevant Europe 2020 flagship initiatives 9. Widening participation across the EU in research and innovation and helping to close the research and innovation divide in Europe 10. International networks for excellent researchers and innovators such as European Cooperation in Science and Technology (COST) 11. Cooperation with third countries 12. Responsible research and innovation, including gender 13. SME involvement in research and innovation and broader private sector participation 14. Enhancing the attractiveness of the research profession 15. Facilitating transnational and cross-sector mobility of researchers.
Differences in Differences (DiD)	A counterfactual impact evaluation (CIE) method. For more information, see Annex 2.
Direct leverage	Difference between a project's total costs and the EU contribution given to the project.
Direct leverage factor	Ratio of the direct leverage and the EU contribution. It is related to the 'Funding rate' (see the definition below) via the following formula: $Direct\ leverage\ factor = \frac{1}{Funding\ rate} - 1$
Dissemination action	The public disclosure of the results by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications in any medium.
European innovation partnerships (EIPs)	Public-private partnerships that bring together actors at EU, national and regional level to: boost research and development; coordinate investment in demonstration and pilots; anticipate and fast-track any necessary regulations or standards; and increase demand,

	in particular through better coordinated public procurement to ensure that any breakthroughs are quickly brought to market.
European Research Council (ERC)	The European Research Council is a European funding organisation for excellent frontier research which offers different grant schemes: starting grants, consolidator grants, advanced grants, synergy grants and proof of concept. The ERC is led by an independent governing body, the Scientific Council.
European technology platforms (ETPs)	Public-private partnerships in the form of industry-led stakeholder forums to develop research and innovation agendas and roadmaps for action at EU and national level (private and public funding), mobilise stakeholders to deliver on agreed priorities and share information across the EU.
Eurostars-2	The Eurostars-2 joint programme under Horizon 2020 supported SMEs that carried out R&D. It brought together 33 participating countries, 4 partner countries and the EU. The programme was based on Article 185 of the TFEU and was implemented by the EUREKA Secretariat (ESE), participating countries and the EU.
Excellent proposals	Eligible proposals assessed with a score above the quality threshold (proposals evaluated positively).
Exploitation action	The use of results in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities.
FET flagships	Large-scale European public-private partnerships that are science-driven at the start but gradually increase industrial participation over their 10-year duration. There are currently two flagships: Graphene and the Human Brain Project.
Financial instruments	Equity or quasi-equity investments, loans, guarantees and other risk-sharing instruments. Horizon 2020's financial instruments operated in conjunction with those of COSME. Strong synergies were to be ensured with the European Fund for Strategic Investments (EFSI) to create the maximum possible impact. This was the main form of funding for activities close to market under Horizon 2020.
Fast track to innovation (FTI) actions	A type of action under Horizon 2020 that funded any kind of project on close-to-market innovation activities.
Focus areas	Five focus areas were defined in Horizon 2020 to stimulate the development of knowledge and technologies deemed crucial to tackling societal challenges: • boosting the effectiveness of the Security Union (predominantly funding projects on vulnerabilities and threats related to European cybersecurity, migration and (financial) technologies); • connecting economic and environmental gains - the circular economy (predominantly funding projects on technological innovations in industrial processes and the reuse of resources to reduce waste and CO_2 emissions); • digitising and transforming European industry and services (predominantly funding projects concerned with automation, artificial intelligence and machine learning, as well as Earth observation); • building a low carbon, climate-resilient future (predominantly funding projects on energy production and consumption, emphasising the economic and environmental aspects of electricity storage, distribution and use). • promoting sustainable blue growth in the marine and maritime sectors through a responsible management of marine resources for a healthy, productive, safe, secure

	and resilient seas that are at the core of thriving eco-systems, climate regulation, global food security, human health, livelihoods and economies.[1]
Funding rate	Ratio of the EU contribution to a project and project's total costs.
Future and emerging technologies (FET) actions	Type of action under Horizon 2020, funding projects on future and emerging technologies (such as biotechnology, global system science, green technology, medical and neuro-technology, nanotechnology, quantum technology, robotics, and new materials).
High quality proposal	A proposal that scores above the quality threshold.
IKAA	In-kind contributions to additional activities. Under Horizon 2020, private members of some JUs (CS, FCH, BBI, S2R) had also to provide a minimum amount of in-kind contributions in respect of costs incurred for 'additional activities' outside the JU's work programme and budget, but falling within the scope of the JU's general objectives.
IKOP	In-kind contribution to operational activities. As provided for in the Joint Undertakings' founding regulations, all private members must contribute a minimum amount to the costs of the JUs' research and innovation projects. Under Horizon 2020, IKOP represented the total costs incurred by private members in implementing the JU's research and innovation actions, less the contribution of the other members of the JU (EU co-financing, contribution of participating states or intergovernmental organisations), as well as any other EU contribution to those costs.
Innovation action	An action primarily consisting of activities directly aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services.
Interservice groups	Commission mechanism to ensure internal consistency of policy interventions.
Intervention logic	A (narrative) description and usually a diagram summarising how the intervention was expected to work. It describes the expected logic of the intervention or chain of events that should lead to the intended change
Joint programming initiatives (JPIs)	Public-public partnerships with EU Member State authorities to increase joint programming of national research programmes in a specific area, by developing a shared vision for the area, defining a Strategic Research Agenda (SRA) and SMART objectives (specific, measurable, achievable, relevant and time-bound) and preparing their implementation.
Joint undertakings (JUs)	Public-private partnerships with industry and stakeholders for the joint funding and implementation of strategic research and innovation agendas (via a joint undertaking under Article 187 of the EU Treaty, co-owned by the EU). There are currently six initiatives: the Innovative Medicines Initiative (IMI), Electronic Components and Systems for European Leadership (ECSEL), Fuel Cells and Hydrogen (FCH), Clean Sky, Bio-based Industries (BBI)and Shift2Rail (S2R). In addition, there are two JUs that are not JTIs: Single European Sky ATM Research (SESAR) and Fusion for Energy (F4E).
Knowledge and Innovation Communities (EIT KICs)	Partnerships between stakeholders in the innovation process (higher education institutions, research organisations, companies, etc.). They take the form of a strategic network, co-funded by the European Institute of Innovation and Technology (EIT). The network can have various legal forms and carries out multi-annual strategic planning

[1] European Commission, Blue Economy Report, 2021, pp. 109-110,

	(mid- to long-term), to develop innovative products and services, start or support new companies and train entrepreneurs. The EIT KICs under Horizon 2020 were: EIT Climate-KIC, EIT Digital, EIT InnoEnergy, EIT Health, EIT Raw Materials, EIT Food, EIT Manufacturing and EIT Urban Mobility. The EIT Culture and Creativity has been created under Horizon Europe.
National contact points	Network funded by the framework programme tasked with providing guidance, practical information and assistance on all aspects of participation in Horizon 2020.
Newcomer	A Horizon 2020 participant who was not involved in an FP7 Project (not an FP7 participant).
Oversubscription	Share of eligible proposals evaluated as above quality threshold that were not retained due to budget constraints, out of all eligible proposals evaluated by experts with a score above the quality threshold.
Participant	Any legal entity carrying out an action or part of an action under Horizon 2020.
Participation	The act of involvement of a legal entity in a Project. A single participant can be involved in multiple projects.
Policy mix	The set of activities, instruments and types of actions used to implement Horizon 2020.
Prizes	Financial contribution (lump-sum) given as the prize in a contest. Prizes are a 'test-validate-scale' open innovation approach that brings together players who are new to an industry and small players that may pursue more radically new concepts than large, institutionalised contestants. Inducement prizes offer an incentive by mobilising new talents and engaging new solver communities around a specific challenge. They are only awarded based on the achievement of a set target, solving the challenge defined.
Programme co-fund action	An action funded through a grant. The main purpose is to supplement individual calls or programmes funded by entities, other than EU funding bodies, that manage research and innovation programmes. A programme co-fund action may also include complementary networking and coordination activities between programmes in different countries.
Public-private partnership (PPP)	These support the development and implementation of research and innovation activities of strategic importance to the EU's competitiveness and industrial leadership, or to address specific societal challenges. They take the form of Joint Undertakings under Art. 187 of the TFEU and organise their own research agenda.
PPPs also provided via the Art. 185 initiatives	Article 185 of the TFEU allows the integration of national efforts into a programme undertaken jointly by several Member States, with the participation of the EU, including participation in the structures created for the execution of the joint programme.
Regression discontinuity design (RDD)	A counterfactual impact evaluation (CIE) method. For more information, see Annex 2.
Reimbursement rate	See funding rate.
Research and innovation action (RIA)	An action primarily consisting of activities aiming to establish new knowledge and/or to explore the feasibility of a new or improved technology, product, process, service or solution. It may include basic and applied research, technology development and integration, or testing and validation on a small-scale prototype in a laboratory or simulated environment.

SME instrument	The SME instrument targeted all types of innovative SMEs that showed a strong ambition to develop, grow and internationalise. It provided support at different stages of the entire innovation cycle, in three phases, complemented by a mentoring and coaching service. • Phase 1: Feasibility study verifying the technological/practical as well as economic viability of an innovation idea. • Phase 2: Innovation projects that demonstrate high potential in terms of company competitiveness and growth underpinned by a strategic business plan. • Phase 3: Support to commercialisation.
Social Sciences and Humanities (SSH)	SSH encompass various disciplines such as social sciences, education, business, law, and humanities and the arts, including economics, sociology, demography, anthropology, psychology, geography, human rights, journalism, library and museum science, religion and theology, foreign languages and cultures, history, philosophy, fine arts, performing arts, graphic and audio-visual arts design.
Societal Challenges	Priorities identified in the Europe 2020 strategy aiming at stimulating research and innovation to achieve the EU's policy goals: 1. Health, demographic change and wellbeing 2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy 3. Secure, clean and efficient energy 4. Smart, green and integrated transport 5. Climate action, environment, resource efficiency and raw materials 6. Europe in a changing world: inclusive, innovative and reflective societies 7. Secure societies: protecting freedom and security of Europe and its citizens.
Success rate	The percentage of proposals that are retained for funding out of the total number of eligible proposals expressed as a percentage (Funded proposals/Eligible proposals*100).
Synergy	Synergy occurs when the sum of the (expected) results of programmes or initiatives, as a whole, is greater than the sum of the parts. Upstream synergies are defined in this document as occurring when another programme paves the way to apply to Horizon 2020. Downstream synergies, on the contrary, occur when other programmes take up the outputs of Horizon 2020 towards the market.
Technology Readiness Levels (TRL)	Technology Readiness Levels indicate the maturity level of particular technologies through a common understanding of technology status and addresses the entire innovation chain. TRL 1 – basic principles observed; TRL 2 – technology concept formulated; TRL 3 – experimental proof of concept; TRL 4 – technology validated in the lab; TRL 5 – technology validated in a suitable environment; TRL 6 – technology demonstrated in a suitable environment; TRL 7 – system prototype demonstration in an operational environment; TRL 8 – system complete and qualified; TRL 9 – actual system proven in an operational environment.
Widening countries	Countries identified as 'low-performing' in research and innovation, and thus eligible to apply for actions dedicated to spreading excellence and widening participation. In Horizon 2020, these were Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia and Slovenia (EU Member States) and Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Georgia, Moldova, Montenegro, North Macedonia, Serbia, Tunisia, Turkey and Ukraine (associated countries).

1. INTRODUCTION: PURPOSE AND SCOPE OF THE EVALUATION

Horizon 2020 is the eighth EU framework programme for research and innovation, set up by Regulation 1291/2013.[2] Following the adoption of the regulation on the European Fund for Strategic Investments[3], the total budget of Horizon 2020 was set at EUR 75 623 million in current prices. This *ex post* evaluation of the programme was required to be carried out by 31 December 2023.[4]

The scope of this evaluation is Horizon 2020, including the activities of the European Institute of Innovation and Technology[5] and the direct, non-nuclear, research activities of the Joint Research Centre.[6] It covers activities carried out or begun between 2014 and 2020 in the EU constituted of 28 Member States for the period of 2014-2020 (including the UK[7]) but also in a set of non-EU countries participating to the programme, including those associated to Horizon 2020.[8] An interim evaluation of Horizon 2020 was published in 2017.[9]

The evaluation covers the whole programme Horizon 2020. It addresses in more detail programme parts when they are particularly relevant for reaching one of the programme objectives, for instance the Marie Skłodowska-Curie Actions (programme part), for providing training, career development and transnational mobility of researchers (programme's specific objective) or InnovFin (programme part) for enhancing access to risk finance in the EU (programme's specific objective).

Exceptions are seven public-private partnerships[10] (implemented through Joint Undertakings established under Article 187 of the Treaty on the Functioning of the European Union (TFEU)) funded under Horizon 2020 which have legal successors in Horizon Europe. Whereas this evaluation explains how Joint Undertakings contributed to Horizon 2020 and the additional funds they leveraged, they will be fully evaluated as part of the interim evaluation of Horizon Europe according to regulation 2021/2085, which repeals and replaces previous relevant individual regulations of Joint Undertakings[11]. This evaluation also refers to the contribution of three public-public partnerships established under Article 185 of TFEU and already evaluated in 2022[12]: the Partnership for Research & Innovation in the Mediterranean Area (PRIMA), Active and Assisted Living Research and Eurostars 2.

Data from the seventh framework programme (FP7), that preceded Horizon 2020, are used to

[2] Complemented by Regulation 1290/2013 laying down the rules for participation and dissemination in Horizon 2020 and by Council Decision 2013/743 establishing the specific programme implementing Horizon 2020.
[3] In line with Regulation (EU) 2015/1017 on the European Fund for Strategic Investments, the European Investment Advisory Hub and the European Investment Project Portal, amending the Horizon 2020 regulation (EU) NO 191/2013, and Regulation (EU) NO 1316/2013.
[4] Article 32.4 of Regulation (EU) No 1291/2013 establishing Horizon 2020 - the framework programme for research and innovation (2014-2020).
[5] The European Institute of Innovation and Technology (EIT) has a separate legal base and is funded by Horizon 2020. It was allocated EUR 2 711 million in current prices, representing 3.18% of Horizon 2020 total budget.
[6] Nuclear research actions by the JRC are evaluated in the evaluation of the Euratom programme. Non-nuclear direct actions of the JRC were allocated EUR 1 855 million (2.45% of Horizon 2020).
[7] The UK's withdrawal from the EU took effect on 31 January 2020 but the Withdrawal Agreement allowed the UK to continue to participate in EU programmes, including Horizon 2020, until the end of the transition period.
[8] Associated countries: Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Georgia, Iceland, Israel, Moldova, Montenegro, North Macedonia, Norway, Serbia, Switzerland, Tunisia, Turkey, Ukraine. Other: the United Kingdom.https://research-and-innovation.ec.europa.eu/statistics/framework-programme-facts-and-figures/horizon-2020-country-profiles_en
[9] Interim Evaluation of Horizon 2020 (2017), https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/interim-evaluation-horizon-2020-key-documents_en
[10] Bio-based Europe, Clean Aviation, Clean Hydrogen, Europe's Rail, The Innovative Health Initiative, The Key Digital Technologies, Single European Sky ATM Research.
[11] Article 174.13 of Council Regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe.
[12] PRIMA COM(2023) 285, Final evaluation of the Active and Assisted Living Research and Development Programme SWD/2022/404 final), and Eurostars-2 (2023, https://data.europa.eu/doi/10.2777/333838).

assess the long-term impact of the programme, in accordance with the relevant Council conclusions.[13]

All five compulsory evaluation criteria (i.e. effectiveness, efficiency, relevance, coherence, and the European added value of Horizon 2020) are assessed in this evaluation. This evaluation is informed by a set of 12 external studies[14], Commission monitoring reports, studies and reports issued by other European institutions (the European Court of Auditors, the European Economic and Social Committee, the European Parliament). The evaluation methods used include: (i) a review of documentation and analytical data; (ii) text analysis; (iii) more than 1,000 interviews with beneficiaries, national authorities and implementing bodies; (iv) a survey of successful and unsuccessful applicants[15]; (v) counterfactual analysis; (vi) a stakeholder consultation which ran from 1 December 2022 to 23 February 2023 gathering 1 818 replies. This mix of qualitative and quantitative methods provided a comprehensive evidence base.

Limitations in the analysis are due to the sizable share of projects that were still ongoing at the time of preparing this final evaluation: only 21 030 (59%) of the 35 426 projects signed had finished (59%), while 14 396 projects (41%) are still ongoing, in all programme parts and in all three pillars[16]. In addition, it is widely acknowledged in economics research[17] that evaluating R&I activities is challenging because of the nature of knowledge generation and its diffusion process. It takes time for R&I activities to produce results, outcomes, and impacts because of the importance of trial and errors, with an inherent need for risk taking and failures. The question of attribution of the effects observed is another challenge as scientific progress builds on knowledge that cumulates over decades and spreads unexpectedly in multiple domains and applications.

Programme indicators[18] used in this evaluation are referred to in section 4 and in the evaluation matrix, in Annex 3. It should be noted that the performance on all programme indicators is expected to still increase as projects continue delivering upon their completion.

Indicators and their monitoring system suffer from inherent shortcomings. Thorough checks were conducted in order to ensure that data is robust. Nevertheless, the evaluation wants to recognize four challenges in this field. First, as already noted in the interim evaluation, Horizon 2020 indicators refer only to parts of the programme's intervention logic. Second, indicators could have been better designed, as they were not accompanied systematically by baselines values (i.e. values before the programme) or by target values (i.e. expected values at the end of the programme). Third, monitoring data recorded in the Commission's IT systems can minimise but not completely exclude cases of multiple counting, e.g. the same publications/patents reported in one year are reported again in other years. Fourth, information on patents is provided voluntarily by beneficiaries with possible cases of erroneous reporting and under-reporting. In addition, Intellectual Property Rights (IPR) from Horizon 2020 and FP7 may include "background patents", i.e. patent (or other IPR) applications filed before the start of the Horizon 2020 project, for which no causal link can be established with the support received by the programme.

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[13] Council conclusions on the seventh framework programme (FP7) ex post evaluation of 27 May 2016 (https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/119692.pdf,) and the Council conclusions on Horizon 2020 interim evaluation of 1 December 2017 (https://www.consilium.europa.eu/media/31888/st15320en17.pdf) invited the Commission to assess the long-term impact of the programme, in the *ex post* evaluation of Horizon 2020.

[14] Available at Horizon 2020 indicators - Publications Office of the EU (europa.eu) and also listed in the evaluation matrix (Annex 3).

[15] 5 417 complete and 449 partial responses were received, covering Pillar 1, horizontal SWEPs and SwafS.

[16] European Commission, R&I dashboard, figures as of 31/12/2022.

[17] Cunningham, J. A., Harney, B., & Fitzgerald, C. (2020). University research commercialisation: Contextual factors. In Effective Technology Transfer Offices (pp. 15-31). Springer, Cham. Science, Research & Innovation performance of the EU, 2022 (SRIP), Chapter 15, - Science and technology gestation lags.

[18] Horizon 2020 indicators: assessing the results and impact of Horizon, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098

Data used in this evaluation is publicly available in the Horizon dashboard database, but a direct one-to-one comparation between the figures presented here and the dashboards is not possible due to different reference dates and, for some indicators, different approaches to data cleaning and removal of duplicates.

Section 3 provides data on the implementation of the programme since its launch until 1 January 2023. Section 4 provides an evaluation of the programme based on triangulation of evidence that predates 1 January 2023[19] (e.g. most external studies were carried out in 2022, based on programme data that was extracted at the end of 2021).

2. WHAT WERE THE EXPECTED OUTCOMES OF HORIZON 2020?

2.1 Horizon 2020 and its objectives

The impact assessment[20] of Horizon 2020 identified several **weaknesses** in the European science and innovation system, which were factors in low productivity, declining competitiveness and inadequate responses to societal challenges.

While Europe has a historically strong science base, it often lags behind the United States when it comes to highly cited science or top-ranking universities, with increasing competition as well from other countries. An **increase in spending on frontier research**, associated infrastructure and training and education was identified as necessary to strengthen Europe's scientific and technological performance, and to provide the basis for the EU's competitiveness in the future.

The EU had not yet managed to translate its early lead in many green and 'quality of life' technologies (in health or security, etc.) into an innovative and competitive lead, experiencing **insufficient technological leadership and a lack of innovation capacity in companies**.

In addition, a lack of coordination of research to tackle the challenges faced by society led to missed opportunities to generate scale and synergies. Coordination between Member States for R&I was deemed insufficient. On average, in the EU, only some 10% of public budget for R&D is allocated at European level through the FP for R&I, enabling coordination and collaboration across countries.[21]

The **complexity of administrative procedures to apply for funding and take part in the framework programme** were identified as the **biggest obstacle to implementation.**[22]

In line with the needs described above, Horizon 2020 was designed with the **general objective** to '*contribute* to *building a society and an economy based on knowledge and innovation by leveraging additional R&I funding, and contribute to attaining R&I targets, including the target of 3% of GDP for R&D by 2020. It shall support the implementation of the Europe 2020 strategy and other Union policies, as well as the achievement and functioning of the European Research Area (ERA)'*.

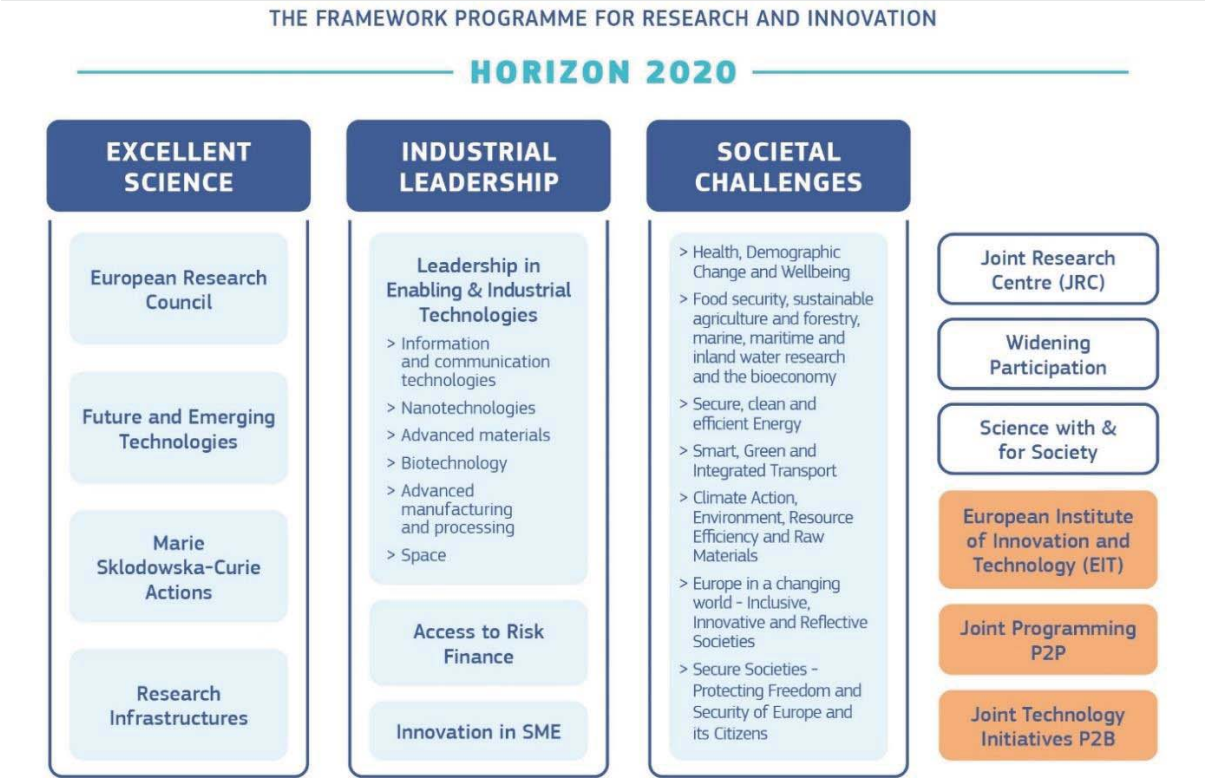
[19] Figures on Key Performance Indicators extracted by the Commission's internal monitoring system are updated, unless otherwise specified, on 21 April 2023.
[20] SEC(2011) 1427, volume 1, p. 6, https://research-and-innovation.ec.europa.eu/document/e9965187-3737-488f-a051-9cd8f5c6e867_en.
[21] DG RTD calculations using GBARD and EU Spending and revenue (europa.eu), as of August 2023.
[22] SEC (2011) 1428, volume 2, p. 14.

The programme's **specific objectives** were to:

1. **Strengthen Europe's scientific base (32% of the total budget)**, through:
    a. the European Research Council (ERC) providing attractive and flexible funding to enable EU competition for frontier research. (17% of the total budget);
    b. fostering collaboration on radically new ideas to accelerate the development of Future and Emerging Technologies; (4% of the total budget);
    c. Marie Skłodowska-Curie actions, providing training, career development and transnational mobility of researchers; (8% of the total budget);
    d. Support for excellent European research infrastructures. (3% of the total budget).
2. **Boost Europe's industrial leadership and competitiveness (22% of the total budget)** thanks to:
    a. Leadership in enabling and industrial technologies, i.e. support for research, development and demonstration of key technologies; (17.5% of the total budget);
    b. Access to risk finance, i.e. provision of debt and equity finance for R&I driven companies; (3.5% of the total budget);
    c. Innovation in SMEs, support for all forms of innovation in SMEs. (1% of the total budget).
3. **Increase R&I's contribution to tackling Societal Challenges (SC) (39% of the total budget)**, through basic research, applied research, knowledge transfer and innovation. The focus should be on the EU's policy priorities, without predetermining the precise choice of technologies or solutions that should be developed in:
    a. Health, demographic change and well-being (Societal Challenge (SC)1) (10% of the total budget);
    b. Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bio economy (SC2) (5% of the total budget);
    c. Secure, clean and efficient energy (SC3) (8% of the total budget);
    d. Smart, green and integrated transport (SC4) (8% of the total budget);
    e. Climate action, environment, resource efficiency and raw materials (SC5) (4% of the total budget);
    f. Inclusive, innovative and reflective societies (SC6) (2% of the total budget);
    g. Secure societies (SC7) (2% of the total budget).
4. **Spread excellence and widen participation (1% of the total budget)** via actions aimed at distributing the benefits of an innovation-led economy across the EU, in accordance with the principle of excellence.
5. **Increase the role of science in society (1% of the total budget),** to build effective cooperation between science and society.
6. **Optimise the delivery of the programme.**[23]

[23] Source: Horizon 2020 implementation data. Percentages include funding provided to EIT (3% of budget) and JRC direct actions (2%).

Figure 1: Horizon 2020's structure



Source: European Commission, 2023.

A set of **cross-cutting issues** were also promoted across the programme, in particular gender equality, social sciences and humanities, international cooperation, responsible research and innovation, widening participation, sustainable development, biodiversity and climate action, the digital agenda, SMEs and broader private sector participation.

From an **implementation perspective**, the programme's objective was focused on simplifying and reducing the administrative burden during the phases of preparing a proposal and implementing a project, with targets for the time to award a grant and the time to pay.[24] To boost innovation, a target was set in Leadership in Enabling and Industrial Technologies (LEIT) and Societal Challenges to allocate at least 20% of the budget to SMEs.[25]

The JRC (with 2% of Horizon 2020's total budget) and the EIT (3% of the total budget) were expected to contribute to both the general objective and the specific objectives by (1) providing customer-driven scientific and technical support for EU policies, and (2) integrating the knowledge triangle of higher education, research and innovation. The indicators for assessing the performance of the EIT[26] stem from the activities of universities, businesses and research organisations integrated in the EIT Knowledge and Innovation Communities and collaboration inside the knowledge triangle leading to the development of innovative products, services and processes.

As a result of the annual budget procedures from 2014 to 2020, the programme finally received a voted budget of EUR 75 623.6 million (in current prices[27]). A total of 78% of the budget was

[24] Horizon 2020 rules for participation.
[25] Horizon 2020 Regulation recital (35), article 22(3) and Annex II 'Breakdown of the budget'.
[26] Full list of EIT Key Performance Indicators: https://eit.europa.eu/sites/default/files/2022-08_20220316-gb71-08_eit_kpis.pdf
[27] MFF 2014-2020 – Horizon 2020 – Budget implementation, https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-overview/horizon-europe-performance_en#mff-2014-2020--horizon-2020. This amount is the final budget, including transfers and adjustments following the annual budget adoption, while the amount on p.1 is the amount of the legal base, after amendment by the EFSI Regulation.

granted to transnational collaborative projects (through research and innovation actions and innovation actions) while support to individual researchers and companies was provided through the ERC grants, some Future and Emerging Technologies (FET) schemes, the Marie Skłodowska-Curie Actions (MSCA) and under the SME instrument. Other types of actions included the procurement of innovative solutions, public-public partnerships (including ERA-NET Co-funds and Article 185 actions), public-private partnerships (including Article 187 partnerships, Joint Technology Initiatives and contractual public-private partnerships), inducement prizes and financial instruments. Coordination and Support Actions (CSA) and procurements were used for studies, expert groups, conferences, and to disseminate and exploit results. A special form of collaborative project was also piloted, the Fast Track to Innovation, which focused on industrial actors. The Commission also undertook direct R&I actions through its Joint Research Centre.

Funding was mostly allocated through biennial work programmes. In evaluating project proposals excellence was the main criterion, next to the quality and efficiency of implementation and the expected impact.

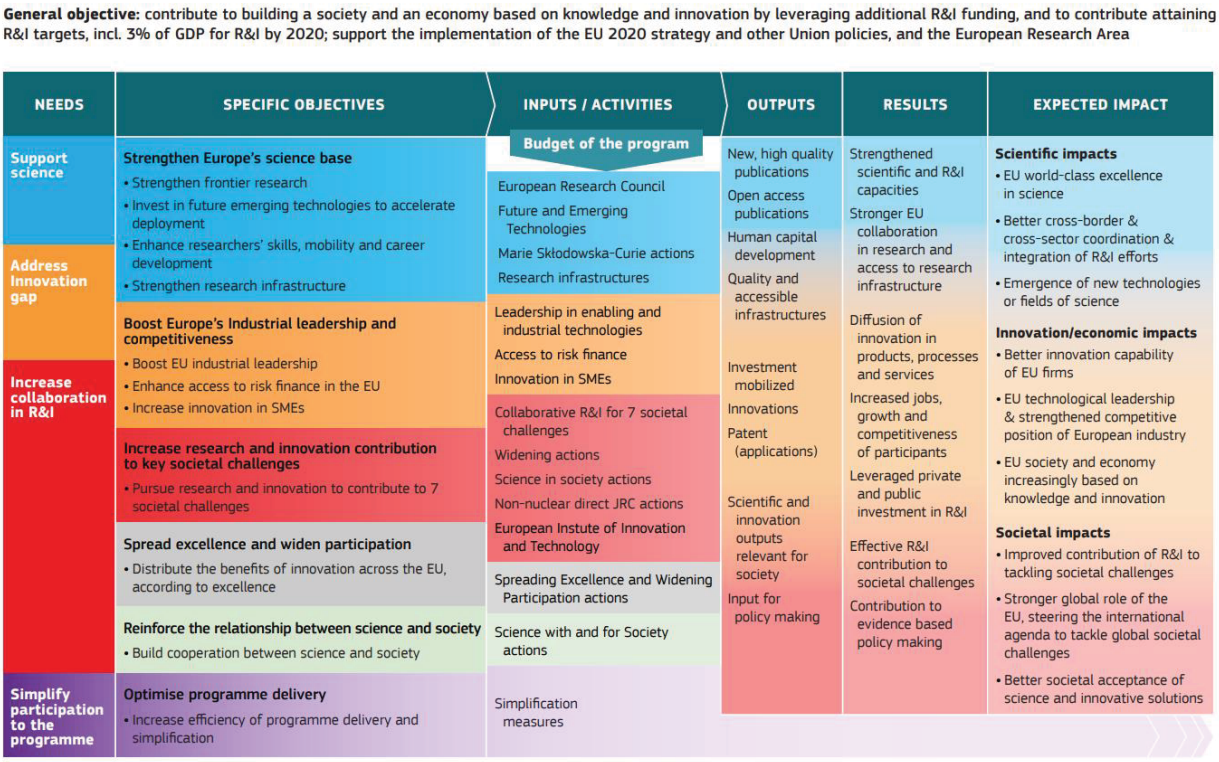
Horizon 2020 brought considerable change compared to FP7 by including all support for innovation in one programme, which had previously been financed by separate EU programmes: the innovation-related part of the Competitiveness and Innovation Programme, and the EIT.

Horizon 2020 attempted to simplify access for participants, with a single web portal for all information and projects, less paperwork when applying, and more focused controls and audits.

Several changes were made during the last two years of the programme, following the interim evaluation. These included a pilot of lump sum funding and two-stage application procedures, the launch of a pilot for the European Innovation Council, flagship initiatives for international cooperation, and cross-cutting calls for proposals on specific policy priorities, such as the 2020 call for proposals to support the European Green Deal through R&I.

Horizon 2020 **was expected to deliver** scientific, technological and innovation outputs that would translate into scientific, economic and societal impacts related to the specific objectives of the programme. The main impacts expected of Horizon 2020 are illustrated in Figure 2 (on the programme's intervention logic). It shows that all parts of the programme can bring scientific, economic and/or societal value.

Figure 2: Horizon 2020 intervention logic



Source: European Commission, 2023.

Progress towards the objectives was monitored according to **23 key performance indicators** (KPIs) that were either set out in the legal base[28] or subsequently developed by the Commission[29]. The Horizon 2020 indicators represented a step forward in the monitoring process because this was the first time that KPIs were introduced, although they did not cover the entire programme and contained a number of shortcomings (presented in Annex 2).

The performance indicators for assessing progress against the general objective were[30]:

- the **research and development target (3% of GDP)** of the Europe 2020 strategy;
- the **innovation output indicator** in the Europe 2020 strategy[31]; and
- the **proportion of researchers in the active population**.

Some indicators were accompanied by baseline values and specific **targets** for the end of Horizon 2020. All indicators are presented in the evaluation matrix in Annex 3.

The Horizon 2020 programme set additional quantitative targets for:

- Sustainable development related investment: at least at 60% of overall investment;
- Renewable energy, end user energy efficiency, smart grids and energy storage activities: at least 85% of the overall Energy Societal Challenge funds;
- Funding to SME: at least 20% of in the LEIT programme and under Societal Challenges (of which 7% committed through the SME instrument);
- Climate change-related investment: at least 35% of overall investment.

[28] Annex II of Council Decision 2013/743.
[29] Horizon 2020 indicators (2015) https://ec.europa.eu/newsroom/horizon2020/items/25823/en.
[30] Article 32.5 of the Horizon 2020 Regulation states that the performance indicators for assessing progress against the general objective of Horizon 2020 and for the EIT are set out in Annex I.
[31] Communication from the European Commission to the EP, the Council, the European Economic and Social Committee and the Committee of the Regions, 'Measuring innovation output in Europe: towards a new indicator', COM(2013)0624 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0624:FIN:EN:PDF.

2.2 Points of comparison

The main point of comparison is the impact assessment carried out for Horizon 2020. Where the expected effects were quantitatively estimated or targets were set in the Horizon 2020 impact assessment or in the legal base, this evaluation compares the actual Horizon 2020 data to these expectations. This is the case for the analysis of macroeconomic impacts and KPIs on publications, patent applications, mobility of researchers, risk finance, and for targets on simplification, SME participation and climate-related spending, high quality publications by FET, female representation in advisory panels, efficiency metrics (time to contract, time to pay, error rate, etc), leverage factors per selected JU).

In the absence of targets, this evaluation compares the current Horizon 2020 performance to data from the end of FP7. This is the case for the number of publications, patents funded with a contribution from Horizon 2020, female representation in advisory panels, participation from entities located in widening countries, contribution to Sustainable Development Goals, JRC concrete contributions to policies and international cooperation.

Where this approach is not possible, or where additional insights could be gained, this evaluation compares the actual results of Horizon 2020 against those of other relevant EU or international benchmarks. This is the case for the quality and influence of scientific publications, JRC's publications, share of publications freely and publicly available, number of public private academic co-publications.

If none of the above is possible, newly available data on Horizon 2020 are presented, without any baseline nor benchmark. This is the case for the number of patents and publications for some of the Societal Challenges and leverage factor at programme level.

3. HOW HAS THE SITUATION EVOLVED DURING THE EVALUATION PERIOD?

The overall completion rate of Horizon 2020 projects at the time of this final evaluation is 59%, while the remaining projects are still in progress and due to submit their final report. The cumulative implementation rates at the time of the evaluation were 99.99% for Horizon 2020 commitments and 87.84% for payments.

Implementation delays due to lockdowns linked with the Covid pandemic temporarily affected networking and project dissemination and exploitation opportunities. However, the completion rate of Horizon 2020 is higher than at the time of the final evaluation of the preceding programme, FP7 (50%). While unfinished projects inevitably generate a degree of uncertainty, comparison of results with the FP7 baseline is being done at a similar point in time. Long-term analysis of FP7 also shows that some effects are likely to increase as the final project reports are received and in the years that follow (see section 4.1.5. on long-term impacts).

Calls for proposals

During the lifetime of Horizon 2020, 1 076 calls for proposals, covering a total of 3 706 topics, were launched and evaluated. These calls attracted over **285 000 eligible proposals,** which **requested** EUR 478 billion in EU funding. A total of 1.8% of the proposals submitted were ineligible.[32]

[32] CORDA data extracted on 1 March 2023, including ineligible, inadmissible and duplicate proposals.

Although 46% of the eligible proposals were assessed as being of high quality[33] by external experts, funding could not be granted to all, resulting in an average success rate[34] of 11.9% and an oversubscription rate[35] of 74%.

The percentage of proposals above the quality threshold and the percentage of proposals funded (success rate) were highest under Spreading Excellence and Widening Participation (67.1% and 15.9%), followed by Excellent Science (55.2% and 13.7%), and lowest under Industrial Leadership (34.3% and 8.7%).

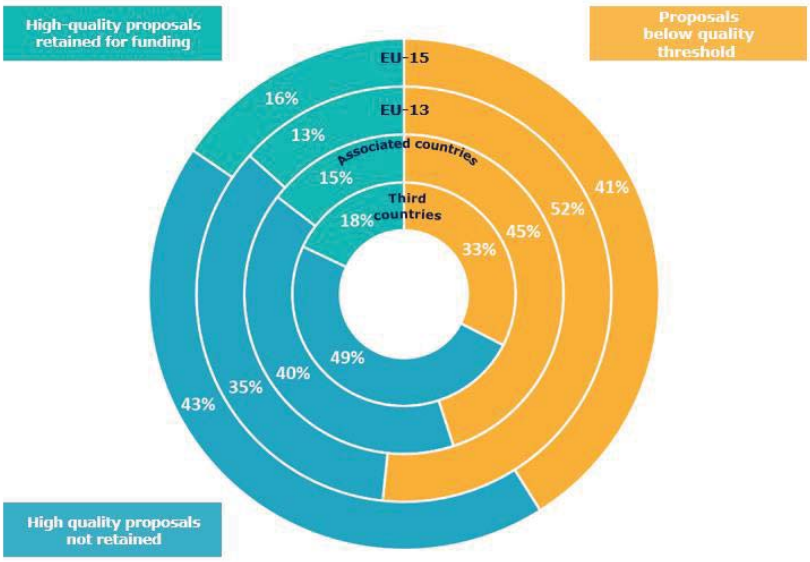
Applications to Horizon 2020

The eligible proposals included over **1 million applications**[36]. Most applications originated from private for-profit organisations (40%), followed by higher education institutions (36%) and research organisations (17%). SMEs accounted for 24% of applications. More details are provided in Annex 6, including detailed data tables on applications by country, organisation type and pillar, and success rates by country.

88% of the applications originate from EU-28 Member States, half of which originated from entities located in four countries: Spain, Italy, Germany and the United Kingdom. EU-13 countries represent 10% of the applications and - putting the number of applications in perspective with the scientific population of each country - the most active Member States were Cyprus, Greece, Slovenia and Estonia.

Figure 3 presents applications coming from EU-15 (Member States that joined the EU before 2004), EU-13 (Member States that joined in or after 2004), associated countries and third countries.

Figure 3: Applications by country group



Source: CORDA data – cut-off date: 1 January 2023

As regards third countries, Switzerland, Norway, Israel and Turkey accounted for 84% of the 83 377 applications submitted by entities located in countries associated to Horizon 2020. Entities

[33] Proposals are considered as being of high quality when the expert evaluators gave them a score above the quality threshold.
[34] The success rate is the percentage of proposals that are retained for funding out of the total number of eligible proposals.
[35] The proportion of eligible proposals evaluated as above the quality threshold and which were not retained due to budget constraints, out of all eligible proposals evaluated by experts to be above the quality threshold.
[36] Note: the same organisation applying N times in N different proposals is counted N times.

located in non-associated countries outside the EU represent 3.7% of all applications and 1.2% of the requested amount in retained proposals. The United States led with 10 336 applications, almost one third of all applications from non-associated countries, followed by China (2 970 applications) and Canada (2 282 applications).

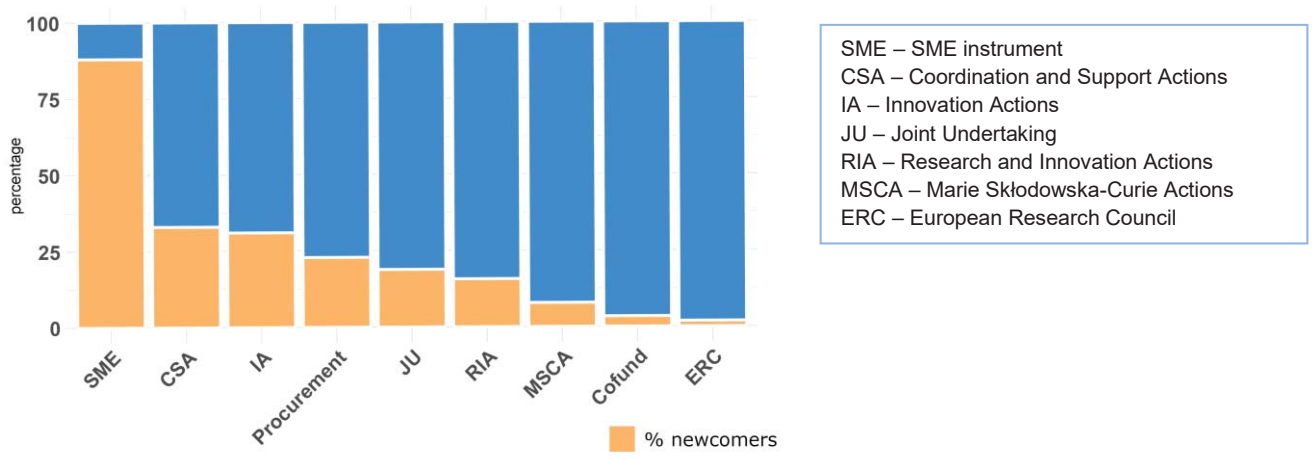
Funding allocation

EUR 68.3 billion were allocated through 35 426 signed grants, 31.6% of the funds being allocated to the top 100 beneficiaries.

Around 50% of Horizon 2020 funding was allocated to 341 organisations. Around 10% of funding went to the 50 best-performing universities in Europe, based on the Leiden ranking data.[37]

Around 19% of Horizon 2020 funding (approx. EUR 12.9 billion) went to newcomer organisations, i.e. organisations that had not participated in FP7. Across the programme, around 50% of the total funding to private companies went to newcomers: most newcomers are in fact SMEs. Newcomers are in general more common in types of actions with high industry participation; within Joint Undertakings, 19% of all funding went to newcomers.[38]

Figure 4: Share of EU funding to Horizon 2020 newcomers by type of action[39]



Source: CORDA data, 2 August 2022. Taken from European Commission, 'Newcomers in EU R&I programmes – Main trends in Horizon 2020, first evidence from Horizon Europe', monitoring & evaluation report, https://data.europa.eu/doi/10.2777/198795

The **average budgetary size** of the signed grants[40] was EUR 2.3 million but this varied substantially between the three pillars, from EUR 1.2 million under Excellent Science to EUR 3.7 million under Societal Challenges.

SMEs, with an application success rate of 12% (slightly higher than the programme average), accounted for 19.8% of all participations and received EUR 11.4 billion in funding.

[37] Ibid. https://www.leidenranking.com/

[38] European Commission, DG for Research and Innovation, "Newcomers in EU R&I programmes: main trends in Horizon 2020, first evidence from Horizon Europe", Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/911220.

[39] An overview of Horizon 2020 types of action is available in the Horizon 2020 online manual, section "What you need to know about Horizon 2020 calls": https://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/applying-for-funding/find-a-call/what-you-need-to-know_en.htm

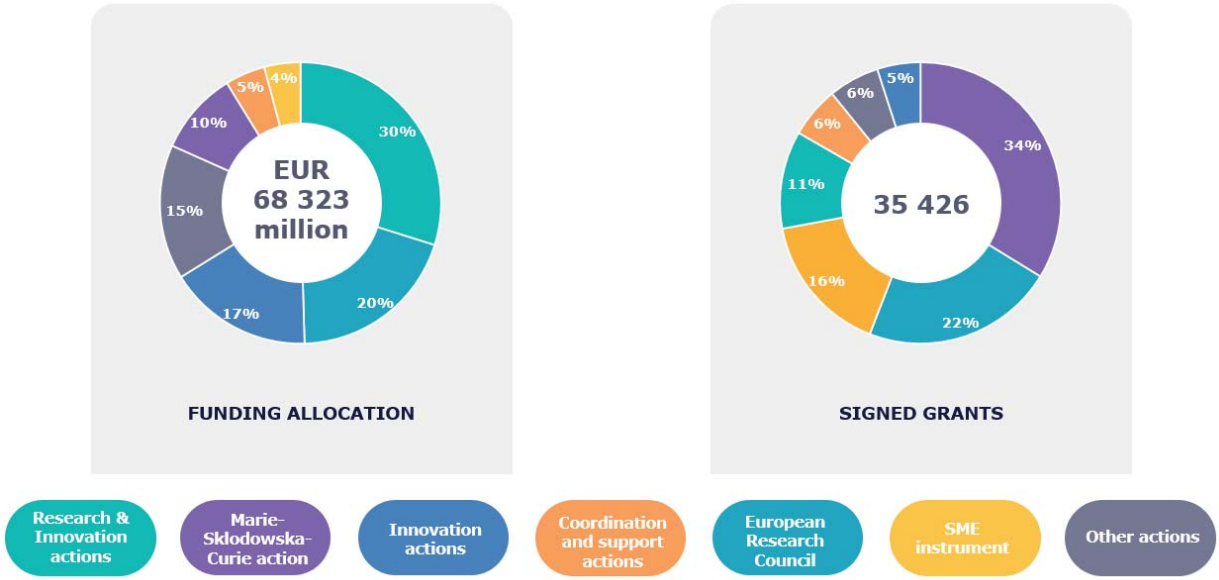
[40] FP7's average grant size was EUR 1.8 million, suggesting an increase under Horizon 2020 (under 18%), even when adjusted for inflation. Calculation of Horizon 2020's average grant size excludes very small grants of 50 000 EUR under SME instrument phase 1, to avoid distorting the overall figure. When included, the average drops to EUR 1.9 million.

The proportion of Horizon 2020 **budget spent on climate action**[41] reached **32%.**[42]

Type of Actions

Most funding was allocated through research and innovation actions (RIAs, 9.830% of the funding), followed by frontier research grants awarded by the ERC (19.7%), innovation actions (17%) and the MSCA (10%). The MSCA accounts for the highest number of signed grants (11 960) followed by the ERC (7 838), the SME instrument (5 734) and RIAs (3 978).

Figure 5: Funding allocation by type of action



Source: CORDA data – cut-off date: 1 January 2023

The new funding scheme for innovation, the **innovation actions (IAs),** aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services, demonstrations, piloting and prototyping. Despite representing just 6% of all Horizon 2020 projects, IAs represented 17% of the total financial contribution (or EUR 11.4 billion). Except for the first year of the programme, the proportion of funding to IAs constantly increased, from 13% in 2015 to 21% in 2021[43]. IAs are characterised by high participation rates by private for-profit entities, which received over EUR 5 billion in total. In the Industrial Leadership pillar, 32% of all funding was for IAs and 25% in Societal Challenges (35%). The balance between demonstration activities and 'first-of-a-kind' innovation activities is heavily lopsided towards the former, by a ratio of almost ten to one (and even higher in the Industrial Leadership pillar).[44]

Beneficiaries

Different organisations received Horizon 2020 funding, 42% of which were SMEs and 69% were newcomers to EU research and innovation programmes.[45]

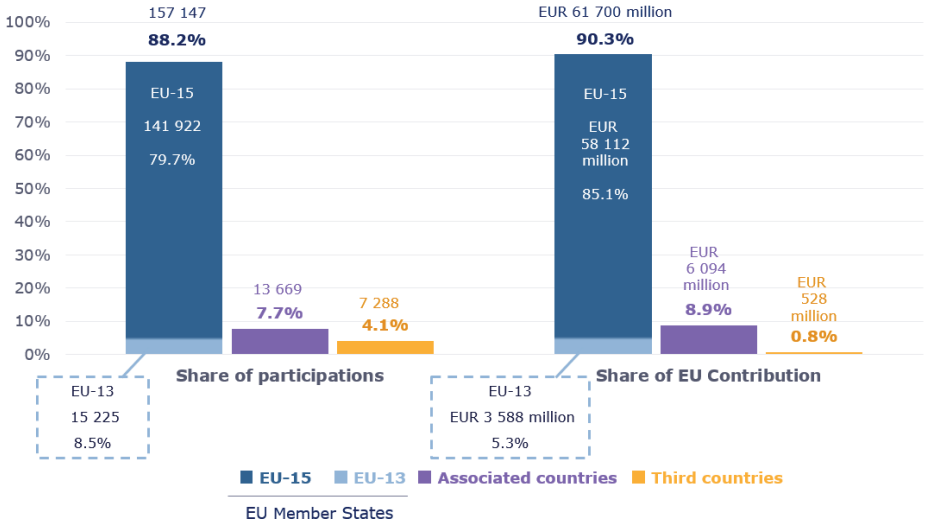
The majority of funding (78% or EUR 53.3 billion) went to **collaborative projects**, which brought together an average of 11 participants in 14 612 supported projects. Looking at the number of individual grants, 59% (20 814 grants) went to a **single beneficiary**, mostly for ERC, MSCA and SME instrument representing 22% of the funding (EUR 15 billion).

[41] This is calculated on the basis of the 'RIO markers' methodology developed by the OECD.
[42] Based on Programme Statement data. This is slightly higher than the 31.6% reported by the Study on the Relevance and Internal Coherence of Horizon 2020, which was based only on programme data that is available in eCorda.
[43] Source: CORDA data – cut-off date: 1 January 2023.
[44] Ibid, Annex 3, section 6.3, pp. 79-81.
[45] European Commission, DG for Research and Innovation, "Newcomers in EU R&I programmes: main trends in Horizon 2020, first evidence from Horizon Europe", op. cit., https://data.europa.eu/doi/10.2777/911220.

Higher education institutions come first in terms of the EU contribution received (39% or EUR 26.8 billion), followed by private for-profit entities (28% or EUR 19.3 billion) and research organisations (25% or EUR 17.1 billion).

Participation varied by country group, between EU Member States, associated countries and third countries as shown in Figure 6.

Figure 6: Participants and funds by country group in Horizon 2020



Source: CORDA data – cut-off date: 01/01/23

More than half of the Horizon 2020 funding allocated to **Member States** went to four countries: Germany (16%), the United Kingdom (13%), France (12%) and Spain (10%). However, when comparing the amounts received from Horizon 2020 to million EUR of gross domestic expenditure on R&D, smaller countries such as Estonia, Greece, Cyprus and Latvia performed better than bigger Member States. More details on this are available in Annex 6, including detailed data tables on Horizon 2020 investment by country, pillar and organisation type.

For **non-associated third countries**, the share of participations is around 4%. The relatively low figure for the share of EU funding that went to these participants can be explained by the fact that only low- and middle-income third countries are automatically eligible for funding, while high-income countries had to contribute with their own funds to Horizon 2020 projects.[46]

Participation of SMEs

The participation of private for-profit entities in Horizon 2020 was higher than in FP7. They accounted for 33.5% of all participations (against 30.3% in FP7), and 28.2% of all EU financial contributions to the programme, 3.3 percentage points more than in FP7.[47]

Horizon 2020 has so far awarded 22.2% of EU funding to SMEs in the LEIT programme and under Societal Challenges. The highest rate of SME participation was in Nanotechnologies, advanced materials, biotechnology and advanced manufacturing and processing (NMBP, 29%)[48], where a few sub-programmes had particularly high 1.5 participation: 42% of funding in nanotechnology topics and 36% in biotechnologies went to SMEs. This was much higher than the SME share in the New Production Technologies theme of FP7 (25.6%).[49] Lower shares of

[46] Compared to FP7, some sizeable countries (Brazil, Russia, India and China) were moved from the category of low- and middle-income countries to high-income countries, so they were no longer automatically eligible for funding.
[47] European Commission, R&I projects Dashboard, data frozen on 31/12/2022.
[48] Figures from the R&I Project Dashboard. The share of SMEs in NMBP diminishes to 25% if only SMEs flagged as "private for-profit" entities are considered - cf. Digital and Industrial Transition study, section 3.2.2, p. 28.
[49] FP7 figures are extracted from the R&I Project Dashboard.

EU funding were seen in SC1 (health, 17%), SC4 (transport, 17%) and SC6 (inclusive societies, 14%).

Around one third of funding to SMEs was provided through the SME instrument. This represents 7.1% of overall Horizon 2020 funding, which is above the 7% target set at the start of the programme (see Table 1).

Table 1: Cross-cutting key performance indicators (KPIs) on SME participation in Horizon 2020

Source: Cross-cutting issues study (2023), elaboration on CORDA data (2022).

Horizon 2020 was also successful in attracting new SME participants. Around half (50.3%) of all EU funding to private for-profit businesses went to newcomers, and two thirds of this amount to SMEs. In general, actions that attract more SMEs – the SME instrument, as well as innovation actions – have high rates of newcomer participation. Conversely, actions that target collaboration with the private sector, but not necessarily SMEs, had fewer new participants.[50]

[50] European Commission (2023), DG for Research and Innovation, "Newcomers in EU R&I programmes – Main trends in Horizon 2020, first evidence from Horizon Europe", op. cit., https://data.europa.eu/doi/10.2777/911220.

4. EVALUATION FINDINGS

4.1 To what extent was Horizon 2020 successful and why?

This section provides an evidence-based assessment of the successes and shortcomings of the Horizon 2020 programme in terms of its effectiveness, efficiency and coherence. It begins by examining how effectively Horizon 2020 achieved its scientific, societal and economic objectives, as well as the programme's parallel objectives of spreading excellence, widening participation and promoting science in society. This section then considers the cost of pursuing these objectives. Finally, it provides evidence of the degree to which the programme has operated in a coherent way, both internally between its different instruments, and externally with other relevant EU and national programmes.

4.1.1. Effectiveness: **Scientific impacts** – To what extent has Horizon 2020 strengthened Europe's scientific base?

The objective of Horizon 2020 was to reinforce and extend the excellence of the Union's science base and to consolidate the European Research Area (ERA) in order to make the Union's research and innovation system more competitive on a global scale. Throughout the course of Horizon 2020, excellence was assured by means of pan-European competition for funding and a stringent project proposal evaluation process[51]. All actions across all Horizon 2020 pillars are expected to contribute towards achieving scientific impact.

The Horizon 2020 Regulation[52] requires that progress on its over-arching general objective is assessed against a number of indicators, including the proportion of researchers in the active population in the EU. Eurostat data show that, in 2021, the number of full-time equivalent (FTE) researchers employed in the EU was 2 million[53], or 1% of the total active population[54]. This represents an increase[55] of over 570,000 researchers compared with 2012 (1.43 million, 0.7% of the labour force). This 33% increase in the number of researchers in the active EU population between 2012 and 2021 is not considered a direct consequence of Horizon 2020 funding as other external factors (e.g. tax and labour law changes in Member States) also play a role and this evaluation is unable to quantify the direct contribution of Horizon 2020 to this increase.

Horizon 2020 contributed to scientific impact through multiple streams that delivered quality research and contributed to scientific breakthroughs, while reinforcing human capital, research infrastructure[56], and encouraging participation from countries least performing in research and innovation as described in the sections that follow.

What messages emerged from the stakeholder consultation?

Overall, 80% (1 432) of respondents to the consultation agreed or strongly agreed that **Horizon 2020 encouraged excellent science**: this view was held by 82% (760) of respondents from academic and research organisations, 65% (20) from business associations, 84% (175) of EU citizens and 88% (53) of non-EU citizens. Among all other stakeholder groups (including, among others, companies, public authorities, trade unions, NGOs and environmental organisations, 77% (424) agreed or strongly agreed with this view. Similarly, EU citizens (775) and

[51] Study on the proposal evaluation system for the EU R&I framework programme: final report, Publications Office of the European Union (2022), https://data.europa.eu/doi/10.2777/16211
[52] Regulation (EU) No 1291/2013, Annex 1.
[53] Eurostat (RD_P_PERSOCC), Professional position: Researchers, FTE.
[54] Eurostat (RD_P_PERSLF), Professional position: Researchers, Percentage of population in labour force – numerator in FTE.
[55] Within the EU, the number of researchers increased in almost all Member States between 2011 and 2021. In the case of Poland and Sweden, the total number more than doubled, reaching 135 700 and 100 100, respectively, in 2021. In relative terms, Hungary (88%), Greece and Belgium (both 79%) recorded the highest growth rates. In absolute terms, Germany, followed by France, Italy, Spain and Poland are the EU countries with the highest number of researchers employed.
[56] European Commission, DG for Research and Innovation, Horizon 2020 indicators: assessing the results and impact of Horizon, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098

respondents from academic and research organisations (184) - both respectively 84% - either agreed or strongly agreed that **Horizon 2020 supported the development of the European Research Area**. 88% (52) of non-EU respondents indicated that Horizon 2020 supported the development of the European Research Area, showing that the views regarding the scientific impacts of Horizon 2020 are coherent.

According to 78% (711) of respondents from academic and research institutions, 75% (24) of business associations and 73% (226) of respondents from companies, Horizon 2020 fosters **scientific breakthroughs, higher risk research and research in emerging areas of science and technology.** This claim was supported by 76% of EU citizens (163) and an even greater share of non-EU citizens (86%; 59).

More respondents agreed or strongly agreed that Horizon 2020 **improved the skills of Europe's researchers and facilitated the emergence of new researchers** (85%; 1 500): 92% (54) of non-EU citizens, 88% (803) of respondents from academia, 82% of respondents from NGOs (61) and EU citizens (179) and 81% (26) of respondents from business associations supported this claim.

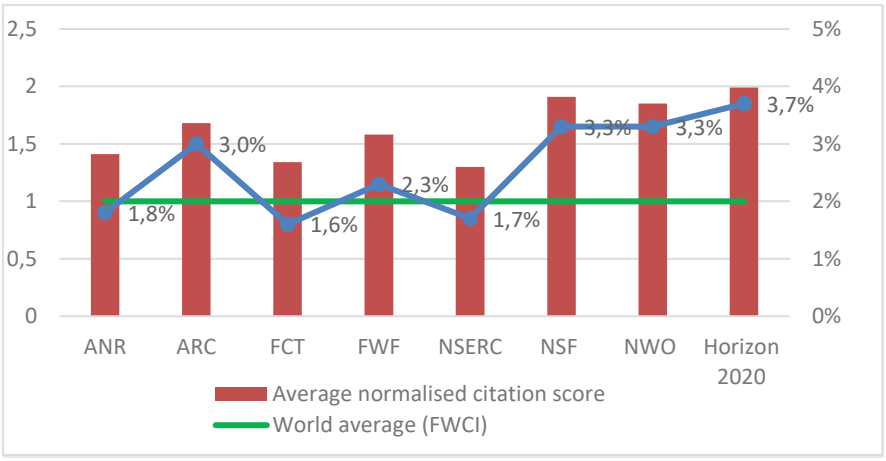
In terms of **facilitating cross-sector and cross-border mobility of researchers**, 88% (804) of respondents from academia, 76% (235) of respondents from companies as well as 71% (22) of business associations either agreed or strongly agreed that Horizon 2020 had a positive effect. Similarly, 73% (666) of respondents from academia, 67% (20) of respondents from business associations as well as 60% (90) of companies deemed that the programme is **making Europe more attractive for world class researchers from abroad.** This claim is also supported by 66% (52) of non-EU citizens, compared to 88% (164) of EU citizens responding.

Strengthening frontier research: Publications, quality of research and scientific advancements

Horizon 2020 has strengthened the EU's scientific position worldwide. Bibliometric analysis shows that Horizon 2020 had a significant positive impact, both in terms the overall number and the quality of publications produced, and of the standards of scientific excellence across the entire programme.[57] In the period 2014-2022, Horizon 2020 produced a total of 276 784 peer-reviewed publications.[58] Compared with the previous framework programme (FP7: 219 620 publications[59]), the total number of publications is higher and is still expected to rise when all projects have been completed. Horizon 2020 publications are cited at twice the world average rate for similar publications (with an FWCI of 2.03), while 3.9% of these publications are among the top 1% most cited publications worldwide.[60] Furthermore, evidence from benchmarking exercises[61] demonstrates that the citation scores for Horizon 2020 are higher than those of selected international funders,[62] both as a proportion of the top 1% most cited publications and in terms of its average normalised citation score. Activities funded under the Excellent Science pillar have the highest number of publications, mainly under the European Research Council (ERC) and Marie Skłodowska-Curie Actions (MSCA) (36% and 22% respectively).[63]

[57] Excellent Science evaluation study (2023), op. cit., p. 45. Also: Mahieu, B., Lotito, A., Viscido, S., et al., Evaluation study on for addressing Global Challenges and Industrial Competitiveness - Focus on activities for the Digital and Industrial Transition (2023), p. 77-78, https://data.europa.eu/doi/10.2777/99438.
[58] Commission monitoring system (CORDA), figures updated on 24/04/2023.
[59] European Commission, DG for Research and Innovation, Interim evaluation of Horizon 2020: Commission staff working document, Publications Office, 2017, p. 39, data reference date: 01/01/2017, https://data.europa.eu/doi/10.2777/220768
[60] Excellent Science evaluation study (2023), op. cit., table 14, p. 34.
[61] Excellent Science evaluation study (2023), op. cit., table 15, p. 34, with details in Annex 6.15 - case study: Impact of the FP in spreading excellence across the Union, p. 951, https://data.europa.eu/doi/10.2777/353383.
[62] Horizon 2020 was compared with: NWO (the Netherlands), the French National Research Agency (ANR), the Australian Research Council (ARC), the FCT (Portugal), the Austrian Science Fund (FWF), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the National Science Foundation (USA).
[63] Of the total number of publications validated by the Excellent Science study (2023), Annex 3, section 1.6, pp. 430-431, figure 3.1.2, https://data.europa.eu/doi/10.2777/353383.

Figure 7: Horizon 2020 key publication metric comparison with other funders



Source: Bibliometric analysis, Excellent Science Evaluation study, 2023. *NWO (the Netherlands), the French National Research Agency (ANR), the Australian Research Council (ARC), the FCT (Portugal), the Austrian Science Fund (FWF), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the National Science Foundation (USA).*

The ERC has provided attractive and flexible funding to encourage EU competition in frontier research. Not only did it exceed its Horizon 2020 target (see KPI 1 in Table 3), but it currently accounts for the highest number of peer-reviewed publications across Horizon 2020 (49 496 publications), receiving an average of 24.4 citations per publication.[64] ERC publications have also been cited at over twice the average worldwide rate for similar publications (an FWCI of 2.32).

The Future and Emerging Technologies (FET) programme has met its Horizon 2020 target for high-quality publications (see KPI 2, Table 3). The value is likely to increase further as project implementation is still ongoing. It has also achieved high citation impact, with, on average, 28.2 citations per publication.

The **Societal Challenges pillar** has made limited progress towards its Horizon 2020 target related to publications (KPI 14). Nevertheless, the Societal Challenge 1 (health, demographic change and well-being) and Societal Challenge 5 (climate action, environment, resource efficiency and raw materials), have achieved high citation rates, with 7.4% and 5.9% of their publications among the top 1% most cited publications, respectively. Moreover, those publications were cited close to three times the global average rate (with FWCIs of 2.86 and 2.61, respectively).

The scientific impact of JRC publications, as measured by bibliometric indicators[65], is on a par with leading universities and prestigious research organisations. During the course of Horizon 2020, JRC scientists published over 7 000 peer-reviewed scholarly publications, a third of which feature in the top 10% most highly cited publications in their field.[66] In addition, the JRC produced a wide range of policy-relevant outputs, such as standards, reference materials, technical systems and guidance on policy implementation (KPI 22 below).

[64] Numbers are expected to increase when all Horizon 2020 projects are finalised.
[65] Field-Weighted Citation Impact, Publications in Top 1% Journal Percentiles by SJR (%), Publications in Top 10% Journal Percentiles by SJR (%), Output in Top 1% Citation Percentiles (%), Output in Top 10% Citation Percentiles (%).
[66] Excellent Science evaluation study (2023), op. cit., p. 35.

Table 2: Horizon 2020 KPIs on scientific impact[67] – **KPIs, 1, 2, 14, 22, and 23**		
KPI 1: percentage of publications from ERC funded projects which are among the top 1 % highly cited[68]		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
Data unavailable	1.8%	6.4%
KPIs 2, 14: Number of peer-reviewed publications/EUR 10 million		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
FET: *Data unavailable*	FET: 25 publications/EUR 10 million	FET: 25.4 publications/EUR 10 million
Societal Challenges: *Data unavailable*	Societal Challenges: 20 publications/EUR 10 million	Societal Challenges: 7.0 publications/EUR 10 million
KPI 22: JRC – annual number of occurrences of tangible, specific impacts on European policies resulting from technical and scientific support provided by the JRC		
Baseline (FP7, in 2013)	Target (in 2020)	Achieved value (in 2020)
248	330	513
KPI 23: JRC – annual number of peer-reviewed publications in high impact journals		
Baseline (FP7, in 2013)	Target (in 2020)	Achieved value (in 2020)
460	500	548

Sources: KPI1 - European Research Council Executive Agency, Annual Activity Report 2022, p. 6, https://commission.europa.eu/system/files/2023-06/ERCEA_AAR_2022_en.pdf; KPIs 2 and 14 - Commission monitoring systems - CORDA, data on 24/04/2023; KPIs 22 and 23 - Joint Research Centre, *Ex post* evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020: final report of the ex post evaluation panel, Publications Office of the European Union, 2022, p. 69, https://data.europa.eu/doi/10.2760/257315

Horizon 2020 support has enabled European and other supported researchers to **reach top-tier status in their field**. For Societal Challenges 2, 3, 4 and 5, Horizon 2020 funding boosted citation impact for 2014-2021 publications when measured against a baseline of comparable publications by the same authors.[69] Likewise, Horizon 2020 funding in this area enabled researchers to out-perform other, non-Horizon 2020-funded, publications.[70]

Horizon 2020's **open access principles and requirements** had a positive impact on the proportion of publications that were made freely and publicly available online, which rose from 65% in 2014 to 82% in 2022 and compares favourably with similar international programmes.[71] The number of open access datasets arising from Horizon 2020 projects also increased, from 64 open datasets in 2015 to 1 694 open datasets in 2020. However, despite Horizon 2020 producing a larger number of open access datasets, this data did not always meet the principles of findability, accessibility, interoperability and reusability (FAIR) and there were significant variations across disciplines and programme parts. Although over half of all respondents to a survey on the matter[72]

[67] Numbers are expected to increase when all Horizon 2020 projects are finalised.
[68] Number of the KPI follow the publication: European Commission, DG for Research and Innovation, Horizon 2020 indicators: assessing the results and impact of Horizon, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098
[69] The analysis was based on citation impact profiles including 5 indexes: Average of relative citations (ARC), Citation distribution index (CDI) and Shares of highly cited publications at 10%, 5% and 1% threshold). For all Societal Challenges 2, 3, 4 and 5 the citation impact profiles demonstrated a higher performance, along all indexes for Horizon 2020 funded research. Evaluation study on the European FPs for Research and Innovation for addressing Global Challenges and Industrial Competitiveness - Focus on activities for the Green Transition, Annex 5, section 3.3.4, pp. 111-113, https://data.europa.eu/doi/10.2777/744656.
[70] Based on the counterfactual analysis on the Citation Distribution Index considering Horizon 2020 supported publications and non-Horizon 2020 publications (parallel papers), conducted by evaluation study on the European FPs for Research and Innovation for addressing Global Challenges and Industrial Competitiveness - Focus on activities for the Digital and Industrial Transition, op. cit., p. 50. For DIT overall and its research areas as well as the three LEIT programmes, analyses show a higher Citation Distribution Index (CDIs) (19.8 against 7.0 for non-funded research) and higher score for highly cited publications (2.4 against 1.2 for non-FP funded research). The levels observed are similar to the ones in FP7. (Annex 5, section 2.4).
[71] Excellent Science evaluation study, op. cit., p. 37.
[72] MOAP survey: European Commission, DG for Research and Innovation, Monitoring the Open Access Policy of Horizon 2020: final report, Publications Office, 2021, https://data.europa.eu/doi/10.2777/268348

considered that their Horizon 2020-funded study was reproducible[73], complementary research[74] found that many open access datasets did not meet all the FAIR principles. For instance, only 35% of datasets were findable and only 29% were accessible and interoperable. In terms of reusability, only 61% of datasets included a text and data mining licence.

The total number of **public-private academic co-publications** produced under Horizon 2020 was 53 813[75]. Although no target was set for this indicator, either in the legal basis for Horizon 2020 or in subsequent programme statements, some desk research suggests that more **public-private co-publications were produced than under FP7 (see Table 4)**[76]. This rate was also higher than for equivalent non-framework programme publications in other EU countries and internationally. This suggests that Horizon 2020 successfully selected projects and researchers that were able to contribute to knowledge transfer between the business and academic sectors. Some partnerships, such as ECSEL, cPPP 5G, cPPP Photonics, cPPP SPIRE and EIT Raw Materials, also produced high proportions of public-private co-publications[77].

For the Societal Challenges, direct comparison with FP7 is more difficult. However, some performed especially well, notably SC7 and SC3. Public-private co-publications were also more common under Horizon 2020 projects than under non-framework programme projects.[78]

Table 3: Number of joint public-private publications, **KPI 8 and KPI 17**		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
No baseline as new approach in Horizon 2020	*Unavailable*	LEIT (KPI 8): 10 907 Societal Challenges (KPI 17): 13 436

Source: Internal Commission monitoring systems (CORDA), data on 24/04/2023. Numbers are expected to increase when all Horizon 2020 projects are finalised.

Scientific breakthroughs and advancements

External evaluation showed that Horizon 2020 **contributed to scientific breakthroughs**[79] **and advancements** in emerging areas of science and technology, especially in the medical sciences, quantum mechanics, chemical engineering and composite materials. Specific examples include: capturing the first ever image of a black hole[80]; research into metal-halide perovskites[81] (with potential applications in solar cells, light-emitting diodes and other optoelectronic devices); strong coupling plasmonic[82] (with potential applications in quantum-mechanical and classical optical information processing and in fundamental studies of light-matter interaction) and quantum entanglement[83]

2022 Nobel Prize winners supported by Horizon 2020
Three ERC grantees won Nobel Prizes in 2022 (two were also former MSCA supervisors, as was the winner of the Nobel Prize in Chemistry):

- **Svante Pääbo**, Nobel Prize in Physiology or Medicine (former ERC grantee)
- **Alain Aspect** and **Anton Zeilinger**, Nobel Prize in Physics (former ERC grantees, MSCA supervisors and FET beneficiaries)
- **John F. Clauser**, Nobel Prize in Chemistry (former MSCA supervisor).

[73] European Commission, DG for Research and Innovation, Assessing the Reproducibility of Research Results in EU Framework Programmes for Research, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/186782
[74] European Commission, DG for Research and Innovation, Monitoring the Open Access Policy of Horizon 2020, Publications Office, 2021, https://data.europa.eu/doi/10.2777/268348.
[75] Commission monitoring system (CORDA), figure at 24/04/2023.
[76] European Commission, R&I Dashboard, "Key Performance Indicators (KPI)", data frozen on 31/12/2022.
[77] Digital and Industrial transition study (2023), op. cit., section 6.2.4., p. 57-58.
[78] Digital and Industrial transition study (2023), Annex V ("Bibliometrics"), pp. 464-469.
[79] Excellent Science evaluation study (2023), Annex 6.2, case study on the ERC Proof of Concept (PoC), p. 722.
[80] BlackHoleCam project: https://cordis.europa.eu/project/id/610058.
[81] For an overview: https://erc.europa.eu/projects-figures/stories/perovskites-promise-boost-solar-power-technology
[82] HYPER project: https://cordis.europa.eu/project/id/279881
[83] Example, the CAVITYQPD project: https://cordis.europa.eu/project/id/615755

(observation of the quantum properties of macroscopic objects and quantum cryptography). The programme also made advances in ancient DNA dating (including the discovery of the Denisovans[84], and evidence of Europe's first homo sapiens[85]), predicting new protein structures and interactions[86] (by applying powerful AI tools to structural biology and chemistry), immunotherapy (personalised cancer vaccines[87]), understanding climate change, as well as developing the Pfizer-BioNTech and Oxford-AstraZeneca vaccines against Covid-19.[88]

The contribution of Horizon 2020 to the **advancement of frontier research** has been recognised internationally through various rewards and prizes. Horizon 2020 has supported 33 Nobel Prize winners[89] prior to or after the award of their prize (up from 17 reported in the interim evaluation). In addition, between 2014 and 2020, six ERC grantees were awarded a Wolf Prize and one received a Fields Medal. Furthermore, a survey of beneficiaries suggests that they recognise Horizon 2020's role in helping to promote fundamental and novel research activities, owing to the degree of freedom and originality the programme offered them.[90] Beneficiaries felt that their participation boosted their credibility among their peers and helped to position them at the centre of international networks of R&I experts.[91] The survey findings also confirmed Horizon 2020's role in helping to generate high-quality research outputs and findings, obtain scientific awards and prizes and produce high-quality publications.[92]

Investing in future emerging technologies to accelerate deployment

Bibliometric analysis provides additional evidence on the contribution of **Horizon 2020 to new and fast-growing research topics in science**.[93] Namely, 26% of all Horizon 2020 publications were linked to these topics, of which 1.5% were also among the top 1% of most highly cited publications worldwide. Pillar 1 performed similarly well, with 24% of publications linked to these hot topics and 1.6% of those among the top 1% most cited publications. Under Pillars 2 and 3, around one third of publications concerned new and fast-growing research fields, of which 2.2% and 1.3%, respectively, were among the top 1% most highly cited.

Horizon 2020 allocated significant resources to projects in the fields of **artificial intelligence, quantum computing and clean energy technologies** (see Figure 8). Biological sciences, gene expression and environmental engineering were the top three frontier research areas tackled by ERC grantees, followed by astronomy, theoretical physics, atmospheric sciences, and magnetic fields.[94]

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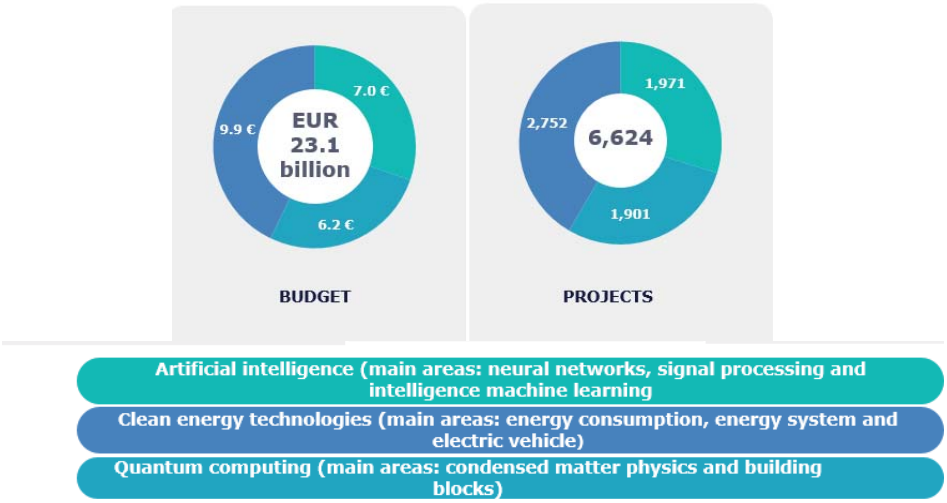
[84] FINDER project: https://cordis.europa.eu/project/id/715069
[85] SUCCESS project: https://cordis.europa.eu/project/id/724046
[86] DeNovoImmunoDesign project: https://cordis.europa.eu/project/id/716058, and the ComplexAssembly project: https://cordis.europa.eu/project/id/724349
[87] SUMMIT project: https://cordis.europa.eu/project/id/789256
[88] For an overview: https://erc.europa.eu/news-events/magazine/tackling-covid-19-%E2%80%93-role-european-research
[89] Commission's internal records.
[90] European Commission, DG for Research and Innovation, Evaluation study on the external coherence and synergies of Horizon 2020 within the European research and innovation support system, hereafter "External Coherence study" (2023), case study 8: Coherence in support to agri-food value chains; case study 16: Fictional case on a fish farmer, https://data.europa.eu/doi/10.2777/90147.
[91] External coherence study (2023), case study 3: Complementary financing with Cohesion policy at project level, case study 8: Coherence in support to agri-food value chains.
[92] Excellent Science evaluation study (2023), op. cit., Survey of Horizon 2020 beneficiaries.
[93] Excellent Science evaluation study (2023), Annex 3.1, p. 456. A total of 132 Horizon 2020 publications were analysed. Future and emerging technologies are research activities thematically related to new and fast-growing research topics in science. 9 000 of such topics were identified and they include: gut microbiome, microplastics, random forest and artificial intelligence.
[94] Excellent Science evaluation study (2023), Annex 6.1, case study on the ERC impact on creating new or pushing existing frontiers of science, p. 699.

Figure 8: Horizon 2020 funding to new and emerging areas



Source: CORDA data – cut-off date: 04/04/22 from the Excellent Science study

The FET **flagships** in particular (see two examples in the box below) had a sizeable impact on knowledge creation. The majority of FET projects (83%) dealt with research ideas not previously present in the scientific community and thus deemed to be 'radically new'.[95] As a consequence, more than one third of the publications stemming from the FET programme are linked to future and emerging research and technology fields with 1.6% being amongst the top-1% most highly cited worldwide. With publications in high impact journals like Science or Nature,[96] FET results were cited in many different scientific fields.[97]

'Graphene Flagship' and the 'Human Brain Project'

The **Graphene Flagship** was a large collaborative research and innovation project launched in 2013 with the objective of creating and commercialising new technologies based on graphene and related materials. It was funded with EUR 500 million from the European Commission and €500 million from EU Member States and other sources.[98] Over the past nine years, the Graphene Flagship has brought graphene out of the lab, creating a productive European industrial ecosystem that develops new applications for graphene and layered materials, which, based on evaluation evidence would not have been possible without the FET flagship instrument. It also led to the establishment of many companies, start-ups and infrastructures. Evaluation evidence shows that this flagship has halved the time-to-market for new materials in commercial applications. Currently, the flagship includes over 100 companies working together with academic partners in fields ranging from aviation and electronics to energy, and biomedicine.

The **Human brain project (HBP)** began in 2013 and was one of the largest research projects in the world, with total costs of EUR 1.019 billion (EUR 500 million from the European Commission and the rest from national, public and private organisations)[99]. More than 500 scientists and engineers at over 140 universities, teaching hospitals and research centres across Europe came together to study the human brain. During its lifetime, the HBP drove outstanding advances in the field of brain research and in the development of brain-derived applications in medicine and technology, e.g. human brain simulation, medical imaging and insights into brain function. Evidence suggests that these scientific findings and the emergence of the surrounding ecosystem and infrastructure would not have been possible without the flagship instrument.

For both these projects, evaluation findings suggest that building an enduring network and establishing long-lasting partnerships across Europe were among their greatest achievements.

[95] Excellent Science evaluation study (2023), Annex 1, Section 3.2, p. 131.
[96] Excellent Science evaluation study (2023), Annex 1, Section 3.2, p. 143.
[97] 36% of the sample of FET projects analyses had an impact on more than 20 scientific fields.
[98] Excellent Science evaluation study (2023), Annex 6.6, p. 796.
[99] Ibid, Annex 6.7, p. 809.

Enhancing researchers' skills, mobility and career development

Horizon 2020 has **diversified and improved researchers' skills and knowledge**. The survey of beneficiaries showed that around 85% of those who were awarded MSCA individual fellowships considered the training provided and supervision to be 'very good' or 'good'. The survey also showed that 70% of respondents had received training on new or advanced scientific methods in their own research field.[100] Under ERC projects the skills most frequently developed were 'scientific methods and/or techniques, 'project and people management' and 'thinking'.[101] The 'Research infrastructures' and 'Science with and for society' (SwafS) programmes also contributed to skills development, as training was a frequent project component. Specifically, over 80% of the SwafS survey respondents said their projects had improved their research skills and knowledge and given them transferable skills (e.g. project management and teamwork).[102]

Horizon 2020, mainly via the MSCA, also supported the international and intersectoral mobility of researchers. The corresponding programme target (KPI 4) is expected to be met once all projects are completed.

Table 4: **KPI 4** on the number of researchers undertaking cross-sector and cross-country mobility, including PhD candidates

Baseline (FP7)	Target at the end of Horizon 2020	Achieved value[103]
50 000 researchers (2007-2013), of which 20% PhD-level	65 000 researchers (out of which 25 000 PhD candidates)	49 475 *unique* researchers (of which 25 676 PhDs)

Source: Baseline from: European Commission, DG for Research and Innovation, Horizon 2020 indicators: assessing the results and impact of Horizon, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098. Achieved values: CORDA data, updated on 19/01/2023 (provided by DG EAC). Numbers are expected to increase when all Horizon 2020 projects are finalised.

Horizon 2020 plays a strong role **worldwide as regards the international mobility of researchers**. According to survey results, around 89% of recipients of individual fellowships under the MSCA[104] said their project offered international mobility opportunities. This proportion was significantly lower (63%) for unsuccessful applicants who still implemented their project, indicating that the programme was successful in this regard. Almost 70% of the ERC principal investigators surveyed,[105] at the very least 'rather agreed' that ERC projects contributed to international mobility opportunities. Indeed, half of the programme's ERC team members were nationals of a country other than that of the host institution, while 40% of the scientific and technical staff moved country when they started working on the ERC grant.[106]

The Horizon 2020 programme also had a positive impact on **intersectoral mobility**. For example, the MSCA Research and Innovation Staff Exchange (RISE) and the Innovative Training Networks (ITN) actions contributed significantly to the mobility of fellows to the private sector (24.2% of RISE and 15.7% of ITN beneficiary fellows had a private for-profit organisation as their main host institution). Similarly, 36% of those awarded fellowships under RISE and 23% of ERC principal investigators said they had intersectoral mobility opportunities because of their project (compared with 26% and 17%, respectively, among the unsuccessful applicants to the same programmes).[107] Finally, MSCA fellows who engaged in intersectoral

[100] Excellent Science evaluation study (2023), Annex 1, p. 75.
[101] Excellent Science evaluation study (2023), Annex 1, p. 27.
[102] Excellent Science study (2023), op. cit., p. 48, Survey of Horizon 2020 beneficiary organisations.
[103] The figure is expected to increase, as 39% of COFUND, RISE and ITN projects were still ongoing at the reference date (19 January 2023).
[104] Excellent Science evaluation study (2023), op. cit., Survey of Horizon 2020 MSCA beneficiaries.
[105] Excellent Science evaluation study (2023), op. cit., Survey of Horizon 2020 ERC beneficiaries.
[106] Excellent Science evaluation study (2023), op. cit., p. 48.
[107] Excellent Science evaluation study (2023), Annex 6.15 – case study "Impact of the Framework Programme in spreading excellence across the Union", table 5 on p. 957.

mobility were more likely than other MSCA fellows to be employed after the end of the fellowship and found better and more diverse job opportunities outside of academia.[108]

MSCA further supported mobility flows between countries by enabling researchers to return to their home country, if they so wished. In particular, the Reintegration Panel of the European Fellowships (IF-EF) helped nationals or long-term residents of Member States or Associated Countries to return to their home country. In several countries where priority was given to widening participation,[109] (Romania, Lithuania, Bulgaria, Latvia, Slovakia, Cyprus, Croatia, Estonia, Poland and Hungary), over half of incoming MSCA researchers awarded individual fellowships were returning to their country of origin. Similarly, over 25% of experienced postdoctoral researchers used the MSCA COFUND to return to Member States where widening participation was prioritised. This proportion rose to 50% for the specific countries mentioned above. In the context of MSCA, 570 EU nationals benefited from the IF-EF scheme, or 7.2% of all IF-EF fellows. Of these, 335 fellows (58.8%) used the scheme to return to their home country.[110] Furthermore, the 'Widening Fellowship' pilot (renamed 'ERA fellowships' under Horizon Europe) significantly increased the inflow of researchers to countries designated as widening countries.

Participation in Horizon 2020 improved **researchers' career prospects**, particularly those of early career researchers, such as MSCA fellows, ERC Starting and Consolidator grantees, FET grantees and more junior members of teams supported by 'Spreading Excellence and Widening Participation' (SEWP) actions.[111] Almost 93% of ERC principal investigators rated their ERC project as having had, at least, a 'good' impact on their career prospects, with the impact being particularly evident for early stage researchers.[112] Most FET researchers said that FET projects had advanced their careers and enabled them to venture into previously unfamiliar areas and disciplines and to benefit from an interdisciplinary approach.[113] SEWP interviewees and survey respondents were generally convinced that the widening actions had had a positive impact on research careers across all career stages and that SEWP actions and enabled them to further develop their skills.[114] The main benefits cited were: study visits to institutions in countries where the research was more advanced; knowledge exchange with partners more advanced in the field; training activities and access to and more effective use of high-quality research infrastructure.

Strengthening Research Infrastructures

Horizon 2020 has enabled the EU to conceive, deliver and upgrade large-scale research infrastructures at a European and global level. The **Research Infrastructures** programme, in particular, played a role in promoting the development of pan-EU research infrastructures, providing support for collaboration, joint research and services, as well as access to such infrastructures. It also provided support for the development of the pan-EU research infrastructures included in the European roadmaps published by the **European Strategy Forum on Research Infrastructures (ESFRI)**. These roadmaps list the most important research infrastructures in Europe for the next 10-20 years, with the aim of stimulating the implementation or upgrading of these infrastructures. In 2021, 41 infrastructures listed by ESFRI had achieved a state of maturity. Interviews with stakeholders and beneficiaries[115] confirm that this was largely thanks to the contribution of INFRA calls. The INFRA programme is on track to achieve its Horizon 2020 target as project implementation is still ongoing. The three most-used research

[108] Excellent Science evaluation study (2023), Annex 1 - MSCA effectiveness, p. 61.
[109] Countries identified as "low R&I performing", and thus eligible to apply to dedicated spreading excellence and widening participation actions, are listed in the Horizon 2020 regulation and in the glossary, for ease of reference.
[110] Excellent Science evaluation study (2023), Annex 1 – MSCA effectiveness, p. 70.
[111] Excellent Science evaluation study (2023), op. cit., section 4.4.7, p. 48.
[112] Excellent Science evaluation study (2023), Survey of Horizon 2020 ERC beneficiaries, Annex 1, p. 23.
[113] Excellent Science evaluation study (2023), Annex 1, Section 3.2.2, p. 143.
[114] 71% of the SEWP beneficiaries indicated that their SEWP project increased the research skills, knowledge and competences of researchers, incl. an increase in researchers' transferable skills of (73%).
[115] Excellent Science evaluation study (2023), op. cit., p. 45.

infrastructures were SOLEIL in France, Diamond in the UK, and MAX IV in Sweden. However, support of Horizon 2020-funded work on infrastructures experienced regular difficulties in implementation, due to legal issues, see section 4.3.2. on synergies.

Table 5: **KPI 5** – number of researchers who have access to research (e-)infrastructures through Union support		
Baseline (FP7, 2013)	Target at the end of Horizon 2020	Achieved value
22 000 researchers (excluding e-infrastructures)	20 000 additional researchers	24 235 researchers. Share of researchers with access to e-infrastructures[116]: 35.6%

Source: Baseline from: European Commission, DG for Research and Innovation, Horizon 2020 indicators: assessing the results and impact of Horizon, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098. Achieved values: Commission monitoring system (CORDA), data on 24/04/2023. Numbers are expected to increase when all Horizon 2020 projects are finalised.

Spreading excellence and widening participation

Horizon 2020 aimed to spread excellence and build up R&I capacity across the EU. It earmarked EUR 935 million of funding under SEWPs to widen participation in lower R&I-performing countries.[117] Evaluations show that some progress was made in expanding participation and funding to institutions in these countries.[118] Overall, entities from 'widening countries' represented 12.3% of Horizon 2020 participations, a 1.3 percentage point increase from the FP7 baseline.[119] All 'widening countries', except Croatia and Hungary, increased their participation. In terms of the average number of applications received per 1 000 scientists and engineers as a proportion of the country's population, or the amount of EU funding received as a percentage of GDP, widening countries performed very well compared to other Member States, especially Cyprus, Estonia and Slovenia.[120]

What messages emerged from the stakeholder consultation?

In total, 74% (1 305) of respondents agreed or strongly agreed in the stakeholder consultation with the notion that **Horizon 2020 spread excellence and widened participation in R&I**. This view was held by 81% (677) of respondents from business associations, 75% (26) of respondents replying on behalf of companies and businesses, 74% (677) of respondents from academia and 73% (48) of respondents replying on behalf of NGOs. At the same time, 73% of non-EU citizens agreed or strongly agreed (43), compared to 68% of EU citizens (148).

Breaking down the responses of all respondents by countries, it becomes clear that 77% (138) of respondents from EU-13 countries, 74% (1 027) of EU-15 countries, 73% (99) of associated countries and 70% (41) of third countries agree or strongly agree with the notion that Horizon 2020 spread excellence and widened participation in R&I.

Comparatively, only 62% (1 097) of respondents believed that **Horizon 2020 helped building R&I capacity in EU countries lagging behind**: this view was primarily shared by non-EU citizens (70%; 41), environmental organisations (67%; 2), companies and businesses (64%; 199), academia / research organisations (62%; 566) followed by EU citizens (61%; 132). The views of business associations were less favourable, only having 55% (17) supporting the claim that the programme helped building R&I capacity in EU countries lagging behind, whereas 23% (199) of respondents replying on behalf of businesses indicated that the effect of Horizon 2020 in this endeavour was neutral. Nevertheless, other stakeholder groups held more favourable views, with less respondents deeming the effect neutral, e.g. 11% of academia (200), 10% of companies (31). Overall, only a small fraction of respondents indicated that it had no effect at all: 3% of businesses (8) and companies and 1.5% of academia (14).

Given its specific focus, participation from widening countries is much higher for SEWP actions than the rest of the programme.[121] There are important differences in the widening countries' participation patterns: around half of the Horizon 2020 SEWP funding went to four of the 15

[116] Defined as number of e-infrastructure users divided by maximum possible number.
[117] The full list of widening countries is provided in the glossary.
[118] Cross-cutting issues evaluation study, op. cit., Annex 10 - Case study "Widening Participation", p. 14.
[119] The total amount of EU financial contribution to widening countries (EUR millions) was 7.7% for Horizon 2020 – an increase of 1.7 percentage points from the baseline of FP7.
[120] ECA (2022), Special Report N.15, Figure 6, https://op.europa.eu/webpub/eca/special-reports/h2020-15-2022/en/.
[121] 51% of the participants in these actions come from widening countries. 32% of participants come from EU-13. Evaluation study on Excellent Science in the European FPs for Research and Innovation, p. 50.

countries (Portugal, Cyprus, Poland and Estonia).[122] Also, when the widening funding is normalised considering the population size, it can be observed that the countries benefiting the most from the widening measures are Cyprus, Estonia, Latvia, Slovakia, which also demonstrated higher participation in previous FPs.[123]

In a dedicated report on measures aiming to widen participation in Horizon 2020, the European Court of Auditors noted that, although the large-scale effects of the widening instruments will only be visible in the long term[124], change depends to a large degree on R&I investments and reforms at national level.[125] Similarly, the evaluation study on the cross-cutting issues of Horizon 2020 concluded that the degree to which widening measures were a causal factor in raising levels of participation across Horizon 2020 is difficult to gauge and that they are likely to have long-term rather than immediate impact.[126]

Nonetheless, initial results of the participation of widening countries over Horizon 2020 have been positive. The SEWP actions funded **researchers and research groups with high levels of excellence.** This is reflected by the good representation in SEWP actions of institutions listed in the Leiden Europe 250 ranking[127], both for participants from widening and non-widening countries. At the same time, the participating researchers and research groups from widening countries seemed to be able to **improve research production and quality thanks to the participation in SEWP**. Beneficiaries of twinning and teaming projects indicated that it is specifically the partnering with the advanced institutions (e.g. through trainings, workshops and staff exchanges with these partners) that contributed the most to the quality of the research.[128] The survey and interviews stressed that the widening projects helped the project partners to structure and institutionalise these collaborations. Specifically, 97% of respondents indicated that these projects strengthened existing collaborations with partner organisations, enabling researchers in the widening countries to access know-how, expertise, infrastructure and equipment that is often not available in their countries.[129]

As a result of participation in the programme, widening countries improved their research production and quality. While publications stemming from the SEWP actions account for 3.6% of all Horizon 2020 publications[130], for widening Member States almost one-third of their total number of publications generated in Horizon 2020 is produced within the widening actions.[131] Among publications stemming from the SEWP actions, highly cited ones increased from 6% in 2014 to 17% in 2020. Moreover, 28% of the highly cited Horizon 2020 publications produced by widening countries were linked to widening actions. This reflects the importance of this programme part for widening countries in terms of producing excellent science. This relative importance is particularly high for Cyprus, Estonia, and Latvia.

However, evaluation findings show that there are few new entrants in the SEWP programme, compared to the share of newcomers in Horizon 2020. This shows that **SEWP-funded researchers and research groups had often previously participated in the FP.**[132]

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[122] ECA (2022), Special Report No15, p. 23.
[123] ECA (2022), Special Report No15, pp. 24-25.
[124] ECA (2022), Special Report No15, p. 26.
[125] ECA (2022), Special Report No15, p. 26.
[126] Cross-cutting issues evaluation study, Case study "Widening participation", p. 11.
[127] The Leiden University rankings are based on bibliometric data. In this exercise, the "Scientific excellence" dimension of the rankings have been used over the time period of 2017-2020. The indicators are based on the share of highly cited publications in the university's publication count.
[128] Excellent Science evaluation study (2023), Annex 1, pp. 240-241.
[129] Excellent Science evaluation study (2023), Annex 1, p. 223.
[130] Excellent Science evaluation study (2023), Annex 3: bibliometric analysis.
[131] Ibid, case study: Impact of SEWP in improving quality (and coverage) of research in widening countries.
[132] 14% of unique participants according to the Excellent Science study (2023) p. 31 and Corda data. This analysis was based on organisation-level information (i.e. PIC numbers) and conceals the impacts at the level of research groups and individual researchers.

Table 6: **KPI 20** on SEWP: evolution of peer-reviewed publications in high-impact journals (ERA Chairs and Twinning activities)[133]		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
Data unavailable	No target	Before EU funding: 1 263 After EU funding: 3 098

Source: Commission monitoring system (CORDA), data on 24/04/2023

4.1.2. Effectiveness: **'Societal impacts'** – To what extent has Horizon 2020 increased the R&I contribution to Societal Challenges?

This section reports on the effects of Horizon 2020 actions grouped under **'Societal impacts'** in the Intervention Logic (Figure 2). The term primarily refers to the **direct, non-market benefits**[134] of the programme, which increase the **welfare of society**, for instance by means of improvements in **health, security** and the **environment**. In general, these effects only become visible in the medium-longer term. This also covers a few **indirect, non-monetary benefits** such as positive impacts on **gender equality**. The section describes the **impact** Horizon 2020 had on national, European and international **policies** including via research actions by the JRC and addresses the programme's contribution to the Sustainable Development Goals (**SDGs**). Conclusions on the effectiveness of actions under this pillar are based both on KPI data and the qualitative evidence from case studies provided below.

Pursuing research and innovation to contribute to Societal Challenges

The programme allocated funding in seven broad areas, referred to as Societal Challenges.[135] Table 8 details the baseline, targets and results for the two key performance indicators relevant to all Societal Challenges (KPIs 14 and 15).

Table 7: KPIs 14, 15 – Number of publications and patents in the areas of different Societal Challenges		
KPI 14: Publications in peer-reviewed high impact journals, per EUR 10 million		
Baseline (FP7)	**Target at the end of Horizon 2020**	**Achieved value**
Data unavailable – new approach in Horizon 2020	20 (for all Societal Challenges)	7.0 publications per EUR 10 million of EU funding[136]
KPI 15: Patent applications and patent awarded, per EUR 10 million		
Baseline (FP7)	**Target at the end of Horizon 2020**	**Achieved value**
Data unavailable – new approach in Horizon 2020	2 patent applications and patents awarded per EUR 10 million funding	0.35 patent applications and 0.26 patents awarded per EUR 10 million[137]

Source: Commission monitoring systems (CORDA), data on 24/04/2023.

The evaluation has made apparent that the Horizon 2020 monitoring and evaluation framework is not adequate to comprehensively capture positive effects under Societal Impacts. The

[133] "Evolution (compared to a reference period prior to the signature of the grant agreement) of the publications in high impact journals in the given research field of the research organisation funded". Numbers are expected to increase when all Horizon 2020 projects are finalised.
[134] Better Regulation Toolbox, tool #57, section 5.
[135] The seven Societal Challenges are presented in figure 1 and recalled here, for ease of reference: SC1) Health, demographic change and wellbeing; SC2) Food security, sustainable agriculture, marine and maritime research and the bio-economy; SC3) Secure, clean and efficient energy; SC4) Smart, green and integrated transport; SC5) Climate action, environment, resource efficiency and raw materials; SC6) Europe in a changing world, inclusive innovative and reflective societies; SC7) Secure societies, protecting freedom and security of Europe and its citizens.
[136] Achieved values broken down per Societal Challenge: SC1: 13.5 publications; SC2: 8.7 publications; SC3: 3.8 publications; SC4: 1.7 publications; SC5: 10.6 publications; SC6: 4.7 publications; SC7: 1.9 publications.
[137] The achieved values, broken down per Societal Challenge, are as follows: SC1: 0.23 patent applications; SC2: 0.27; SC3: 0.47; SC4: 0.42; SC5: 0.32; SC6: none; SC7: 0.17. If only *foreground* patent applications (see Annex 2) are considered, the ratios to EUR 10 million is 0.20 (across the Societal challenges).

outcomes and even outputs of some projects such as of projects fostering cross-border co-operation or resulting in an influence on a specific policy agenda were incompletely recorded. Potential additional effects from projects cannot be excluded. Case study evidence nevertheless suggests that encouraging trends and clear effects could be observed in specific topic areas, as illustrated by the examples that follow. A more detailed account of societal impacts of Horizon 2020 projects is provided in Annex 3 and in the underlying set of evaluative studies and materials.

In health-related research, societal effects were generated in particular in the areas of rare diseases[138], orphan medicines[139] and antimicrobial resistance.[140] Following effective efforts to combat Ebola and Zika outbreaks that were already documented in the interim evaluation, Horizon 2020 and previous FPs also funded research instrumental for understanding and combatting COVID-19 which produced societal impacts. Analysis conducted in 2021 documented the contribution of EU funding to publications on COVID-19 research and to the main discoveries and insights on COVID-19.[141] EU funding has contributed to 3 000 papers on COVID-19 coming from almost all parts of the framework programmes (FP7 and Horizon 2020), with Societal Challenge 1, the ERC, and MSCA accounting for about 80% of the total.[142] The EU is the third most frequently acknowledged funding source for COVID-19-related research, after the US Department of Health and Human Services and the National Natural Science Foundation of China.

The delayed or abandoned implementation of clinical trials negatively affected the benefits from health-related research. In the context of a relatively low share of 79% of Societal Challenge 1 projects meeting all or most of their objectives (compared to 97% under FP7 Health), the area of 'Treating and managing disease' was particularly affected, with a share of only 70%. Apart from Covid-19 emergency measures, the reduction reflects an overall trend affecting the increasingly complex clinical trials[143].

Under Societal Challenge 2, Horizon 2020 research projects **increased knowledge of the marine environment and fishing methods** and supported policy, most notably contributing to the further development of the European Common Fisheries Policy. Examples include the DISCARDLESS[144] and MINOUW[145] projects which contributed towards reducing discards, a practice that wastes resources and poses a threat to the health and stability of marine ecosystems.

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[138] Projects under Pillar 1 Excellent Science (198 projects) and Pillar 3 Societal Challenges (139 projects), contributed towards a better understanding of rare diseases, the development of related therapies (e.g. the BATCure project), diagnostics approaches (e.g. the ChiLTERN project), as well as the aggregation of rare disease patient data (e.g. the UM Cure 2020 project on uveal melanoma patients) for future research.

[139] Horizon 2020 projects were found to be effective in generating results in the development of orphan medicines in a number of designations (titanium dioxide, cisplatin, nitric oxide, doxorubicin and oxytocin) and in bringing substantial results towards the development of treatment of amyotrophic lateral sclerosis, glioma and severe combined immunodeficiency, among others.

[140] Horizon 2020 facilitated European scientific collaboration in the sectors and AMR disciplines of infection prevention and control, monitoring and surveillance, diagnostics, vaccines, clinical studies, novel treatments, and antimicrobial stewardship. Horizon 2020 supported cross-border collaborations, allowing novel methods and interventions to be tested out in high-resistance settings with distinct healthcare systems, were identified as vital to strengthening AMR research capacity across the EU and globally. Resilient Europe, final report, case study 1.

[141] Meeting the Pandemic Challenges Contribution of EU R&I funding to COVID-19 related research, Research Working Paper 2021/01.

[142] Over half of the publications (56%) are internationally co-authored. 66% of publications are co-funded by the EU and other entities. The publications come from several research disciplines: the fields with most publications are virology, cell biology, genetics, and biochemistry. Other noticeable areas are environmental (health) areas, zoology, and nanotechnology.

[143] Stančiauskas, V., Kazlauskaitė, D., Zharkalliu, K., et al., Evaluation study of the European framework programmes for research and innovation for a resilient Europe: final report - phase 1, Publications Office of the European Union (2023), Section 7.1, p. 52, https://data.europa.eu/doi/10.2777/60819.

[144] https://cordis.europa.eu/project/id/633680 and http://www.discardless.eu/

[145] https://cordis.europa.eu/project/id/634495 and http://minouw-project.eu/

As regards the **smart European electricity grid**,[146] projects successfully established an innovation community directed at next generation technologies and tools for grid automation, integration of storage, energy system integration and increasing the share of renewables in the electricity system.

While the **circular economy** has been reflected in Horizon 2020 calls since 2014, it gained in importance and presence in the last work programme (2018-2020)[147], accompanying the successive Circular Economy Action Plans published in 2015 and 2020. The calls for proposals evolved from their initial scope that covered waste management and water innovation to a broader scope aimed at boosting global competitiveness, encouraging sustainable economic growth and generating new jobs. The focus also shifted from supporting SMEs to considering other actors, such as industry, policymakers and the global community for the relevant sectors. This change helped to implement the Circular Economy Action Plan and other high-level EU priorities.

Expenditure on sustainable development[148] **exceeded the Horizon 2020 target of 60%[149], at 64.4% of the total budget.** Societal Challenges performed well above target, with 84.7% of all expenditure going to projects contributing to sustainable development. Except for expenditure on Science with and for Society (62.7%), all parts of the remaining programme were below the 60% target, particularly the EIC Pilot, Spreading Excellence, the Excellent Science pillar and the Industrial Leadership pillar.

While many relevant projects were funded under Societal Challenge 3 (**Secure, clean and efficient energy**), its Horizon 2020 target (KPI 19), detailed in Table 9, was not met.

Table 8: **KPI 19** on % of the overall Energy Societal Challenge funds allocated to renewable energy, end user energy efficiency, smart grids and energy storage activities

Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
Not available	85%	69.6%

Source: Commission monitoring systems (CORDA), data on 24/04/2023. Based on policy monitoring flagging by project officers.

In the area of **offshore renewable energy**, funded projects contributed to an increase in publicly available knowledge and evidence, technical innovations enabling future cost reductions and upscaling, upskilling and training, as well as the diffusion of offshore renewable energy to a wider geographic area.[150] An important contribution was to inspire confidence in policymakers about the feasibility of offshore renewable technologies and the role they can play in the energy system.[151]

In the area of **urban transport** (under Societal Challenge 4), many projects contributed to the refinement of Sustainable Urban Mobility Plans (SUMP).[152] For example, thanks to the work of the Park4SUMP project, cities could implement well-tailored parking measures and integrate them into sustainable urban mobility planning which improved parking policies in 16 partner cities. The multiple strategies supported by Horizon 2020 contributed to more sustainable and healthy urban transport in different EU cities through a concerted push towards measures such as improving cycling infrastructure.

[146] Green Transition evaluation study (2023), Annex IX, case study 5, section 5.1.
[147] Green Transition evaluation study (2023), op. cit., pp. 105-109.
[148] This is calculated on the basis of the RIO markers methodology developed by the OECD, and based on eCorda data analysis (September 2021) in Annex C of the Evaluation Study on the Relevance and Internal Coherence of Horizon 2020 and its Policy Mix (2023), https://data.europa.eu/doi/10.2777/95070, p. 3.
[149] Regulation (EU) 1291/2013 establishing Horizon 2020.
[150] Green Transition evaluation study (2023), Annex IX, section 6.1.
[151] Green Transition evaluation study (2023), Annex IX, section 6.3.5.5.
[152] Green Transition evaluation study (2023), Annex IX, section 10.3.5.4.

Projects funded via partnerships played a central role in Horizon 2020 supporting the ambition to make European transport systems sustainable and seamless for all to use[153]. For example, the Fuel Cells and Hydrogen JU[154] drove forward the deployment and scalability of fuel cell buses, as well as the design of key solutions necessary for low-emission air travel also supported by Clean Sky 2[155].

The Horizon 2020 project IMPACT-SC5 (**Climate action, resource efficiency and raw materials**) evaluated the progress of 87 projects funded under the Societal Challenge 5 Work Programme for 2014-2015. It found that most of the projects produced policy-related outputs addressing EU policy priorities and the SDGs, particularly in the portfolios of climate, waste, and environment, ecosystems and biodiversity.[156] Climate change mitigation and adaptation, as well as the reduction of waste generation and environmental depletion, were the focus of policy contributions produced by the projects.[157]

Horizon 2020 devoted 32% of its investment to climate-related research, falling short of the 35% target.[158] The situation was different in each of the three pillars:[159] Societal Challenges spent around half of its budget on climate action, while Excellent Science and Industrial Leadership fell well below the 35% target (with 17.5% and 21.2% respectively).[160] An aspect to be considered in this context[161] is the over-estimation of the climate contribution from the bottom-up parts of the programme, due to the difficulty to accurately estimate and quantify in the form of *ex-ante* figures the extent to which programme parts, which aim for excellence and competitiveness of the R&I system, should also address political priorities regarding societal challenges – when some of them, in particular the ERC, are not geared towards specific thematic needs, but provide a bottom-up funding mechanism open to all thematic domains. The lessons learnt in Horizon 2020 should be used to avoid repeating the same underperformance in Horizon Europe where the 35% target has been maintained.

The EU is the second most frequently acknowledged funding source of the research referenced in the **Intergovernmental Panel on Climate Change (IPCC)**'s 6th Assessment Cycle reports, after the National Science Foundation of the United States.[162] FP7 and Horizon 2020 supported over 4 500 publications cited by the IPCC, coming from over 1 200 projects. These correspond to about 10% of all references cited in the reports. The **IPCC** was instrumental in creating a broader, evidence-based consensus on climate-related knowledge with a tangible contribution from research funded by the programme.

On **migration** research (within Societal Challenge 6), interviewees said the programme is the most important funding source on the topic worldwide and a major factor in the emergence of new networks and the increase in the number of young people entering the field of migration

[153] Green Transition evaluation study (2023), pp. 136-137.
[154] https://www.clean-hydrogen.europa.eu/media/publications/2021-success-stories_en
[155] https://cleansky.paddlecms.net/sites/default/files/2021-08/Highlights-2020_en.pdf.
[156] Assessing the Impact Pathways of IA/RIA SC5 Projects through the Use of Portfolio Analysis, D4.1.1 Synthesis report, 30 April 2021, p. 17. https://impact-sc5.eu/wp-content/uploads/simple-file-list/D4_1_Synthesis-Report-Final.pdf
[157] Ibid, p. 37.
[158] According to the 2022 Programme Statement and the study on Relevance and internal coherence of Horizon 2020 (2023), https://data.europa.eu/doi/10.2777/058655.
[159] Evaluation study on the relevance and internal coherence of Horizon 2020 and its policy mix, Annex C, Analysis of eCorda data, https://data.europa.eu/doi/10.2777/95070. Calculation made on the basis of the RIO markers methodology developed by the OECD. Projects are assigned a score of 0% (not targeted), 40% (significant objective), 100% (principal objective), which is then applied to the EU budget contribution.
[160] Ibid, Annex C, table 1, p. 62. NB: Data from eCORDA submitted to project team by the EC on 7 September 2021.
[161] Ibid, main report, p. 31.
[162] Contribution of the framework programmes (FP7 and Horizon 2020) to the knowledge base of IPCC reports based on openly available data, EC Monitoring & Evaluation Flash, March 2023, https://data.europa.eu/doi/10.2777/235579

research. Of the 41 migration projects, 12 projects have published a total of 44 publications to date, including two that were highly cited. In contrast, determining the policy[163] influence of the programme was challenging. This is because statements about the influence of projects on political agenda-setting are largely based on anecdotal evidence.

Social Sciences and Humanities in Horizon 2020 were addressed both as a programme part (SC6 Europe in a Changing World: Inclusive, Innovative and Reflective Societies), and as a cross-cutting issue. Evidence shows the value of integrating SSH[164] into R&I projects to achieve a multi-disciplinary and/or inter-disciplinary approach in the programme.[165] Horizon 2020 was the first EU research and innovation framework programme into which SSH was systematically integrated[166], with over 20% of total call budget allocated to SSH-flagged topics.[167]

A lack of a well-established monitoring process and clear definitions acted as barriers to efficient implementation of SSH in addressing societal needs.[168] The work on SSH integration under Horizon 2020 produced some positive results, but also revealed such limitations.[169]

SC6 funded a variety of themes spanning from migration and socio-economic inequalities to topics on culture and cultural heritage.[170] SC6 projects were reported to have performed well[171] and, in most instances, delivered high-quality results. They were particularly strong in generating outputs that allowed immediate exploitation. Key outputs included peer-reviewed papers, as well as books, online databases, support for evidence-based policymaking and policy advice – a significant share of SC6 projects produced policy evidence and knowledge that was also taken up by EU institutions, agencies, and other organisations.[172] Actions from the culture and cultural heritage sector proposed market-ready products and services.[173] For example, the project ARCHES[174] developed technological solutions that enable inclusiveness so that people with special needs can access and engage with heritage content in cultural spaces.

SSH integration increased over the lifetime of the programme and the budget allocated to SSH partners grew significantly, especially for the 2015-2018 period.[175] Furthermore, the quality of

[163] For example, New Pact on Migration and Asylum, EU blue card, Migration policy in the strategic agenda 2019-2024, EU visa policy, Malta Declaration, EU asylum agency.
[164] Social sciences and humanities encompass various disciplines such as social sciences, education, business, law, and humanities and the arts, notably including economics, sociology, demography, anthropology, psychology, geography, human rights, journalism, library and museum science, religion and theology, foreign languages and cultures, history, philosophy, fine arts, performing arts, graphic and audio-visual arts, design.
[165] Cross-cutting issues evaluation study (2023), Annex 3, section 4.5, referring to the Interim evaluation of Horizon 2020 (European Commission, 2017) and the five periodic monitoring reports on the integration of SSH in Horizon 2020, https://op.europa.eu/en/publication-detail/-/publication/f094a641-30dd-11e9-8d04-01aa75ed71a1.
[166] European Commission, Directorate-General for Research and Innovation, Integration of social sciences and humanities in Horizon 2020 – Participants, budgets and disciplines 2014 - 2020 – Final monitoring report, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/075642, p. 58.
[167] Ibid, p. 9.
[168] Cross-cutting issues evaluation study (2023), Annex 3, sections 4.8 and 4.9.
[169] European Commission, DG for Research and Innovation, Kania, K., Bucksch, R., Integration of social sciences and humanities in Horizon 2020: participants, budgets and disciplines, Publications Office of the European Union, 2020, https://data.europa.eu/doi/10.2777/141795, p. 66.
[170] Resilient Europe evaluation study, op. cit., p. 22.
[171] Ibid, p. 45.
[172] Ibid, p. 43.
[173] Ibid, p. 50.
[174] https://cordis.europa.eu/project/id/693229 and https://www.arches-project.eu/. Among other achievements, the project filed a patent application for a portable visual perception 2.5D printer that could create replications of museum masterpieces.
[175] Cross-cutting issues evaluation study (2023), Annex 3, p. 60. Percentage of EU financial contribution allocated to SSH in the SSH-tagged projects increased from 62.7% in 2015 to 67.4% in 2018. Moreover, according to the 5th monitoring report on Integration of Social Sciences and Humanities in Horizon 2020 (p. 5), budget allocated to SSH partners in projects funded under SSH flagged topics was EUR 197 million in 2015 and EUR 415 million in 2018. More details on the two last funding years of Horizon 2020 are presented in the Final Monitoring Report on Integration of SSH in Horizon 2020, https://data.europa.eu/doi/10.2777/075642, p. 11.

integration – although still uneven between programme parts and in need of improvement in terms of countries and SSH disciplines – was identified to have improved overall over time.[176]

Notably, frontier research funded by the ERC has supported social sciences and humanities via 1 595 grants, with a total value of EUR 2.8 billion.[177] SSH have also been addressed by calls for proposals in the last phase of Horizon 2020, but interviewees reported that their integration into multidisciplinary projects remained challenging, as they were often perceived as an add-on element in the research design.[178] This was confirmed by respondents in the stakeholder consultation.

What messages emerged from the stakeholder consultation?

Overall, 37% (656) of respondents indicated in the public consultation that they either agree or strongly agree with the notion that **calls for proposals sufficiently took Social Sciences and Humanities into account.** It is important to mention that 29% (527) of respondents did not answer this survey question or indicated that they do not know or have no opinion. This indicates that a significant share of respondents has rather limited knowledge of the integration of Social Sciences and Humanities in the programme. Bearing this caveat in mind, 36% of respondents representing companies and businesses (110), 33% (306) of respondents from academia, 32% (29) of respondents from public authorities deemed that the calls for proposals did indeed sufficiently take Social Sciences and Humanities into account. Among both EU and non-EU citizens, 30% believe Social Sciences and Humanities were sufficiently taken into account (68 and 18 respectively). Still, respondents that neither agree nor disagree with the abovementioned statement include representatives from NGOs (26%; 17), research institutions (24%; 218), companies and business associations (both 22% 7 and 69 respectively). Notably NGOs (31%; 20) and public authorities (26%; 24) either disagree or strongly disagree with the notion that Social Sciences and Humanities were sufficiently taken into account.

In **civil security research** (under Societal Challenge 7), societal impacts relate both to policy uptake and the fact that security research supported the development of an end-product or service (capability driven approach)[179] in areas such as the fight against crime and terrorism, travel facilitation and border surveillance as well as in the field of disaster resilience[180]. While the contribution of specific projects to policy development and implementation is difficult to assess, the positive contribution of security research has been recognized in strategic EU security policy documents[181] and resulted in specific research and innovation provisions in the new mandates of relevant EU Agencies (Frontex, Europol, eu-LISA).

The LEIT programme parts supported advances with societal relevance in the **Key Enabling Technologies**..[182] For example, human-centric approaches were espoused by projects like SHERLOCK (under the Factories of the Future cPPP), which enhanced worker satisfaction by developing user-friendly robotic technologies suited to different production environments.[183] Other applications are relevant for sustainability and decarbonisation: for example, the CORALIS project (under the SPIRE cPPP), aimed at optimising use of energy and resources in three industrial parks[184]. These societal goals were addressed by the nanotechnology area as well:

[176] Cross-cutting issues evaluation study (2023), Annex 3, section 4.7, see dedicated case study on the cross-cutting issue of social sciences and humanities in Horizon 2020.
[177] Commission monitoring systems (CORDA) data based on all signed grants in Horizon 2020 in the ERC Starting, Consolidator and Advanced Grant calls.
[178] Evaluation study on the relevance and internal coherence of Horizon 2020 and its policy mix (2023), op. cit., p. 7; Case Study 18.
[179] Resilient Europe evaluation study, op. cit., p. 51.
[180] Commission staff working document 'Enhancing security through research and innovation, SWD(2021) 422 final of 15.12.2021.
[181] Inter alia, the 2020 Security Union Strategy, the 2020 Counter-Terrorism Agenda, the EU Maritime Security Strategy.
[182] Digital and Industrial transition evaluation study, op. cit., section 9.1 (key findings on the performance of the LEIT programme part), p. 76.
[183] https://cordis.europa.eu/project/id/820689
[184] https://cordis.europa.eu/project/id/958337

for instance, the Open Innovation testbed NewSkin facilitated industrial uptake of more efficient water-repelling surfaces for solar panels.[185]

Contribution to the Sustainable Development Goals (SDGs)

There were no specific requirements within Horizon 2020 to meet targets with respect to the SDGs. Compared to FP7, contributions to SDGs have remained largely stable, with most contributions aligning with SDG 3 (Good health and well-being), SDG 7 (Affordable and clean energy), as well as SDG 13 (Climate action).[186] An analysis of LEIT project outputs suggests strong alignment also with SDG 9 (Resilient infrastructure, sustainable industrialization and innovation) for publications, and with SDG 8 (Inclusive and sustainable economic growth) for innovation outputs.[187]

A Horizon 2020 monitoring report[188] discloses the results of a similar analysis[189] conducted by the Commission services: looking at 20 994 projects, accounting for EUR 37.7 billion, the report concluded that **up to 84% of the current Horizon 2020 investments relate to at least one SDG**.[190] Specifically, the Green Deal Call, which was launched in 2020, included EUR 350 million that directly link with the SDGs.[191]

The Joint Research Centre' direct research actions – Science for policy

The panel of external experts for the ex post evaluation of the **Joint Research Centre (JRC)** observed that "the JRC has made important contributions to key policy goals and contributed significantly to the Commission's working methods and funding instruments."[192] Horizon 2020-funded research by the **Joint Research Centre** (JRC, representing 2% of the Horizon 2020 budget) was found to have helped shape selected European policies. At the end of FP7, in 2013, JRC's monitoring data recorded 248 tangible specific impacts on European policies[193] that resulted from the technical and scientific support it provided. By 2020, JRC had surpassed its target of 330 and recorded 513 impacts[194] (see KPI 22 in Table 3).

An analysis of 39 Horizon 2020 case studies evaluated by external experts[195] found that in 82%[196] of the studies, the JRC was instrumental in shaping and implementing EU policies. For example, the JRC's support for chemicals policy helped translate risk assessments into regulatory limits

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[185] https://cordis.europa.eu/project/id/862100

[186] PPMI, Ontotext, Fraunhofer & Intrasoft. *Tracking of Research Results: Measuring the contributions of the EU FPs to SDGs: data, insights and lessons learned.*

[187] Digital and Industrial transition study (2023), op. cit., Section 6.2.3, p. 55-56.

[188] European Commission (2020), Monitoring report "Keeping our eyes on the Horizon", p. 84.

[189] Searching keywords throughout the Horizon 2020 proposals and project deliverables.

[190] European Commission (2020), Monitoring report "Keeping our eyes on the Horizon", p. 84.

[191] European Commission (2020). *News article: €350 million in support of the green deal.*

[192] European Commission, Joint Research Centre, *Ex post* evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020: final report of the ex post evaluation panel (p. 69), Publications Office of the European Union, 2022, p. 4 https://data.europa.eu/doi/10.2760/257315.

[193] Revised after data checks from the original baseline of 211 reported in the DG RTD 2015 publication 'Horizon 2020 indicators: assessing the results and impact of Horizon', p. 15, https://data.europa.eu/doi/10.2777/71098.

[194] Impact is defined as "the use of JRC results for policy preparation (e.g. impact assessments), monitoring (e.g. COM reports), implementation (e.g. methods, materials, guidance) and evaluation". See European Commission, Joint Research Centre, *Ex post* evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020: final report of the ex post evaluation panel (p. 69), Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2760/257315.

[195] In 2021, a new impact evaluation methodology was applied to assess the JRC's work. It is based on research impact assessment by tracing impact pathways of activities. Case studies describing activities in 2014-2020 were produced and evaluated against 11 criteria by experts from academia, businesses, NGOs and national administrations. This sample of case studies represents 20% of JRC human resources allocated to the work programme projects and 10% of the JRC budget.

[196] In the above-mentioned '*Ex post* evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020', the percentages and number of case studies are different because they also cover Euratom.

for the development of legislation on nanomaterials[197], endocrine disruptors[198], tattoo inks and permanent make-up[199], and chemical mixtures.[200] Similarly, the JRC's evidence on the costs of climate inaction played a significant role in the developing the European Green Deal by providing evidence of the need for more ambitious actions on climate adaptation and urgent steps toward climate neutrality.[201]

In addition, most of the Horizon 2020 case studies (67%) demonstrated long-term societal impacts where the JRC contributed to increasing quality of life and community well-being through consumer protection, reducing costs for firms by fighting fraud, and increasing public awareness about worldwide concerns such as climate change. For example, EU legislation on energy labels and eco-design – whose implementation has been largely supported by the JRC – is estimated to bring energy savings of approximately 230 million tonnes of oil equivalent by 2030. For consumers, this means an average saving of up to EUR 285 per year on their household energy bills. Energy efficiency measures will also create EUR 66 billion in extra revenue for European companies.[202]

Promotion of gender equality in Horizon 2020

While gender equality has been increasingly addressed since FP5, Horizon 2020 has encouraged gender balance in research teams at all levels, integrating the gender dimension in the content of research and innovation, as a cross-cutting issue.[203]

To **ensure gender balance in research teams at all levels**, project proposals that had a more gender-balanced team were favoured if two projects were given the same evaluation score.[204] Only unstructured data in the call evaluation reports is available relating to how many projects were granted preferential treatment following the measures introduced to foster gender equality across the framework programme.

Table 9: Women participants across the framework programmes	FP7		Horizon 2020	
	n	%	n	%
'Coordinators' (main contact)	11 369	44%	6 486	23%
Contact person for scientific aspects (collaborative projects)	3 657	20%		
Principal Investigators (ERC)	1 283	21%	2 241	28%
MSCA fellows	3 235	36%	21 970	42%
Researchers	99 211	39%	417 230	37%
Other than researchers	52 099	43%	446 313	49%
Women among the workforce	161 310	41%	876 664	42%

[197] As recognized in the impact assessment on 'Possible amendments of Annexes to REACH for registration of nanomaterials' [SWD(2018)474] – footnote 2 on p. 6.
[198] Commission staff working document [SWD(2020) 251 final] fitness check on endocrine disruptors accompanying the Communication from the Commission on Chemicals Strategy for Sustainability.
[199] Commission Regulation (EU) 2020/2081 amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards substances in tattoo inks or permanent make-up, C/2020/8758. OJ L 423, 15.12.2020, footnote 2 on p. 1.
[200] Commission staff working document [SWD(2020) 250 final]: Progress report on the assessment and management of combined exposures to multiple chemicals (chemical mixtures) and associated risks, accompanying the document 'Communication from the Commission on Chemicals Strategy for Sustainability: Towards a toxic-free environment', footnote 17, p. 3.
[201] Communication from the Commission: Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change" COM(2021) 82 final, footnote 5, page 1. And SWD(2021) 25 final, footnote 105, p. 17.
[202] JRC, "Evaluating the impact of JRC's scientific activities under Horizon 2020 and Euratom - case studies 2014-2020, report to the ex post evaluation panel" (2021), Box 5 – Examples of societal impact of JRC's activities, p. 15.
[203] Gender equality as a cross-cutting issue. Horizon 2020 online manual. Retrieved 12/04/23 from https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/gender_en.htm
[204] Horizon 2020 – Work programme 2018-2020 (General annexes) – retrieved 12/04/23 from https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

Expert evaluators	14 965	36%	55 644	42%
Among potential experts	7 310	29%	16 414	38%

Source: FP7 - H2020 Gender Dashboard - Gender in EU R&I Programmes | Sheet - Qlik Sense (testa.eu) retrieved on 02/08/2023 for all data except data on the contact person for scientific aspects which is from CORDA (cut-off date 07/07/2023)

Throughout Horizon 2020, 42% of **project participants** (in any role) were women. This corresponds to a slight increase of 1 percentage point compared to FP7, as shown in Table 9.

Comparing the women **main contacts (coordinator)** figures across FP7 and Horizon 2020 proves difficult due to changes in the reporting system. In FP7, there was a distinction between scientific and administrative contacts which was discontinued in Horizon 2020:

- Throughout FP7, applicants were requested to indicate both a main "contact person" and, in collaborative projects[205] also a 'contact person for scientific aspects'.
- In Horizon 2020, the application form probed for a 'main contact' (only) instead, which corresponds to a primarily scientific role.
- Moreover, to minimise administrative burden, in the Horizon 2020 programming period, beneficiaries were not obliged to provide information on the gender of said main contact, which further complicates a meaningful comparison[206].

Therefore, the best way to assess the evolution of women coordinators is to compare the Horizon 2020-reported figure of 23% of women coordinators with the FP7-related figure on women contact persons for scientific aspects in collaborative projects (20%) - showing a slight increase of 3 percentage points.

The share of **women researchers** in Horizon 2020 decreased by 2 percentage points compared to FP7, whereas at European level the proportion of women among Grade A academic staff did show incremental increase between 2010 and 2018 (see box below). Nevertheless, the absolute number of women researchers increased strongly across the programme as a whole.

During both FP7 and Horizon 2020, women's participation in roles marked as **'other than researchers'** (potentially administrative, financial or legal) was also monitored: this share increased from 43% in FP7 to 49% in Horizon 2020 (as shown in Table 9).

Gender Equality in Research in the EU

Data from the "She Figures" Report[207] suggests that the under-representation of women in senior academic and decision-making positions in the EU continues to be a significant challenge:

- At European level, the proportion of **women among Grade A academic staff**[208] increased from 20.0%[209] in 2010 to 24%.1 in 2015 and 26.2% in 2018. In each field of R&D, women represented no more than around one third of Grade A staff at the European level in 2018. The highest proportion of women among grade A staff was observed in Humanities (35%) and Social Sciences (30.9%) and Engineering & Technology (17.9%). **Among researchers** generally, the average percentage of women was 33.8% in 2018, up from 33.4% in 2015 and 29% in 2010.[210]
- When looking at the evolution of **women who acted as heads of institutes**, it becomes clear that some progress has been made in improving women representation in decision-making and

[205] In ERC and Marie Skłodowska-Curie Actions the scientific lead in projects was instead represented, respectively, by the Principal Investigator and by MSCA Fellows. Both figures also exist in Horizon 2020, shown in Table 9.
[206] The gender of Horizon 2020 main contacts is provided at time of proposal instead. Figures presented here take into account all successful proposals, but due to the said limitations, they cannot acknowledge any changes in project roles that took place after that time.
[207] European Commission, DG for Research and Innovation, She Figures 2021: Gender in research and innovation – statistics and indicators, Publications Office (2021), Ch. 6, pp. 176-203, https://data.europa.eu/doi/10.2777/06090
[208] The single highest grade/post at which research is normally conducted (as defined in the 2012 She Figures Report).
[209] She Figures Report 2012 (2013), Chapter 6, p. 90, https://data.europa.eu/doi/10.2777/38520
[210] She Figures Report 2021 (2021), pp. 96-98, for EU-28 countries, https://data.europa.eu/doi/10.2777/06090.

leadership positions in this sector: In 2019, 23.6% of women were heads of institutes in higher education which corresponds with 2.4 percentage point increase compared to 2016 (21.3%).

Gender equality analysis for mono-beneficiary programmes, where outcomes can be more easily associated to one individual, shows the following results:

- The ERC has had a gender equality plan in place since 2009 and the various actions in this plan have succeeded in raising the **success rate of women responding to the ERC's calls** for proposals from 8% in all FP7 calls (as opposed to 11% for men) to 13% in Horizon 2020 calls (and with an equal success rate for men and women). The share of **principal investigators** who are women remains lower than parity at 28% but did increase by 7 percentage points compared to FP7, as shown in Table 9. This reflects the underrepresentation of women in senior academic staff Europe-wide (see box above).
- The MSCA were successful in removing barriers to the mobility of women researchers[211]: 42% of MSCA fellows under Horizon 2020 were women, which is not only higher than the average percentage of women researchers in the EU (33.8% in 2018)[212], but also corresponds to a 6 percentage points increase from FP7 (36%).[213]
- In the SME instrument, women represented 17% of successful applicants.[214] Data on companies started by women that were supported by the EIC pilot is not available to this evaluation. Targeted initiatives encouraging women to engage in innovative entrepreneurship, such as the EIC Prizes and the EU Prize for Women Innovators, were introduced in 2011 with the aim of highlighting women entrepreneurs behind Europe's most ground-breaking innovations. The number of Women Innovators prize applications rose over time, reaching 64 in 2016[215] to 197 applicants in 2020.[216] This aspect is important to monitor because the ratio of men to women involved in business creation in 2016-20 was 1.61[217] and women remain disadvantaged in view of raising capital in Europe (men accounted for 91% of all capital raised for deep tech in 2020).[218]

To ensure gender balance in decision-making[219], the targets of 50% for *advisory panels* and 40% for *evaluation panels* in terms of the representation of women.[220] This was accompanied by a requirement to have at least three women present on each panel.[221] In Horizon 2020, women constituted 43% of advisory group members, so the target of 50% was not met but this still corresponds to a 10 percentage point increase compared to FP7. At the same time, 42% of evaluation panel members were women, thus surpassing the 40% target (a 6-percentage point increase from FP7).[222]

[211] Excellent Science Evaluation Study (2023): case study 4: Inclusiveness and gender dimension in the MSCA.
[212] She Figures Report 2021, pp. 96-98, https://data.europa.eu/doi/10.2777/06090. Figure is for EU-28 countries.
[213] As reported in the FP7 – Horizon 2020 Gender Dashboard FP7 - H2020 Gender Dashboard - Gender in EU R&I Programmes | Sheet - Qlik Sense (testa.eu) retrieved on 02/08/2023.
[214] European Commission, DG for Research and Innovation, Rodriguez-Rincon, D., Feijao, C., Stevenson, C., et al., Study on the proposal evaluation system for the EU R&I framework programme: final report, Publications Office of the European Union, 2022, p. 24-25, https://data.europa.eu/doi/10.2777/16211
[215] Data from CORDA, extracted on 10/08/2023.
[216] Data from the homepage of the European Prize for Women Innovators, "Statistics 2019-2022" https://eic.ec.europa.eu/eic-prizes/european-prize-women-innovators-powered-eic-eit_en#statistics-2019---2022, retrieved on 10/08/2023.
[217] OECD/European Commission (2021), The Missing Entrepreneurs 2021: Policies for Inclusive Entrepreneurship and Self-Employment, OECD Publishing, Paris, p. 5, https://doi.org/10.1787/71b7a9bb-en.
[218] Atomico, The State of European Tech 2020, https://2020.stateofeuropeantech.com/chapter/diversity-inclusion/.
[219] Staff Working Document: Interim evaluation of Horizon 2020 (SWD(2017)221), p. 38.
[220] Article 16 (Gender Equality) of the Horizon 2020 Regulation.
[221] *Ex post* evaluation of the seventh framework programme (SWD(2016) 2 final), p. 18.
[222] Horizon 2020 Dashboard: Cross-cutting issues. Retrieved 08/09/22; Gender Dashboard, Retrieved on 02/08/23.

Incorporating the gender dimension into research and innovation content was measured by tracking the number of 'gender-flagged' topics across the programme[223]: the share of projects that explicitly indicated in their project proposals that the gender dimension is reflected has increased in every work programme and overall 23% of projects took the gender dimension into account. Comparatively, gender was most comprehensively addressed in relation to Societal Challenge 1 (Health), where 58% of projects incorporated gender-related issues.[224] This monitoring system was introduced in Horizon 2020 so comparable data from FP7 is not available.

What messages emerged from the stakeholder consultation?

48% of respondents (849) either agreed or strongly agreed that gender equality as a cross-cutting issue has been effectively implemented. 27% (478) neither agreed nor disagreed, while 11% (204) disagreed or disagreed strongly. 14% (248) did not express an opinion.

The stakeholder groups that were most positive about the implementation of gender equality as a cross-cutting issue were academia (50%; 455), followed by public authorities (49%; 45), companies (47%; 143) and non-EU citizens (47%; 28). EU citizens (45%; 98), NGOs (44%; 29) and business associations (31%; 11) on the other hand were less positive: the difference between academia and business associations showed a 19 percentage point difference which might be rooted in the smaller variation within the stakeholder group – only 32 business associations replied to the related question overall, whereas the figure was significantly higher for respondents from academia (919).

How did international cooperation contribute to the impacts of the programme?

In Horizon 2020, **international cooperation** was mainstreamed across the programme as a **cross-cutting priority**, in contrast to FP7, which had dedicated international cooperation schemes with ring-fenced budgets. The ambition of Horizon 2020 was to maintain international cooperation at least at the level of FP7.

International cooperation decreased in the first half of the programme due to the discontinuation of dedicated international cooperation schemes, specific eligibility conditions for certain countries, increased competition and geopolitical challenges. Corrective measures, such as clearer emphasis on international cooperation in work programmes, the introduction of co-funding mechanisms, and more awareness raising and support actions, resulted in a recovery of third country participations in the second half of the programme.

As Table 10 illustrates, the 4.1% participation rate of non-associated third countries in collaborative Horizon 2020 projects **slightly exceeds the FP7 baseline** of 3.6%. In contrast, the share of EU contributions granted to third country parties decreased from 1.3% to 0.8%, mainly due to the discontinuation of the automatic funding for certain countries.[225]

Table 10: International cooperation in collaborative projects

Indicators	Share of non-EU participations			Share of EU contributions to non-EU participants		
	Horizon 2020	Mid-term Horizon 2020	FP7	Horizon 2020	Mid-term Horizon 2020	FP7
Third countries	4.1%	1.9%	3.6%	0.8%	0.6%	1.3%
Associated countries	7.7%	7.0%	8.2%	8.9%	6.5%	8.9%

Source: R&I Projects Dashboard, data cut-off date 01/01/23

The extent of international cooperation varied across programme parts and topics:

[223] Regulation (EU) No 1291/2013 Establishing Horizon 2020 (Art. 16). When submitting a project proposal, (potential) beneficiaries have the possibility to "flag" specific issues tackled/addressed – "gender flagging" in this case relates to projects that indicated that there is a gender-dimension in their respective project proposals.
[224] Cross-Cutting issues evaluation study, Annex A (2023), p. 57.
[225] Brazil, Russia, India and China were no longer automatically funded under Horizon 2020 as was the case in FP7.

- Under **the Excellent Science pillar (Pillar 1)**, MSCA[226] and ERC[227] remain attractive to international researchers due to their prestige in academic environments. By supporting researchers of 160 different nationalities and the participation of organisations from 139 countries worldwide, the MSCA constituted the most international component of Horizon 2020, accounting alone for over half of all third country participations in the programme.
- In contrast, **participation of third countries in SEWP** actions remains limited. SEWP beneficiaries from widening countries report that they often experience difficulties in attracting international talent to their projects.
- Participation of non-EU organisations in Societal Challenges related to Climate, Food, Health, and Inclusive Societies was above the Horizon 2020 average since these **topics were perceived as addressing global challenges**.[228]
- Conversely, **international partnerships were more limited in the LEIT programme** due to geopolitical considerations. A survey carried out among the LEIT programme participants revealed that, in their opinion, the programme did not provide sufficient funding opportunities for international collaboration.[229] Interviewed participants reported that developing more structured cooperation with non-EU partners was hindered by lack of interest from large industrial players, as well as by the broader geopolitical developments after 2017, which raised increasing concerns about Europe's technological and data sovereignty, for instance in the field of 5G.[230]

International cooperation contributed to the achievement of various Horizon 2020 objectives by improving the quality of research. It contributed to **scientific impact** by attracting world-class talent to the programme. Peer-reviewed FP7 and Horizon 2020 publications, involving a contributor from at least one associated or other non-EU country, have a higher scientific impact (cited more than Member State-only publications and cited three times more than the world average).[231] Also, the success rate of the proposals increases when the consortium includes international partners.[232] Moreover, international cooperation facilitated access to and increased the participation of EU companies in international value chains, especially through the involvement of participants from countries with advanced R&I capabilities (e.g., Norway, Israel, Switzerland, and the United States).[233]

International cooperation also contributed to the **societal impact** of the programme by increasing the EU's focus on and role in tackling global challenges.[234] In the case of PRIMA, strengthening the Mediterranean area was at the core of the partnership, with participating states from European, Associated and third countries.[235] Funded projects specifically addressed the needs of the Mediterranean region in terms of ecological, economic and social conditions, leading to valuable solutions for the EU Mediterranean states as well as enabling market expansion of technology providers from all EU member countries of PRIMA.

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[226] MSCA has supported researchers from 160 nationalities (40% of all researchers involved are nationals of non-EU countries) and participations of organisations from 139 countries worldwide.
[227] The ERC research teams include 18% of non-ERA nationals coming from 90 countries: India (18%), China (17%), US (12%) and Russia (7%). These shares are similar to the ones under FP7, with two notable changes: the decrease in the share of US team members (from 16% to 12% in Horizon 2020), and the increase in the share of Indian team members (from 13% to 18%).
[228] Resilient Europe evaluation study (2023), op. cit., p.50.
[229] From the 703 respondents, 7% stated that the adequacy of the EU funding opportunities for internationalisation was not good at all, 29 % stated it was sufficient to a limited extent and 33% stated it to be sufficient to a moderate extent. Digital and Industrial Transition evaluation study, Annex VII, Figure 40.
[230] Ibid, section 6.3.1 and Annex VII.
[231] Cross-cutting issues evaluation study (2023), op. cit., case study international cooperation, p. 91.
[232] Monitoring flash series "Keeping our eyes on the Horizon", Flash #3, p. 47.
[233] Monitoring flash series "Keeping our eyes on the Horizon", Flash #3, p. 61.
[234] Green Transition evaluation study (2023), op. cit., p. 76; Resilient Europe evaluation study (2023), op. cit., p. 65.
[235] Green Transition evaluation study (2023), op. cit., pp. 52-53.

4.1.3. Effectiveness: **Economic impacts** – To what extent has Horizon 2020 boosted Europe's leadership in enabling and industrial technologies and competitiveness?

As outlined in the programme's impact assessment, Horizon 2020 was designed to support industrial research and innovation 'from idea to market', with a view to improving innovation diffusion in products, processes and services, and thereby improving the attractiveness and competitiveness of industry participants and of the European economy as a whole.

The section describes the main results of Horizon 2020 for innovation: IPR forms and other measures of innovation diffusion, effects on capital raised and on the economic performance of industrial participants, with a particular focus on SMEs.

Horizon 2020's innovation outputs

Innovation outputs can be measured notably based on **IPR**[236] reported by project participants. IPR remains a widely used indicator of innovation **despite several limitations**, both inherent to the IPR process[237] and related to how these outputs are monitored under the programme (see Annex 2, Methodology).

Horizon 2020 has produced a substantial number of IPR applications and is expected to continue to do so in the future. Horizon 2020 participants reported 3 898 IPR applications, with a ratio of 0.57 applications per EUR 10 million of EU funding. Three quarters of these applications were for patents (3 012, or 77.3%), with a ratio of 0.44 per EUR 10 million. Trademarks (12.8%) made up most of the rest.[238] Without ERC, the number of IPR applications is 3 210, i.e. 0.58 per EUR 10 million.[239]

In relative terms, the self-reported IPR performance of Horizon 2020 projects is similar to that of FP7 at the same stage. Around two years after the end of FP7, project participants (excluding ERC projects[240]) had reported 2 266 applications for IPR, of which 1 742 were patent applications.[241] This is roughly equivalent to 0.6 IPR applications per EUR 10 million, slightly higher than in Horizon 2020 at the reference date.

As shown in Section 4.1.5, two years after the end of FP7, the number of IPR applications in Horizon 2020 was significantly lower than FP7's overall production as measured at the end of 2022. Comparative performance between Horizon 2020 and FP7 is to be reassessed at a later point, when more Horizon 2020 projects will have closed.[242]

Horizon 2020 had three new measurable targets with reference specifically to patent applications, shown in Table 11. As the target values below were set for end 2020, it is clear that these were

[236] Including patents, trademarks, registered designs, and utility models.
[237] Patents are useful instruments to codify knowledge and help its transfer to the wider economy. However, not necessarily all innovations are patented – e.g. for reasons of secrecy – nor do they reflect all the research and innovative efforts behind an invention. Moreover, the propensity to patent varies notably across sectors and countries, as well as the quality of the data generated by the patenting process.
[238] Commission monitoring systems (CORDA), data at 24/04/2023.
[239] Calculations based on European Commission, *Ex Post* Evaluation of the seventh framework programme, Commission Staff Working Document, SWD(2016) 2 final, 19 January 2016, p. 12.
[240] A rigorous comparison between IPR output in FP7 and Horizon 2020 is complicated by methodological issues, which prevent setting an appropriate baseline now. FP7 figures presented at the time of the *ex post* evaluation do not include European Research Council applications. Due to limitations of the monitoring system used at the time, the exact status of IPR applications in ERC at the reference date cannot be reconstructed, and is hence not possible to compare the whole of FP7 with the whole of Horizon 2020. These limitations have been since overcome, and *current* FP7 figures on project outputs include ERC.
[241] European Commission, *Ex post* Evaluation of the seventh framework programme, Commission staff working document, SWD(2016) 2 final, 19 January 2016, p. 20.
[242] 18% of all Horizon 2020 projects will close in 2024 or later.

overly optimistic[243], particularly with reference to the Industrial Leadership and Societal Challenges pillars.

Table 11: **KPI 3, KPI 6 and KPI 15** on patent applications

Key Performance Indicators	Target value	Current result (2022)[244]
KPI 3: Patent applications in Future and Emerging Technologies per EUR 10 million funding	1 per EUR 10 million EU funding	0.84 patent applications per EUR 10 million 0.55 patents awarded
KPI 6: Patent applications in the different enabling and industrial technologies (LEIT) per EUR 10 million funding	3 per EUR 10 million EU funding	0.56 patent applications per EUR 10 million 0.38 patents awarded
KPI 15: Patent applications in Horizon 2020 Societal Challenges per EUR 10 million funding	2 per EUR 10 million EU funding	0.35 patent applications per EUR 10 million 0.26 patents awarded

Source: R&I Results Dashboard, data frozen on 01/01/23.

Industrial Leadership was the pillar with the highest number of IPR applications (1 441). Analysis of a subset of patents (end 2021) shows that Pillar 2 also had the highest average number of patent citations and number of claims, which are indicators of the quality of the protected invention[245]. Around 40% of patents self-declared by LEIT participants contributed towards key enabling technologies such as photonics, with high shares also for micro- and nanoelectronics.[246] The ratio is low for the Space objective (23 patent applications, 0.2 per EUR 10 million), as it was under FP7 (0.3 applications per EUR 10 million[247]).

The SME instrument is more likely to produce IPR applications.[248] It is expected that SME instrument projects will have high patent productivity relatively soon after the end of Horizon 2020, due to their shorter duration[249] and the high technology-readiness (TRL) level supported (TRL 6, demonstration).[250] SME instrument brought about an increase of 8 to 15 percentage points in the probability of a patent application.[251] Moreover, beneficiaries of Horizon 2020 show a 15% to 31% increase in citation-weighted patents.

The low number of IPR applications suggests that most are at a low maturity level: high-potential ideas were supported by the programme, but their low exploitation readiness means that their inventors do not yet consider them ready for patenting.[252] This finding is confirmed by

[243] These targets were set for 2020 already, when many Horizon 2020 projects will not have been yet completed, and IPR FP7 levels at the current day (9 years after its end) for thematically similar programme parts are much below these targets.
[244] If only *foreground* patent applications (see Annex 2) are considered, the ratios to EUR 10 million are: Future and Emerging Technologies: 0.67; Leadership in enabling and industrial technologies: 0.44; Societal challenges: 0.20. Figures from Commission monitoring systems (CORDA), reference date 24/04/2023.
[245] Naujokaitytė, R., Stančiauskas, V., Cakić, M., et al., Evaluation study of the European framework programmes for research and innovation for an Innovative Europe, Publications Office of the European Union (2023), https://data.europa.eu/doi/10.2777/467162, Table 18, p. 51.
[246] Digital and Industrial transition evaluation study (2023), op. cit., section 6.2.2, p. 35. Some parts of LEIT NMBP have relatively high patenting propensity: the nanotechnologies programme part under LEIT has a patent applications-to-funding ratio of 2.0 per EUR 10 million.
[247] Ibid, section 6.2.2, Table 9, p. 52.
[248] Ibid.
[249] Phase 1 runs for up to half a year, Phase 2 up to two years.
[250] European Commission, "Interim evaluation of Horizon 2020", Commission staff working document, published 16 August 2017, doi: 10.2777/220768.
[251] According to a study focusing on the first years of SME instrument, Pietro Santoleri, Andrea Mina, Alberto Di Minin, Irene Martelli; The Causal Effects of R&D Grants: Evidence from a Regression Discontinuity. *The Review of Economics and Statistics* 2022; doi: https://doi.org/10.1162/rest_a_01233
[252] Digital and Industrial Transition study (2023), op. cit., section 6.2.2, p. 53.

Innovation Radar[253] data, showing that over half of all innovations recorded are in an 'Exploring' stage (53%) and only 17% are considered ready for market introduction[254]. High-readiness innovations stem mostly from the Industrial Leadership pillar[255] and specifically LEIT projects, where a few areas have a slightly higher proportion of market-ready innovations, such as the internet of things, advanced computing and advanced materials.[256] The Societal Challenges pillar produced around 20% of all innovations under Horizon 2020; the Excellent Science pillar contributed 31%, most of which were assessed to have a low level of technological readiness.[257] **Nonetheless, Innovation Radar data also suggest that the programme has funded potentially ground-breaking technological innovations**.[258] Most innovations were categorised as 'Obviously innovative with easily appreciated advantages for the customer' (47%) or 'Innovative but could be difficult to convert customers' (29%). Moreover, most involve the development of a new product (31%), followed closely by a significantly improved product (28.6%).[259]

Encouraging European leadership in enabling and industrial technologies – key factors in LEIT programmes

Participation analysis shows that **the LEIT programme part was successful in setting up the desired cross-sectoral collaboration dynamics involving industry actors**[260]**, aimed to bridge exploratory science and the development of applications addressing Societal Challenges**. The NMBP programme stands out for the broad range of sectors involved, mainly in the manufacturing and processing research areas (Factories of the Future and SPIRE cPPPs). Large enterprises participating in the LEIT ICT key digital technologies areas also tended to participate in NMBP intervention areas, such as advanced materials and processing technologies. The LEIT Space programme, however, was characterised by rather limited integration with other LEIT areas.[261]

The Digital and Industrial transition evaluation study highlighted the value of the creation of **technology infrastructures** (such as European Digital Innovation Hubs and open innovation test beds). A clear success, according to stakeholders, is the effort to increase availability to technology infrastructures throughout Europe, which has facilitated and accelerated the development of piloted, demonstrated, and tested research result. The LEIT programme parts also put emphasis on supporting projects involving actors across the entire value chain. This trend also resulted in an **increase in the number of partners involved in consortia, as well as higher average project budgets**. Overall, LEIT project applicants appreciated the focus on the structuring of R&I communities. Some, however, pointed out that this approach places higher demands on project management in terms of the skills and resources needed. This carries the risk that larger and more complex projects may become less attractive to SMEs.[262] Still, SME participation remained high in LEIT programmes throughout the lifetime of Horizon 2020.[263]

In line with the 'closer-to-market' focus of the programme as a whole, projects under LEIT NMBP demonstrated a **shift from an 'enabling' perspective towards 'product-oriented' perspectives**[264]. This trend is perhaps linked to an increase in the influence of industry partners in agenda setting, particularly through cPPPs).[265] Nonetheless, evaluation studies highlighted the continued importance of research with low or mid-level

[253] An in-house tool of the European Commission, the Innovation Radar (https://www.innoradar.eu/) is aimed at identifying high-potential innovations in EU-funded programmes, with particular reference to their level of commercial and technological readiness. This survey-based tool, which covered only a part of Horizon 2020 projects, identified around 8 000 distinct Horizon 2020-funded innovations by November 2021 (https://www.innoradar.eu/resultbymaturity/0).
[254] Innovative Europe evaluation study (2023), Annex 7, p. 270.
[255] Excellent Science evaluation study (2023), op. cit., p. 53.
[256] Digital and Industrial Transition evaluation study (2023), op. cit., executive summary and section 6.2.2.
[257] Innovative Europe evaluation study (2023), Annex 7, p. 270.
[258] Most innovations are categorised as "Obviously innovative and easily appreciated advantages to customer" (47%) as well as "Innovative but could be difficult to convert customers" (29%).
[259] Innovative Europe evaluation study (2023), Annex 7, p. 270.
[260] Digital and Industrial transition evaluation study (2023), op. cit., section 6.3.1, p. 61.
[261] Ibid.
[262] Based on interviews and participation trends, the Digital and Industrial Transition evaluation study, section 6.1.2.
[263] Digital and industrial transition evaluation study (2023), op. cit., chapter 3 ("Beneficiaries").
[264] Ibid, section 4.1.1.
[265] In the LEIT ICT programme, cPPPs steered half of the funding, showing an ongoing increase over time (from 22% in 2014/15 to 66% in 2018/20). In the NMBP programme, cPPP-based projects accounted for about 40% of the total funding, encompassing close to 100% of the projects in the advanced manufacturing and processing technologies area. Source: Digital and industrial transition study (2023), section 6.3.2.

technological readiness for capacity-building to meet longer-term needs.[266] Across the FP, some stakeholders, including the Expert group on the economic and societal impact of research and innovation (ESIR)[267], see a risk of upsetting the balance between industry-oriented R&D and more fundamental research, which could damage Europe's innovation and transition potential.[268]

When looking at the economic and innovation outputs of the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT), the number of organisations from universities, business and research that were integrated in the **EITKICs** increased from 200 organisations in the 2010-2013 period to 2 153 in 2020, almost double the programme target (of 1 200 partner organisations). The collaboration inside the knowledge triangle led to the development of innovative products, services and processes, including the creation of start-ups and spin-offs. The target number of active partners collaborating in the EIT KICs – representing the core indication of effectiveness in developing innovation ecosystems and integrating the knowledge triangle – was exceeded by a factor of two.

The EIT KICs fostered the launch of 1 501 new or improved products and processes on the market across the whole period.[269] Table 12 shows results for the different KICs.

Table 12: Core EIT KICs key performance indicator totals across the period 2010*-2020 (*=or starting year of the respective KIC)[270]

	Climate	Digital	Inno Energy	Health	Raw Materials	Food	Manu-facturing	Urban Mobility	**Total**
Products (goods or services) or processes launched on the market	628	437	142	68	175	36	4	11	**1 501**
Start-ups supported by EIT KICs	1 190	297	379	1 230	299	350	57	60	**3 862**
Investment attracted by start-ups supported by EIT KICs (EUR millions)	552.3	400.9	2 078.4	522.3	156.6	198.1	0	9.3	**3 918**

Source: EIT monitoring data reported in Naujokaitytė, R., Stančiauskas, V., Cakić, M., et al., Evaluation study of the European framework programmes for research and innovation for an Innovative Europe, Publications Office of the European Union (2023), https://data.europa.eu/doi/10.2777/467162 (2023), section 7.1, p. 43.

The number of start-ups created by the EIT KICs is another indicator of effectiveness. The baseline number in 2012 was 33.[271] Progress values are reported by EIT in two batches, with one indicator serving from 2010-2016, which was subsequently replaced with two indicators for the period 2017-2020.[272] While numbers were generally low in the early years, **an increase in the number of start-ups created is evident** over the observed period[273], resulting in 305 start-ups and spin-offs created across Climate KIC, EIT InnoEnergy, EIT Digital, EIT Health and EIT Raw Materials from 2010 to 2016. From 2017-2020, an additional 36 start-ups were created by students enrolled on and graduates of EIT-labelled MSc and PhD programmes. Over the same period, 99 start-ups were created as a result of innovation projects for the indicated KICs. Taking

[266] Digital and Industrial transition evaluation study (2023), op. cit., section 6.3.2, pp. 68-69.
[267] European Commission, DG for Research and Innovation, Dixson-Declève, S., Dunlop, K., Renda, A. et al., Research and innovation to thrive in the poly-crisis age, Publications Office of the EU, 2023, https://data.europa.eu/doi/10.2777/92915, p. 15: "In a context of crisis and urgent transformation, **investment in innovation and innovation policy needs just as much focus on the design of change and support for change and adoption processes**." Use of TRLs places an emphasis on the deployment of solutions with a high private sector interest, which can affect the evaluation.
[268] Digital and industrial transition evaluation study (2023), op. cit., p. 80.
[269] Innovative Europe evaluation study (2023), op. cit., section 7.1, p. 44.
[270] Ibidem.
[271] European Commission, Programme statement 2022, COM(2021) 300 – June 2021, p. 71, https://commission.europa.eu/system/files/2021-07/db2022_wd_1_programme_statements_web_0.pdf
[272] Innovative Europe evaluation study (2023), op. cit., pp. 44-45.
[273] Ibidem.

all this into account, the cumulative target of 600 start-ups and spin-offs created[274] was not reached by 2020. The lack of achievement of the target for start-ups created by the intervention of EIT KICs can be explained by the fact that the EIT Impact framework has been revised in 2017, the methodology for calculating the indicator on number of start-ups created has changed and for this reason the increase of start-ups created has slowed down from 2017. The KPI 'Number of start-ups/spin-offs created' was tracked until 2016 only and according to the different methodology as compared to the post-2017 tracking. From 2017 onwards, the start-ups created were tracked in two ways, i.e. (1) as a result of the EIT KICs supported innovation projects or (2) as a result of creation by students enrolled and graduated from EIT-supported education courses.

One of the main objectives of Knowledge and Innovation Communities was to obtain financial autonomy from the European Institute of Innovation and Technology. The KICs should become sustainable after 15 years of operation. The EIT KICs' budgets were growing, but most of the funds still come from EIT.[275] The first-wave KICs (EIT Digital, EIT InnoEnergy, and EIT Climate established in 2010) show a positive trend in financial sustainability – external investments increased in proportion to EIT funding. Start-ups supported by the EIT KICs received more than EUR 3.9 billion in investments[276] for the period of 2010-2020. Start-ups supported by EIT Inno Energy attracted the biggest amount of investments, around EUR 2.1 billion, followed by Climate KIC (EUR 552.3 million), EIT Health (EUR 522.3 million), EIT Digital (EUR 400.9 million), EIT Food (EUR 198.1 million) and EIT Raw materials (EUR 156.6 million).

When looking specifically at SMEs, so far, Horizon 2020 exceeded its target of at least 20% of EU financial contribution going to SMEs. Around one third of funding to SMEs was provided through the SME instrument. This represents 7.1% of overall Horizon 2020 funding, which is above the 7% target set at the start of the programme.[277]

Table 13: Cross-cutting key performance indicators (KPIs) on SME participation in Horizon 2020

#	INDICATOR DESCRIPTION	TARGET	INTERIM EVALUATION VALUE	FINAL VALUE
KPI 3.1	Percentage of EU financial contribution going to SMEs (LEIT and Societal Challenges)	**20%**	23.9%	**22.2%**
KPI 3.2	Percentage of EU financial contribution committed through the SME instrument (LEIT and Part III of Horizon 2020)	**7%**	5.6%	**7.1 %**

Source: Cross-cutting issues study (2023), elaboration on CORDA data (2022).

Horizon 2020 was also successful in attracting new SME participants. Around half (50.3%) of all EU funding to private for-profit businesses went to newcomers, and two thirds of this amount to SMEs. In general, actions that attract more SMEs – the SME instrument, as well as innovation actions – have high rates of newcomer participation. Conversely, actions that target collaboration with the private sector, but not necessarily SMEs, had fewer new participants[278].

[274] Target set in Programme Statement, p. 32, https://commission.europa.eu/system/files/2022-07/ps_db2023_he_h1_1.pdf.
[275] Innovative Europe evaluation study (2023), op. cit., p. 42.
[276] Ibid, section 7.
[277] Ibidem. Figures as of 8 February 2022.
[278] European Commission (2023), "Newcomers in EU R&I programmes – Main trends in Horizon 2020, first evidence from Horizon Europe", https://data.europa.eu/doi/10.2777/911220.

Facilitating access to risk capital

Private organisations participating in Horizon 2020 have been generally successful in raising risk capital.

If we could attribute this success directly to participation in the framework programme, this would be a very important finding: innovative enterprises in the EU have historically lagged behind international comparators in collecting equity finance. The 2020 report on "Science, Research and innovation performance of the EU" (SRIP) [279] points out that as much as '8 times more venture capital (VC) funds are raised in the US than in the EU', given that, in the EU, lower access to risk capital impedes scaling up.[280]

However, very limited data available to this evaluation is suitable to draw systemic conclusions. As equity funding rounds are often confidential, and therefore not easily monitored, the evaluation relies on partial estimates of amounts collected. This type of data is not tracked by the Commission monitoring systems, and no "official" repositories of VC funding and risk capital exist.

External evaluation studies have attempted to analyse additional capital collected by Horizon 2020 participants (across the entire FP), by using open specialised data sources, such as Dealroom[281] and Crunchbase.[282] One of these studies found that Horizon 2020 beneficiaries received more risk capital investment than unsuccessful applicants: private companies across the FP matched to the Dealroom investment database received around EUR 10 million each, against around EUR 3 million for comparable non-funded entities.[283] However, these figures must be interpreted with caution and as rough estimates, as this study did not control for the origin of the funding rounds recorded in Dealroom – which might include EU funding in some cases.

Detailed figures on equity funding collected after FP participation are available for LEIT programmes, where SME participants attracted at least EUR 9.36 billion of private funding overall, spread over 1 232 funding rounds between 2014 and 2022 – mostly from venture capital and private equity. SME participants active in the high-value-added service industries, such as computer programming, and participants in the SME instrument, accounted for most private funding.[284] These figures are relevant if compared to the EUR 1.7 billion in EU funding these entities have collected (cfr. section 4.4.1); however, the analysis method used cannot determine causality of this additional funding.

Some research available to this evaluation was conducted with a design suitable to assess causal effects. A study on the SME instrument participants between 2014 and 2017 suggests that its beneficiaries attracted more subsequent investment with respect to a comparable control group (between 46% and 97% increase).[285] Moreover, a '**signalling effect**' of the programme funding, which facilitates access to finance from financial institutions by demonstrating the quality, relevance and potential of the supported projects was observed.

[279] European Commission, DG for Research and Innovation, Science, research and innovation performance of the EU, 2020: a fair, green and digital Europe, Publications Office, 2020, https://data.europa.eu/doi/10.2777/534046
[280] Ibid, p. 26.
[281] https://dealroom.co/
[282] https://www.crunchbase.com/
[283] Innovative Europe evaluation study (2023), Annex 4, tables 23 and 24.
[284] Digital and Industrial Transition study (2023), executive summary and section 6.2.2, p. 54. Data based on participant SMEs that could be matched to the Crunchbase company database (https://www.crunchbase.com/). Note that the coverage of the Crunchbase platform is not exhaustive: not all SME participants in Horizon 2020 are listed on the Crunchbase platform, hence some private funding rounds raised by Horizon 2020 participants might not be accounted for in this analysis.
[285] Santoleri et al. (2022) The Causal Effects of R&D Grants: Evidence from a Regression Discontinuity, op. cit.

Horizon 2020 also funded – with EUR 3.7 billion as of 2021[286] – an EIB Group financial facility, **InnovFin**, aimed at facilitating and accelerating access to private finance (debt and equity) for innovative businesses in Europe – ranging from start-ups to large research facilities.[287] InnovFin is perceived as an effective instrument to channel debt and equity funding towards innovative organisations. Three performance indicators of Horizon 2020 refer to the funding operations facilitated by InnovFin, as well as to the organisations they reached (see Tables 14 and 15). The latest figures available indicate that the total volume of investments mobilized via debt financing and venture capital investments since the launch of the programme reached EUR 77.5 billion (of which EUR 43.6 billion are specifically private non-bank funds), and reached around 38 000 organisations. Both figures exceed by a large factor the operational targets set for these indicators.

Table 14 : **KPIs 9-10** on total investments mobilised via Horizon 2020's equity and debt facilities (InnovFin)		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
Not available	EUR 25 billion (either source)	EUR 77.5 billion, as of April 2022

Source: EIB group estimate based on implementation data (2022 annual report). Figures reported in European Commission, DG Research and Innovation Annual Activity Report 2021, p. 47. Available at https://commission.europa.eu/system/files/2022-05/annual-activity-report-2021-research-and-innovation_en.pdf

Table 15: **KPI 11** on the number of organisations funded – entities supported by Horizon 2020's equity and debt facilities (InnovFin)		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
300 organisations funded	5 000 organisations funded EUR 35 billion in private funding	37 921 (as of April 2022) Private funding leveraged: EUR 43.6 billion

Source: Baseline from: European Commission, Programme Statement 2022, COM(2021) 300 – June 2021, https://commission.europa.eu/system/files/2021-07/db2022_wd_1_programme_statements_web_0.pdf. Achieved: EIB group estimate based on implementation data, reported in the 2021 Annual Activity Report, p. 47, https://commission.europa.eu/system/files/2022-05/annual-activity-report-2021-research-and-innovation_en.pdf

Besides facilitating funding flows, InnovFin also fostered the development of venture capital (VC) ecosystems and networks. An analysis of the InnovFin equity facility (IFE) showed that it has been contributing to a growing maturity as well as a growing competitiveness of the European VC ecosystem, helping emerging investors reach a minimum critical fund size. Without the EIF's involvement via the InnovFin IFE, some VC funds could not have been set up, and others would have had less equity capital to their disposal (see also section 4.4.3).[288]

Improving Europe's economic growth and competitiveness

Micro-econometric modelling generally shows that Horizon 2020 funding has a positive and causal impact on beneficiary companies' growth. A counterfactual study[289] on all Horizon 2020 participating firms[290] estimates that **companies receiving Horizon 2020 grants increased on average their employment level by 20% compared to comparable non-funded firms with high quality proposals, and their total assets and revenues by about 30% in the years following the receipt of the first grant**. To ensure comparability, the control group includes only non-funded applicants with high quality proposals. Additional characteristics, such as country of origin, NACE code, number of submitted applications, are controlled for. In line with

[286] Delegation agreement between the EU, the European Investment Bank and the European Investment Fund, dated 12/6/2014, 10th amendment (C(2020) 4483 final), Annex I, p. 24.
[287] https://www.eib.org/en/products/mandates-partnerships/innovfin/index.htm
[288] Innovative Europe evaluation study (2023), op. cit., section 7.2, p. 45.
[289] European Commission, DG for Research and Innovation, Mitra, A., Niakaros, K., The Horizon effect – A counterfactual analysis of EU research & innovation grants, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/584781.
[290] SME Instrument. Analysis focuses on Phase II of the SME Instrument, accounting for more than 90% of the funding.

the literature, companies are tracked 5 years before and up to[291] 5 years after the receipt of the grant. The above-mentioned effects are on average present even after 2.5 years of the receipt of the grant, which is the average duration of a project in the sample – meaning that companies can sustain the positive effects even after Horizon funding. With projects still ongoing, to have a complete picture for the whole Programme such analysis could be repeated in the future when additional data on post-grant outcomes is available.

Another paper[292] - focusing only on the SME instrument phase 2 - studied the variation in firm-level outcomes. It suggested that these grants lead to an increase in subsequent firm investment, particularly in intangible assets, and a boost in innovation output, as indicated by a **rise of between 15% and 31% in citation-weighted patents**. R&D grants do not only affect firms that are already involved in innovative activities but also lead to more firms engaging in patenting. Moreover, these grants have a positive impact on the rate of firm growth and reduce the probability of failure, bringing it to almost zero.

Several other counterfactual analyses have been published but given the method used (Difference-in-Differences), causality cannot be definitively claimed due to the short time lag or lead (years of data available before or after the intervention) of the analysis:

- A 2023 counterfactual analysis[293] investigated the effects of Horizon 2020 on SMEs, confirming **positive impacts on employment** (4% more than control group) and **turnover** (10%, more than control group) but no effects on productivity.
- A counterfactual analysis[294] of calls for proposals under the EIC Pilot 2018 Accelerator programme showed a **significant effect on employment** within a year of launching the scheme. On average, beneficiaries hired two additional employees thanks to Horizon 2020.[295] The short-term positive impact on beneficiary companies' turnover and staffing levels, however, reflects the immediate impact of the grant and may not predict successful product commercialisation or sustained growth.[296]

Moreover, **non-counterfactual analysis** provides similar findings, of course limited to correlation. A multiple regression analysis of economic outcomes of private companies participating in LEIT programme parts shows a positive correlation between EU funding and post-participation performance and growth.[297] Companies that successfully applied for EU funding under the LEIT programmes have on average a higher turnover per employee (interpreted as higher productivity) and especially, higher EBITDA[298] (interpreted as higher profitability) than unsuccessful applicants. This difference is even more pronounced when comparing successful applicants with firms with similar characteristics who did not apply for EU funding under LEIT. The positive effect of EU funding is more pronounced for SMEs than for large enterprises.[299]

Macroeconomic effects include the programme's impact on EU's GDP and employment. While these variables are essential indicators of a thriving economy, it should be noted that their evolution is not a *guarantee* of competitiveness. Data for KPIs used to monitor the competitiveness of EU industry with focus on research and innovation are reported: (a) in the

[291] Depending on data availability. For companies that applied in the later years of the Programme (e.g., in 2020), 5 years after the grant were of course not available for the analysis.
[292] Santoleri et al. The Causal Effects of R&D Grants: Evidence from a Regression Discontinuity, op. cit.
[293] Innovative Europe evaluation study (2023), Annex 4. More methodological details in SWD Annex 2.
[294] The EIC Pilot Evaluation (2022), op. cit., section on economic impacts, pp. 57-58, https://data.europa.eu/doi/10.2777/261324.
[295] EIC pilot evaluation study (2022), methodological annex, https://data.europa.eu/doi/10.2777/645064.
[296] A more revealing analysis could be repeated in the future on a longer time horizon (time lead).
[297] Digital and Industrial Transition evaluation study (2023), op. cit., section 6.2.2, p. 53-54.
[298] Earnings Before Interest and Taxes, Depreciation and Amortization.
[299] Digital and Industrial Transition evaluation study (2023), op. cit., p. 53-54.

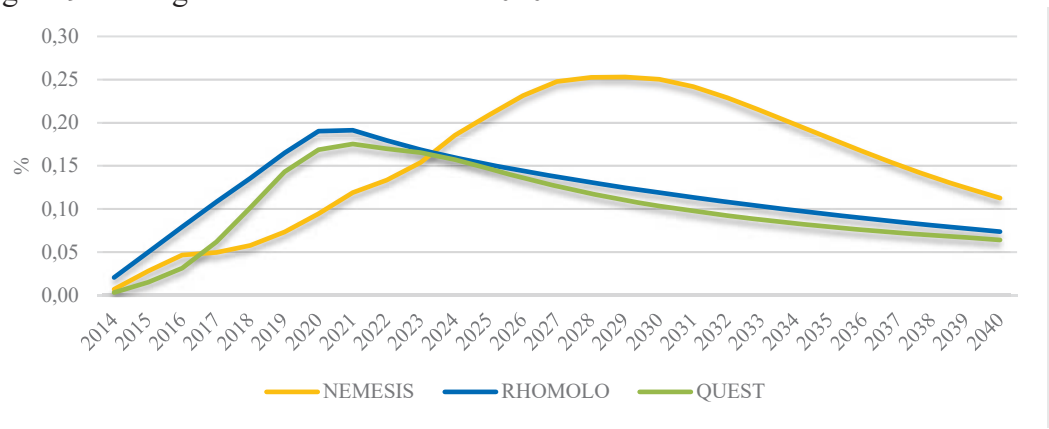
section on Horizon 2020's innovation outputs above (in terms of patent applications supported by Horizon 2020) and (b) towards the end of the current section – on R&D intensity as a percentage of GDP[300].

The impact of the Horizon 2020 on EU GDP was estimated using three macroeconomic models.[301] All models show that the **impact on GDP began to increase steadily during the Horizon 2020 implementation phase** up to 2021[302] relative to the baseline[303] (Figure 9). During the period 2021-2030, with the **gradual arrival of innovations in processes and products in the economy**, impacts on GDP reach their highest point. This pattern is most pronounced in the results of the NEMESIS model with a peak GDP gain of +0.25% in the four years between 2027 and 2030. The other two models suggest an earlier peak in 2021, with a lower maximum GDP gain of +0.18% (QUEST) and +0.19% (RHOMOLO). After 2030, the annual impact starts to diminish in all three models due to the **gradual obsolescence of the new knowledge and innovations** the programme has helped to generate. A positive impact is also reported at sector level.[304]

Considering the period to 2040, the **total wider economic impact of Horizon 2020**, in terms of increases in GDP, add up to **EUR 429 billion** (RHOMOLO)[305]. The estimated **average annual GDP impact is EUR 15.9 billion**[306]. Only NEMESIS results[307] are in line with the expectations in the interim evaluation[308,309], which estimated an average GDP gain, for the period up to 2030, of between EUR 24 billion and EUR 35 billion per year.

[300] COM(2023)168 final, "Long-term competitiveness of the EU: looking beyond 2030", Annex, p. 22, https://commission.europa.eu/system/files/2023-03/Communication_Long-term-competitiveness.pdf.
[301] RHOMOLO, QUEST and NEMESIS. Results from NEMESIS were produced by a team of external experts, while RHOMOLO and QUEST results were produced by the European Commission services (DG Joint Research Centre for RHOMOLO and DG Economic and Financial Affairs for QUEST). More information on the models' specificities can be found in Annex 2.
[302] GDP gain estimated for 2021 vary between 0.12% (NEMESIS), 0.17% (QUEST) and 0.19% (RHOMOLO).
[303] A hypothetical scenario without Horizon 2020.
[304] Results based on RHOMOLO simulation. Please refer to Annex 2 for more detailed information.
[305] 2014-2040, 2020 prices, with range between EUR 421 billion (QUEST) and EUR 798 billion (NEMESIS).
[306] 2014-2040, 2020 prices, with range between EUR 15.6 billion (QUEST) and EUR 28.5 billion (NEMESIS).
[307] Average annual GDP gain until 2030 of NEMESIS EUR 24.7 billion, 2020 prices; (RHOMOLO) EUR 18.2bn; (QUEST) EUR 16.9 billion.
[308] The assumptions of the models run for the Impact Assessment of Horizon 2020 were completely different, hence it is not sensible to do comparisons. For an overview of the different assumptions, see Table 49, "Study to support the monitoring and evaluation of the framework programme for research and innovation along key impact pathways", https://op.europa.eu/s/yzOL.
[309] For the NEMESIS results, a sensitivity analysis has been performed identifying *low*, *medium,* and *high* scenarios depending on the stringency of assumptions on the crowding-in effect of the FP on applied research, and the EAV of the FP (see Annex II). The reported annual average GDP gain (2014 -2030) corresponds to the *medium* scenario; with a *low* estimate of EUR 14.4 billion and a *high* one of EUR 30.8 billion.

Figure 9: GDP gains linked to Horizon 2020[310]



Source: European Commission, DG Research and Innovation, 2023.

The higher GDP gain in the simulations of the NEMESIS model can be explained by the fact that the three models use different sets of innovation channels and elasticities.[311] Notably, NEMESIS uses higher leverage and performance expected from EU funding of R&I compared to national funding as an illustration of the EU added value of the framework programme. This can potentially explain a significant part of the difference between the results from NEMESIS and the other models. Several studies[312] provide empirical evidence that shows that EU funding could be expected to perform 'intrinsically' better at EU level compared to national level due to factors that are not directly captured by these models, such as multidisciplinary transnational collaborations or critical mass. However, the way this EU added value is translated in a model, i.e. the size of the effect, is not trivial and requires caution in its interpretation.

In short, the three models used here are based on different modelling strategies, assumptions and parameter specifications and values, which results in different quantitative estimates of the economic impact. Nevertheless, the comparison of results across different models is essential to ascertain the consistency of a policy intervention. This comparison is also required to understand the different aspects and mechanisms at play within the models, which partially mirror those determining the actual impact of framework programmes.

As regards **employment** (see Figure 10 and details in Annex 2):

- According to the **NEMESIS** model, the investment phase (up to 2020) is characterized by an average rise of about 85 000 jobs compared to the situation in the reference scenario (Figure 10), and a significant increase in the number of people employed in the research sector, with the creation of up to 100 000 jobs in research by 2019-2020 (see Annex 2) as Horizon 2020 grants stimulated innovation by helping R&D intensive companies to attract more high-skilled labour from traditional production activities into research, which offers higher wages. Between 2021 and 2030, the average employment gain produced by the programme is estimated at approximately 123 000 additional jobs. The **maximum impact is expected to be reached in 2030 (+229 000 jobs),** exceeding projections in the interim evaluation, where EU contributions via Horizon 2020 were forecast to increase the level of employment by between 110 000 and 179 000 units (FTEs) in the period 2014-2030. After 2030, the employment gains lessen gradually to +36 000 in 2050.

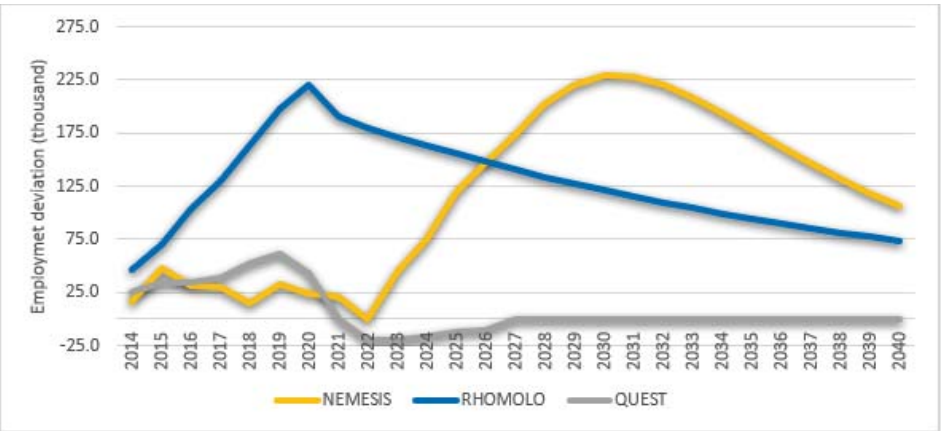
[310] Percentage change relative to the reference scenario, i.e. a situation without the FP.

[311] Macroeconomic Modelling of R&D and Innovation Policies, edited by Ufuk Akcigit, Cristiana Benedetti Fasil, Giammario Impullitti, Omar Licandro, Miguel Sanchez-Martinez, chapter 8 "Taking Stock" by Cristiana Benedetti Fasil, Miguel Sanchez-Martinez and Julien Ravet, 2022, p. 159, https://doi.org/10.1007/978-3-030-71457-4.

[312] Delanghe et al., 2011, "European research policy and bibliometrics indicators, 1990–2005", Scientometrics, 87(2); Vullings et al., 2014, "European added value of EU science, technology and innovation actions and EU-member state partnership in international cooperation"; Rosemberg et al., 2016, "*Ex post* evaluation of Ireland's participation in the 7th EU framework programme"; ECDG & Elsevier, 2017, "Overall output of select geographical group comparators and related FP7- and H2020 -funded publication output"; PPMI, 2017, "Assessment of the Union added value and the economic impact of the EU framework programmes (FP7, Horizon 2020)".

- According to the **RHOMOLO** model, the programme also leads to improvements in employment. The impact rises during the investment phase to peak at **220 000 additional jobs in 2020**, after which the annual employment gains again become gradually weaker until 2050.
- Concerning **QUEST**, given the specific features of the model and the way the policy interventions are simulated as productivity enhancing measures, the results suggest only a **slight short-run increase in employment** during the demand boost (up to 2020), which disappears with rising real wages in the medium to long-run, after the end of the implementation period.

Figure 10: The impact of Horizon 2020 on employment



Source: PPMI - NEMESIS simulation, Innovative Europe evaluation study (2023). RHOMOLO model by Joint Research Centre. QUEST MODEL by DG Economic and Financial Affairs.

When using and interpreting the results produced by these models, it is essential to acknowledge their main limitations. Any model allows only for a partial representation of reality, subject to the assumptions made. RHOMOLO balances its detailed spatial and regional dimensions by keeping optimisation problems static and, hence, not capturing the inter-temporal consequences of innovation decisions. These are binding constraints for ensuring the tractability of the model. In addition, it does not distinguish between private and public innovation or between different types of endogenous innovation. On the other hand, QUEST, not being a multisector macroeconomic model, groups all R&D activities in a unique R&D sector without capturing the complexity and diversity of the type of R&D investments, such as private and public R&D activities, product and process innovation, non-R&D and disruptive innovations. These elements are also not present in RHOMOLO, albeit the latter features more extensive sectoral and geographical details. Lastly, NEMESIS is based on empirically observed relationships among variables as well as on adaptive expectations instead of forward-looking ones, allowing for more degrees of freedom in behaviour than in other models. This may generate inconsistencies with recent developments in macroeconomic theory. As opposed to the other two models, however, NEMESIS incorporates private and public R&D activities, product and process innovation, and non-R&D investments.[313]

Horizon 2020 also had two high-level indicators where changes cannot be attributed to its effects but which serve to monitor Europe's competitiveness:

- Investment in research and development is part of the Horizon 2020's general objective and was also identified as one of the KPIs to monitor the competitiveness of EU industry, with focus on research and innovation.[314] In 2020, the rate of **research and development**

[313] Macroeconomic Modelling of R&D and Innovation Policies, op. cit., p. 158.
[314] COM(2023)168 final, "Long-term competitiveness of the EU: looking beyond 2030", Annex, p. 22, https://commission.europa.eu/system/files/2023-03/Communication_Long-term-competitiveness.pdf. Also one of the main indicators of economic competitiveness in COM(2021)350final, p. 6, https://commission.europa.eu/system/files/2021-05/communication-industrial-strategy-update-2020_en.pdf

expenditure driven by both private and public (national and EU) investments **as a proportion of GDP stood at 2.32%, an improvement of 15% compared with the 2013 figure of 2.02% but below the 3% target** referred to in the Horizon 2020 general objective.

The budget of Horizon 2020 represents about 10% of governments' budget allocations for R&I in EU28[315] and therefore its contribution to reaching the target of 3% of EU GDP spending on R&I is limited (although augmented by its capacity to leverage other sources of funding, see section 4.4.1).

- Against the general Horizon 2020 objective of building a society and world-leading economy based on knowledge and innovation across the whole Union, the Horizon 2020 Regulation[316] envisaged the monitoring of the **EU innovation output indicator (IOI)**,[317] a measure of innovation diffusion developed by the European Commission.[318] This is a synthetic measure indexed to 100, representing the value observed in 2011. Over the period 2013 to 2020, **the IOI increased in the 27 EU Member States,** from 100.2 **to 105.2**.[319] The EU improved its IOI performance during the Horizon 2020 period, slightly reducing the gap with main international comparators (e.g. the United States).[320] The IOI is reported in this evaluation for completeness but its link to Horizon 2020 is indirect.

In spite of these improvements, Europe's overall **competitive position has not fundamentally changed** over the duration of Horizon 2020. The EU still ranks third in terms of overall R&D investment[321], behind the US and China. Its long-standing growth and productivity gap with the US has so far also not been reduced. Business investment remains concentrated: almost half of all EU R&D investment goes to the automotive and other transport sectors. There is also a lag in terms of venture and growth capital - as a result, there is a pronounced scaling-up gap to the US and China.[322]

It is not because the EU's overall competitive position has not changed during 2014-2020 that Horizon 2020 did not contribute to EU competitiveness. There is extensive literature[323] on how R&I improves competitiveness and productivity. Innovation is a crucial driver of productivity as it boosts it through the development and deployments of new products and processes. But there are other factors at play, and the overall global landscape is also evolving over time. There are both firm level and institutional drivers of productivity and competitiveness. At the firm level, it has been found that innovation, management practices and human capital are key determinants of higher productivity and competitiveness. In the aggregate, a stable

[315] GBARD based on Eurostat data for 2020; Spending and revenue (europa.eu)
[316] Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020, Annex I, "Broad lines of the specific objectives and activities".
[317] The IOI has four components: patent-based technological innovation, skilled labour force feeding into the economic structure of a country, competitiveness of knowledge-intensive goods and services, and employment in fast-growing enterprises in innovative sectors. The index and its underlying indicators are calculated for 40 countries, including European Union Member States and selected third countries.
[318] Legal basis: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Measuring innovation output in Europe: towards a new indicator" (COM/2013/0624 final).
[319] European Commission, Joint Research Centre, Bello, M., Caperna, G., Damioli, G., et al., The innovation output indicator 2021, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2760/802325, p. 26.
[320] Ibid., p. 24, and European Commission, DG for Research and Innovation, Science, research and innovation performance of the EU 2022: building a sustainable future in uncertain times, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/78826, p. 472.
[321] Gross domestic expenditure on R&D (GERD), 2021, Eurostat (rd_e_gerdtot) and OECD database. Eurostat article on R&D expenditure.
[322] Evaluation study on the Relevance and Internal Coherence of Horizon 2020 and its Policy Mix (2023), op. cit. Based on Elsevier SCOPUS, EPO PATSTAT, Eurostat and OECD data, EU Industrial R&D Investment Scoreboard, broad-based review of further studies, see References in Annex A.
[323] The positive impact of R&I on these variables is assessed in the Science, Research and Innovation Performance of the EU report (chapter 4.1: https://research-and-innovation.ec.europa.eu/system/files/2022-07/ec_rtd_srip-2022-report-chapter-4.pdf).

macroeconomic environment, property right enforcement, openness to trade, effective government, and properly regulated markets are other key factors.[324]

The EIC pilot (2018-2020) tackled the persistent difficulty to translate research breakthroughs into innovation[325], which were acknowledged at the start of the programme[326] and again in more recent analyses.[327] In this context, the first phase of the EIC pilot was launched in the last two years of Horizon 2020 to strengthen breakthrough and disruptive innovations and sustain the scaling-up of European high-growth innovative companies[328]. To this end, the EIC Pilot brought together pre-existing Horizon 2020 instruments: the Future Emerging Technologies Open (FET), the SME Instrument (SMEI), the Fast Track to Innovation (FTI) and Horizon 2020 Prizes.

The EIC support filled a gap as limited breakthrough schemes existed at national level. Survey results for both successful and unsuccessful applicants to the EIC show that there are limited alternatives to the EIC.[329] Stakeholders and beneficiaries interviewed for this evaluation agreed that the EIC, with its focus on deep tech, breakthrough innovation, European dimension and substantial funding, offers unique advantages to beneficiaries that other national or regional programmes cannot match. National and regional schemes, often supported by the EU structural funds, have a limited geographical dimension and a focus on incremental innovation.[330] Even in countries where support to innovative companies through a mix of grants and financial instruments is available, the EIC stands out as the only programme having sufficient breadth and providing substantial support to deep tech companies, requiring investment in equipment, facilities and new staff. Some stakeholders consider that even if there were some overlaps, these should not be regarded as a major issue given the existing gaps for innovation financing compared to China and the US.[331]

4.1.4. Dissemination and exploitation of results

The exploitation and dissemination of results is a best effort obligation in Horizon 2020, but implementation varied:[332]

- In programme parts where projects are more business-oriented, dissemination was typically carried out via non-scientific publications. For such beneficiaries it is often important to give publicity to investments received and market potential: private platforms such as Dealroom already play an important part. Examples are provided in the box below. However, they often lack incentive to communicate the findings of their research activities, due to concerns about confidentiality and protecting market potential.[333]

[324] Grifell-Tatjé et al. 2018, Syverson 2011, Bartelsman and Doms 2000.
[325] Horizon 2020 Work Programme 2018-2020, "Towards the next framework programme for research and innovation: Enhanced European Innovation Council (EIC) Pilot", https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-eic_en.pdf.
[326] Already in 1995, the Green paper on Innovation addressed this issue as "the European paradox", stating that "one of Europe's major weaknesses lies in its inferiority in terms of transforming the results of technological research and skills into innovations and competitive advantages." European Commission, Green paper on Innovation, Bulletin of the European Union, Supplement 5/95, 1995.
[327] See SRIP report 2020 which suggests that the EU is lagging with a view to an environment that facilitates investment in relevant intangibles and scale-up funding. The SRIP 2020 also highlights the insufficient availability of risk finance for innovative investments in the EU – although there has been improvement after the Eurozone crisis – and deplores the fact that the European system still mainly relies on bank financing.
[328] Horizon 2020 Work Programme 2018-2020, "Towards the next framework programme for research and innovation: Enhanced European Innovation Council (EIC) Pilot", op. cit.
[329] European Commission, DG for Research and Innovation, Evaluation study on the European Innovation Council (EIC) pilot, Publications Office of the European Union (2022), p. 62, https://data.europa.eu/doi/10.2777/261324.
[330] Ibidem.
[331] Ibidem.
[332] Article 28 of Horizon 2020 regulation provides that "activities to disseminate information and carry out communication activities shall be an integral part of all actions supported by Horizon 2020" and that specific actions shall be supported in order to "optimise the communication, exploitation and dissemination of results".
[333] Innovative Europe evaluation study (2023), op. cit., section 7.4, p. 53.

- For Societal Challenge 1 (Health, demographic change and well-being), the monitoring data revealed that over **half (53.4%) of SC1 projects reported carrying out dissemination activities**.[334]
- The results of the bibliometric analysis for SC2 (Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy), SC3 (Secure, clean and efficient energy), SC4 (Smart, green and integrated transport) and SC5 (Climate action, environment, resource efficiency and raw materials) concluded that Horizon 2020 **failed to reach satisfactory levels of dissemination of scientific results within the scientific community and to policymakers**.[335] The beneficiaries surveyed[336] highlighted limitations in dissemination when it came to reaching out to policymakers and end users. They raised concerns about the resources and skills needed for dissemination and the need for continued knowledge management after the end of a project.

Despite the above-mentioned challenges, a bibliometric analysis indicated a satisfactory level of dissemination of scientific results within the scientific community and towards policymakers in certain fields.[337]

Example of dissemination practice for EU-funded innovations: Innovation Radar prize

Since 2015, the Commission has been awarding an annual Innovation Radar Prize, putting a spotlight on the innovations funded by the programme.[338] Innovators are shortlisted based on technological and business readiness of innovations developed in collaborative projects.[339] Examples of award-winning Horizon 2020 innovations:

- A new method for magnetic resonance imaging (MRI) based on quantum technology, paving the way for better treatment of cardiovascular diseases (NVision, Germany – MetaboliQs project[340]).
- A machine system generating all type of construction elements and architectural surfaces, 40 times faster than the methods used today (Svelte, Romania – SVELTE project[341]).
- A thermophotovoltaic battery that stores surplus renewable generation at ultra-high temperatures and produces combined heat and electricity on demand (Univ. Politecnica de Madrid, NATHALIE project[342]).
- A bio-based solution to replace petrochemical solutions used in cardboard packaging boxes, making the products stronger and easier to recycle (MetGen, Finland, FALCON project[343]).

The winner of the prize is featured in a special broadcast on Euronews[344] and receives wider support (via the dealflow.eu platform) to help increase their visibility for investors.

Shortcomings in dissemination may contribute to the scant uptake of the findings of Horizon 2020 projects.[345] The main challenge lies in the amount and consistency of the information available on the exploitable results of Horizon 2020 projects. On the one hand, many projects produce a wealth of research findings and data. On the other hand, the information that is published on project results is often incomplete and inconsistent, either due to objective reasons (e.g. pending patent applications) or to an incomplete understanding of what type of information is useful for which target group.

[334] Resilient Europe evaluation study (2023), op. cit., p. 48.
[335] Ibid, pp. 41 and 129. Analysis in Annex V.
[336] Green Transition evaluation study (2023), op. cit., section 3.1.5.2.
[337] Ibid, pp. 41 and 98.
[338] https://www.innoradar.eu/innoradarprize
[339] https://www.innoradar.eu/methodology
[340] https://cordis.europa.eu/project/id/820374
[341] https://cordis.europa.eu/project/id/887858
[342] https://cordis.europa.eu/project/id/945858
[343] https://cordis.europa.eu/project/id/720918
[344] For example, for the 2021 overall winner, MetGen: https://www.euronews.com/next/2021/11/19/enzymes-and-wood-biomolecules-a-winning-combo-for-sustainable-packaging
[345] External Coherence study (2023), op. cit., pp. 28 and 69.

What messages emerged from the stakeholder consultation?

Respondents indicated scientific publications, workshops or other events, project websites and social media (especially LinkedIn) as the initiatives that mostly helped dissemination, exploitation and access to research and innovation results – in particular, 69% (1 213) and 62% (1 083) of respondents stated that scientific publications and workshops/other events were helpful 'to a great extent'.

Regarding the helpfulness of dissemination and exploitation support services initiated by the Commission, a significant share of respondents did not have an opinion or did not know: over 50% for the Innovation Radar and IPR Helpdesk, 30-40% for the Horizon Dashboard, Horizon Results Platform and Horizon Results Booster, and 22% for CORDIS. For publications, the project website, social media and workshops, this share is 6-11%.

Overall, this indicates that particularly in view of the **Innovation Radar** and the **IPR Helpdesk**, stakeholders are not sufficiently convinced of these tools' usefulness for dissemination and exploitation. Nevertheless, while EU citizens (15%; 31), non-EU citizens (14%; 8) and respondents from academia (12%; 111) favour the IPR Helpdesk over the Innovation Radar (7%; 15, 11%; 6 and 9%; 80 respectively), only 16% of business associations (5) and 12% of companies (36) hold the belief that the IPR Helpdesk fosters dissemination and exploitation of results to a great extent.

Among all stakeholder categories, **CORDIS** is deemed the most relevant EU-wide exploitation support service: 32% of non-EU citizens (18), 29% of EU citizens (61), 28% (255) of respondents from academia, 28% (85) from companies and 24% (22) from public authorities indicated that CORDIS helped disseminate and exploit results to a great extent.

Following CORDIS, the **Horizon Dashboard** is most used among business associations (16%; 5), companies (16%; 48), non-EU citizens (16%; 9), EU citizens (15%; 33) and public authorities (15%; 14), similar to the **Horizon Results Booster** which was assessed by business associations (16%; 5), NGOs (14%; 9), non-EU citizens (14%; 8), companies (13%; 38) and EU citizens (12%; 25) as helpful to a great extent.

Among respondents from research or academia, 14% (122) found that the **Horizon Results Platform** helped dissemination and exploitation to a great extent, whereas only 9% (85) among them shared the same view regarding the **Horizon Results Booster**. A similar trend is also pronounced in the responses of companies with 16% rating the **Horizon Results Platform** (48) as helpful to a great extent, while only 13% (38) said the same about the **Horizon Results Booster**.

4.1.5. Analysis of the long-term impact of previous framework programmes

As requested in Council conclusions[346], this evaluation addresses the long-term impacts of the seventh framework programme, especially with regards to IPR and effects of ERC grants.

IPR outputs from Horizon 2020's predecessor, FP7, increased significantly after its end. As of 1 January 2023, FP7 projects reported 6 328 IPR applications. This is almost three times higher (+179%, 2 266) than the figure available at the time of the final evaluation of FP7.[347] Specifically for patents, FP7 projects produced 5 545 applications, which is more than double the number recorded on 1 January 2017[348] (2 669, +108%), three years after the end of FP7.[349]

Another advantage of analysing IPR outputs several years after the end of a framework programme is that most patent applications (95.4% for FP7[350]) have been eventually awarded. A wide enough evidence base on awarded patents enables reporting on more refined indicators, such as technological relevance, economic value and their propensity to spur additional patented innovations. The majority of self-reported FP7 inventions were patented in health-related areas, such as biotechnology (accounting for 14% of all FP7 patents, while just 1.5% of all inventions

[346] Council conclusions on the interim evaluation of Horizon 2020, https://www.consilium.europa.eu/media/31888/st15320en17.pdf, 1 December 2017.
[347] The figure, also reported in section 4.1.3, dates to 1/12/2015 and did not include IPR output of ERC projects. Even if ERC outputs are omitted, the increase over 2015 is still more than twofold (4567 applications, +102%).
[348] Reference date for Horizon 2020's interim evaluation, which also reported on FP7 IPR applications as baselines.
[349] All figures are from R&I Project Results Dashboard, frozen at 31/12/2022.
[350] Ibid.

at global level are in this field) and pharmaceuticals (9%). Lower shares were observed for ICT-related and environmental technologies.[351]

The estimated value of the patents[352] is not homogenous across sectors, ranging from EUR 1.1 million for macromolecular chemistry to under EUR 100 000 for audio-visual technologies. The valuation of FP7 patents was above the global average in most cases, with a few exceptions: even if many in number, numerous medical patents had a lower value than global average, while ICT patents are not just valued below the global level but are also less valuable compared to other framework programme patents. Almost half of all inventions were flagged as 'interdisciplinary' – i.e. they relate to more than one technology class – which is twice the world average. Patenting in multiple patent offices is common, as almost as many patents are protected at the European patent office (75%) and in the United States (74%). An analysis of patent owners shows that more than half (52%) are SMEs. This is important towards the objective of improving the competitiveness of the European economy: companies that hold patents or other forms of intellectual property are more likely to grow and experience high growth than those that do not.[353]

Qualitative analysis of **ERC-funded work** shows that since its creation in 2007, 81% of projects funded by the ERC resulted in a scientific breakthrough or major advance.[354]

Counterfactual analysis[355] showed that **in FP7 ERC grants increased research productivity (quantity and quality of publications**, i.e., on H-Index and publications in top 1% and top 10% ranked journals) **in the long term**, namely up to 9 years after receiving the grant, in some fields and depending on the type of grant received (i.e. Starting or Advanced Grant). Positive results are visible for the top-ranked project proposals as bottom rank winners have similar productivity to the unsuccessful applicants in the control group (proposals around the funding threshold).[356]

This analysis confirmed the existence of a "Matthew effect" across all fields and grants, i.e. **researchers who received an ERC grant were more likely to obtain other EU grants** by themselves (or through their co-authors) even if the total number of funds they received was similar to the one of non-beneficiaries. However, this does not imply biased and unfair selection in EU grants. Having successfully run an ERC grant would likely be considered an asset in subsequent selections given that it may be seen as a signal of experience accumulated in managing large competitive funds.

[351] European Commission, "Patents in the framework programme – From Horizon 2020 to Horizon Europe", looking at FP7 patent applications for the 2009-2018 period, R&I monitoring and evaluation flash, Aug. 2020, p. 5.
[352] Estimated in "Patents in the framework programme" monitoring flash using IP-BI method, retrieved from Orbis Intellectual Property database. This methods takes into account the following 26 indicators: Community application, R&D strength of the invention, R&D applicant ratio, Technology in different term trend, Sustainability of technology trend, Total size of activity, Family size, Transferability to different industries, Heterogeneity of potential applications, Exploitation in different technologies, Total amount of exploitation possibilities, Evidence of use, Relevance for other technologies/applications, Differentiation to the state of the art, Differentiation from direct competitor technologies, Interfering with competitors technologies, Validity level, Patent maturity, Claim width and coverage, Validity in certain countries, Intended worldwide protection, Procedural State and Grant lag.
[353] Meniere, M., Rudyk, Y., Wajsman, I., Kazimierczak, N. (2019). High-growth firms and intellectual property rights. IPR profile of high-potential SMEs in Europe. EPO & EUIPO Report, May 2019. ISBN 978-3-89605-228-5
[354] Based on the qualitative evaluations (annual independent reviews) of completed ERC- funded projects carried out during 2016-2021. The evaluation was carried out each year on a sample of completed projects from all three ERC scientific domains. This sample was randomly selected from a pool of ERC projects funded under FP7.
[355] For details of the counterfactual analysis see Annex 2, section 10.
[356] Ghirelli C., Havari E., Meroni E. and Verzillo S. (2023) "The Long-Term Causal Effects of Winning an ERC Grant", IZA discussion paper 16108.

4.2 Efficiency

This section reports on the actual costs of Horizon 2020 for different stakeholder groups. It also assesses how benefits compare to costs, how simplification measures performed relative to targets and objectives, and discusses the main opportunities for further simplification.

4.2.1 Costs, affected stakeholder groups, and overall value-for-money of Horizon 2020

Horizon 2020 and the processes through which it was implemented gave rise to several types of costs incurred by different stakeholder groups.

1. The operational expenditure of Horizon 2020 is EUR 71 195 million. It is the programme's input cost, incurred by EU society and funded mainly through the Union's budget. The part that was allocated to research and innovation projects following calls for proposals amounted to EUR 68.3 billion and has been fully committed. EUR 62 133.6 million have already been paid out.[357]

2. The administrative expenditure of Horizon 2020 is EUR 4 428 million. It is the **administrative cost of the European Public Sector** funded through the EU budget. EUR 4 292.3 million have already been paid out.[358]

3. Beneficiaries' administrative costs are compensated by grant payments and included in the operational expenditure (point 1). They have the potential to introduce inefficiencies (disproportionate administrative burden) into the programme from the point of view of society. Feedback from beneficiaries suggests that the overall costs to participate in Horizon 2020 are at least similar or even higher than those of other R&I programmes. Indicated time cost range between **4.5 to 7 person-days per month of project duration**. This implies that, if expressed as indicative money value, the total cost amounts to between EUR 135 million and EUR 215 million.[359] Beneficiaries' administrative costs were explicitly targeted by Horizon 2020's simplification measures.

4. Application costs (the cost of preparing and submitting proposals) are faced by successful and unsuccessful applicants up front. To some extent they are necessary to maximise benefits by ensuring the most competitive proposals can be identified - but application costs also have the potential to introduce inefficiencies into the programme, particularly given low success rates. The evaluation **estimates that an average cost of a proposal** falls into the range of **EUR 18 000 to EUR 37 000**, which suggests that **successful proposals** in total may have cost **EUR 609 million to EUR 1.25 billion** to prepare. The total application cost embodied in the large number of **unsuccessful proposals** is likely even more substantial and may well reach a value in the **order of EUR 5 billion to EUR 10 billion.**[360]

The costs and benefits reported in the evaluation have been used to assess Horizon 2020's societal value-for-money by calculating an **approximate public sector benefit cost ratio (BCR).** Conceptually, this metric relates the total welfare benefits of the programme to the total cost associated with it.[361]

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[357] Actual paid operational expenditure as of 01.01.2023; The amount paid out is lower than the budget figure, primarily as projects are still ongoing and are yet to receive payments; Source: MFF Performance Dashboard.
[358] Actual paid administrative expenditure as of 01.01.2023; Source: MFF Performance Dashboard.
[359] The confidence in these values is very low due to the small sample of respondents and the non-representative nature of the survey. See also Annex 4.2 for further information on monetisation of the total cost.
[360] The confidence in these estimates is very low due to a lack of systematic and robust evidence. The estimates should be read as rough illustrative figures only. See Annex 4.2 for further information, including on the question of proportionality, on oversubscription and on the involvement of consultancy firms in consortia.
[361] The difference between a (public sector) benefit cost ratio of a programme and a (private sector) return-on-investment is that the BCR takes the wider perspective of EU society and should include all costs and benefits that affect welfare. A BCR of 1 (break-even) indicates that each euro of costs that the programme generated welfare benefits equivalent to one euro.

While the costs associated with Horizon 2020 are incurred early on, its **benefits**[362] only emerge over a long period of time. A meaningful assessment of their overall relationship at this point thus has to involve estimates of benefits that have not yet materialised. The closest available proxy for a total welfare benefit of Horizon 2020 is the macro-economic forecast of its long-term GDP impact (section 4.1.3). It is likely an underestimate of the overall welfare benefits of Horizon 2020 in that not all welfare impacts on society are fully captured by GDP.[363]

Quantified benefits other than GDP (e.g., number of patents, effects on employment) are not added again to avoid double-counting. The forecast GDP value excludes any impacts on countries outside of the EU. The period of up to 2040 allows for all projects to be completed and benefits to channel through to a marketable impact. As the last projects end in December 2028, GDP impacts had at least 13 years to materialise. To anchor the forecasts to *ex post* evidence, observed Horizon 2020 dashboard information was used as modelling input data. The output of models, particularly those forecasting the future, is inherently uncertain and subject to multiple assumptions and limitations.[364] Consequently, the total benefit value used in the BCR calculations[365] is more uncertain in nature than the total cost estimate, which is dominated by the programme's budget.

For the total cost value, the **administrative and operational expenditure** invested in Horizon 2020 and the **application costs** invested by successful and unsuccessful applicants are added up. The evidence underpinning the application cost estimates is not robust, however, ignoring this type of cost would knowingly underestimate the total costs. Beneficiaries' administrative costs are not added again to avoid double counting because these costs are compensated and thus already included in the operational expenditure figure. As the BCR calculation considers a very long time horizon, the conservative assumption was made that all of the available budget will be spent by 2040.[366]

Based on the above, the **benefit cost ratio** (dividing total benefit by total cost) is around 5, consistent with a high value-for-money that reflects the potential of R&I support to generate substantial benefits over a long time horizon.[367] It suggests that **one euro of costs to society associated with the programme (programme costs and costs to applicants) is estimated to bring about five euros of benefits for EU citizens (measured through GDP impact) in the period up to 2040.**

[362] Benefits are reported in Section 4.1 (Effectiveness) and in the summary table Annex 4 Table 1.
[363] Gross Domestic Product (GDP) accounts for goods and services bought and sold in markets. Other factors, not traded in markets, can also change due to R&I impacts and raise the welfare of society, e.g. in the areas of health, leisure, non-market services, and a reduction in negative environmental externalities.
[364] The limitations and assumptions of the macro-modelling are presented in detail in section 4.1.3 (Improving Europe's economic growth and competitiveness) and in Annex 2.1.
[365] The total benefit value used in the calculation is EUR 491.967 billion in current prices (to match the price base of the available budget cost data). This differs from the one reported in Section 4.1.3, which shows 2020 prices.
[366] Please note that this differs from the assumption used in the benefit estimate, which is limited to the observed Horizon 2020 dashboard data. In both cases the approach is conservative, as the higher the cost and the lower the benefits, the lower the resulting benefit-cost ratio and value-for-money. The total cost value range used in the calculation is EUR 81.233 billion to EUR 86.874 billion (see Annex 4.5 Table 14 for a split by components).
[367] See Annex 4.5 Table 14 and Figure 8, for further reporting, illustration, and additional calculations that vary the assessment period and the macro model output used for benefits. The BCR value should be treated as indicative.

4.2.2 Performance of Horizon 2020's simplification measures

Optimising programme delivery has been one of Horizon 2020's specific objectives.[368] Simplification[369] aimed at:

1. Reducing **administrative costs of applicants and beneficiaries** in terms of the time, money and effort involved in participating in Horizon 2020[370], thus increasing the overall programme efficiency.
2. **Accelerating all processes relating to proposal and grant management**[371], thereby increasing the efficiency of administering the programme.
3. **Decreasing the financial 'error rate'** for Horizon 2020[372] thus increasing the efficiency of the programme's administration by the EU public sector and reducing administrative costs for beneficiaries.

Two main strands of simplification measures were introduced:

- **Structural simplification and a general overhaul of implementation processes**, primarily targeting simplification objectives 1 and 2, and as a secondary effect, objective 3 above.
- **Simpler funding rules and a revised 'control and risk strategy'**. These measures primarily set out to optimise the balance between the administrative costs of beneficiaries (objective 1) and the benefits of reducing financial errors (objective 3).[373]

4.2.2.1. Structural simplification and revision of implementation processes

Horizon 2020's programme architecture **brought together previously separate support programmes**[374] in one framework, governed by a **single set of rules**, **requirements and processes** with common **guidance documents** and **support services** (Common Implementation Centre or CIC). Various mechanisms were devised[375] to increase awareness and facilitate participation in Horizon 2020. Intensifying simplification efforts under FP7[376], Horizon 2020 also introduced **new management modes**, which saw the extensive delegation of programme implementation to specialised Executive Agencies and Joint Undertakings[377], to increase the quality, efficiency, and consistency of Horizon 2020's implementation[378], leaving the European Commission to focus on core policy and institutional tasks.[379]

The European Court of Auditors' report[380] collected extensive and detailed qualitative feedback from programme participants[381] to assess their effects 4 years into the programme. Its overall finding was that '**the majority of the simplification measures have been effective in reducing**

[368] Regulation No 1291/2013, Framework Programme for Research and Innovation, Preamble 20.
[369] Horizon 2020 - The Framework Programme for Research and Innovation, COM(2011) 808 final.
[370] Simplifying the implementation of the research framework programmes, 2010/2079 (INI); Horizon 2020 - The Framework Programme for Research and Innovation COM(2011) 808 final.
[371] Horizon 2020 - The Framework Programme for Research and Innovation, COM(2011) 808 final, p. 7.
[372] COM(2011) 808 final. Management Measures, simplification p. 97; Regulation(EU) 1291/2013, Framework Programme for Research and Innovation, Preamble 20.
[373] Horizon 2020 - The Framework Programme for Research and Innovation, COM(2011) 808 final, p. 8.
[374] FP7, CIP, EIT.
[375] For instance, the participant portal, the annotated model grant agreement (AMGA), the Horizon 2020 online manual, FAQs and National Contact Points (NCPs).
[376] Evaluation of FP7, Section 6.2.3.
[377] In contrast to FP7, where 30% of the budget was implemented by Executive Agencies (REA, ERCEA).
[378] COM(2011) 808 final.
[379] See also Horizon 2020 Interim Evaluation (2017), Section 7, for an assessment of measures and application processes, and an analysis of participation patterns and 'thematic' assessments of programme parts at interim stage.
[380] Court of Auditors, Special Report. No28 (2018).
[381] Including an online survey of 59 questions, covering 2014 (start of programme) to January 2018, sent to 32 918 contacts from 20 797 organisations granted funding. With 3598 respondents, despite not being representative by design, the survey is an important source of evidence on beneficiaries' views on the effectiveness of the simplification measures. Interviews of 8 beneficiaries (2 SMEs, 2 universities, 1 large private enterprise and 3 Research and Technology Organisations) collected further detail.

the administrative burden for beneficiaries in Horizon 2020' it but also pointed out that '**not all actions produced the desired result and opportunities to improve still exist**'.[382] New organisational and horizontal structures had led to a more consistent implementation of the programme. The creation of a common implementation centre for Horizon 2020 was highlighted as a 'major contribution' to simplification, as were the harmonisation of rules for participation and IT solutions for grant management and reporting.[383] Particularly, the introduction of electronic signatures and the annotated model grant agreement were found to have had a notable effect.[384]

What messages emerged from the public stakeholder consultation?

Regarding the structure and available information of Horizon 2020 calls, most respondents (both successful and unsuccessful applicants) agreed or strongly agreed that '**the descriptions of Horizon 2020 call for proposals were clear**' (63%; 1170), that '**the priority setting via the work programmes was adequate**' (61%; 1 091) and that '**the communication activities to attract applicants were adequate**' (58%; 1 029). However, over a quarter of respondents (27%; 478) disagreed or strongly disagreed that **finding the right call for proposals was easy**. **Lack of knowledge about the framework programme** was selected as a factor preventing participation by over a third (39%; 637) of Horizon 2020 beneficiaries, similarly to unsuccessful applicants (33%; 15), coming in fourth place after other aspects of application costs.

Among the different types of stakeholders, 31% (286) of research institutions as well as business associations disagreed or strongly disagreed that it was easy to find the right call, whereas companies and business organisations indicated that they had slightly less difficulties (26%; 81). Likewise, 42% (384) of research institutions, 50% (16) of business associations and 47% (145) of companies and business organisations, 47% of EU citizens (104) and 39% (23) of non-EU citizens found it easy to find the right call for their proposals.

Regarding the implementation processes of the calls, stakeholders indicated that '**using an electronic-only management system**' (82%; 1 403) and having '**harmonised processes and guidance documents across the framework programme**' (72%; 1 220) were understood to have reduced at least 'somewhat' the administrative burden for respondents. Likewise, most respondents think that **effective simplification measures** included: **removing the negotiation stage** during grant preparation (67%; 1 133) and '**using a funding model with a single reimbursement rate and a single flat rate**' (59%; 1 033)**.** The measure with the **highest number of negative views** was the 'to further use of the **two-stage application process**', although overall positive responses still outnumber negative ones, three to one.

A 2022 study on the **proposal evaluation system**[385] found evaluation processes were **fair and transparent**, although the **overall consistency** and the **feedback provided to applicants** could be improved. Stakeholder feedback also suggests that the positive effects on the **proposal submission processes**, and thus on application costs, were limited. While participants indicated an overall high satisfaction with the process itself[386], the **burden imposed on applicants** remains an area for improvement.[387] According to the ECA survey, the **proposal preparation effort has not substantially changed for applicants since FP7**.[388] Around half of the respondents reported no difference at all, 20% a lower workload and 30% an increased workload. Newcomers to EU funding schemes, in particular SMEs, found it difficult to deal with the complexity of the Commission's IT tools.[389]

What messages emerged from the public stakeholder consultation?

Views on how the **effort involved in participating in Horizon 2020 compared to FP7** were not uniform: 39% (692) of respondents think the effort was similar, 12% (219) that it was lower, and 17% (303) that it had increased since FP7. One third of respondents did not provide an opinion. **Relative to other research and innovation**

[382] Ibid. Executive Summary.
[383] Court of Auditors, Special Report. No 28 (2018), Conclusions, p. 48.
[384] Court of Auditors, Special Report. No 28 (2018).
[385] Study on the proposal evaluation system for the EU R&I framework programme (2022), op. cit.
[386] Ibid.
[387] Study on the Proposal Evaluation System (2022), Horizon 2020 evaluation support studies on Excellent Science, Resilient Europe, Digital and Industrial Transition, Innovative Europe and Green Transition (2023), op. cit.. Evaluation of Research Executive Agency (REA) 2015-18; Evidence gathered through interviews and (non-representative) surveys. Beneficiaries dominate the responses of participants.
[388] Court of Auditors. Special Report. N.28 (2018).
[389] Ibid.

funding programmes, the effort to participate in Horizon 2020 is deemed greater (43%; 771, particularly academic and research institutions) **or similar** (39%; 692) **by most**. Only a small minority of respondents (7%; 219) consider it lower.

The **main reasons that held back potential beneficiaries** from Horizon 2020 were all linked to application costs, namely the **low success rates of applicants**, which both successful and unsuccessful applicants agree on (57%; 924 and 69%; 31 respectively), the **cumbersome application process** (42%; 681 among successful and 53%; 24 among unsuccessful applicants, and 50%; 67 respondents from associated countries), as well as the **lack of resources:** Interestingly, a larger fraction of successful applicants (41%; 670) than unsuccessful candidates (27%; 12) deemed the potential applicant's lack of resources to prepare a proposal as a reason negatively affecting participation. Compared to EU-13 respondents, respondents from associated countries are 10 percentage points less likely to identify limited resources as a deterring factor for participation.

Low success rates were also considered a further deterring factor to participation by 59% (830) of EU-15 respondents, 64% (115) of EU-13 respondents and 40% (54) of respondents from associated countries.

Two quantitative targets allow to track the aggregate impact of the simplification measures on **EU public sector administrative efficiency** and can be assessed.

First, the Horizon 2020 Regulation set out an overall **efficiency benchmark** for the programme's administrative expenditure of no more than **5% of the specific programme budget envelope, excluding JRC and EIT actions**. Throughout the programme, the administrative expenditure was also to decrease, aiming at a **target of 4.6% or less in 2020**.[390] Horizon 2020's **administrative expenditure implemented to date** suggests that the programme overall performs well against these benchmarks: excluding the JRC and EIT[391], the total administrative expenditure implemented reached **3.90%**[392] (EUR 2 783.3 million) of the budget in current prices.[393] The percentage stayed approximately constant between 2014 to 2020, reaching **3.37%** in its last year, well under the 2020 target.

Second, several time targets were set for specific administrative processes[394], in particular the **time-to-grant (TTG) target**.[395] Except for ERC calls[396], **each grant agreement had to be signed 8 months (245 days) after the deadline for submission of proposals**. On average and overall, Horizon 2020 was expected[397] to reduce the average 'time to grant' by 100 calendar days relative to FP7. The European Commission and the Executive Agencies were able to process Horizon 2020 proposals and grant agreements faster, without a corresponding increase in the human resources involved: **Achieved time-to-grant** periods[398] show that Horizon 2020 clearly outperformed FP7, even relative to its more stringent target. **Under Horizon 2020, 90% of grants were signed on time, compared to 41% under FP7. The average time-to-grant period was 187 days. This means that 126 days were saved per grant on average compared to FP7**, which had an average TTG value of 313 days. FP7 calls on average had missed the 270 day-target at the time by 43 days. Given Horizon 2020's total of 27 576 grants signed (excluding ERC grants), this means in aggregate **over 9 500 years** of working time in the EU public sector

[390] Art.4.3, Council Decision of 3/12/2013 (2013/743/EU) establishing the specific programme implementing Horizon 2020 (O.J. L347/965 on 20.12.2013. "No more than 5 % of the amounts referred to in Article 6(2) of Regulation (EU) No 1291/2013 for Parts I to V of the specific programme shall be for the Commission's administrative expenditure. The Commission shall ensure that during the programme its administrative expenditure will decrease and it will endeavour to reach a target of 4,6 % or less in 2020."

[391] In the case of non-nuclear direct research actions of the JRC, the administrative expenditure (EUR 1636.8 million) is not directly comparable, as it includes the cost of staff and scientific infrastructure to carry out research. EIT's administrative expenditure amounts to EUR 8.5 million. Figures as of 01/01/2023.

[392] Based on committed budget; Admin. Expenditure 2014-2020, point 5.1 of Statement of Estimates of the EC for financial year 2020. Figures account for 2020 annual budgetary procedure, amendments, and transfers.

[393] FP7 does not lend itself as a point of comparison, as a comparable assessment of the ratio was not reported.

[394] Regulation 2021/695, Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013. Art 31.

[395] Annex 4.4 provides further detail on TTG performance, as well as related time cost targets.

[396] ERC: TTG may exceed the target if justified (e.g. complex actions, many proposals, and request by applicants).

[397] COM/2011/0808 final; The Framework Programme for Research and Innovation.

[398] Monitoring data on FP7 and Horizon 2020 (as of 1 January 2023).

were saved, relative to the time it would have taken if FP7's average TTG performance had continued. The performance was, however, not uniform throughout, with some **programme parts experiencing delays**. This applies in particular to the initial period of the **EIC pilot**, when companies faced delays of up to 12 months and considerable uncertainty.[399] The introduction of an **electronic grant management** workflow and the **withdrawal of the negotiation stage** were identified[400] as key factors behind the sizable reduction, with beneficiaries broadly welcoming the withdrawal of the negotiation stage.

What messages emerged from the public stakeholder consultation?

A majority of respondents agreed, or strongly agreed, that it took 'adequate time' to **evaluate the proposals** (66%; 1175) and to **sign the grant agreement** (69%; 1230). The feedback provided on the **evaluation was seen as 'clear and informative**' by half of the respondents (769), however nearly a quarter (24%; 426) of respondents disagreed or strongly disagreed with this assessment. For both aspects, no significant difference was identified between different stakeholder groups – the averages presented above provide a balanced view.

4.2.2.2. Simpler funding rules and revised control and risk strategy

As a second strand of simplification measures, Horizon 2020 changed funding rules and its approach to controls and risks.

The **rules on reimbursement of costs and time-recording** were amended, to better account for beneficiaries' established practices, including those of SMEs. The measures thus responded to previous evidence[401] that rules on cost reimbursements were complex and a persistent source of unintentional financial errors. While overall Horizon 2020 funding rules became simpler than under FP7, specific aspects of the methodology for calculating personnel costs did not and even increased in complexity.[402]

What messages emerged from the stakeholder consultation on funding rules?

A large majority of respondents 'agreed' or 'strongly agreed' that their 'organisation's **usual accounting practices** were accepted' (69%; 1 227). The agreement among respondents from NGOs and companies was even higher, both at 74% (49; 651) respectively. EU citizens (61%; 135) and non-EU citizens (51%; 30) agreed to a lesser extent. Only a small fraction of respondents found that their usual accounting practices were not accepted, namely public authorities (2%; 2), NGOs (8%; 3), companies (7%; 23), business associations (6%; 2) and academia (8%; 77).

Beyond that, stakeholders agreed that '**the mechanisms for project monitoring and reporting were adequate**' (69%; 1 214), showing the highest level of agreement among companies (74%; 226), followed by respondents from academia (70%; 634), business associations (68%; 21), EU citizens (66%; 143), non-EU citizens (60%; 35) and NGOs (58%; 38) . At the same time, another fraction of respondents from academia were of the opinion that the monitoring and reporting mechanisms were not adequate (10%; 93), followed by NGO-associated respondents (17%; 11), respondents on behalf of companies (9%; 28) and business associations (3%; 1).

Overall, respondents agreed with the statement that '**the cost calculation rules were clear**' (66%; 1 177). Nevertheless, there was some variation between the different stakeholder groups: business associations agreed to the greatest extent (74%; 23), followed by companies (72%; 224), academia (68%; 620), NGOs (62%; 41) , EU citizens (61%; 120), public authorities (57%; 52) and non-EU citizens (54%; 37) respectively. At the same time, the level of dissatisfaction with the clarity of cost calculation rules varies to a smaller extent among the different types of stakeholders, ranging from 9% of companies (27), up to 13% for academia (118), public authorities (12) and business associations (4) respectively.

More than half of respondents were **'satisfied with the support received by the EC services (including agencies) during grant preparation and implementation**' (58%; 1 022): business associations are beyond the average of all respondents satisfied with the support received by the EC services (67%; 21), along with companies (64%; 199). At the same time, respondents from academia (57%; 524) and NGOs (48%; 32) were less satisfied. Interestingly, the level of satisfaction between EU citizens and non-EU citizens differs: **non-EU citizens** (64%; 27) **are less satisfied[403] with the support received by the EC services, compared to EU citizens** (55%; 122).

[399] EIC pilot evaluation (2022), op. cit. Please refer to Annex 4.4 for more detail.
[400] Court of Auditors. Special Report. N.28. Evidence from survey and interviews, primarily from beneficiaries.
[401] *Ex Post* Evaluation of the 7th EU framework programme (2007-2013), Commitment and Coherence
[402] As pointed out by ECA Annual Report on the implementation of the budget for years 2018 (5.16) and 2020 (4.13)
[403] By 9 percentage points.

The revised approach of the '**control and risk strategy**' was designed to optimise the balance between the beneficiaries' enforcement costs from controls and auditing[404] and the benefits of audits, which reduce the risk of misallocation of public resources. The new approach[405] **shifted the focus from a minimisation of financial error rates under FP7** associated with high costs of controls, **to one that a priori trusted beneficiaries, combined with lighter auditing *ex post***.

The evaluation assesses the new approach using two observable outcomes: the number of beneficiaries with control burden from audit (as a proxy for their enforcement costs) and the error rate performance of Horizon 2020.

The trust-based approach achieved the **intended direct positive effect of lowering the control burden (enforcement cost) on beneficiaries**. The actual share of unique beneficiaries (PICs) affected by an audit to date, fell from 11.76% under FP7 to 6.02% under Horizon 2020[406], staying well under the targeted 7% maximum[407] (lowered from 20% under FP7) and **generating savings for approximately 2 500 unique beneficiaries** which would have been audited otherwise.

To gauge the extend of the new control and risk strategy's potential unintended negative effect on financial errors, the assessment looked at the performance of Horizon 2020 with respect to two error rates. The **Representative Error rate** (RepER) is an error metric that relates the money lost due to errors (amount at risk) to the programme expenditure, using audits completed during several years.[408] The **Residual Error rate** is a comparable rate that, in addition, accounts for corrective activities by the administration.

This shift of focus[409], away from a minimisation of error rates, took place in a context of traditionally high error rates in R&I funding. FP7's error rates had consistently exceeded a 2% target[410] with a cumulative multi-annual Representative Error Rate of 4.95%.[411] The FP7 ex post evaluation considered the elevated error rate a significant shortcoming in its implementation and attributed it in parts to the lack of consistency between programme parts and the programme's overall complexity.[412]

Despite this context, the expectations for **Horizon 2020**'s error rate had been further relaxed. This change was the outcome of negotiations accounting for the "trust-based approach". While the approach allows for fewer audits and controls to reduce beneficiaries' burden it also increases the risk of financial errors. A new **target range of 2% to 5%** was therefore set for the programme period of Horizon 2020.[413] According to the Common Audit Service, the **achieved cumulative Residual Error rate of Horizon 2020 up to now is 1.67%, with a cumulative RepER of 2.71%**.[414] This means **Horizon 2020's error rates stay within the targeted range and are also an improvement relative to FP7.** Although an attribution can only be reasoned, this reduction in spite of the shift away from control and audit, is plausibly a positive effect of the simplification of funding rules.

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[404] Regulation No. 1291/2013 Framework Programme for Research and Innovation, Preamble 44.
[405] *Ex post* Audit Strategy Horizon 2020 for 2016-2025; COM(2011) 808 final.
[406] Figures provided by Common Audit Service; Horizon 2020 figure 2 years after closing of programme.
[407] Common Audit Service, KPI 14 (total percentage of H2020 unique beneficiaries (PIC) audited, target 7%)
[408] Horizon 2020 *Ex post* Audit Strategy (February 2016)
[409] Regulation No 1291/2013, Framework Programme for Research and Innovation, Preamble 44.
[410] Declaration d'assurance methodology DAS (1994), European Court of Auditors.
[411] European Court of Auditors Annual reports concerning the financial year 2017, section 5.2.4; Residual error rates, reported at the level of the involved DG, varied between 2.79 % and 3.55 %.
[412] *Ex post* evaluation of the seventh framework programme (2016), Section 7.1 Lessons Learned. The FP7 evaluation did not assess the value for FP7's error rate.
[413] Legislative Financial Statement in 2011 Commission proposal for the Regulation on Horizon 2020 (COM/ 2011/809) of 30 November 2011, p. 98-102; COM(2011) 808 final;.2.2 Management and control system. P. 99.
[414] Both cumulative error rates for Research and Innovation, DG RTD Annual Activity Report 2022; The Common Audit Service reports the (multi-annual) error rates at programme level only, without any further breakdowns.

Despite this positive development, the evaluation does not draw an overall positive conclusion on Horizon 2020's error rate performance. Between 2018 and 2021, each **European Court of Auditors** annual report concluded that the **level of error remains high** for research and innovation expenditure.[415] The ECA reports annual average error rates of R&I support of 3.97% for 2018, 6.64% for 2019, and 5.29% for 2020.[416]

The ECA also found that Operational Expenditure on R&I support (of FP7 and Horizon 2020 together) continued to be 'an area of above-average risk and errors', and that the detected **financial errors were of a repeated and avoidable nature**.[417] Errors mainly concerned the erroneous reimbursement of ineligible costs declared by beneficiaries, particularly costs relating to human resources (personnel costs), incorrectly declared subcontracting costs, and costs that had not actually been incurred.

The simplification measures introduced by the new 'control and risk strategy' were successful in that they achieved the expected fall in beneficiaries' control burden (enforcement cost). Although the measures reduced financial controls and audits, Horizon 2020's cumulative error rate did not rise but could even be lowered - presumably an effect of Horizon 2020's simplified funding rules. The persistence of frequent financial errors, however, remains an ongoing challenge for the framework programme and underlines the complexity involved in trade-offs between simplification of financial controls and auditing, and the risk of misallocation of public resources.

To keep the advantages of the "trust-based approach" but, at the same time, tackle avoidable financial errors, the use of lump sum funding was piloted in the last years of Horizon 2020. Its simplification potential is discussed below.

4.2.3 Potential areas for further simplification

Lump sum funding

Lump sum funding means that beneficiaries are paid out a lump sum for each delivered work package, which are fixed in the grant agreement. It is expected to substantially reduce the reporting costs of beneficiaries, by essentially removing all financial reporting requirements, and to shift the focus of project monitoring away from financial checks to project performance and content. It also has simplifying effect on some grant management processes and is ultimately expected to bring down the elevated rates of financial errors.

A comprehensive **pilot of lump sum funding for R&I projects** was carried out between 2018 and 2020 under Horizon 2020. It included 16 topics, over 1 500 proposals and covered grants of all main types, different sizes and levels of complexity. EUR 454 million were allocated to 525 lump sum grants.

In 2021, the findings of the pilot's ex post assessment[418] suggested that lump sum funding was a possible means of further simplification and generally fit for all types of organisation and types of grants. It found qualitative evidence on lower administrative costs of beneficiaries at reporting stage and no evidence for a rise in application costs. Initial concerns, participants could artificially increase the number of work packages to trigger more frequent payments in the interest of cash flow, and in this way counteract the achievable reporting cost savings, were not substantiated by evidence.[419] The *ex post* analysis found that a majority of beneficiaries welcomed

[415] European Court of Auditors Annual reports concerning the financial years 2018, 2019, 2020 and 2021.
[416] European Court of Auditors, Statistics audited transactions R&I (SoA2020 Vs SoA2019).
[417] European Court of Auditors, Annual Report 2020, Chapter 4, MFF 1a.; The ECA concluded the that 'the level of errors in spending on Competitiveness for growth and jobs' MFF1a (covering Horizon 2020) was 'material'.
[418] Assessment of the Lump Sum Pilot 2018-2020: Analysis of qualitative and quantitative feedback (2021).
[419] Commission guidance for applicants and beneficiaries of lump sums addresses the concern and makes clear that splitting work packages should not lead to the subdivision of the project into many small work packages. The added work packages would have introduced avoidable reports (associated with reporting costs) as an unintended negative side effect. The number of work packages of submitted projects did not confirm such a pattern.

lump sums and considered the tool effective in reducing their administrative work. The stakeholder feedback was collected from a comprehensive set of affected groups (applicants, beneficiaries, evaluation experts, EU Commission staff and National Contact Points). As with any larger simplification measure, there are clear indications of the presence of adjustment costs in stakeholder feedback (e.g. applicants, beneficiaries and evaluators adapt and require information, training and guidance).

The analysis had some limitations: While the pilot's design, and therefore its transferability, and the collected qualitative information were overall good, it did not allow for a quantitative assessment of the overall net effect of costs associated with the introduction of lump sums. The pilot did not collect any quantitative evidence on changes in costs of applicants and evaluators. As lump sum grants are not subject to financial audits their wider use will change the composition of audited grants and so affect indicators linked to financial audits. Due to its size, the pilot did not allow for an analysis of the overall effects of lump sum funding on the programme's error rates or the total costs from auditing (to beneficiaries and EU public sector). Finally, the one-off nature of the pilot did not lend itself to observe any potential for strategic behaviour of applicants and beneficiaries over the medium term.

What messages emerged from the stakeholder consultation on funding rules?

Across all stakeholder groups, the support for the lump sum pilot is held the most with respondents associated with public authorities (38%; 35), which is followed by respondents from companies (36%; 110), EU citizens as well as non-EU citizens alike (36% respectively; 78, 25) As expected, respondents from companies favour the introduction of the lump sum pilot to a greater extent compared to respondents from academia (33%; 299) however not significantly (only 3 percentage points). Similarly, 16% of respondents from academia (144) are negative about the introduction of the lump sum pilot, compared to 13% of respondents from companies (37) once again showing a difference of 3 percentage points.

A 2022 study by the European Parliament Research Service[420] equally found that beneficiaries overall preferred the use of lump sums, however, not necessarily in all programme parts (32% of respondents expressed a general preference, whereas 57% preferred it for some funding schemes and 7% preferred the traditional funding system). The study highlighted a few practical challenges relevant for the tool's design. Beneficiaries raised concerns about an increase of their own financial risk. As of September 2023, it is too early to draw a robust conclusion, however, current data does not confirm a change in risk, with more than 99% of requests for payments under the lump sum funding having been paid out in full to beneficiaries so far.

The scale of the simplification potential from extending the use of lump sums in the future will depend on details of implementation. Administrative cost reductions (due to the removal of all financial reporting requirements) are expected to benefit beneficiaries. Risks exist around additional (transitional) costs, including to applicants (who submit an additional budget table with lump sums), evaluators (who assess proposed lump sums), and to a lesser extent for administrators (who adjust to a change of focus away from financial reporting towards content). Lump sum funding can also be expected to have an effect on the approach to financial auditing, as lump sum projects cannot be covered by the established audit practice. The overall net effect on costs and benefits will strongly depend on the extent to which risks can be mitigated through details of implementation. Monitoring and further evidence-based adjustments to an evolving practice over time will be required to ensure and maximise a net savings effect. This means it will be necessary to continue to collect and assess (quantitative) evidence and feedback from current applicants, beneficiaries, evaluators, and administrators involved in lump sum funded grants under Horizon 2020 and Horizon Europe.

[420] A reimbursement system based on a fixed lump sum, European Parliamentary Research Service (2022).

Seal of Excellence

The low success rates in some parts of Horizon 2020 bring with them that the efficiency of the framework programme is sensitive to any changes that influence the costs of applicants, as most of this cost is a net loss to EU society. While administrative details of the proposal preparation and submission process will always remain a valid area for simplification efforts, many key drivers of the cost of application, such as developing a high-quality idea or setting up a consortium, cannot be reduced. In this context, any effective measure with a potential to lessen the loss of effort invested in unfunded proposals has potential to increase the programme's efficiency.

One such measure is the **Seal of Excellence** (**SoE**), a quality label awarded under Horizon 2020, which attempts to capture the value embodied in successful yet unfunded proposals from mono-beneficiaries with the aim to facilitate their resubmission to alternative funding programmes. Its value also extends to the proposal evaluation carried out under Horizon 2020. Other funding bodies can reduce their future evaluation costs, by partially avoiding the reassessment of the content of the proposals. Of the 97 403 high quality proposals not retained for funding, 20 890 received a Seal of Excellence certificate under Horizon 2020, where it was available for the SME Instrument (later called the EIC Accelerator), for MSCA, for Teaming actions and for the ERC Proof of Concept. The SoE has shown some first signs of promise in encouraging alternative funding. As managing authorities were not obliged to report on the funding of SoE proposals, complete figures are not available. However, data from three countries known to have funded SoE SME Instrument proposals under ESIFs, show that an average of 26% were successful in subsequently securing funding.[421] Member States' lack of access to information on awarded Seals of Excellence was flagged as a hindering factor[422]. Further, Czechia, Cyprus and Lithuania have designed support from ESI funds for SoE holders from MSCA Individual Fellowships.

The current SoE is restricted to mono-beneficiary actions. Other limiting factors are the voluntary nature of recognising the seal in regional and national funding programmes, the information flow, and the still to be strengthened 'Seal of Excellence community of practice'. Addressing these constraints would strengthen the measure's potential to increase the programme's efficiency. An *ex post* evaluation does not provide the necessary evidence for a quantification of the simplification potential of an adjusted Seal of Excellence, which will be a task for the impact assessment of the next framework programme.

Two-stage application process

The evaluation of **proposals** in two separate stages is a recurrent measure discussed in the context of further potential for simplification: after an initial evaluation of a shorter proposal only a subset of applicants is asked to prepare a full proposal, which is why the process **has the potential to reduce the costs of applicants**, **specifically that of the many unsuccessful applications**. Two-stage evaluations also change the costs of evaluating proposals that fall on the EU public sector. A smaller number of proposals is evaluated in detail (by experts), but a larger number of proposals has to be handled overall and over a longer period of time. The net effect can be positive or negative, as the cost is driven by the number of applications submitted in the first phase and the number remaining in the second phase.

The European Court of Auditors[423] pointed critically at the fact that, as of 2018, only a fraction of Horizon 2020 calls made use of two-stage evaluations. A wider introduction had a **potential**

[421] ECA Special Report 23/2022, p. 30, Table 2, PL 26% (20 proposals), PT 32% (35), SI 28% (15), from sample of 5 Member States selected on basis of R&I performance, availability of ESIF for R&I, and H2020 participation.
[422] Portugal proactively set up a system for obtaining information about national SoE grantees, which allowed it to target existing national calls for proposals and thus attract 108 SoE applicants, of which 32% secured ESI funding.
[423] Court of Auditors. Special Report. N.28 (2018), Conclusions, p. 48.

to reduce the application costs for many unsuccessful applicants. A survey of beneficiaries[424]suggests that most respondents, across all **stakeholder groups, generally supported two-stage evaluations**, with the relatively lowest support coming from large private companies.

What messages emerged from the stakeholder consultation on funding rules?

Among the simplification measures sought feedback on in the public consultation, the notion of extending the use of the two-stage application process has received the highest number of negative responses, although positive responses (42%; 711) still outnumber the negative ones (15%; 255). The majority of respondents agrees with the idea of further expanding the two-stage application process for some programme parts, notably respondents from academia (56%; 433), non-EU citizens 52% (27), public authorities (49%; 36), business associations (48%; 11) and EU citizens (48%; 87) were in favour.

From the perspective of the applicants, it is essential that any further roll-out of two-stage evaluations takes the procedure's limitations into account. The process lasts approximately **3 months longer**.[425] This introduces a potentially critical delay, which risks reducing the positive impacts of R&I funding, for instance, in a competition for first-mover advantage. At the same time, key factors that influence the application cost cannot be reduced through a two-stage process. Applicants still must set up a consortium, develop a detailed idea, and prepare for a potential second stage. The study on the proposal evaluation system[426] found that the two-stage application processes may overall even increase the burden. It pointed out that, considering costs and downsides for applicants, **around 75–80% of the applications would have to be rejected at the first stage for the overall net effect to effectively lead to simplification.** Particularly the costs associated with the first stage had the potential to increase, rather than reduce the overall applicant burden. The study, however, also acknowledges that two-stage evaluations may still be appropriate in some cases.

In summary, there may still be further potential for simplification in a wider application of two-stage evaluations in areas of the framework programme, where the success of a project (i.e. the potential benefit) is **not strongly affected by a 3-month delay of the project start date and proposals typically have a success rate of under 20%, and the absolute number of unsuccessful applicants is high**. In such cases, the total net effect on applicants' costs will more likely be positive. As two-stage evaluations also substantially change the costs of evaluating proposals that fall on the EU public sector, a careful ex-ante assessment will be necessary on a case-by-case basis to ensure that the overall net effect on the costs of the framework programme is negative or that an informed decision on trade-offs can be taken.

4.3 Coherence

4.3.1. Internal coherence

The interim evaluation of Horizon 2020 judged the **number of instruments excessive**, making 'the landscape for EU R&I support difficult to navigate and [potentially leading] to less coherent interventions'. This issue continued to be a concern right up to the end of Horizon 2020. Several interviewees highlighted this issue – either from their perspective regarding the programme parts or from the beneficiary perspective – adding that it necessitates highly professional support structures to assist the applicants.

However, **different approaches to grants** (mono-beneficiary and collaborative, more research-oriented vs more innovation-oriented) interacted in a complementary way.[427]

[424] Court of Auditors. Special Report. N.28 (2018), p. 35.
[425] Commission estimation, Horizon 2020 SWD(2017) 220 final – "In-depth interim evaluation of Horizon 2020".
[426] Study on the Proposal Evaluation System for the EU R&I framework programme (2022), op. cit.
[427] Study on the Relevance and Internal Coherence of Horizon 2020 and Its Policy Mix (2023), op. cit. The examples from different pillars include: the complementarity of ERC and MSCA (and FET) in pillar 1 (p. 56),

Under Pillar 1, MSCA and ERC form the most coherent set of actions. As reported in the interim evaluation, the age profile of the MSCA fellows is complementary to ERC grantees as they tend to be younger and around 40% of MSCA fellows are doctoral candidates. Furthermore, there is evidence that former MSCA fellows tend to be more successful when applying for ERC grants. An analysis of ERC applicants under Horizon 2020 who were MSCA fellows in FP7 estimates their average success rate at 16%, compared to 12% among all applicants to the same calls.[428]

Findings from the interviews also support the overall internal coherence of the Horizon 2020 policy mix (in Pillar 2). The fact that SME Instruments (and EIC) are primarily mono-beneficiary instruments – compared to the emphasis on collaborative projects in other Horizon 2020 parts – was highlighted, along with the introduction of equity financing as part of the EIC Accelerator. The importance of non-financial support (most notably INNOSUP actions and EEN) in accompanying financial instruments was also highlighted in the interviews.

Pillar 2, together with many other parts of Horizon 2020 (except for Pillar 1), are focused on research and innovation at higher Technology Readiness Levels. In LEIT, research and innovation activities (RIA) account for EUR 5.4 billion (45%) and innovation activities (IA) for EUR 4.2 billion (35%). Thus, when looking at the pillar as whole, funding has focused more on research-focused projects than on innovation-focused ones. There are, however, differences in emphasis between different thematic areas. Emphasis on science-driven activities is the most evident in the case of biotechnology: RIA accounts for EUR 238 million and IA 46 million. Space follows biotechnology with EUR 485 million invested in RIA and EUR 226 million in IA. Only in advance manufacturing and processing investments in innovation outweigh the investments in research activities (RIA: EUR 632 million, IA: EUR 1.1 billion).

New types of action were introduced in Horizon 2020 to realise a broader innovation and impact orientation:

- The SME instrument was – in terms of numbers of projects granted and allocated budget – the most important new type of action. The mono-beneficiary SME Instrument showed good complementarities with other types of action and contributed to realising the turn towards more innovation orientation. Because of this, some stakeholders consulted for the evaluation study on the relevance and internal coherence of Horizon 2020 criticised its termination in favour of the newly set up EIC pilot.[429]
- The EIC Pilot was the only instrument designed to cover almost the entire TRL spectrum, pursuing a portfolio approach that is set to follow the most promising projects through their technology asset development from the very early stage. It supported the commercialisation of game-changing innovations across all sectors and technology domains - offering blended finance for innovative, high risk and not yet bankable entrepreneurial projects. Therefore, the EIC Pilot had a unique target and configuration,[430] enabling it to respond to needs not

complementarity within pillar 2, in particular of SME instrument and EIC with collaborative projects – IA, RIA (p. 57), complementary additions to the policy mix in pillar 2 with equity financing and capacity building support provided by INNOSUP and EEN (p. 57), research and innovation orientation in pillar 2, the policy mix of the societal challenges programme as an example for complementarity in the societal challenges pillar (p. 58). In addition, the examples for the whole Horizon 2020 include complementarities between pillars 1 and 2 (p. 56), the lack of opportunities for collaborative fundamental research (pp. 56-57), the importance of having bottom-up funding (ERC) in the policy-mix oriented towards policy objectives, top-down (p. 34).

[428] SWD on the interim evaluation of Horizon 2020, SWD(2017) 220 final, pp. 151-152, https://op.europa.eu/s/yXiZ.

[429] Study on the Relevance and Internal Coherence of Horizon 2020 and Its Policy Mix, op. cit., p. 57.

[430] EIC Pilot evaluation study (2022, p. 60) found that its uniqueness in the EU R&I policy mix lies in four features. 1) It is the only instrument designed to cover almost the entire TRL spectrum, with a view to converting breakthrough innovations from universities and research centres into commercially exploitable innovations, leading to the scale-up of innovative SMEs. 2) It pursues a portfolio approach that involves following the most promising projects through technology asset development from a very early stage. This aspect was not properly tested in the pilot phase, which lacked a proper instrument to connect the two programme parts. This missing linkage was remedied by the launching of transition calls and the recruitment of programme managers in 2020. 3) It supports the

addressed by other programme parts.[431] The 2022 evaluation of Pilot found that it complemented other parts of Horizon 2020, most notably the 'Innovation in SMEs' (consisting of the SMEI and INNOSUP actions until 2018). Introduction of the EIC pilot helped to create a better distinction between support for actors implementing the innovation – and INNOSUP Actions that strengthen the dynamism and the resilience of the ecosystem in which these actors operate. Nevertheless, one area where the evaluation found weaker performance were synergies with the European Institute of Innovation and Technology, which were "not clearly defined and tested in the Pilot phase".[432]

- Innovation actions were introduced for Horizon 2020. Innovation actions mainly target activities directly aiming at producing plans and arrangements or designs for new, altered, or improved products, processes or services. For this purpose, IAs can include prototyping, testing, demonstrating, piloting, large-scale product validation and market replication. For Pillar 2 these actions focusing on higher TRL levels were highly important, and 87% of all IA projects were funded by Pillar 2.

In terms of programme design, the promotion of selected topics referred to as **cross-cutting issues**[433] (such as international cooperation or widening participation in the programme), without dedicated budgets or instruments, created challenges for implementation. Some issues lacked agents of change, intellectual ownership and/or indicators for tracking progress. In addition, assessing some cross-cutting themes can be problematic because of issues related to data availability and measurability.[434]

The main objective of the **focus areas** (listed in the glossary), bringing together efforts from different Societal Challenges, was to stimulate the development of knowledge and technologies deemed crucial for tackling specific cross-cutting challenges. They increased internal awareness of what was happening in other Commission departments, and focused attention on finding ways to increase the impact of R&I investment[435]. However, coordination issues emerged because focus areas were created on top of other existing initiatives[436] and because there was no clear dissemination and communication plan.[437]

High staff turnover in the Commission had a detrimental effect on the internal coherence of the programme, as staff did not sufficiently accumulate knowledge.[438] Large organisations face challenges in establishing longer-term learning processes internally to an organisation, and the European Commission is not an exception in this regard. Contract Agents[439], which represent a particularly high share in DG RTD compared to other DGs, who coordinate and implement programme activities, have a maximum total contract of six years. Qualified and trained people

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commercialisation of game-changing innovations across all sectors and technology domains. 4) Blended finance is available for innovative, high risk and not yet bankable entrepreneurial projects.

[431] Ibid, p. 71.

[432] European Commission, DG for Research and Innovation, Evaluation study on the European Innovation Council (EIC) pilot: final report, Publications Office, 2022, p. 61, https://data.europa.eu/doi/10.2777/261324.

[433] Cross-cutting issues are listed in the glossary. More details are available in the study on the implementation of cross-cutting issues in Horizon 2020 (2023), op. cit.

[434] Cross-cutting issues evaluation study (2023), op. cit., pp. 52-53. When project officers misinterpret guidance on flagging topics, this can also distort figures on how a cross-cutting issue is implemented.

[435] European Commission, DG for Research and Innovation, Bening, J., Bergmans, J., Bieszczad, S., et al., Opportunities and challenges in targeted funding of Research and Innovation: lessons learned from the Horizon 2020: focus areas and implications for Horizon Europe missions, Publications Office of the European Union, 2021, p. 18, https://data.europa.eu/doi/10.2777/59160.

[436] Ibid, p. 20.

[437] Ibid, p. 22.

[438] In DG RTD, 27% of the people in In the Commission's DG for Research and Innovation (DG RTD) are contract staff (source: DG HR and Security, Statistical Bulletin, "Staff by DG, by Location", January 2023, p. 1). The study on Relevance and Internal Coherence of Horizon 2020 (2023, op. cit.) noted that qualified and trained people are lost rather quickly both at managerial level and among those coordinating and implementing the programme.

[439] In DG RTD, 27% of the people are contract staff (Source Statistical Bulletin, October 2022), https://commission.europa.eu/about-european-commission/organisational-structure/commission-staff_en.

are lost in this way – only a fraction of them stays if they manage to pass a 'concours' or get a position in another institution. As a result, Commission Services in the research and innovation field do not sufficiently accumulate knowledge and tend to lose knowledge rather quickly, external evaluation found. Interviewees brought up also arguments in favour of horizontal mobility, in terms of avoiding silo-thinking and enabling learning and cross-fertilisation across domains. While there is no easy solution to this challenge, the various interviews indicated that the balance between continuity and mobility of staff – both at managerial and operational levels – is an issue of concern.

In response, many of the process elements of Horizon 2020 were established to mitigate this loss of knowledge due to high staff turnover:

- The strategic programming, which organised the consultation of stakeholders and experts differently as compared to former FPs and which invested in a broad EC-internal 'co-creation' process across DGs in order to arrive at an overarching strategic document. For the first time, also multi-annual programmes have been set up, which should allow for a better (and more prospective) response to new developments and challenges from the R&I side while contributing significantly to the EU's overall policy objectives. These approaches have been developed during Horizon 2020. For example, after the first WP adoption a lessons-learned catalogue was elaborated: more than 50 lessons learned were collected and fed back in the discussion and processes for the following WP.
- The role of the advisory groups changed during the implementation, giving increasing recognition to the advice of the expert groups (and hence the views of external stakeholders).
- Under Horizon Europe, staff mobility between Commission and executive agencies has been further reinforced through a new pilot staff exchange scheme. The pilot allows, for example, colleagues from executive agencies to work in a DG, or from JRC to work temporarily in DG RTD and thus share different perspectives and experience with the FP.

4.3.2. External coherence

Compared to FP7, greater emphasis was put on the synergetic use of Horizon 2020 and European Structural and Investment Funds (ESIF) funds, with the inclusion of specific references in founding regulations.[440] Within ESIF, synergies with the European Regional Development Fund (ERDF) are of particular importance as ERDF committed EUR 41 billion over 2014-2020 to activities linked with research and innovation. Against an increased focus on synergies among EU programmes their implementation on the ground varied between upstream synergies, downstream synergies, alternative and complementary funding.

As per **upstream synergies**, i.e. using EU funds (especially ERDF) to build capacities needed to compete in Horizon 2020, there is evidence[441] that ESIF was used to a sizeable degree for the specific purpose of **increasing the chances of winning a Horizon 2020 grant** (i.e. support for stakeholders in the application process) and the ERDF was used to upgrade research infrastructure used by recipients of Horizon 2020 funds for their projects. **Also, in research infrastructure**, Horizon 2020 supported strategy development and ensured open access to facilities, while the ERDF[442] funded the construction of the infrastructure and the training of personnel (typically with national funds and EIB instruments).[443] In spite of this good alignment,

[440] Article 21 of Regulation 1291/2013 and Annex 1 to Regulation 1303/2013.
[441] ECA Special report 23/2022, points 50-54.
[442] In the 2014-2020 programming period ERDF provided around EUR 16 billion for building or upgrading research and innovation infrastructures and around EUR 21 billion for R&I support services that foster the exploitation and development of technologies.
[443] Examples of synergies between Horizon 2020 and the ERDF for investment in research infrastructures include: Extreme Light Infrastructure (ELI-ERIC), where FP7 and Horizon 2020 are used for preparation, the ERDF for construction, and members' contributions for operating the facility. The European Spallation Source (ESS) in Lund

when **complementary funding** was targeted (i.e. bringing together funding from horizon 2020 and ESI funds in the same project) difficulties regularly arose with support for research infrastructure due to various legal issues such as the non-eligibility of European Research Infrastructure consortia (ERICs) in national calls or insufficient funding at national level.

However, **downstream synergies**, i.e. using other European programmes to fund actions that capitalise on Horizon 2020 projects, to exploit and diffuse their R&I results were found rarer and unsystematic. Measures to create synergies allowing the ERDF to deploy results of Horizon 2020 projects were hardly implemented,[444] due to technical[445] and administrative barriers[446], and also due to the lack of sufficient information on Horizon 2020 projects results.[447] While processes exist for involving the Commission Directorates-General responsible for ESIF and Horizon 2020 and national and regional players responsible for designing and implementing the two programmes (e.g. the 'Seal of Excellence community of practice'), the European Court of Auditors indicated that these were positive but not regular.[448] Little systematic cooperation happened between managing authorities responsible for the implementation of ESIF funds and the Horizon 2020 National Contact Points (NCPs). The ESIF managing authorities and the Horizon 2020 NCPs focused on the programmes in which they have responsibility, without having the opportunity to prioritise synergies between the two programmes. The absence of a map of projects hampered synergies between the two programmes. Open databases on funded projects were implemented only towards the end of the programming period for both programmes (the dashboard providing information on Horizon 2020 was launched in 2018, Kohesio in 2022).

The **EIT** has been evaluated as having a strong alignment with ESIF, due to its funding model[449] in which 75% of the overall budget of the Knowledge and Innovation Communities (KICs) have to come from either partners or other private or public funding sources.

What messages emerged from the stakeholder consultation?

The question on synergies between Horizon 2020 and other EU programmes received the highest number of 'do not know/no opinion' responses (ranging from 48% (831) of all responses on synergies with ESIF to 28% (484) on synergies with Erasmus +). **Only a minority of respondents believe that synergies between Horizon 2020 and other programmes are fully or partially exploited**: 30% (519) for synergies with Erasmus+, 21% (362) with LIFE, 12% (206) with the Connecting Europe facility, 14.5% (251) with European Structural and Investment Funds, 10% (173) with the common agricultural policy, and 9% (155) with EFSI.

As the Erasmus+ programme as well as LIFE stand out positively across all respondents, further analysis revealed that non-EU citizens (48%; 27) and respondents from the field of academia indicated that synergies with Erasmus+ were either fully or partly exploited (36%; 326), whereas the figure is lower among EU citizens (32%; 67), companies (21%; 65) and business associations (16%; 5). This leads to the assumption that the field of academia leaves greater room for synergies. This should not come as a surprise considering that the two programmes in view of academia have a strong link. In view of LIFE, a similar trend can be seen: 22% of non-EU citizens (12), 21% of EU citizens (43) as well as 21% of respondents associated with academia (191), 18% of respondents associated with a company or business (56) and 13% of respondents associated with business associations (4) indicate that synergies were either fully or partly exploited. At the same time, 20% of respondents

has received funding from 13 Horizon 2020 projects and uses that in complementarity with the ERDF and grants from a broad range of other regional, national and international programs, External Coherence study, op. cit., p. 40.

[444] Court of Auditors, Special Report No. 23. 'Synergies between Horizon 2020 and European Structural and Investment', 2022, p. 4.

[445] Technical and administrative barriers hampered the blending of different sources of funding in the scope of individual projects, such as the need for two separate Grant Agreements, non-existent or unspecified co-funding rules and mismatches in funding cycles and times to grant. Court of Auditors, Special Report No 23. 'Synergies between Horizon 2020 and European Structural and Investment', 2022, pp. 12-13.

[446] External Coherence study, op. cit., pp. 26 and 28.

[447] External Coherence study, op. cit., p. 29. Court of Auditors, Special Report No. 23. 'Synergies between Horizon 2020 and European Structural and Investment', 2022, p. 27.

[448] ECA Special Report 23/2022, pp. 20-24.

[449] The EIT funding model was amended in Horizon Europe: the concept of "KIC complementary activities" has been abandoned.

from academia (178), 22% of respondents from business associations (7) and 13% of respondents associated with a company or business (41) indicated that either few or no synergies were exploited.

Respondents to the stakeholder consultation for the *ex post* evaluation of the ERDF, closed in April 2023, had a more positive perception of synergies with Horizon 2020: **58% believe the ERDF and Horizon 2020 are mutually reinforcing** and 5% believe they duplicate each other, 37% have no opinion. A targeted stakeholder consultation by the European Economic and Social Committee indicated that while most respondents see value in seeking synergies between the ERDF and R&I funding, about half believe these are not fully exploited[450]. In particular, most interviewees believe that National Contact Points (NCPs) could do more to promote synergies between the two programmes.[451]

The potential to roll out research and innovation funded by Horizon 2020 **in other EU programmes**, such as LIFE, the European Fund for Strategic Investments, Connecting Europe Facility, is well acknowledged in the respective regulations[452] but only seldom materialised.

The Connecting Europe Facility (CEF) was complementary to the financial instruments of Horizon 2020: it focused on cross-border transnational projects in the transport, energy and telecom sectors, while the financial instruments under Horizon 2020 do not have transnational requirements and support first-of-a kind projects. By design, complementarities were expected between LEIT-ICT and CEF, as the latter starts when the former stops, but data mining produced no evidence of LEIT-ICT projects translated into CEF projects.

The **LIFE programme** was designed to mildly incentivise exploitation of Horizon 2020 projects by giving two extra points (out of 100) during evaluation to proposals that make use of results of other EU-funded projects, including Horizon 2020. This encouraged projects to move towards implementation by means of demonstration, piloting, and creating conditions for potential upscaling. Almost 40% of LIFE-financed projects received bonus points for demonstrating the uptake of environmental and climate-related research and innovation projects financed by Horizon 2020 (or by previous framework programmes) and the added value of this uptake for the project.[453]

In education, Horizon 2020 complemented **Erasmus+** well. Erasmus+ and **MSCA** offer mobility, training and career development opportunities respectively for students, doctoral candidates and researchers. The guidance on ensuring synergies between MSCA and Erasmus+ actions in the field of higher education also provides examples of such synergies.[454]

Horizon 2020 financial instruments (InnovFin actions) are broadly consistent in design with other EU funds and financial instrument schemes supported by **EFSI**.[455] Synergies with the InnovFin instrument have been established for the construction of and major upgrades to five pan-European research infrastructures. For example, the EIB and the European Organisation for Nuclear Research (CERN) singed EU-backed loan agreements worth up to EUR 228.2 million to finance the High Luminosity Large Hadron Collider (HL-LHC) project, the world's largest and most powerful particle accelerator.[456]

[450] European Economic and Social Committee (2023), '*Ex post* evaluation of Horizon 2020', Evaluation report, INT/974, Conclusion 2.8 and Recommendation 5.6. Adopted on 23/03/2023. Available at https://www.eesc.europa.eu/en/our-work/opinions-information-reports/information-reports/ex-post-evaluation-horizon-2020

[451] Ibid. Technical Annex, paragraph 3.1.

[452] LIFE: Regulation (EU) No 1293/2013, recital 11. EFSI: Regulation (EU) 2015/1017 recital 24. CEF: Regulation (EU) No 1316/2013 recital 34.

[453] LIFE final evaluation, forthcoming, data by DG ENV.

[454] European Commission, DG for Education, Youth, Sport and Culture, Synergies between the Marie Skłodowska-Curie Actions and Erasmus+ in the area of higher education, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2766/958920.

[455] On complementarity of InnovFin and EFSI – see case study 7 in the external coherence study (2023), op. cit.

[456] External Coherence study (2023), op. cit., p. 43.

The **Seal of Excellence**[457], a prime example of **alternative funding**, has received a broadly positive assessment in the final stage of Horizon 2020 as it did in the interim evaluation.[458] It is viewed as a means of facilitating access to other sources of funding for Seal of Excellence holders and of allowing other funding bodies to benefit from the robust and internationally known evaluation system used in the EU framework programmes.[459] The recent revision of the General Block Exemption Regulation facilitated access for SMEs (holders of the Seal of Excellence label) to national research and innovation programmes, or to other funders (when Horizon 2020 recognised theirs as high-quality proposals but could not fund them), hence promoting alternative funding. More analysis is available in section 4.2.3 on potential areas for further simplification.

On **complementarities between Horizon 2020 and national programmes**, research and technological development is a shared competence of the European Union. **Synergies with national programmes** varied depending on the type of research activities supported, the Member States and the programme parts in question.

In fundamental research, the interplay between Horizon 2020 and national funding varied across thematic fields.[460] For example, health-related topics were more often covered by national programmes while topics related to the green and digital transitions are more prominent in research funded by Horizon 2020. In **applied research** (at higher TRLs), Horizon 2020 offered more opportunities than national funding[461] in the sampled Member States and thematic fields. By SMEs active in research, regional and national support schemes are perceived as more suitable for their incubation phase, while Horizon 2020 became more prominent in their expansion phase.

In Member States which offer significant national funding for basic research, like Sweden or Germany, researchers tend to apply more to national schemes; in Member States with more limited resources for basic research, such as Spain, researchers tend to apply more to Horizon 2020. This occasionally leads to funding displacement effects, e.g. the area of concentrated solar power in Spain. However, this effect is not observed in all countries with more limited funds and across all R&I thematic areas.

As yet, there is scant evidence of Horizon 2020 results being further deployed through dedicated national-level programmes. Even when there are dedicated national initiatives (e.g. through the Seal of Excellence), the stakeholders interviewed noted that it was difficult to continue Horizon 2020 projects using support from national schemes, because these tend to be shorter and have budgets deemed insufficient to bring R&I results to the market.[462]

Several Horizon 2020 instruments were designed to play a role in fostering synergies with national programmes, and in particular aligning research agendas, such as **ERANET Cofunds** (i.e. transnational call for proposal launched by national bodies in areas of mutual interest using national funds, sometimes coming from ESIF). There Horizon 2020 strengthened consistency between EU and national programmes. **MSCA** is synergetic with national schemes as it helps early-stage researchers gain relevant knowledge that can later be applied in national research projects. In addition, the fact that MSCA and ERC are well established schemes and are not thematic makes them particularly appealing for researchers who could also apply nationally,

[457] Created in 2015, the Seal of excellence is a label granted to project proposals which ranked above a predefined quality threshold in the project evaluation done as part of the Horizon 2020 application process but which were not funded due to insufficient budget. The label was intended to facilitate alternative funding from ESI funds, as it testifies of a recent positive evaluation by Horizon 2020. However, no obligation to recognise the Seal of Excellence was included in the ESIF Regulation, leaving its application voluntary.
[458] SWD (2017) 221, p. 44.
[459] External Coherence study (2023), op. cit., p. 67.
[460] According to data mining results in the External Coherence study (2023), op. cit.
[461] According to data-mining results in the External Coherence study (2023), op. cit., case study on health-related research in Sweden, Germany, Spain and Poland.
[462] External Coherence study (2023), op. cit., p. 31.

albeit for national, country-centred mobility schemes, which are often relatively small in scope and with national competition. The **MSCA COFUND** is an example of an attempt to create the right conditions for synergies between regional, national and international mobility programmes at both PhD and post-doctoral levels. MSCA COFUND is considered to have enabled many synergies with ESIF and Erasmus+. Participation in COFUND, on average, increases participation of organisations in ESIF (primarily ERDF) projects by over 100% in the 2 years after the COFUND project starts.[463]

4.4 EU added value

4.4.1. Horizon 2020 leveraged additional resources for R&I

Direct leverage

The **direct leverage** factor, which is the ratio of the direct leverage and the EU contribution[464], or in other words the average co-funding rate, of Horizon 2020 is 0.23[465]. This means each euro the EU is investing in Horizon 2020 directly attracts an additional EUR 0.23.

There was **no target** for leverage in Horizon 2020. The direct leverage factor of FP7 is EUR 0.41. However, **benchmarking** against FP7 is not appropriate, as the two programmes have different types of action with different funding rates.[466] Similarly, benchmarking against other funding programmes should be done cautiously, i.e. between same types of leverage (in this case direct leverage, and not investments after the projects), and targeting similar TRLs. Two attempts can be shared:

- Approximately one third of Horizon 2020 funding goes to fundamental science so this was the first benchmark researched. The U.S. National Science Foundation generally does not allow voluntary committed cost sharing in its proposals[467]. This means a funding rate of 100%, and hence a direct leverage factor of 0, similar to Horizon 2020 for this type of research.
- Around 17% of Horizon 2020 funding is allocated to SMEs, so this evaluation also attempted a comparison with the ERDF funding for SME competitiveness[468] (finding a leverage factor of 0.43). However, this funding is distributed to the Member States and regions, rather than directly to the SMEs. For Horizon 2020, the leverage factor of funds going to SMEs is 0.34.

Focusing on Horizon 2020, the direct leverage factor **varies across types of actions** which have different reimbursement rates depending on the type of research funded (e.g. basic research has a higher reimbursement rate than applied research) and on the beneficiary (e.g. non-profit entities have higher reimbursement rate than private for-profit entities).[469] Considering only private for-profit entities (PRCs), the leverage factor of the whole programme goes up to EUR 0.57. For

[463] External Coherence study (2023), op. cit., case study 5.
[464] Definitions and formulas in the glossary.
[465] There is no programme-wide target for the direct leverage factor.
[466] For Horizon 2020 see next footnote, for FP7 see https://ec.europa.eu/research/participants/data/ref/fp7/93289/fp7-ga-annex2_en.pdf, p. 20).
Indicatively, Collaborative Project ToA, which accounts for 53% of FP7 funding, had a funding rate of 50% (75% for non-profit). In Horizon 2020, Research and Innovation Actions and Innovation actions, which account for 29% and 16% of Horizon 2020 funding, have funding rates of 100% and 70% (100% for non-profit), respectively.
[467] https://new.nsf.gov/funding/proposal-budget/cost-sharing
[468] Data source: https://cohesiondata.ec.europa.eu/. Extraction date: 02/08/2023. ERDF funding for SME competitiveness: EUR 41,389,149,516. Total project funding for SME competitiveness: EUR 59,089,742,340.
[469] https://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/applying-for-funding/find-a-call/what-you-need-to-know_en.htm. For certain Types of Action, the funding rate can be used for comparisons, as it is related to the direct leverage factor (formula in the glossary). However, as different types of participants (e.g. for profit entities) have different funding rates, even within the same type of action, we cannot determine a priori the "expected" direct leverage factor per type of action, as this will depend on the composition of participants.

certain types of actions, like partnerships, this figure can go up to EUR 2.2 of additional investment[470] for each euro that the EU is investing.

Regarding the ability to leverage funding from their members, the Joint Undertakings displayed varying degrees of achievement concerning the contribution targets set by their respective founding regulations for Horizon 2020 activities[471] (Table 16). The total leverage factor (as of 31.12.2021) was EUR 1.43 for the JUs mentioned in Table 16, compared to EUR 1.57 (inferred from the regulation). Bio-based Industries had the highest direct leverage factor with EUR 2.47 for each euro invested, followed by Fuel Cells and Hydrogen (EUR 2.09) and Electronic Components and Systems for European Leadership (EUR 1.65).

In terms of total contributions by partners compared to the regulation targets, FCH2, Shift2Rail and Clean Sky 2 had already met or surpassed the targets. By contrast, European High-Performance Computing was far from reaching the target[472].

However, looking only at in-cash contributions, the picture is different. In most cases, in-cash contributions are only a small part of the total contributions by partners which are mostly in-kind. Electronic Components and Systems and European High-Performance Computing were the only ones with in-cash contributions above EUR 50 million (in both cases most of cash contributions came from participating states[473]).

Table 16: Total members' contribution targets for JUs, as per the founding Regulation and legal decisions, and actual contributions, as of 31 December 2021 (2014-20, in EUR million)

	Expected members' contributions, as per founding Regulation and legal decisions			Actual members' contributions, as of 31.12.2021		
JUs under Horizon 2020	EU contribution, in EUR	Total contributions by partners, in EUR	Expected direct leverage factor	EU contribution, EUR	Total contributions by partners (out of which, in cash), EUR	Actual direct leverage factor
SESAR	585	772	1.32	536	535 (24)	1
CS2 – CA	1 755	2 194	1.25	1536	2 141 (27)	1.39
IMI2 -IHI	1 638	1 638	1	838	889 (32)	1.06
FCH2 - Clean H2	665	380	0.57	546	1 140 (11)	2.09
ECSEL - KDT	1 185	2 828	2.39	1 058	1 741 (472)	1.65
BBI - CBE	835	2 730	3.27	728	1 797 (18)	2.47
S2R - EU-RAIL	398	470	1.18	339	495 (11)	1.46
EuroHPC (3)	536	908	1.69	307	138 (120)	0.45
Total	7 597	11 936	1.57	5 888	8 425 (716)	1.43

Source: ECA Report, Tables 2.4, 3.2, 4.3, 5.3, 6.2, 7.2, 8.2, 9.2, 2.1[474], authors' calculations.
Notes: Definitions provided in glossary. Total contributions include in-cash, in-kind contributions to operational activities and in-kind contributions to additional activities. The direct leverage factor is not part of the regulation per se, though it can be calculated using the first two columns. EU contributions is referred to as "EU Cash" in the

[470] This figure includes both in kind and in cash contributions, whenever data availability permits the evaluation differentiates between the two.
[471] Data reflects the situation from end 2021, thus it is likely that the situation as of end 2022 has improved. Achievement rates also depend on how ambitious the targets of the JUs have been. We relied on the European Court of Auditors Annual report on EU Joint Undertakings for the financial year 2021. There will be a dedicated report for each JU covering Horizon 2020 and Horizon Europe, in the Annex of the interim evaluation of Horizon Europe.
[472] Contributions from the EU come faster, while contributions from the partners other than the Union are likely to be delayed and therefore maybe not visible at the time. In particular, the EuroHPC JU was launched in 2018 under H2020. The first actions with budgetary commitments were only starting in 2020. In 2019, we only launched the calls for expression of interest for the EuroHPC supercomputers and started the procurements. There was only one very small call for proposals in 2019, and a bigger one in 2020. Hence, if the reference period for the calculation stops in 2021, it should not be a surprise if the totality of the budget was not allocated.
[473] ECA (2022) Annual report on EU Joint Undertakings, Tables 6.2, 9.2.
[474] ECA (2022) Annual report on EU Joint Undertakings.
https://www.eca.europa.eu/Lists/ECADocuments/JUS_2021/JUS_2021_EN.pdf

ECA Report. For EuroHPC, the EU contribution includes EUR 100 million from the CEF programme. Additional notes about S2R are provided in the Annex.

With regards to the public-to-public partnerships, for instance:

- the Partnership for Research and Innovation in the Mediterranean Area (PRIMA) had a direct leverage factor of EUR 1.43 compared to a target of EUR 1.[475]
- the Active and Assisted Living research and development programme (AAL2) had a leverage of EUR 2 (EUR 1.12 of additional national contributions and EUR 0.88 of own contributions by the beneficiaries).[476]
- the European Metrology Programme for Innovation and Research (EMPIR) had a direct leverage factor of EUR 1, as EUR 300 million is brought in by participating (member) states and EUR 300 million is from the European Commission through Article 185.[477]
- Eurostar-2 had a direct leverage factor of 3, with EUR 287 million coming from the EU and EUR 856 million from the participating countries.[478]

Looking at specific programme parts, focusing on Innovation Actions[479], it appears that Societal Challenges attract more direct leverage than other programme parts. Ranging from EUR 0.44 attracted for each euro invested by the EU for "Secure, clean and efficient energy", to EUR 0.15 for "Climate action, environment, resource efficiency and raw materials". The only Industrial Leadership part in the top five is LEIT, directly attracting EUR 0.21 for each euro invested by the EU.

Participants in non-associated Third countries leveraged EUR 1.43 billion, while received EUR 1.8 billion, or equivalently for each euro invested by the framework programme they leveraged EUR 0.79.

Additional Investments

Beyond direct leverage, or co-funding, 7% participants of Horizon 2020 can attract **additional investments after the project signature**.[480] The evaluation could track only 7% of Horizon 2020 beneficiaries in investment databases (such as Dealroom or Crunchbase), suggesting that a large majority of firms do not receive additional funding after the project signature. However, it is unclear if this is the case because data are incomplete or extracted too early.

With regards to contractual public-private partnerships (cPPP), the private sides of the cPPPs committed to invest funds in R&I activities specific to the partnership domain. A leverage factor of additional investment[481] for industrial deployment in the range of 5 to 10 was often established between the partners, e.g.:

- leverage factor of EUR 6.3-10 (8.5 on average) for the SPIRE cPPP – compared to a target of EUR 5-10;
- EUR 7.8 for the Big Data cPPP – compared to a target of 4;

[475] Interim Evaluation of the Partnership for Research and Innovation in the Mediterranean Area (PRIMA).
[476] Active and Assisted Living research and development programme (AAL2) final evaluation.
[477] Digital and Industrial Transition study (2023), p. 47.
[478] Innovative Europe Study, (2023) section 4.
[479] Focusing on one type of action facilitates comparability between programme parts. For instance, if a programme part uses more a type of action that has a lower expected funding rate, then it will probably have higher leverage factor compared to another programme part that uses more a type of action that has a lower expected funding rate.
[480] It might be too early to calculate the additional investment. Moreover, this might require tracking through external investment databases. The information we provide is thus only partial.
[481] Note that this figure includes both direct leverage (direct contributions from the industry to the cPPP projects, as predetermined in the projects), and, additional investment, as data cannot be always disaggregated. Indicatively, for Big Data cPPP, the direct leverage is EUR 0.3 for each euro invested, while additional investment is 7 times more than the EU contribution (EUR 448 million, compared to EUR 63.52 million). Source : https ://www.bdva.eu/sites/default/files/MR2018_BDV_cPPP_Main%20Report_and_Annex%201_V1.0.pdf

- Leverage factor of EUR 4.65 for the FoF cPPP –compared to a target of EUR 5–10 at the end of Horizon 2020[482]).[483]

SME participants in the LEIT programmes were successful in raising private funding of EUR 9.4 billion following their Horizon 2020 activities. This is almost four times the EU contribution to the same participants.[484] SME Instrument recipients tend to attract additional investment thanks to the programme, as EU grants represent a catalyst for follow-on equity investment: firms experience a higher likelihood of receiving private equity (over 100% increase), and this is associated with larger funding rounds and a higher number of deals.[485]

Indirect leverage

Lastly, Horizon 2020 is expected to continue to generate **indirect leverage**.[486] Using the NEMESIS macroeconomic model[487], the indirect leverage of the Horizon 2020 for 2014-30 is estimated to be between EUR 4.23 and EUR 12.22 billion.[488] For 2014-50, the estimated amount is between EUR 13.71 and EUR 25.82 billion.

4.4.2. Horizon 2020-supported activities that would not have been possible without EU funding

A majority of Horizon 2020 applicants who responded to surveys in external evaluation studies reported that it would not have been possible to conduct the intended research through other means or funding source[489]. Similarly, only a minority of respondents to the stakeholder consultation declared that they would have secured enough funding from national public sources (12%), private sources (4%) and other EU programmes (3%).

Survey data shows[490] that the majority of unsuccessful applicants did not implement their projects, or implemented them with significant changes after being rejected for Horizon 2020 funding. A small share of unsuccessful applicants indicated that they implemented their projects with minimal or no adaptation.

When asked what prevented them from implementing their project, the overwhelming majority of unsuccessful applicants who did not implement their projects indicated that no alternative

[482] No explicit target for leverage was mentioned in FoF Progress Monitoring Report (https://www.effra.eu/sites/default/files/fof_cppp_progress_monitoring_report_for_2017_online.pdf).
[483] Digital and Industrial Transition evaluation study (2023), op. cit., p. 47 and Annex II.
[484] Digital and Industrial Transition evaluation study, op. cit., p. 54. & Annex IV, p. 394-398. For more information see analysis of risk capital raised under section 4.1.3 of this document.
[485] Santoleri et al. The Causal Effects of R&D Grants: Evidence from a Regression Discontinuity, op. cit. This peer reviewed paper studied the causal effect of receiving an SME-2 grant.
[486] This refers to the additional R&D investment engaged by a research entity, whether financed by the FP or not, as a response to the modification of the overall economic activity that the FP brought about.
[487] For more details on the modelling aspects, see section "Macro-economic impacts: Horizon 2020's impact on employment and GDP".
[488] For the NEMESIS results, a sensitivity analysis has been performed identifying three different scenarios (Low, Medium and High) depending on the stringency of the assumptions about the crowding-in effect of the FP on applied research, and the EAV of the FP (see Annex II).
[489] For Excellent Science: this was the case for 53% of unsuccessful applicants who answered the survey conducted in August-September 2022 (main report, figure 9, p. 52). For LEIT (survey conducted within the Digital and Industrial Transition study, main report, p. 55): In the absence of Horizon 2020 funding, 25% of unsuccessful applicants declared having abandoned their research idea and 70% resubmitted it to other funding sources. When respondents declared having implemented their project either through national funding or their own funding, only one in five declared that they could implement their project as originally planned – for 75% this implied a reduction in scale or ambition. Green Transition survey of successful applicants: over 70% of respondents in Societal Challenges 2-5 said that the project would not have been implemented without Horizon 2020 support (Annex VII, pp. 21, 40, 58 and 74).
[490] Digital and Industrial Transition evaluation study (2023), op. cit., p. 73-74. Evaluation study on Excellent Science (2023), op. cit., Figure 9, p. 52.

funding was available for that type of research.[491] Although promising, the Seal of Excellence label aimed at encouraging alternative funding for excellent but unfunded Horizon 2020 projects proposals remains small, as it is applicable to only mono-beneficiary schemes and national and regional implementing authorities are free to consider or disregard it in their regional and national programmes.

Horizon 2020 supported larger scale, more complex and more ambitious research than would be possible without the programme's support. Compared to national or regional programmes with similar objectives, Horizon 2020 often granted a higher amount of funding.[492] Without the EU support the projects would have been implemented at a smaller scale[493], with less substantial results and benefits. Additionally, Horizon 2020 also **funded research in areas that were relevant from a European perspective** but in some cases less of a priority at national level[494], such as cultural heritage[495], migration[496], emerging and neglected infectious diseases in sub-Saharan Africa[497] and the exploitation of marine resources.[498]

For instance, Horizon 2020 offered opportunities for international collaborations in **civil security research**, on topics not supported in nationally focused funding schemes[499] involving **cross-border challenges and areas of overlapping interest for all Member States and many Associated Countries**. Activities had a Europe-wide scope, relevance or collaborative networks with projects funded through national or regional instruments. It is deemed unlikely that this would have taken place without the EU support.[500] Smaller Member States, which may have more limited research programmes and industrial bases providing solutions to security practitioners, are considered to have benefitted the most from their participation.[501]

Also, Horizon 2020 provided training for researchers across different areas, such as open access, foreign languages, research ethics, IPRs, etc.[502], that would not otherwise be available. When asked which type of training they received as part of their project, only 5% of MSCA Individual Fellowships (MSCA IF) indicated that they did not receive any training, compared with a share of 22% among unsuccessful applicants (those who pursued their projects with alternative funding). 89% of MSCA IF fellows gained opportunities to work abroad as a result of their project (compared to 63% among the control group of unsuccessful applicants) as well as interdisciplinary cooperation opportunities (80% among MSCA IF fellows vs 65% among the control group).

[491] In the Excellent Science evaluation study (2023, Figure 10, p. 54): 78% of ERC applicants, 83% of MSCA organisations, 69% of MSCA IF applicants, 81% of FET applicants, 92% of INFRA applicants, 90% of SEWP applicants and 86% of SwafS applicants. In the Digital and Industrial Transition study, see section. 8.1.
[492] EIC Pilot Evaluation (2022, p. 9), Innovative Europe evaluation study (2023, p. 54), Excellent Science evaluation study (2023, p. 62).
[493] Case studies and survey of EIC Pilot Accelerator unsuccessful applicants (Annexes, p. 76), Survey of LEIT unsuccessful applicants (study on Digital and Industrial Transition, 2023, op. cit., executive summary (p. 15) and section 8.1), Survey of Horizon 2020 beneficiaries and unsuccessful applicants, interviews and case studies on the ERC (Excellent Science evaluation study, 2023, Annex 1, p. 68).
[494] Green Transition evaluation study (2023), op. cit., p. 38.
[495] Resilient Europe evaluation study (2023), op. cit., p. 57.
[496] Ibid, p. 57.
[497] Ibid, p. 65
[498] Green Transition evaluation study (2023), op. cit., p. 31.
[499] Commission staff working document 'Enhancing security through research and innovation, SWD(2021) 422 final of 15.12.2021, p. 2.
[500] Resilient Europe evaluation study, Annex I.3.4, p.106.
[501] Ibid.
[502] Excellent Science evaluation study (2023), Annex 1, p. 120-121.

4.4.3. Horizon 2020 promoted multidisciplinary and European cooperation in R&I

Horizon 2020 supported more than two million collaborations between individual organisations, **helped pull together a critical mass of expertise, skills and resources from different countries** and disciplines and provided a framework for lasting networking and collaboration. None of this would have been possible without the EU support.[503] For example:

- EU funding was the only option for accomplishing cross-border cooperation, as many national funding schemes only allowed for cooperation with organisations within that same country.[504] Also, interviews with ERC grant recipients showed that both the multidisciplinary aspect and the international nature of the ERC have contributed significantly to frontier research.[505]
- Spreading excellence and widening participation actions (SEWP) provided a framework for networking and collaboration between research groups from widening countries and leading research organisations in Europe.[506]
- Collaboration with partner institutions from other countries, organising consortium-level training programmes and obtaining access to international experts in their respective fields would have been difficult or impossible to achieve for most of the beneficiary researchers.[507]
- The FET Human Brain Project (HBP) illustrates well the European scale of the extensive multidisciplinary research efforts involving more than 750 scientific collaborators and engineers from 114 institutions in 24 European countries.[508] This resulted notably in six ICT Platforms, which are the core of the emerging HBP research infrastructure for brain research.

What messages emerged from the stakeholder consultation?

According to 35% (32) of public authorities, 34% of academia (311), 31% of NGOs (20) and 23% of companies (71) deem that the **introduction of international flagship initiatives has boosted international cooperation**.

In view of **facilitating cross-sector and cross-border mobility of researchers**, 88% (804) of respondents from academia, 76% (235) of respondents from companies as well as 71% (22) of business associations either agreed or strongly agreed that Horizon 2020 had a positive effect. Similarly, 73% (666) of respondents from academia, 67% (20) of respondents from business associations as well as 60% (90) of companies deem that the programme is **making Europe more attractive for world class researchers from abroad.** Still, this claim is only supported by 66% (52) of non-EU citizens, contrasting 88% (164) of EU citizens responding to the consultation.

Overall, 74% of respondents (1 324) agreed that participating in Horizon 2020 improved their cooperation with partners from other countries (within the EU and beyond): Particularly EU-associated countries support this claim (77%; 205), followed by EU-15 countries (74%; 1 046) and EU-13 countries (73%; 131). At the same time, only 61% of third countries share this view (36).

Stakeholder interviews indicate that even in countries where other funding instruments support similar types of activities in specific areas (e.g. support for green innovation in Sweden, Denmark and Germany, support for agri-food in Italy), participation in Horizon 2020 is still attractive in terms of the international context of projects, the network of excellent players it brings together and opportunities to share expertise in this network.[509]

[503] External coherence evaluation study (2023).
[504] Excellent Science evaluation study (2023), Annex 6 – case study on achievement of commercial and/or social innovation potential of ERC projects that received ERC Proof of Concept funding, p. 713.
[505] Excellent Science evaluation study (2023), Annex I, p. 33.
[506] Excellent Science evaluation study (2023), Annex 6 – case study on the contribution of SEWP to integrating research groups from widening countries, p. 871.
[507] Excellent Science evaluation study (2023), Annex 6 – case study on the structuring impact of MSCA ITN on doctoral programmes, p. 772.
[508] Excellent Science evaluation study (2023), Annex 1, p. 158.
[509] Case study 1 "Deployment of green innovation" and case study 8 "Coherence in support to agrifood value chains" in the External coherence evaluation (2023), op. cit.

4.4.4. Horizon 2020 increased excellence in research and innovation, by creating EU-wide competition

Horizon 2020 created strong and direct pan-European competition, which guarantees its EU added value. For instance, competition for ERC and MSCA grants is intense, with success rates of 12.9% and 14.4% respectively.[510] Such competition allows the ERC and MSCA to draw on a wider pool of talent and ideas than would be possible for any national scheme. In this way the best researchers with the best ideas received funding, irrespective of local bottlenecks or the availability of national funding.

Interviews with stakeholders confirm that the need to compete for funding with other top researchers from all over Europe boosts the quality of research proposals and general level of research excellence achieved in the projects.[511]

Excellence-based EU-wide competition increased the quality and visibility of R&I output beyond what is possible with national or regional-level competition. This is shown by the fact that Horizon 2020 publications were cited at twice the world average rate (FWCI of 2.03), while 3.9% of these publications were among the top 1% of most cited publications [see section above 4.1.1].

4.4.5. Horizon 2020 helped consolidate the European Research Area

Horizon 2020 has facilitated the emergence of thousands of new collaborations between researchers, having a strong structuring effect[512] on the European Research Area (ERA)[513] – the single, borderless market for research, innovation and technology that is under construction in the EU.

There is stronger intensity of cooperation after a Horizon 2020 project compared to the period before the project, indicating that Horizon 2020 funding helped to build and sustain research teams and build a stronger ERA.[514] The number of co-author pairs counted after the end of Horizon 2020 projects is higher than those counted before.[515]

However, there is mixed evidence on the impact of Horizon 2020 on institutional changes in beneficiary organisations. According to survey data, most beneficiary organisations agreed that their projects contributed across different aspects of institutional growth and developments within the beneficiary institution.[516] The framework programme did improve and align organisational practices and structures, but in different ways and to varying extents:

- Horizon 2020 support in the fight against COVID 19 was part of a coordinated European response, via the **ERAvsCorona Action Plan**.[517]
- The **MSCA had a positive structuring effect on organisations**, by improving the quality of training, career development, human resources practices and procedures and improving working conditions.[518]
- Several institutions argued that, although it is still early to judge the full structuring impact, they have already introduced some changes either because of or influenced by

[510] Excellent Science evaluation study (2023), op. cit., p. 29.
[511] Excellent Science evaluation study (2023), op. cit., p. 56.
[512] Excellent Science Evaluation study (2023): Findings based on the analysis of the indicator SC4: Structuring effect of FP funding (2023), op. cit., p. 42.
[513] Communication on a new European Research Area for Research and Innovation.
[514] Cross-cutting issues evaluation study (2023), Annex 8 – case study "ERA", p. 13.
[515] Excellent Science evaluation study (2023), op. cit., p. 39.
[516] Excellent Science evaluation study (2023): case study "Impact of the framework programme in spreading excellence across the Union", p. 301.
[517] Available at https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/european-research-area_en#eravscorona-action-plan.
[518] Excellent Science evaluation study (2023), Annex 1, p. 416.

their participation in the Horizon 2020 action. These changes concern: recruitment practices, the way supervision is carried out, the monitoring and evaluation of progress by early-stage researchers, the adoption of a doctoral training similar to the ITN training model (e.g. with the identification of transferable skills and competences, to enhance early-stage researchers' employability).

- The interviewed institutions perceive that the MSCA ITN has been working as a framework to **align and standardise doctoral programmes'** requirements and standards in some of the participating organisations.[519]
- The **Research Infrastructures programme shaped the European R&I landscape** through the European Roadmap published by the European Strategy Forum on Research Infrastructures (ESFRI).[520]
- **SwafS actions** have contributed to the emergence of talented new researchers and **opportunities to work in different countries and sectors**, especially through the EURAXESS services and portal.[521] SwafS actions have also played a role promoting the introduction of **Responsible Research and Innovation (RRI)** to the political agenda across Europe. The importance of responsible research and the different dimensions of RRI (ethics, public engagement, governance, gender equality, science education, open access) has been picked up by many Member States. For example, 19 Member States have followed the framework programme's example and now have at least one research funder with a policy on open access for publications.[522] Moreover, programmes have been launched in some Member States that provide funding for RRI, for example through specific calls for citizen science.[523]
- One of the main achievements of SwafS is also its impact on the **advancement of gender equality in R&I across the ERA**, with 206 beneficiaries having developed a Gender Equality Plan through SwafS projects[524]. Through its operating model, the **MSCA** also contributed to the adoption of practices that promote gender balance and inclusiveness, both inside Europe and beyond.[525]

Table 17: **KPI 21** on the number of institutional change actions[526] promoted by the programme		
Baseline (FP7)	Target at the end of Horizon 2020	Achieved value
No baseline	100	381 (total) 348 (Member States)

Source: Commission monitoring systems (CORDA), data on 24/04/2023.

Horizon 2020 catalysed **changes in implementing national R&I reforms** through the periodic review exercises involving leading experts and policy practitioners from the Member States (e.g. mutual learning exercises, the periodic feedback of the Policy Support Facility - PSF).[527] However, often the national implementation plans were not updated and monitoring is limited.[528] At the same time, the ECA report noted (i) the limitations in the PSF's ability to induce needed changes in national systems, which are linked to the limited availability of resources for the PSF,

[519] Excellent Science evaluation study (2023), op. cit., p. 63.
[520] External coherence evaluation study (2023), op. cit., p. 23.
[521] Excellent Science evaluation study (2023), Annex 1, p. 258.
[522] O'Neill, G., & Martziou, S. (2023). Data of Survey on National Contributions to EOSC 2022 (Version V1) [Data set]. Zenodo, https://doi.org/10.5281/zenodo.10155993. Also exploitable in an online dashboard at https://eoscobservatory.eosc-portal.eu.
[523] Excellent Science evaluation study (2023), op. cit., p. 42.
[524] Ibid, Annex 1, p. 275.
[525] Excellent Science evaluation study (2023), Annex 6 – case study on 'Inclusiveness and gender dimension in the MSCA', p. 746.
[526] Institutional change actions towards RRI at MS-level, at RPO-level and at individual scientist level.
[527] Cross-cutting issues evaluation study, Annex 3 – case study "ERA", p. 124.
[528] Ibid, Annex 3, p. 129.

(ii) the fact that not all widening countries request support and (iii) the freedom of the Member States to decide to what extent they will implement the reforms identified under the PSF.[529]

According to participants, Horizon 2020 supported **the development of long-lasting knowledge networks via partnerships**. Partnerships created a place to meet and discuss with European partners, competitors, and other stakeholders, who often lack such a structured channel for regular interactions. Cooperation between public and private parties improved their understanding of each other's goals and ways of operating, creating a stronger base for future cooperation.[530]

For example:

- the **Fuel Cells and Hydrogen Joint Undertaking** managed to attract some of the biggest industrial players in the field, playing a significant part in consolidating a previously scattered and fragmented hydrogen ecosystem.
- Similarly, the **Bio-based industries JU** exerted a structuring effect in organising the value chain across sectors and effectively mobilised key stakeholders across sectors and geographical areas.[531]
- **Public-private partnerships**, in particular, also increasingly aim to anticipate users' needs to improve technology diffusion and uptake by end-users.[532]
- The European Metrology Programme for Innovation and Research public-to-public partnership (EMPIR) has been effective in enabling collaboration between national metrology institutions, reducing fragmentation and duplication, and thereby reinforcing the EU position as a world leader in metrology research.[533]

4.5 Relevance

Interviewees confirmed that Horizon 2020 was highly relevant given the needs, priorities, problems and issues for R&I to be addressed at European level. All three programme rationales (the reinforcement of scientific excellence, the turn towards innovation and the more political and impact-oriented framing of the thematic top-down funding programmes) were anticipated and brought forward by the science, technology and innovation community.

In that way, the three-pillar structure of Horizon 2020 represented the major needs for R&I in Europe at the time when the programme was designed, while also responding more than before to political priorities.[534] In addition, Horizon 2020 contributed to and was relevant for Europe 2020 flagship initiatives, including the "Digital Agenda for Europe" and "Innovation Union", part of the EU 2020 Strategy.[535]

What messages emerged from the stakeholder consultation?

Overall, 70% of respondents (1 483) in the stakeholder consultation conducted for this evaluation agreed or strongly agreed that **'Horizon 2020 helped develop and implement EU policies'** (such as the "Europe 2020" strategy). The strongest support for this statement has been shown among public authorities (78%; 72), followed by business associations (75%; 24), companies (73%; 229) and academia (70%; 644). Only NGOs (66%; 44), EU citizens (66%; 145) and non-EU citizens (60%; 36) have indicated a lesser agreement with the

[529] ECA Special Report No. 15 – Measures to widen participation in Horizon 2020 (2022), p. 38, https://data.europa.eu/doi/10.2865/359822.
[530] Digital and Industrial Transition evaluation study (2023), op. cit., section 8.2, p. 74.
[531] Green Transition evaluation study (2023), op. cit., p. 121.
[532] Digital and Industrial Transition evaluation study (2023), op. cit., p. 74.
[533] Participation of industry in the partnership on Metrology has remained low, particularly in widening countries, and stakeholders have lamented the difficulty of convincing policy-makers about the added value of cooperation in metrology – a field that has wide-ranging impacts on economy and society. Digital and Industrial Transition evaluation study (2023), Annex II - Cross-analysis of the types of partnerships (section 3, p. 203-230).
[534] Evaluation study on the Relevance of Horizon 2020 and its Policy Mix (2023), op. cit., p. 68.
[535] They were both identified as cross-cutting issues for the framework programme.

statement, either agreeing or strongly agreeing that Horizon 2020 helped to develop and implement EU policies.

Overall, few respondents (2%; 37) across all stakeholder groups expressed unfavourable opinions regarding the capacity of Horizon 2020 to help develop and implement EU policies indicating that across all stakeholder groups are indeed overwhelmingly positive about the development and implementation of EU policies by means of Horizon 2020.

Nevertheless, Europe's overall **competitive position has not fundamentally changed** over the duration of Horizon 2020, with a view to its structural strengths and weaknesses. Having an EU R&I programme is therefore still highly relevant.

What messages emerged from the stakeholder consultation?

Overall, 70% (1 248) of respondents stated that "**Horizon 2020 is flexible enough to respond to unforeseen emergencies, such as the COVID-19 pandemic, Zika and others.** Among the various stakeholder groups, respondents generally perceive Horizon 2020 as being flexible enough to respond to emergencies like the COVID-19 pandemic, Zika and others. Most respondents were positive about the flexibility of the programme with 32% of academia (296), 31% of non-EU citizens (18), 30% of public authorities (28), 29% of companies (92), 30% of public authorities (28) and 27% of EU citizens (60) strongly agreeing. The percentages of respondents sharing a more sceptical view on the matter were relatively low: 14% of companies (43), 12% of public authorities (11) and 9% of academia (84) found that Horizon 2020 had little flexibility. Still, the "I don't know / no opinion" option was chosen by 12% of public authorities (11) and 18% of business associations (6).

The possibility to exceptionally award grants without a call for proposals, together with the recently introduced emergency funds, enabled the programme to respond even faster to new emerging challenges such the COVID-19 crisis than it did for Ebola[536] and Zika, thanks to the timely contributions, without which the funding for responding to the COVID-19 crisis would have been too limited.

In addition, two first years of the EIC Pilot reoriented the FP support for innovation by integrating and connecting science with innovation and providing funding for scaling-up. By bringing together the FET and SMEI, the EIC sharpened its focus on deep tech and shifted away from incremental and digitally driven innovation, for which there is already significant public support and private investments.[537] Through the establishment of the EIC Fund, it tackled market failures, such as the insufficient volume of private equity investments in sectors and technologies relevant to addressing the climate and environmental crisis.[538]

The mix of instruments that have been set out to accelerate the transition and time to market objectives was found to be well-designed, and it considers that innovation development and market deployment can occur in multiple ways.[539] The experience of the US DARPA inspired the proactive programme management approach. The evaluation could not fully assess this process since the programme managers were still being recruited and their roles defined at the time of the evaluation.[540]

Many of the **internal process elements** in Horizon 2020 were new, such as the enhanced consultation of stakeholders and experts. Consultation activities included advisory groups, strategic foresight and road mapping, evaluation and monitoring, policy feedback, stakeholder consultations, and the consultation of Member States and Associated Countries in Programme

[536] The EBOVAC 2 – IMI project was launched in response to the Ebola outbreak. The project was considered to have achieved important work in preparing sites and implementing clinical trials with an experimental Ebola vaccine in African and European countries. It has also provided extensive and robust data on the safety, immunogenicity and efficacy of the Ad26.ZEBOV and MVA-BN-Filo vaccine.
[537] European Commission, DG for Research and Innovation, Evaluation study on the European Innovation Council (EIC) pilot, Publications Office of the European Union (2022), p. 66, https://data.europa.eu/doi/10.2777/261324
[538] Ibidem.
[539] Ibid, p. 7.
[540] Ibidem.

Committees.[541] Nevertheless, consultation was perceived by some interviewees as an instrument for legitimising EC priorities, not as an instrument that can open the discussion and bring in new aspects. Stakeholder consultation, in particular the informal channels, favoured the dominant R&I stakeholders - to the disadvantage of newcomers, especially those stakeholders representing the end-users of R&I processes, in particular civil society.[542]

The ambition to generally increase the participation of civil society organisations (CSOs) in projects faced some obstacles. Although their participation increased compared to FP7, the following factors were identified as having an important hindering effect: (1) assessment criteria in research funding were still (too) focused on key performing indicators concerning scientific excellence[543], whereas societal impacts remain difficult to operationalise and assess. Consequently, (2) research programmes and questions appeared highly research-driven and designed toward the needs and interests of the research community. In Horizon 2020, multi-annual programmes were set up (in most cases biennial programmes), to enable applicants to prepare better and earlier, increasing the prospect of high-quality proposals.

What messages emerged from the stakeholder consultation?

66% (1 170) of respondents in the stakeholder consultation conducted for this evaluation either agreed or strongly agreed that '**Horizon 2020 supported cooperation between science and society**'. This objective of Horizon 2020 has been the most controversial one among all objectives, as 6% (99) of respondents maintained that the programme did in fact not do enough to support said cooperation. Nevertheless, this constitutes only a small fraction of respondents within each stakeholder group. It is important to note that the majority of responses were rather favourable, suggesting an overall positive sentiment towards the support of cooperation between science and society. Among the various stakeholder groups, favourable views were shared the most on behalf of NGOs 71% (47), whereas business associations (59%; 19) were the least favourable compared to other stakeholder groups. Non-EU citizens found that Horizon 2020 supported cooperation between science and society to a greater extent (67%; 39) compared to EU citizens (60% 129). .

[541] Evaluation study on the Relevance of Horizon 2020 and its Policy Mix (2023), op. cit., pp. 55-60. More information on the relevance of Horizon 2020 design and strategic planning process were provided in the interim evaluation of the programme, 2017.
[542] Ibid, Pp. 8-9.
[543] Evaluation study on the Relevance of Horizon 2020 and its Policy Mix (2023), op. cit., p. 54. The share of funding awarded to CSOs was lower (4%) than their numerical share of participation (6%), which indicates that civil society actors seemed to generally take on non-core roles in research project consortia and, rather, participated in other parts of the research process like communication, coordination, and dissemination and uptake of research results.

5. WHAT ARE THE CONCLUSIONS AND LESSONS LEARNED?

The overview below proposes a graphic assessment of the extent to which Horizon 2020 achieved or contributed to its objectives/targets using a scale of:

- -- : the evaluation found the objective is **not achieved** (and is not going to be achieved);
- -: the objective is **not achieved** (and is not going to be achieved), but **some positive findings** were also identified;
- +/- : the evaluation found positive progress but it is **unclear** whether there will be only partial achievement or the objective will eventually be achieved;
- + : the evaluation found the objective is **achieved**, or on its way to being achieved;
- ++: the evaluation found the objective is **exceeded**, or on its way to being exceeded.

Effectiveness, scientific excellence. Extent to which Horizon 2020 has:	
• promoted numerous, high-quality publications	+
• promoted open access to research publications	+
• spread excellence in 'widening countries'	+/-
• contributed to the advancement of frontier research	++
• boosted researchers' occupational mobility, training and career prospects	++
• strengthened European research infrastructure	+/-
Effectiveness, societal impacts. Extent to which Horizon 2020 has:	
• increased the R&I contribution to social challenges	+/-
• promoted gender equality	+/-
• promoted social sciences and humanities in the funded projects	+/-
• supported research on the environment and climate change	+
Effectiveness, economic impacts. Extent to which Horizon 2020 has:	
• produced innovation outputs, including new technologies, products and services	+/-
• contributed to European leadership in enabling and industrial technologies	+
• enabled the Knowledge and Innovation communities (KICs) of the European Institute of Technology and Innovation to create economic and innovation outputs	+/-
• facilitated access to risk capital	+
• generated macro-economic impacts on GDP and employment	+
• strengthened the competitive position of Europe	+/-
• improved the economic performance and competitiveness of its beneficiaries	+
• promoted international cooperation, contributing to the impacts of the programme	+
• promoted the exploitation and dissemination of results	-
Long term effectiveness, long-term impact of previous framework programmes	++
Efficiency. Extent to which Horizon 2020 has:	
• reduced the administrative costs for applicants and participants, simplifying their participation in the programme	+/-
• performed against overall administrative expenditure targets	+
• improved the "error rate" in project cost reporting	-
• ensured faster processes leading up to the signature of the grant agreement	++
Internal coherence. Extent to which the various components of Horizon 2020 operated well	+
External coherence. Extent to which Horizon 2020 operated well with other relevant EU and national programmes	+/-
EU added value. Extent to which Horizon 2020 has:	
• leveraged additional resources for R&I	+
• supported activities that would not have been possible without EU funding	++
• promoted multidisciplinary and European cooperation in R&I	++
• increased excellence in research and innovation, by creating EU-wide competition	++
• contributed to consolidating the European Research Area	+
Relevance. Extent to which Horizon 2020 has responded to the original needs and these needs are still present now	+

5.1 Conclusions

Horizon 2020 emerges as a successful programme in many different areas. This evaluation occurred at a moment when 41% of funded projects are still ongoing. The cumulative implementation rates were 99.99% for Horizon 2020 commitments and 87.84% for payments. This high rate of financial commitments and payments indicates a solid base for drawing conclusions on the programme. The completion rate of Horizon 2020 projects (59%) is also higher than the one of the preceding programme (FP7) at the time of its final evaluation.

In line with its foundational objectives, **Horizon 2020 was instrumental in nurturing a society and economy rooted in knowledge and innovation.** It played a key role in **mobilising additional R&I funding** and it made a significant contribution to the EU's target of investing 3% of GDP in R&D by 2020. Nevertheless, Horizon 2020 investments only accounted for 10% of public R&D expenditure in the EU, with the majority of funding originating from the Member States and regional bodies. By the end of 2020, the EU's investment in R&D had risen to 2.32% of GDP, a 15% increase since the programme was first launched.

Horizon 2020 has significantly impacted the research and innovation landscape, benefitting a diverse range of participants – from scientists and researchers working within higher education institutions to research organisations and private-for-profit entities such as small and large businesses. The programme launched over 1000 calls for proposals, attracting over 285 000 eligible projects proposals – double the number received by its predecessor, FP7. This surge in interest highlights the programme's appeal and relevance. Even if close to 35000 projects were funded, the success rate remained low at 12%. Notably, 74% of proposals assessed as high quality by independent experts could not be funded due to budget constraints. Horizon 2020, with a budget of EUR 75.6 billion, would have needed an additional EUR 159 billion to fund all high-quality proposals.

To give excellent unfunded proposals an opportunity to find support at national or regional levels, 1 out of 5 high quality proposals not retained for funding received a Seal of Excellence certificate, supporting subsequent funding under European Structural Funds. However, Member States' lack of access to information on awarded Seals of Excellence has been identified as a barrier to maximizing their impact.

Collaborative projects accounted for 78% of the funding, involving an average of 11 participants in nearly 15,000 projects. The average grant size in Horizon 2020 increased to EUR 2.3 million from EUR 1.8 million in FP7. Higher education institutions received the largest share of funding, followed by private-for-profit organisations and research organisations. SMEs received 17% of the funding, amounting to EUR 11.4 billion. Well-established higher education institutions and research organisations received a large share of the funding, showing a degree of concentration, smaller than under FP7. Still, the programme also attracted newcomers, in particular smaller private-for-profit entities. Newcomers received 19% of Horizon 2020 funds, a share rising to a full 50% when considering only funding to private companies across the programme.

The programme's global appeal is evident from the applications coming from 177 countries. Half of the funding went to just four countries (Germany, UK, France and Spain). However, smaller countries like Estonia, Greece, Cyprus, and Latvia showed impressive performance when comparing Horizon 2020 funding to their gross domestic expenditure on R&D. Widening countries saw an 8% share of the total EU contribution, a slight increase from FP7. Although this may seem moderate, all widening countries except two have increased their participation in the programme. The evaluation identified several challenges for widening countries, including limited capacity in managing international R&I projects, brain drain, weak national support systems or easily available funding alternatives. In response, Horizon Europe has tripled the budget for widening country participation to 3% and introduced several measures to enhance

their involvement, including strengthening the National Contact Point system and offering proposal pre-checks and brain circulation grants.

Horizon 2020 was **coherent**: it had a high number of instruments with different approaches to grants (mono-beneficiary and collaborative, more research-oriented and more innovation-oriented) which served different objectives and interacted in a complementary way.

Horizon 2020 is **relevant** as Europe continues to face economic and scientific competition and its positioning has not fundamentally changed compared to other countries and regions.

Scientific impact

Horizon 2020 was strategically designed to strengthen Europe's scientific and technological bedrock by investing in knowledge, skills and infrastructure. These long-term investments are critical for the EU's current and future ability to lead, react or adapt to dynamic changes in scientific and technological advancement and the ever-changing socio-economic environment.

The programme outperformed its predecessor (FP7) on scientific output, as evidenced by the number of **scientific publications**, which **are twice as cited as the global average,** and 4% in the most cited worldwide. At the time of this evaluation, beneficiaries had reported over **276,000 peer-reviewed publications**, with 18% stemming from projects supported with European Research Council (ERC) grants. This number is still expected to increase as more projects reach completion. Horizon 2020 **made substantial contributions** to **scientific breakthroughs and advancements in nascent domains** of science and technology, particularly in medical sciences, quantum mechanics, chemical engineering and composite materials. Funding for transnational R&I projects enabled significant collaborations that might not have been possible otherwise. More than a quarter of the publications are linked **to new, rapidly evolving research areas.** It played a key role in fostering world-class scientific excellence: 33 Nobel Prize winners were supported either before or after they were honoured.

The programme also had a **profound impact on knowledge circulation,** with 82% of its publications being freely and publicly available online, demonstrating a strong commitment to **open access.** Horizon 2020 was also pivotal in **diversifying and enhancing researchers' skills and knowledge**. **It also improved their career prospects, particularly benefiting early-career researchers**. Nearly 50 000 researchers were supported in cross-sector and cross-country mobility.

In addition, Horizon 2020 has enabled the EU to develop and upgrade **large-scale research infrastructures** at both European and global levels. Over 24,000 researchers and organisations gained access to these infrastructures, enhancing collaborative opportunities and scientific advancements. The Leadership in Industrial Technologies (LEIT) programme part facilitated access to **technology infrastructures** such as open innovation test beds, allowing companies to test innovations in realistic conditions. Another important development was the deployment of common research infrastructures under the roadmap for the European Strategy Forum on Research Infrastructures. While these achievements are noteworthy, the evaluation suggests that **synergies between EU, national and regional programmes** supporting research infrastructures could be further improved, in particular to ensure their sustainable operations

Societal impact

Horizon 2020 bolstered research and innovation efforts aimed at **tackling key societal challenges**, including health, food security, energy, transport, environmental sustainability, climate action, inclusive societies and security.

Particularly noteworthy is Horizon 2020's crucial role in **advancing our understanding of climate change**. Its investments, building on the foundations laid by the predecessor programme FP7, have been influential, with 10% of the scientific publications cited by the Intergovernmental Panel on Climate Change originating from these two programmes. With 32% of its funding allocated to climate action Horizon 2020 has also been instrumental in supporting the development of practical solutions. A prime example is the progress made in alternative and low-emission fuels. The programme also demonstrated adaptability in responding to emerging **health crises**. It responded promptly by launching specific calls for proposals during the Ebola and Zika epidemics, and even greater agility in responding to the COVID-19 pandemic. Horizon 2020 and FP7 are recognised as the third most frequently acknowledged funding sources for COVID-19 related research in the world. The programme also funded research to gain a deeper understanding of **rare diseases** and fostered the development of related therapies, contributing to advancements in personalised medicine and patient care.

By improving fishing methods and reducing discards, Horizon 2020 has contributed to more **sustainable fishing** practices, balancing economic interests with environmental conservation. The programme supported the development of a **smart European electricity grid**, funding projects that focus on automation, energy storage integration and the adoption of renewable energy sources to aid the transition to a more sustainable energy system. Horizon 2020 played a role in improving urban transport by supporting **sustainable urban mobility** plans, including well-designed parking measures and cycling infrastructure to help improve urban liveability and sustainability. The programme supported the development of solution addressing the **human aspects of digital transformation**, such as the development of safe and user-friendly robotics. It improved the accessibility and inclusiveness of cultural spaces, enriching **cultural heritage** experiences and giving access to a broader audience. The programme helped make Europe **more secure** by supporting crime prevention and counter terrorism initiatives, improving border surveillance and improving disaster resilience.

Showing commitment to interdisciplinary research, Horizon 2020 significantly raised the role of **social sciences and humanities** disciplines i.e. sociology, economics, psychology, political science, history and cultural sciences, allocating over 20% of its budget to related topics. However, the evaluation reveals that the level of integration of social sciences and humanities was uneven across different parts of the programme areas. As regards **gender equality** the balance improved under Horizon 2020, with the share of women in evaluation panels reaching 42%, surpassing the 40% target. However, the share of women in scientific advisory panels and as researchers in projects remained below the 50% target, at 43% and 23% respectively, showing room for improvement.

Economic impact

Horizon 2020 made a **significant contribution to the European economy**, not only by stimulating employment and economic growth, but also by effectively **leveraging private funds and boosting the productivity of the companies involved**. It has generated the development of **thousands of innovation outputs**. Looking at the long-term effects of the programme it is estimated to contribute an average **annual increase of EUR 15.9 billion to EU GDP**, totalling EUR 429 billion over the period 2014-2040. Horizon 2020 is also expected to have had a notable impact on job creation, with a net gain in employment levels reaching around 220 000 employees at its peak. In monetary terms, **for every euro the programme is estimated to cost society (in programme costs and costs to applicants), it is estimated to yield five euro in benefits to EU citizens** in the period up to 2040.

On top of its nominal budget, **Horizon 2020 contributed to increasing R&D spending in Europe by attracting co-investment from both public and private sectors**. The greatest leverage was achieved in European partnerships: in joint undertakings, private partners

contributed resources (in cash or in kind) that more than doubled or even tripled the volume of EU funding. Moreover, the programme impacted the **economic performance of participating companies**. They saw on average a 20 % employment rise and a 30 % increase in turnover and total assets, compared to the firms that did not receive funding despite high quality applications. The programme also made a significant contribution to **intellectual property rights (IPR)** developments. Programme beneficiaries reported close to 4 000 IPR applications, of which three quarters are for patents, followed by 12% for trademarks. Given the often lengthy patenting process, Horizon 2020 IPR figures are expected to increase significantly even after the programme's end. Long-term analysis has shown that patents stemming from FP7 not only exceed the global average in economic value but also exhibit a strong tendency towards interdisciplinarity.

The Horizon Innovation Radar, a tool for identifying high-potential innovations within the programme, suggests that Horizon 2020 funded **potentially groundbreaking technological innovations.** Notably, the most ready-to-market innovations have emerged from the Industrial Leadership pillar, particularly within the Leadership in Enabling and Industrial Technologies (LEIT) projects. These projects have shown a higher propensity for market-ready innovations, especially in areas like the Internet of Things, advanced computing, and advanced materials. Additionally, about 40% of patents self-declared by LEIT participants have contributed to key enabling technologies, including photonics, as well as micro- and nanoelectronics. On the other hand, the Societal Challenges pillar has generated about 20% of all innovations under Horizon 2020, while the Excellent Science pillar has contributed 31%, albeit mostly at a lower level of technological readiness.

The interim evaluation of Horizon 2020 identified a notable gap in venture and growth capital in the EU to scale up innovations. To help bridge this gap, a pilot started to run the European Innovation Council (EIC) in the last three years of Horizon 2020. Early indications show that **the EIC pilot had a positive impact on the turnover and staffing levels of its beneficiaries**. It also **tackled a critical funding gap** in high-risk areas where limited alternatives are available at national and regional levels. The Horizon 2020 financial facility leveraged EUR 77.5 billion in debt and equity for over 38 000 organisations, well above its targets, and fostered the development of venture capital ecosystems and networks.

While Horizon 2020 made strides in **bridging the gap between high-quality European research and market innovations**, it has not fully closed this long-standing gap. Measures tracking the spread of innovation suggest that the EU improved its performance during the Horizon 2020 implementation period, yet it still trails behind its main international competitors on this aspect.

Efficiency and added value

Horizon 2020 has demonstrated **substantial value-for-money for European society.** In terms of economic impact, every euro spent on the programme (including both programme costs and costs to applicants) is estimated to yield approximately five euros in benefits to EU citizens, as measured through its impact on GDP, up to the year 2040.

A number of simplification measures were **effective in reducing the administrative burden for applicants and beneficiaries.** Notable improvements include the use of electronic signatures and the annotated model grant agreement. These changes helped accelerate the process to award grants, improved error rates and administrative expenditure that performed well against benchmarks. Key supporting factors mentioned were the new electronic grant management workflow and the change to scrap the negotiation stage. However, the evaluation suggests that further tightening the time-to-grant target might not be necessary as it could inadvertently increase financial error risks. Despite these advancements, the evaluation does not present an

overall positive picture regarding the **programme's error rate.** The European Court of Auditors pointed out that, particularly in operational expenditure and personnel costs, the level of error remains high and often avoidable.

Looking ahead, there is **scope to improve the efficiency** of the EU framework programme. Many stakeholders have indicated that participating in Horizon 2020 requires more effort than for other research and innovation funding programmes. This is significant given the programme's relatively low success rate, as it means that a considerable share of the application cost represents a net loss to EU society. Any effective measure that reduces these costs has a strong potential to improve programme efficiency.

Horizon 2020 significantly enhanced the scope and quality of research and innovation in Europe, achieving impacts that extend far beyond what could have been achieved at national or regional level. It supported larger-scale, more complex and more ambitious R&I activities than would have been possible without its support, accelerating the development of solutions to pressing global challenges by pooling efforts and resources from across Europe. This was evident in the difficulty faced by unsuccessful applicants, many of whom were unable to implement their projects or had to do so with significant modifications, primarily due to the lack of alternative funding sources at the national or regional level.

A key strength of Horizon 2020 was its promotion of multidisciplinary collaboration and European cooperation in R&I. This approach effectively consolidated expertise, skills and resources from various countries, creating a critical mass that elevated the quality of research and innovation outputs. The competitive nature of the EU-wide funding process further enhanced this quality, ensuring that research was conducted in areas of significant relevance from a European perspective.

Limitations to the analysis – monitoring and evaluation arrangements

While Horizon 2020 **met some of its targets or key performance indicators, it did not achieve all of them.** This partial success can be attributed to the inherent nature of R&I investments, which often require a lengthy period to yield exploitable results. Many projects initiated under the programme are still ongoing, and there were also shortcomings in the initial setup of the programme's indicators. As shown by the analysis of the long-term effectiveness of FP7, **R&I programmes need a longer cycle to demonstrate their impacts**. This lesson was identified in the interim evaluation, so the *ex post* evaluation follows up on FP7 outputs. Notably, IPR performance can only be fully assessed up to ten years after project completion. This is particularly important for indicators aiming at assessing societal impact – the *ex post* evaluation found that they did not feature prominently in the performance framework for Horizon 2020, and were generally inadequate to offer a useful narrative about the programme's wider effects on society. Selected targets set for Horizon 2020 proved either too close to baseline or wrongly set. Targets, always supported by baseline values, should be set more carefully in the future.

The **lack of monitoring arrangements for societal impacts** and the relatively short time elapsed since the closure of Horizon 2020 projects made it overall difficult to assess the broader impacts on society. Taking lessons from Horizon 2020 weak indicator system, the monitoring and evaluation system of the programme was consequently overhauled in Horizon Europe with an impact monitoring and performance framework covering the whole programme. It is structured around nine **Key Impact Pathways (KIPs), which equally cover scientific, societal and technological/economic impact, including baseline values and targets** and reinforced data quality systems, avoid self-reporting of IPR data [544] Recent improvements in the EC monitoring system allow to distinguish between background and foreground IPR applications.

[544] More detail is available in the SWD(2023)132 final on the Evidence Framework on monitoring and evaluation of Horizon Europe.

5.2 Lessons learned

The interim evaluation of Horizon 2020 performed in 2017 led to some significant adjustments in the latter half of the programme. New measures to increase open science have borne fruit and the level of international participation was maintained. Further enhancements, such as promoting women's participation, better integrating social sciences and humanities and reducing administrative burden have been carried forward and reinforced under Horizon Europe. Additionally, the monitoring and evaluation framework has been revised for a better tracking of impact over time. The effectiveness of these measures will be closely examined in the interim evaluation of Horizon Europe.

This final evaluation of Horizon 2020 highlighted several key areas for further improvement, providing insights for future enhancements:

- **Broadening participation.** There is scope to broaden participation in the programme. It would involve engaging with non-traditional players from multiple sectors, scientific disciplines and countries. While national reforms of R&I systems can influence readiness for European-level project participation, the programme itself can be improved by greater simplification, visibility and accessibility.

  Broadening participation to entities located in the least R&I performing countries improved under Horizon 2020 but only at a modest rate, and with significant differences among countries. This issue was raised already in the interim evaluation and confirmed as still relevant by the findings of the ex post evaluation. In response, the budget for actions on widening participation has been tripled in Horizon Europe with novelties including a strengthening of the National Contact Point system, possibility for participants from widening countries to join already existing consortia (the so-called "hop on scheme"), proposal pre-checks, as well as brain circulation grants. The *ex post* evaluation indicated that national reforms in R&I systems can impact the readiness to take part in excellent collaborative projects at European level in a more structured way than punctual actions funded by the framework programme. The *ex post* evaluation highlighted that spreading scientific excellence in the European Union deserves further attention. There are fewer new entrants in the part of the programme aimed at increasing participation, compared to the share of newcomers in Horizon 2020 overall.

- **Further simplification needed.** The programme can benefit from a targeted use of the two-stage application process, especially in areas with low success rates and a high volume of unsuccessful applicants. Extending the use of the Seal of Excellence certification scheme could also enable more applications to be reused for other programmes, reducing wasted effort. There is also further potential for simplification in extending the monitored use of lump-sum funding, as well as in improving outreach, information dissemination, and the user experience of programme tools.

  In particular, given the low success rates, any effective measure that reduces applicants' costs has a strong potential to increase the efficiency of the programme. The still limited experience with the two-stage application process (put in motion following the interim evaluation conclusion to address oversubscription) suggests that this approach could be extended in a targeted way, subject to careful ex-ante assessment. It would be suited for areas which combine a low success rate, with a high absolute number of unsuccessful applicants, and project start dates that are not time-sensitive.

  The use of lump sum funding was piloted, following the recommendations of the interim evaluation to promote simplification. Apart from reducing reporting costs of beneficiaries, lump sum funding can yield benefits by keeping the financial error rates in check. It was confirmed by this final evaluation as a relevant efficiency measure to be further applied, monitored, and assessed *ex post*, which will require quantitative evidence.

- **Dissemination, exploitation and deployment of results.** The process of disseminating, exploiting and deploying project results has been uneven and requires more attention. Horizon Europe encourages applicants to give greater thought to the pathway to impact in their applications. Improvements are also needed to ensure the visibility, spread and practical use of project results to unlock broader economic and societal benefits.
- **Supporting women in research and innovation.** Despite efforts, it remains a challenge to achieve gender balance in research, entrepreneurship and innovation. Stronger measures are needed to support women researchers, entrepreneurs and innovators both Europe-wide or within the framework programme.

  This evaluation finds that stronger measures are needed to support women researchers, entrepreneurs and innovators as gender balance in these fields is not yet within reach, Europe-wide nor within the FP. Further actions were taken in Horizon Europe, where the gender dimension is required to be integrated into research and innovation content (i.e. sex and gender analysis), across the whole programme. In particular, public bodies, research organisations and higher education establishments are required to have a gender equality plan (GEP) in place (new eligibility criterion and specific funding available). Flagship measures and activities promoting gender equality under the EIC include a target of 40% women-led companies to be invited to pitch their projects, a target of 50% women among members of advisory structures, a prize for women innovators and a dedicated initiative to support women-led start-ups will be introduced.
- **Unlocking more synergies with other initiatives.** Synergies with other EU, national and regional initiatives could be strengthened, particularly to support the uptake and use of project results. This includes better alignment to ensure the smooth operation of research infrastructures.

  Under Horizon Europe, this issue was acknowledged, and a path was paved towards improvement. The regulation was enriched with a dedicated annex listing programmes and funds where synergies are envisioned to ensure complementarities at design stage. Also, in the 2021-2027 MFF, a greater number of programmes are also using e-grants, enabling an automatic identification of potential synergies (entities funded by more than one EU programme). In 2022, a new guidance was published on synergies between Horizon Europe and the ERDF programmes. Efforts will be needed in the future to further streamline the administrative and financial rules with not only the ERDF but also other funding sources.

The evaluation at hand also underlined the need to monitor the EU' programme's **capacity to contribute to EU's priorities and competitiveness**. Representing around 10% of total public R&I spending in Europe, Horizon 2020 is not equipped alone to overcome the long-established challenge for the EU R&I system, i.e. translating the high-quality research developed in the EU into new innovations on the markets. Nevertheless, it can contribute to EU's competitiveness. A reinforced alignment between EU priorities and the programming of EU R&I funding was introduced in Horizon Europe, with multiannual Strategic Plans that are preceded by an analysis of recent developments and future challenges and opportunities for R&I.

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PART 2/2

COMMISSION STAFF WORKING DOCUMENT

EVALUATION

Accompanying the document

REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Ex-post evaluation of Horizon 2020, the EU Framework Programme for Research and Innovation

{COM(2024) 49 final} - {SEC(2024) 52 final} - {SWD(2024) 30 final}

ANNEX I. PROCEDURAL INFORMATION

The *ex post* evaluation of the Horizon 2020 programme (Decide reference: PLAN/2022/785) has been developed under the lead of DG RTD, under the guidance of the interservice steering group (ISSG) composed of 29 DGs (AGRI, BUDG, CLIMA, CNECT, COMM, COMP, DEFIS, EAC, ECFIN, ECHO, EMPL, ENER, ENV, GROW, HOME, HR, IAS, INTPA, JRC, MARE, MOVE, NEAR, OLAF, OP, REGIO, SANTE, SG, SJ, TRADE) and 4 Executive Agencies (CINEA, EISMEA, ERCEA, HADEA) established in April 2022.

The ISSG met in April 2022 to discuss the expectations of participating services, the draft call for evidence, the draft consultation strategy and the working methods of the ISSG. Following this ISSG the call for evidence was then published in July 2022 for four weeks and received 35 individual replies (presented in Annex 5). The ISSG met again in October 2022 to discuss the feedback received on the call for evidence and the draft questionnaire for stakeholder consultation.

Following this ISSG meeting, the stakeholders' consultation was launched on 1 December and closed on 19 February, having gathered 1 818 replies. The ISSG met for the third time in February: an update was provided about the late advancement of external evaluation studies, emerging findings were discussed and a draft evaluation (SWD) was presented and open for comments. Main messages from the upstream meeting with the Regulatory Scrutiny Board were shared with the member of the ISSG. A revised version of the evaluation (SWD) was open for comments in March by the Directorates General and agencies of the Horizon Europe governance and comments were integrated. The ISSG met on 3 May 2023 to discuss the draft final version of the evaluation SWD before submission to the Regulatory Scrutiny Board (RSB).

This evaluation has been selected for scrutiny by the RSB. The outcome of the scrutiny was the issuance of a negative opinion, following a dedicated meeting on 21 June 2023. In the first negative opinion the Regulatory Scrutiny Board pointed at areas for improvement relating to:

Strengthening the effectiveness and efficiency analysis	• Under Chapter 4.1.3 on economic impacts, a new section was added on 'Improving Europe's economic growth and competitiveness', while the section on 'Facilitating access to risk capital' has been expanded. Under Chapter 4.1.2 on societal impacts, it is recognized that societal impacts take a longer time to become visible and the shortcomings of the monitoring system are recognised, noting that the conclusion is based not only on KPI data but also on qualitative evidence from the enclosed case studies. The section on 'Promotion of gender equality in Horizon 2020' has been completely revised by recreating the missing point of comparaison (FP7) and explaining the data limitations. The assessment period for GDP gains (cumulative and average annual) was changed from 2014-2030 to 2014-2040, to allow enough time for impacts to emerge as the last projects will only end in December 2028. • Under Chapter 4.2 on efficiency, a Benefit Cost Ratio (BCR) of 5 to 1 is stated, referring to a newly created Section 5 in Annex 4 for calculations and further discussion of the BCR. It is clarified that the assessment considers actual, paid out amounts for the EU budget, with data frozen on 1 January 2023. The quantification of time saved from faster grant agreements was corrected. A new section has been added on 'What are potential areas for further simplification?', covering lump sum funding (including expanded data from the pilot exercise), Seal of Excellence (moved from the External Coherence chapter) and the two-stage application process. • Chapter 4.3.1 on internal coherence has been expanded.

	• In Chapter 4.4 on EU added value, the section of leverage now explains that, as different types of participants have different funding rates, even within the same type of action, it is not possible to determine a priori the 'expected' direct leverage factor per type of action. There was no target set for leverage in Horizon 2020 and benchmarking against FP7 is not appropriate, because the two programmes have different types of action with different funding rates. Instead, benchmarking against two other programmes is included, with some limitations. In addition, in the final revision of the FP-wide counterfactual analysis, causality links were explained in more detail – additional information was added on the approach used, including analysis of only comparable companies and ensuring a sufficient number of lead and lag years in the FP-wide counterfactual analysis.
Strengthening the cost benefit analysis	The benefit cost ratio of 5:1 has been added in the main SWD. The overview table and further explanations are available in a new dedicated section in Annex 4. Quantification of costs and benefits has been privileged but non quantified benefits are also presented in Annex 4. In the final revision, information on the benefit cost ratio in the main report was extended (based on information previously in Annex 4). The estimate of the total beneficiaries' administrative cost of Horizon 2020 was added to the main cost table in Annex 4.2 and given more visibility. The price base of the total benefit estimate used in the BCR calculation was changed to current prices. The BCR calculation table presents alternative values broken dwon by model used and assessment period. The central model output used for the calculation of the GDP gain (total benefits) was changed from Nemesis to Rhomolo, to present a more conservative estimate. Additional information on application costs found at Horizon 2020 interim evaluation was added in Annex 4 as a point of comparison.
Strengthening the conclusions	Conclusions have been re-organised and twice further elaborated by repeating some key statistical data from the evaluation findings. For Societal Challenges, conclusions explain the deficiencies of the monitoring system and longer timespan needed to contribute to societal challenges. Following improved analysis of gender aspects, this conclusion has been updated. New conclusions have been added on boosting Europe's economic growth and competitiveness and the cost-benefit ratio. The main areas for improvement are identified: research infrastructure, dissemination and exploitation of R&I results and measures aimed at widening participation in the programme. In the final revision, a new score was added for the programme's contribution to *Europe's* competitiveness. Also the following note was deleted because data was available only for IPR: 'It is expected that the programme will further improve its performance as ongoing projects come to an end, in line with IPR outputs from FP7, which more than doubled in 2023 after the final evaluation of FP7 (2015)'. Lastly, a new sentence was added to further acknowledge uncertainties caused by the ongoing implementation of 41% of the projects, while informing that the cumulative implementation rates at the time of the evaluation were 99.99% for Horizon 2020 commitments and 87.84% for payments. Similar statement also added in the section on 'How has the situation evolved in the reporting period'.
Strengthening lessons learned	The section on lessons learned has been expanded, reflecting all the elements from the previous analysis where any shortcomings were identified and coherent with the overall picture presented in the conclusions. An update has been provided on the main short-term and long-term suggestions for improvement made by the interim evaluation of Horizon 2020. In the final revisions, status was provided for three lessons learned from the interim evaluation, on the programme externalisation, feedback to policy and international cooperation. It was also clarified which lessons learned came from the interim evaluation and which ones from the final. Lastly, when response to a lesson learned was finalised, this was indicated, though most points will require continuous monitoring and follow up in future (Horizon Europe) evaluations.

Following the negative opinion, the ISSG had a written consultation on the revised SWD between 25 August and 5 September. Based on this, the revised evaluation was resubmitted to the RSB on 15 September 2023 – receiving a positive opinion on 12 October 2023.

In the second, positive opinion the Regulatory Scrutiny Board pointed at further areas for improvement relating to:

The report should better explain the underlying assumptions behind the derived Benefit-Cost-Ratio	Assumptions behind the Benefit Cost ratio expanded in the SWD
Given the report's finding that Europe's overall competitive position has not fundamentally changed over the duration of Horizon 2020, while indicating that this does not imply that Horizon 2020 did not contribute to competitiveness, the report should be more balanced in concluding and scoring Horizon 2020'scontribution to boosting EU's competitiveness.	Language nuanced regarding the direct contribution of Horizon 2020 in boosting EU competitiveness
The report should elaborate further on the data limitations related to having 59% of finalised projects. The fact that more projects have been finalised than under FP7 at the corresponding moment does not present a solid base for drawing firm conclusions. (past performance does not guarantee to be repeated). In general, the conclusions should be more nuanced for specific parts of the programme.	Data on finalised projects at the time of the evaluation could not be updated. 59% is higher percentage at the time of the final evaluation of FP7 (50%). Timing of the evaluation could not be postponed but 59% of finalised projects is deemed a solid base.
Several scores allocated in the conclusion section should be critically reviewed to better reflect the outcome of the impact analysis.	Scoring double checked
The report should critically review some of the assumed causality links, such as that Horizon 2020 beneficiaries invest more, recruit more and grow more than nonbeneficiaries.	Different analyses were run for this purpose covering different samples and using a diverse set of methods. An overview of those along with their caveats is provided in Annex 2. The results of the analyses agree in finding positive effect on firms' employment and revenues growth. One of those, which tracks firms up to 5 years before and after their application for funding, found that beneficiary firms increase on average their employment level by 20% compared to non-funded firms with high quality proposals, and their total revenues by about 30% in the years following the receipt of the first grant. These average effects are present even after 2.5 years (the average duration of a project in the sample).
The report should better distinguish between what has been learned from the final (or mid-term) Horizon 2020 evaluation, and be more explicit on which lessons have already been (partly) taken up and revised in the successor programme, and which remain relevant for future revisions in this policy area.	Language reinforced

No exception from the usual procedural requirements of the better regulation guidelines was requested for this evaluation.

This evaluation is based on evidence gathered via different channels and an overview is presented in Annexes 2 and 3. The main sources of evidence are internal analyses by the European Commission, analysis and reports by other European Institutions and by external evaluators who worked on twelve evaluation studies, carried out between 2021 and 2023, listed in Annex 2.

The external evaluation studies operated under the steer of interservice groups composed of relevant Commission services which at the end of the studies agreed on the adequacy of the resulting final reports, with particular respect to their relevance, appropriate design, reliable data, sound analysis and reliable findings.

ANNEX II. METHODOLOGY AND ANALYTICAL MODELS USED

The *ex post* evaluation of Horizon 2020 was coordinated by the Common Programme Analysis & Regulatory Reform Unit of the Commission's Directorate-General for Research & Innovation, with the support of: (i) a working group (the 'MEAVE' - Impact Monitoring, Evaluation and Analysis Virtual Entity) gathering together the R&I family DGs and Executive Agencies; (ii) and an interservice steering group comprising relevant Commission DGs. The *ex post* evaluation of Horizon 2020 started in 2022 and was guided by the Terms of Reference adopted by the Commission after a vote by the Member States' Programme Committee[1].

The evaluation builds on: (i) a large amount of quantitative and qualitative evidence collected through a variety of methods described below; and (ii) a thorough evaluation analysis, applying triangulation of evidence from different sources, ensuring an objective and robust assessment.

Main data sources

The scope of the Horizon 2020 *ex post* evaluation includes all calls with a closure deadline on 31 December 2020 and grants signed by June 2022. Section 3 provides data on how programme implementation evolved from its launch until 1 January 2023, when 41% of projects were still ongoing. Section 4 provides an analysis of the programme based on triangulation of evidence predating 1 January 2023 (most external evaluation studies were carried out during 2022, with programme data extracted at the end of 2021).

The analysis was based on the following data sources:

- The main source of data for the evaluation is the Common Research Data Warehouse (CORDA) Portal. The portal gathers data collected through different Commission tools, including policy monitoring at work programme level, data collected at proposal stage, grand agreement preparation and through continuous project reporting.
- Beyond CORDA, additional datasets were used. This was also to have comprehensive data on the whole framework programme, in particular for the different partnerships (such as European Institute of Innovation and Technology knowledge and innovation communities (EIT KICs) and joint undertakings (JUs)), for the Joint Research Centre (data and analysis provided by the JRC on its activities) and Innovation Radar data.
- Evidence and analysis conducted in the interim evaluation of Horizon 2020[2], the interim evaluation of the EIT[3], and the independent High-Level Group on maximising the impact of EU research & innovation programmes (the 'Lamy Group')[4].
- External datasets such as Scopus[5], Orbis[6], PATSTAT, Crunchbase, Dealroom, Pitchbook, Technote, and MAG/OpenAlex.

[1] C(2022) 7817.
[2] https://op.europa.eu/en/publication-detail/-/publication/bccdcce7-d8c9-11e8-afb3-01aa75ed71a1/
[3] https://op.europa.eu/en/publication-detail/-/publication/7415ff23-db2d-11e8-afb3-01aa75ed71a1
[4] https://ec.europa.eu/info/sites/default/files/conferences/sof/hlg_2017_report.pdf
[5] https://www.scopus.com/search/form.uri?display=basic#basic
[6] https://orbis.bvdinfo.com/version-202251/Orbis/Companies/Login?returnUrl=%2Fversion-202251%2FOrbis%2FCompanies

- Monitoring reports of Horizon 2020[7] and statistical data mainly from the Commission's internal IT Tools (Horizon Dashboard), as well as Eurostat/OECD data.
- Extensive quantitative and qualitative analyses on specific aspects and objectives of Horizon 2020, conducted through 12 external evaluation studies by independent evaluation experts, selected using a transparent process and overseen by relevant Commission departments.

Seven studies covered specific aspects of Horizon 2020. These were: • Evaluation study on the '**Opportunities and Challenges in Targeted Funding of Research and Innovation: Lessons learnt from the Horizon 2020 Focus Areas and implications for Horizon Europe Missions**', https://data.europa.eu/doi/10.2777/40351 • Evaluation study on the **Open access policy study**, https://data.europa.eu/doi/10.2777/268348 • Evaluation study on the **proposal evaluation system under Horizon 2020**, https://data.europa.eu/doi/10.2777/16211 • Evaluation study on the **European Innovation Council (EIC) Pilot**, https://data.europa.eu/doi/10.2777/261324 • Evaluation study on the **external coherence & synergies of Horizon 2020 within European R&I support system**, https://data.europa.eu/doi/10.2777/054469 • Evaluation study on the **relevance & internal coherence of Horizon 2020 and its policy mix**, https://data.europa.eu/doi/10.2777/058655 • Evaluation study on the implementation of **cross-cutting issues in Horizon 2020**, https://data.europa.eu/doi/10.2777/763665
Five other studies covered specific policy objectives of the programme: • Evaluation study on **Excellent Science** in the EU Framework Programmes for R&I, https://data.europa.eu/doi/10.2777/967813 • Evaluation study of the EU Framework Programmes for R&I for addressing Global Challenges and Industrial Competitiveness – Focus on activities for a more **Resilient Europe**, https://data.europa.eu/doi/10.2777/60819 • Evaluation study of the EU Framework Programmes for R&I for addressing Global Challenges and Industrial Competitiveness – Focus on activities for the **Digital and Industrial Transition**, https://data.europa.eu/doi/10.2777/99438 • Evaluation study of the EU Framework Programmes for R&I for addressing Global Challenges and Industrial Competitiveness – Focus on activities related to the **Green transition**, https://data.europa.eu/doi/10.2777/422725 • Evaluation study of the EU Framework Programmes for R&I for an **Innovative Europe**, https://data.europa.eu/doi/10.2777/144504

- Data from other EU institutions, such as the Conclusions on the Interim Evaluation of the Council, the work of the European Parliament's ITRE committee, relevant Court of Auditors' reports[8] and reports/evaluations of the European Economic and Social Committee.
- Input from the public consultation on the Horizon 2020 *ex post* evaluation. This consultation received input from 1 818 respondents and 21 position papers.

Detailed descriptions of the models and methods used in the different information sources mentioned above are available in each respective external study and internal analysis report. Below is a short overview.

[7] https://ec.europa.eu/info/publications/horizon-2020-monitoring-flash_en

[8] For the section on leverage of JUs, the ECA Annual report on EU Joint Undertakings for the financial year 2021 was used and its underlying data. For S2R, the EU contribution includes administrative contributions of EUR 13.5 million. If these are disregarded, the expected leverage factor becomes EUR 1.22, instead of the EUR 1.18 reported.

Main methods used

1. Macroeconomic modelling

Measuring the full impact of R&I, i.e. capturing indirect effects on top of direct ones, is an intricate question, compounded by the often relatively long time lags between policy initiatives and observed actual impacts. The European Commission uses complementary modelling platforms for both the *ex ante* and *ex post* evaluations of research and innovation policies.[9] In this annex, macroeconomic modelling is used to quantify the economic impact of Horizon 2020 in terms of GDP gain and job creation in the EU. While there is consensus that R&I is an important factor in increasing productivity, quantifying the impact of R&I policies at macroeconomic level requires modelling tools that accurately capture how R&I translates into economic gains.

There are several models available to assess the dynamic transmission channels of R&I, each with specific features. This *ex post* evaluation uses results produced by three macroeconomic models: NEMESIS, QUEST and RHOMOLO. This is an *ex post* assessment in the sense that the input data on the Horizon 2020 investments are up to date and reflect the actual disbursements during the programming period. However, the results should not be regarded as a way to exactly track and monitor the actual macroeconomic impact of the Horizon 2020 interventions. This is because they rely on assumptions both on the modelling setup and on the simulation strategy adopted to simulate the investments' impact (i.e. the economic channels activated by them).

Results from NEMESIS were produced by a team of external experts, while RHOMOLO and QUEST results were produced by European Commission departments (the Joint Research Centre for RHOMOLO and DG Economic and Financial Affairs for QUEST). The strength of these models lies in their distinct features. NEMESIS is considered one of the richest models covering *different types* of innovation.[10] QUEST is the most appropriate for assessing the impact of R&I policies *over time*. By modelling regional economies, RHOMOLO is the most suitable model to address the *geographical concentration* of innovative activities.

[9] European Commission, Directorate-General for Research and Innovation, Benedetti Fasil, C., Martino, R., Ravet, J. (2020), *Macroeconomic models for Research and Innovation policy: the present and the future*, Publications Office https://data.europa.eu/doi/10.2777/339051.
[10] Di Comite and Kancs (2015).

1.1. NEMESIS

Presentation of the model

NEMESIS was developed by a European consortium[11] in 2000 to analyse the macro-sectoral impacts of EU policies, based on R&D investments and related knowledge spillovers. The model became a reference tool for assessing EU and national R&I policies, and since 2004 has been used by the European Commission for several analyses. These include the assessments of: (i) the Lisbon Strategy target of 3% of EU GDP to be invested in R&D[12]; (ii) the RTD national action plan related to the Barcelona Objective[13]; and (iii) the impact of European R&I programmes (*ex ante* assessment of the 7th Framework Programme[14], of Horizon 2020[15], and of Horizon Europe[16]).

Structure of the model

NEMESIS is a detailed sectoral macro-econometric model estimated for every country of the EU. It distinguishes between 30 sectors operating within five-level nested-CES functions.[17] The model covers both the supply and demand sides of the economy and incorporates endogenous technical change. Specifically, the representation of technical progress in NEMESIS is derived from the new growth theories, where innovations result from investment in R&D by private firms, and from R&D undertaken by the public sector. In the latest version of NEMESIS used for this *ex post* evaluation (as well as for the interim evaluation of the H2020 programme in 2017), innovations still arise from private and public investments in R&D, as well as investments in two other complementary innovation inputs: ICT and other intangibles (OI), including training and software. These enable improved accuracy in assessing R&I policies by considering the most up-to-date theoretical and empirical findings of economic literature (Le Mouël, 2019; Akcigit et al., 2022).

Table 1: The innovation mechanism in NEMESIS

Schematically, the innovation mechanisms of the model, at the level of a firm (or a sector), can be described as follows:

- Firms determine their investments in the three innovation inputs (private R&D, ICT and OI), depending on their relative costs and their degree of complementarity.
- The investment effort by firms increases their own knowledge (stock variable) as well as the knowledge of other firms, sectors and countries, through the knowledge spillover matrices (knowledge transfers). For each innovation input, the knowledge stock is modelled as a weighted sum of the stock of assets, R&D, ICT or OI, belonging to all sectors

[11] Lab. ERASME / Ecole Centrale Paris (now SEURECO), Federal Planning Bureau of Belgium, E3M3 lab. / ICCS /NTUA and Chambre d'Industrie et de Commerce de Paris.
[12] Brécard, D., Fougeyrollas, A., Le Mouël, P., Lemiale, L. and P. Zagamé (2006), 'Macro-economic consequences of European Research Policy: Prospects of the NEMESIS model in the year 2030', *Research Policy*, No 35(7), pp. 910-924. Doi:10.1016/j.respol.2006.03.001.
[13] Chevallier, C., Fougeyrollas, A., Le Mouël, P., and P. Zagamé (2006), 'A time to sow, a time to reap for the European Countries: A macro-econometric glance at the RTD National Action Plans', *Revue de l'OFCE*, 2006/5 (No 97 bis), pp. 235-257. Doi:10.3917/reof.073.0235
[14] Delanghe, H. and U. Muldur (2007), 'Ex-ante impact assessment of research programmes: The experience of the European Union's 7th Framework Programme', Science and Public Policy, No 34(3), pp. 169-183, doi:10.3152/030234207X218125.
[15] European Commission (2012), *The Grand Challenge – The design and societal impact of Horizon 2020*, Directorate-General for Research and Innovation. Doi:10.2777/85874.
[16] European Commission, Directorate-General for Research and Innovation, (2018), *A new horizon for Europe: impact assessment of the 9th EU framework programme for research and innovation*, Publications Office https://data.europa.eu/doi/10.2777/194210.
[17] European Commission, Directorate-General for Research and Innovation, Benedetti Fasil, C., Martino, R., Ravet, J. (2020), *Macroeconomic models for Research and Innovation policy: the present and the future*, Publications Office. https://data.europa.eu/doi/10.2777/339051

and countries. The coefficients of the matrices used to build these stocks are calibrated based on patent citations between sectors and countries. These matrices combine the citations between patents allocated by technology classes and country with the OECD concordance table, in order to allocate these citations **between sectors (Johnson, 2002). For R&D, the knowledge stock is also influenced by the public investments undertaken by the public sector.**

- The growth in knowledge stocks will generate innovations at a rate that is a positive function of the knowledge absorption capacity of the firm (measured by its investment intensity in each innovation input).
- Innovations take two forms: product and process. Product innovations increase the intrinsic quality of the product sold by the firm, whereas process innovations improve the production process without changing the quality of the product (pure total factor productivity effect).
- Product innovations have a direct positive impact on the internal and external demands addressed to the firm, while process innovations reduce its production cost, and, in a competitive market context, lowers its market price and increases its demand.
- These dynamics at firm or sectoral level are brought together at the macro level by the input-output tables of the model, and the combination of the sectoral interdependencies ('bottom-up') with the 'top-down' macroeconomic forces finally drive the medium- and long-term dynamics of the model.

Key assumptions for the *ex post* evaluation

Key assumptions in NEMESIS for assessing the impact of the H2020 relate to the financing of the programme, the leverage effects of the framework programme investments[18], and the framework programme's economic performance (EU added value)[19]. For the purpose of this evaluation, it is assumed that the H2020 programme was financed by a reduction of public investment equivalent, at Member State level, to the EC contribution. The importance of this cut in public investment in the individual Member States is proportional to their historical contribution to the EU budget. There are net contributors and net beneficiaries, depending on how successful each Member State was at benefitting from the framework programme and their relative contribution to the EU budget.[20] Additionally, it is also assumed that the framework programme has no direct crowding-in and crowding-out effects on basic research. This assumption was retained from the *ex post* evaluation of FP7 by PPMI in 2017[21] and the survey of the dedicated literature realised for the *ex ante* assessment of Horizon Europe in 2018[22].

The assumptions retained are summarised in Table 2.

[18] Amount of additional R&I expenditure leveraged by the initial R&I investment. Note that besides this 'direct' crowding-in effect of the FP on the R&D investments made by its beneficiaries, there is an 'indirect' crowding-in effect that is the additional R&D investments engaged by a research entity, financed by the FP or not, as a response to the modification of the overall economic activity that the FP provokes (and not as the direct result of the EC financial support, as for the direct crowding-in effect). The total crowding-in is therefore the sum of the direct and the indirect crowding-in.

[19] i.e. how much the performance of the R&I investments provoked by the FP (in terms of R&I outcomes) is superior to those of the R&I support from other sources of funding (including national sources).

[20] Note that for the *ex ante* and *ex post* evaluations of FP7, and for the *ex ante* and interim evaluations of H2020, no financing of the programmes was considered, and the FP money was supposed to come from 'nowhere'.

[21] PPMI, 2017.

[22] Boitier et al., 2018.

Table 2: Key assumptions of the NEMESIS model

FINANCING	DIRECT CROWDING-IN EFFECT	EU added value
Equivalent decrease of public investments	Basic research: €0	+15%
	Appl. res.: +€0.15	
	Average: +€0.087	

The value of EUR 0.15 for the framework programme's direct crowding-in effect on applied research was retrieved from the review of dedicated literature realised in 2018 for the *ex ante* assessment of HE[23]. The value of +0.15% for the EU added value of the programme was already used in the *ex ante* impact assessment of H2020 with NEMESIS in 2012[24], based on the evaluation of past FPs. Finally, Table 3 reports the assumptions underlying the precise outline of the framework programme budget, its annual layout, and the distribution of the Commission contribution between basic and applied research, Member States and the different economic activities.

Table 3: Horizon 2020 budget and its repartition

Programme	H2020 budget (EC contribution, in constant billion € 2020)	average duration of FP7 projects (in month)	Repartition between basic and applied research	National allocation of funds	Sectoral allocation of funds
H2020	Horizon 2020 budget in constant prices	35	Basic: 42% Applied: 58%	Historical (based on H2020 dashboard)	Historical (based on H2020 dashboard and Orbis for private for-profit entities)

All the data used for this *ex post* evaluation of H2020 come from 'observed' information available in the H2020 dashboard. Out of a total budget of 68.4 billion 2020 euro in the H2020 dashboard[25], only 61.7 billion was retained in the study. This was done by subtracting the part of the EC contribution that benefits countries outside the EU-28. The split between basic and applied research was 42% for basic and 58% for applied[26], and 40% and 60% respectively if we take into account the total cost of the projects financed. The national allocation of the funds was also based on the H2020 dashboard, and appears very stable compared to FP7 data and to the H2020 data up to August 2016 used in 2017 for the interim evaluation. The sectoral allocation of applied research was itself based on the H2020 historical data for private corporations and on the Orbis database, to make the sectoral mapping using the NEMESIS model.

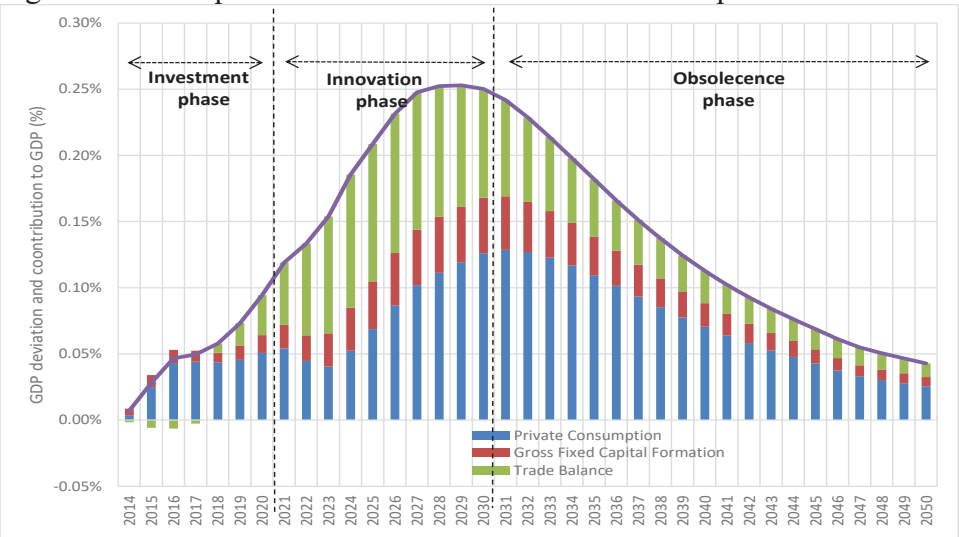
[23] Boitier et al., 2018.
[24] EC, 2012.
[25] With this limitation that the H2020 data used for this *ex post* evaluation include only the figures encoded in E-Grants, related mainly to grants agreements signed in the H2020 dashboard. The overall H2020 covers also other actions (i.e. studies, management and administrative expenditure for the programme, subscriptions, financial instruments, etc.) that are not encoded into E-grants. As such, the dashboard does not contain all the activities/actions/expenditure financed under the programme, and this may slightly (about 5%) under-evaluate the programme's impact on the main indicators presented in this report.
[26] For this repartition, the EC contribution that benefits public bodies and higher education institutions was considered as basic research, and the remaining as applied research. These shares of about 40% for basic research and of 60% for applied were also used in the interim evaluation of H2020 and correspond to the repartition targeted by the Commission when designing the H2020 programme.

Results

Results from the NEMESIS model indicate that Horizon 2020 produces positive effects on GDP. Figure 1 displays the results from the simulation across three main phases: 'Investment', 'Innovation' and 'Obsolescence'.[27] Positive, although limited, GDP gains are already observed in the investment phase: about +0.05 points in average between 2014 and 2020. During these first years, the positive effects of the programme on GDP come mainly from its crowding-in on the R&D investments by programme beneficiaries. The programme is financed by an equivalent cut in public investments in Member States, but the crowding-in effect induces a net positive impact on investment at the macroeconomic level. The high and direct content in labour of R&D investments, compared to other forms of investments, also raises households' income and final consumption, from where the main GDP gains during this first phase originate. There are in return inflationary pressures that deteriorate the external balance during the first 4 years of simulation, but the situation begins to improve from 2018 with the arrival of the first innovations the programme contributed to financing.

GDP gains increase significantly during the innovation phase, reaching a maximum of about +0.25 points in 2027 up to 2030, and an average of about +0.20 points on 2021-2030. After 2030, GDP gains start to gradually decline due to the gradual obsolescence of the new knowledge and the innovations the programme contributed to creating.

Figure 1: The impact of H2020 on EU GDP and its components



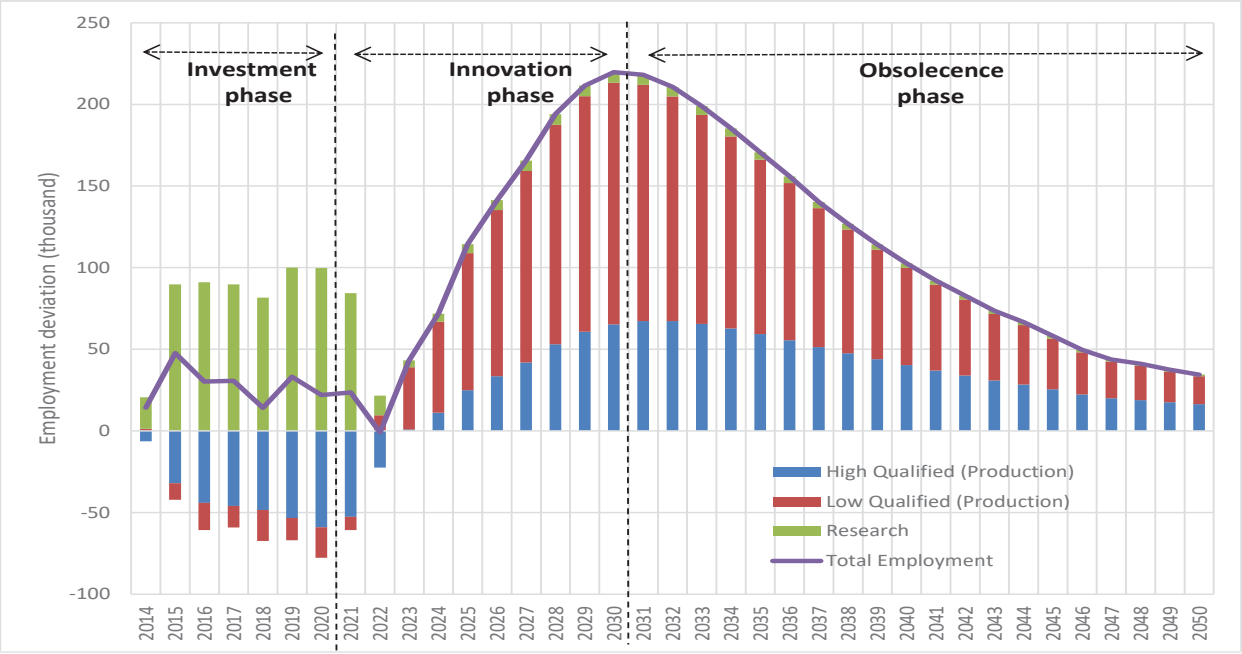
Source: PPMI - NEMESIS simulation.

Positive impacts are observed also on the employment level. As reported in Figure 2, the *investment* phase (up to 2020) is characterised by a significant increase in the number of people employed in the research sector, with the creation of up to 100 000 jobs in research by 2019-2020, and an average rise of about 85 000 jobs compared to the situation in the reference scenario. In turn, high-qualified employment in production activities experience a reduction,

[27] For simplicity, the three phases follow each other chronologically in the figures, but in reality they overlap.

partly due to a re-allocation of high-skilled workers from these sectors to research positions, and partly due to the rise in wages received by qualified workers, which in turn reduces the overall demand for this category of personnel. The same mechanism also induces a slight reduction in the number of low-qualified people employed in production. During the *innovation* phase, the market deployment of the innovations provoked by the H2020 programme translates into substantial job creation in every economic sector. On average, for 2021-2030 the gain in total employment is about +123 000 (with +15 000 for research employment, and +23 000 and +85 000 respectively for high- and low-qualified employment in production). As with GDP, the employment gains decrease gradually during the *obsolescence* phase, from +229 000 in 2030, when they are at their maximum, down to +36 000 in 2050.

Figure 2: The impact of Horizon 2020 on employment



Source: NEMESIS simulation.

Limitations of the model

While NEMESIS' strengths justify its relevance when measuring the impact of R&I policies, the model's specific features also imply a number of limitations to be considered when interpreting the results. First, the model relies on the empirical observation of relationships and allows for flexibility in behavioural functions, which may generate inconsistencies between the most recent developments in macroeconomic theory. Furthermore, it uses adaptive expectations rather than forward-looking ones. NEMESIS also does not link the use of human capital with investments in the educational system.

1.2. QUEST

Presentation of the model

The QUEST model is a global dynamic general equilibrium model developed by the European Commission's Directorate-General for Economic and Financial Affairs.[28] The different model variants have been extensively used for macroeconomic policy analysis and research, e.g. analysing the impact of fiscal and structural reforms and assessing the impact of cohesion policies[29]. QUEST is a fully dynamic structural macro-model with rigorous microeconomic foundations derived from intertemporal utility and profit optimisation. The model also accounts for frictions in goods, labour and financial markets.[30]

Structure of the model

QUEST belongs to the class of micro-founded dynamic general equilibrium (DGE) models that are now widely used in economic policy institutions and are seen as the latest step in the development of macroeconomic modelling. These models are forward-looking and intertemporal, i.e. current decisions account for expectations about the future, subject to budgetary, technological and institutional constraints. The intertemporal forward-looking aspects are particularly relevant for the analysis of R&D promotion policies.

This evaluation uses the semi-endogenous growth version of the European Commission's QUEST model with an R&D production sector (QUEST R&D). The model economy is populated by households, final and intermediate goods-producing firms, a research industry, a monetary and a fiscal authority. In the final goods sector, firms produce differentiated goods which are imperfect substitutes for goods produced abroad. Final good producers use a composite of intermediate goods and three types of labour: low-, medium-, and high-skilled. The model has liquidity and non-liquidity constrained households. Liquidity constrained households have no access to financial markets. They simply consume their current income at each period. Non-liquidity constrained households buy the patents of designs produced by the R&D sector and license them to the intermediate goods-producing firms. The intermediate sector is composed of monopolistically competitive firms, which produce intermediate products from rented capital input using the designs licensed from the household and by making an initial payment to overcome administrative entry barriers. The production of new designs takes place in research labs, employing high-skilled labour and making use of the commonly available domestic and foreign stock of knowledge. Importantly, the model is a global

[28] For the different QUEST model variants and their applications, see https://economy-finance.ec.europa.eu/economic-research-and-databases/economic-research/macroeconomic-models/quest-macroeconomic-model_en

[29] See Varga, J., Roeger W. and in 't Veld, J. 'Growth effects of structural reforms in Southern Europe: the case of Greece, Italy, Spain and Portugal', *Empirica*, 2014, vol. 41, issue 2, 323-363., Varga, J. and in 't Veld, J. (2011). 'A model-based analysis of the impact of Cohesion Policy expenditure 2000-06: Simulations with the QUEST III endogenous R&D model', *Economic Modelling*, 28 (1-2), 647-663. and https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-research/macroeconomic-models_en for other publications using the QUEST model.

[30] As European Commission (2020) points out, one of the main strengths of the QUEST R&D model is its theoretically consistent micro-founded approach based on the forward-looking optimising behaviour of rational agents. As a general equilibrium model, it makes it possible to disentangle the dynamic transmission channels of R&I policies, and to account for reallocation effects and policy trade-offs. European Commission, Directorate-General for Research and Innovation, Annicchiarico, B., Licandro, O., Mohnen, P., et al., *Moving the frontier of macroeconomic modelling of research and innovation policy*, Publications Office, 2020, https://data.europa.eu/doi/10.2777/34199

multi-country model of the EU Member States and the rest of the world, in which individual country blocks are interlinked with international trade and knowledge spillovers.

Key assumptions for the *ex post* evaluation

The simulations assume that countries contributed to the Horizon 2020 budget according to their GDP shares. For this evaluation, results were produced based on three scenarios depending on the financing of the Horizon programme. The first and the second scenarios assume tax-based financing via (i) lump-sum taxes and (ii) value added taxes respectively. In the third scenario (iii), financing is done at the expense of an equivalent reduction in national public investment. Table 3 lists the key modelling assumptions.

Table 4: Key assumptions of the QUEST model

	Key assumptions (Horizon 2014-21)
Budget size	Horizon 2020 budget in constant prices
Budget allocation across years	Across countries and years of the Horizon programme's active operations from 2014 to 2021
Spillovers	International trade and knowledge spillovers, based on trade statistics and elasticities in the relevant literature
Direct leverage effect	Identical leverage of EU funding and national funding
Economic performance	Identical performance of EU funding and national funding
Financing	Increase in lump-sum or value added taxes or reduction in public investment

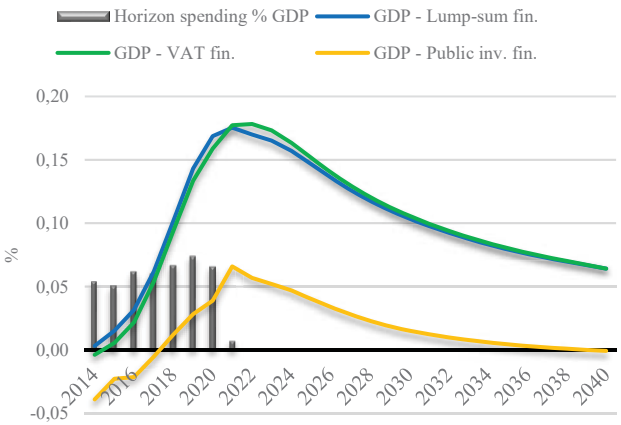
Results

As lump-sum and value added taxes are among the least distortive taxes, financing productivity-enhancing R&D investments from these resources is unambiguously beneficial at the EU level (Figure 3.a). By changing from lump-sum tax financing to public investment cuts (e.g. roads, buildings), Member States lose the potential productivity effects of these public investments and the GDP results are lower both in the short and long run.

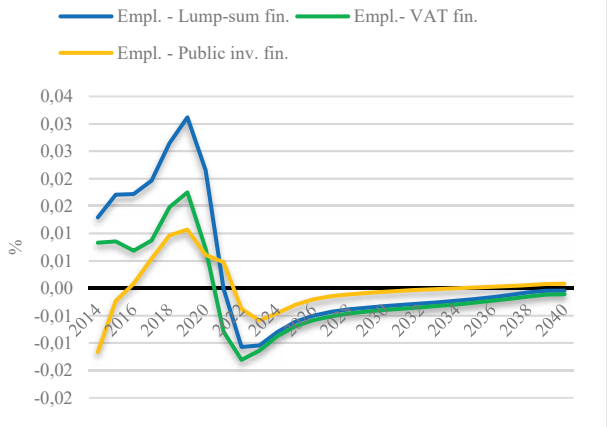
The GDP effects build up gradually, as it takes time for the positive productivity effects to emerge in the production process via the accumulation of intangible (R&D) capital. Member States also benefit from the simultaneous support of R&D via knowledge spillovers: the international diffusion of innovations fosters intangible capital formation in the medium term. Short-term GDP effects are limited due to crowding-out effects at the beginning of the intervention period: R&D subsidies stimulate innovation by helping R&D-intensive companies attract more high-skilled labour from traditional production into research with higher wages. Because of supply constraints for high-skilled workers, part of the fiscal stimulus is offset by higher wages. In the first two scenarios, GDP gains are up to 0.18% by 2021 relative to the baseline and gradually decrease below 0.1% after the programming period due to the depreciation of tangible and intangible capital. Note that in the simulations, both EU- and nationally funded R&I have the same leverage and performance effects.

Figure 3: EU-27 GDP and employment impact of Horizon 2020, QUEST R&D results

a. GDP



b. Employment



Source: European Commission, DG ECFIN, QUEST R&D simulations, 2023. The effects are expressed in percent deviation from the baseline.

In the third scenario, the expected GDP effects are much smaller compared to the tax-based financing scenarios. The output effects are even slightly negative in the short run and close to zero in the medium term. Similar to R&D investments, public investment is also productivity-enhancing. Therefore, this type of financing not only has a direct negative demand effect in the short run but also reduces the productivity and supply effects in the medium to long run.[31] This scenario illustrates that financing matters: even productivity-enhancing R&D programmes should not be implemented at the expense of reducing productive public expenditure.

Given that the programmes are simulated as productivity-enhancing measures, the model results suggest only a slight short-run increase in employment during the demand boost, which disappears with rising real wages in the medium to long run after the end of the implementation period (Figure 3.b).

Limitations of the model

Although the model is well-suited to simulating the effect of public financed subsidies on private R&D, it does not distinguish between research undertaken in private or public R&I entities. All R&D activities are carried out by a single R&D sector. Being an aggregate macroeconomic model, QUEST also misses the extensive regional details present in RHOMOLO.

[31] The productivity effects of public capital in the private sector's production process are captured via the output elasticity of public capital. This elasticity is calibrated based on empirical estimates in the literature. Bom, P., and Ligthart, J. (2014), 'What Have We Learned From Three Decades Of Research On The Productivity Of Public Capital?', *Journal of Economic Surveys* 28: 889-916.

1.3. RHOMOLO

Presentation of the model

RHOMOLO[32] is the macroeconomic model of the European Commission focusing on EU regions. It has been developed and maintained by the Joint Research Centre, in cooperation with the Directorate-General for Regional and Urban Policy. It is used for policy impact assessment and provides sector-, region- and time-specific simulations on investments and reforms covering a wide array of policies. RHOMOLO is built on a micro-founded general equilibrium approach and is used to provide a breakdown of results by region and sector.

Structure of the model

RHOMOLO is a spatial dynamic computable general equilibrium (CGE) model with new economic geography features. The version of the model used for this evaluation includes 276 EU NUTS-2 regions. Each region contains 10 economic sectors operating under monopolistic competition (apart from the agricultural sector and the public services sectors, which operate under perfect competition). Regional goods are produced by combining labour and capital with domestic and imported intermediates.

Final goods are consumed by households, the government and investors. Each region is inhabited by a representative household supplying labour of three skill types, consuming and saving a part of their income. The government levies taxes, purchases public consumption goods, invests in the economy, and transfers resources to the various agents in the economy. Goods and services can either be sold in the domestic economy or exported to other regions. Trade between regions is associated with a set of bilateral regional transportation costs[33]. The RHOMOLO model incorporates imperfect competition in the labour market, allowing for unemployment. Wage formation is modelled with a wage curve (Blanchflower and Oswald, 1995), so that lower levels of unemployment increase workers' bargaining power, thereby increasing real wages[34].

The RHOMOLO model contains two types of capital: sector-specific private capital, and public capital available to firms in all sectors within each region. Sector-specific private capital is accumulated by private investors. The investment-capital ratio is a function of the rate of return to capital and the user cost of capital, allowing the capital stock to reach its desired level in a smooth fashion over time. Public capital is accumulated by the government by means of public investment. Public capital services enter the production function as an unpaid factor of production, meaning that all firms in all sectors enjoy the same level of public capital at no cost. Public capital is subject to congestion[35], so that its efficiency decreases as production increases.

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[32] Christou, T., Crucitti, F., García Rodríguez, A., Lazarou, N.J., and Salotti, S. (2023), 'The RHOMOLO ex-post impact assessment of the 2014-2020 European research and innovation funding programme (Horizon 2020)', *JRC Working Papers on Territorial Modelling and Analysis*, JRC133690.

[33] The transportation costs are modelled as iceberg costs and come from the estimates illustrated by Persyn, D., Díaz-Lanchas, J., and Barbero, J. (2022), 'Estimating distance and road transport costs between and within European Union regions', *Transport Policy*, 124, 33-42. https://doi.org/10.1016/j.tranpol.2020.04.006.

[34] Blanchflower, D.G., and Oswald, A.J. (1995), 'An introduction to the wage curve', *Journal of Economic Perspectives* 9(3), 153-167. DOI: 10.1257/jep.9.3.153.

[35] Fisher, W.H., and Turnovsky, S.J. (1998), 'Public investment, congestion, and private capital accumulation', *The Economic Journal*, 108(447), 399-413. https://doi.org/10.1111/1468-0297.00294.

Table 5: How RHOMOLO models innovation

How RHOMOLO models innovation
➢ Public expenditure in support for applied research is introduced into the model as a reduction in the user cost of capital, which in turn generates an increase in private investments. **R&I expenditure is modelled as private investments. Hence, R&I spending generates demand for capital goods, leading to a temporary increase in the private capital stock** (which depreciates at a 15% yearly rate)**. In addition, R&I spending leads to accumulation of an intangible knowledge capital stock** (the increase is subject to a 5% yearly decay rate) **positively affecting total factor productivity (TFP).** ➢ The impact of R&I expenditure on TFP through the accumulated knowledge capital stock is captured by a set of regional elasticities which are positively related to regional R&D intensity. The intuition is that firms in regions that are already spending much on R&D signal their pre-existing capacity to generate value from innovation activities. The range of the R&D elasticities is between 0.01 and 0.04, in line with the existing literature on the subject.[36] ➢ Public expenditure in support for basic research is introduced into the model as an increase in public investment, leading to a temporary increase in the public capital stock (which depreciates at a 5% yearly rate). This affects the productivity of firms, as public capital enters the production function as an unpaid factor of production. ➢ Expectations are assumed to be myopic and the model is solved sequentially, with stocks being upgraded at the beginning of each period. For this particular exercise, capital mobility within the EU was assumed, but no labour mobility.

Key assumptions for the *ex post* evaluation

Besides the modelling setup, the analysis for the *ex post* impact assessment of Horizon 2020 is constructed following the NEMESIS analysis, which is based on historical H2020 administrative data. The key assumptions retained for the simulation of the results are summarised in Table 4.

Table 6: Key assumptions for the RHOMOLO model

	Key assumptions
Budget size and allocation	Horizon 2020 budget in constant prices. Allocation across regions (NUTS2 level) and years
Support to basic vs applied research	It is assumed that 40% of the funds support basic research and 60% support applied research
Regional spillovers	Regional spillovers are conditional on R&D intensity within the regions
Direct leverage effect	Identical leverage of EU funding and national funding
Economic performance	Identical performance of EU funding and national funding
Financing	Lump sum

In RHOMOLO, the basic research funds are simulated via an increase in public investment, therefore leading to a temporary increase in the public capital stock of regions. Due to the role of public capital in the production function, besides the demand-side effect of increased (public) investments, this increases the productivity of firms. The applied research funds are assumed to reduce the user cost of capital, leading to an increase in private investment. This entails a demand-side effect, which also leads to a temporary increase in the private capital stock. Also, it is assumed that these R&I investments lead to an increase in TFP, with an elasticity which depends on R&D intensity, as explained above.

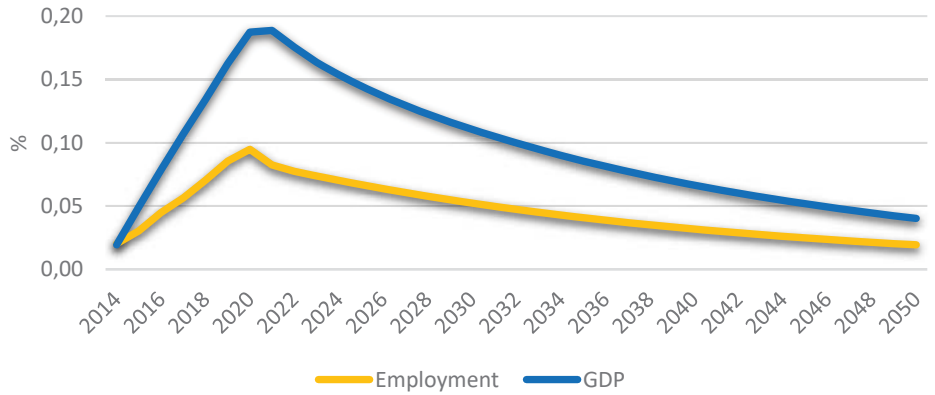
[36] See, for instance, Männasoo, K., Hein, H., and Ruubel, R. (2018), 'The contributions of human capital, R&D spending and convergence to total factor productivity growth', *Regional Studies*, 52(12), 1598-1611. DOI: 10.1080/00343404.2018.1445848.

The investment is assumed to be financed via lump-sum transfers. To mimic how the EU budget is financed, the regional contributions are proportional to the GDP weight of each region over the EU GDP. In other words, a region does not necessarily have to finance the programme with a contribution which matches the amount of H2020 destined to the region itself: the contribution depends on the proportion of EU GDP generated in the region.

Results

The GDP impact increases steadily during the implementation period to reach a peak of +0.189% in 2021. Subsequently, it declines gradually as the monetary injection related to the programme ends, the increased private and public capital stocks depreciate and the temporary increase in TFP decays. In 2050, the programme still has relatively small residual effects, as the GDP is 0.040% above its initial level (Figure 4). The investment also leads to improvements in employment, whose impact reaches a peak of +0.095% in 2020, amounting to almost 220 000 people[37].

Figure 4: Horizon 2020 impact over time on GDP and employment

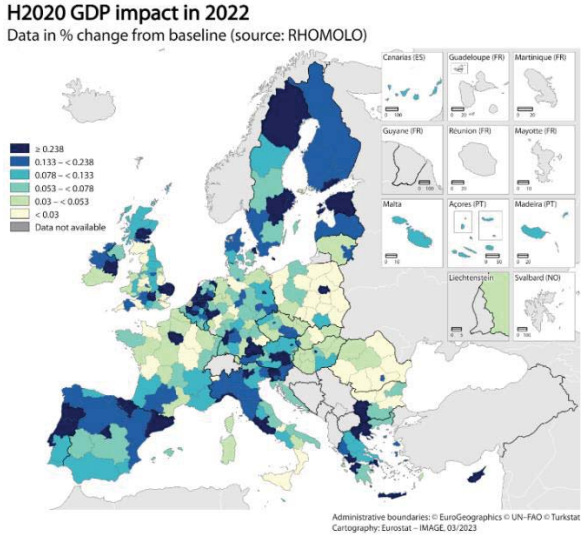


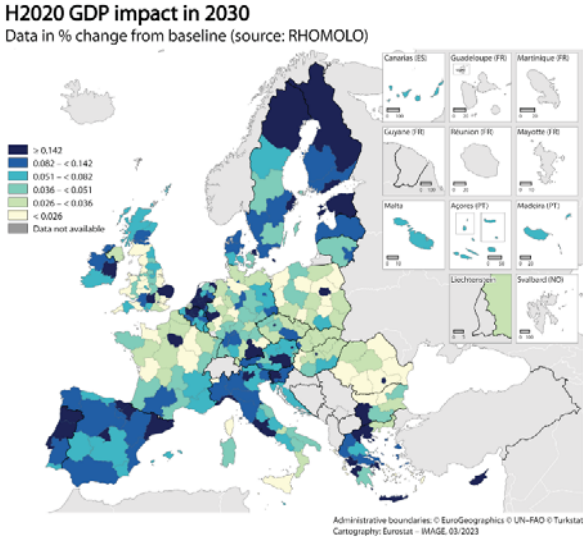
Source: JRC - RHOMOLO simulations, 2023.

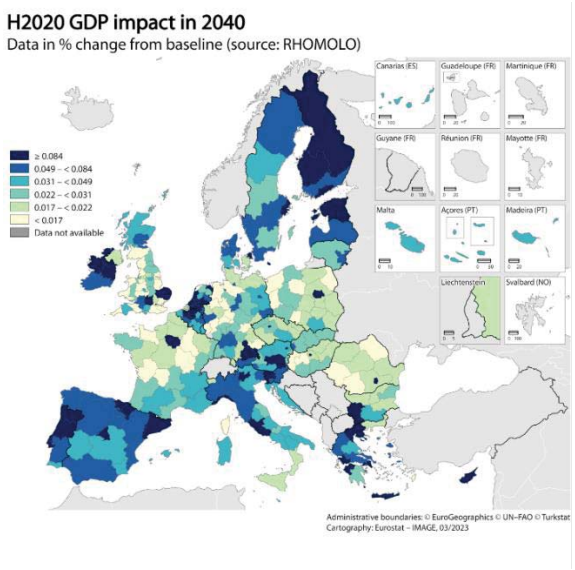
Figure 5 presents the territorial distribution of the GDP impact of H2020 investment, expressed as percentage deviations from the baseline (i.e. a hypothetical scenario without H2020) in 2022, 2030, 2040 and 2050. The GDP impact in 2022 is stronger in the regions with more H2020 investment. Specifically, the programme's macroeconomic effects are relatively larger in the Scandinavian regions, in Central Europe and in the Iberian Peninsula. Moreover, in most countries, the capital city regions benefit more than the other regions, a phenomenon particularly evident in countries like Poland, Czechia, Slovakia, Bulgaria and Romania. Over time, in countries like Spain, Italy, Greece, and Poland, the effects gradually spill over to regions receiving relatively less H2020 funds. Nevertheless, the spillover effects remain mostly concentrated in the richest regions. The magnitude of the impact decreases over time due to: (i) the H2020 investments being limited to the period 2014-2022; (ii) the depreciation rates of the temporarily increased private and public stocks of capital; and (iii) the decay rate of the TFP improvements.

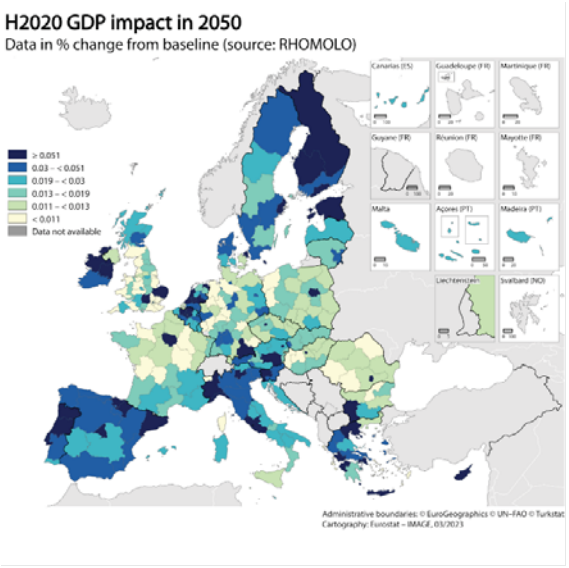
[37] The total number of employed people in the model base year in the EU-28 is about 231 826 000.

Figure 5: Territorial distribution of Horizon 2020's GDP impact, 2022-2050









Source: JRC - RHOMOLO simulations.

The RHOMOLO model is calibrated with data organised over the following 10 NACE Rev. 2 sectors (see Tables 7, 8 and 9 below). Sectoral results should be read keeping in mind that the shocks applied to the model in order to simulate the Horizon 2020 interventions are not sector-specific. Therefore, the results mainly reflect the steady-state data on sectoral production and the input-output relationships across sectors. We report value added because GDP is not available at the sectoral level.

Table 7: RHOMOLO economic sectors

Code	**NACE Rev.2**
A	Agriculture, forestry and fishing
B-E	Industry (except construction)
C	Manufacturing
F	Construction
G-I	Wholesale and retail trade, transport, accommodation and food service activities
J	Information and communication
K_L	Financial and insurance activities, real estate activities
M_N	Professional, scientific and technical activities; administrative and support service activities
O-Q	Public administration, defence, education, human health and social work activities
R-U	Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies

Tables 8 and 9 present respectively the value added and employment sectoral results, for selected simulation years.

Table 8: H2020 sectoral value added impact in selected years

% change w.r.t. baseline	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**	**2040**	**2050**
A	-0.003	0.017	0.039	0.066	0.093	0.123	0.157	0.190	0.197	0.149	0.092	0.056
B-E	-0.002	0.030	0.061	0.098	0.132	0.166	0.205	0.240	0.237	0.159	0.095	0.058
C	-0.006	0.027	0.054	0.087	0.116	0.144	0.180	0.210	0.200	0.119	0.071	0.043
F	0.110	0.152	0.205	0.233	0.260	0.299	0.298	0.200	0.155	0.081	0.050	0.030
G-I	-0.006	0.026	0.052	0.085	0.113	0.143	0.178	0.209	0.202	0.132	0.079	0.048
J	0.023	0.067	0.107	0.147	0.180	0.216	0.245	0.247	0.223	0.123	0.073	0.044
K_L	0.007	0.042	0.073	0.108	0.140	0.173	0.208	0.230	0.221	0.155	0.093	0.057
M_N	0.012	0.052	0.087	0.124	0.156	0.189	0.220	0.233	0.214	0.122	0.073	0.044
O-Q	0.064	0.073	0.094	0.101	0.115	0.132	0.127	0.065	0.049	0.028	0.017	0.010
R-U	0.003	0.028	0.050	0.076	0.099	0.124	0.151	0.170	0.166	0.121	0.073	0.045
Change w.r.t. baseline in mn €	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**	**2040**	**2050**
A	-7	50	113	193	274	360	461	559	577	439	270	165
B-E	-10	137	277	444	598	751	930	1 086	1 076	721	432	261
C	-128	601	1 213	1 952	2 614	3 236	4 034	4 708	4 482	2 675	1 594	969
F	825	1 135	1 530	1 742	1 944	2 231	2 224	1 496	1 156	608	370	225
G-I	-155	684	1 384	2 237	2 995	3 770	4 694	5 539	5 337	3 479	2 100	1 274
J	159	462	736	1 015	1 243	1 492	1 693	1 705	1 538	848	502	304
K_L	144	921	1 595	2 362	3 064	3 785	4 540	5 031	4 839	3 383	2 046	1 236
M_N	188	821	1 385	1 972	2 470	3 000	3 500	3 693	3 389	1 944	1 161	704
O-Q	1 687	1 942	2 484	2 665	3 041	3 484	3 366	1 714	1 310	748	451	273
R-U	16	136	246	373	485	608	738	832	814	591	359	218

Source: RHOMOLO simulations (and DG REGIO for the H2020 contribution).

Table 9: H2020 sectoral employment impact in selected years

% change w.r.t. baseline	2014	2015	2016	2017	2018	2019	2020	2021	2022	2030	2040	2050
A	-0.024	-0.002	0.011	0.033	0.049	0.065	0.095	0.140	0.135	0.090	0.056	0.034
B-E	-0.026	0.001	0.015	0.040	0.058	0.075	0.106	0.152	0.143	0.090	0.055	0.033
C	-0.019	0.008	0.023	0.047	0.064	0.077	0.106	0.138	0.125	0.070	0.042	0.026
F	0.181	0.157	0.190	0.183	0.204	0.240	0.200	0.021	0.024	0.042	0.026	0.016
G-I	-0.021	0.002	0.016	0.037	0.053	0.069	0.096	0.134	0.127	0.081	0.049	0.030
J	0.014	0.030	0.047	0.063	0.073	0.089	0.099	0.095	0.084	0.047	0.029	0.017
K_L	-0.022	-0.006	0.006	0.026	0.041	0.058	0.082	0.122	0.124	0.089	0.054	0.033
M_N	0.001	0.024	0.042	0.062	0.076	0.093	0.111	0.119	0.106	0.059	0.035	0.022
O-Q	0.073	0.060	0.070	0.062	0.071	0.080	0.063	-0.018	-0.016	0.002	0.002	0.001
R-U	-0.011	-0.005	0.003	0.016	0.028	0.043	0.060	0.085	0.093	0.073	0.045	0.027
Change w.r.t. baseline in thousands of persons	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**	**2040**	**2050**
A	-0.694	-0.066	0.305	0.940	1.390	1.852	2.723	3.994	3.874	2.580	1.598	0.980
B-E	-1.458	0.055	0.861	2.260	3.257	4.189	5.933	8.517	8.053	5.038	3.080	1.881
C	-8.019	3.561	10.009	19.989	27.236	32.880	45.057	58.975	53.173	29.781	18.025	10.987
F	24.132	20.949	25.285	24.398	27.116	31.912	26.668	2.800	3.131	5.643	3.508	2.140
G-I	-10.263	0.869	7.713	18.542	26.190	34.246	47.426	66.126	63.003	40.200	24.472	14.901
J	1.428	2.993	4.596	6.173	7.176	8.824	9.797	9.338	8.263	4.675	2.828	1.723
K_L	-2.600	-0.655	0.696	2.967	4.754	6.759	9.548	14.191	14.466	10.325	6.269	3.810
M_N	0.262	6.140	10.900	15.965	19.617	24.065	28.506	30.790	27.337	15.186	9.125	5.543
O-Q	45.263	37.058	43.201	38.375	43.814	49.518	38.954	-11.001	-9.652	1.444	1.039	0.662
R-U	-0.988	-0.440	0.256	1.360	2.423	3.669	5.206	7.298	8.024	6.308	3.859	2.353

Source: RHOMOLO simulations (and DG REGIO for the H2020 contribution).

Limitations of the model

While the spatial dimension of RHOMOLO is a key strength of the model, its extensive regional disaggregation requires that the dynamics are kept relatively simple. This implies that the optimisation problems in RHOMOLO are inherently static and do not acknowledge the intertemporal consequences of innovation decisions that can change not only the level but also the rate of growth of regional economies. This is solved by recursive dynamics. Furthermore, RHOMOLO does not explicitly distinguish between private and public R&D investments or between types of endogenous innovation.

2. Analysis of monitoring data

Monitoring flashes on Horizon 2020, presenting internal analysis on specific topics of interest, were also used to feed into the evaluation report.

3. Documentary review / desk research

Extensive desk research was conducted to ensure background information, as well as to provide evidence that was then triangulated with other sources of information to draft the answers to the evaluation questions. Documents reviewed included legal texts, strategic documents, previous evaluations and policy analyses.

4. Analysis of unstructured data

Two main types of unstructured analyses were carried out: text mining and research topic analysis. Text mining was used to analyse the impact section of H2020 periodic reports and extract key sentences/claims of impact made by the beneficiaries. This work resulted in a dataset of the expected impacts of H2020 projects. This data was used to identify in-depth analysis/interviews to be conducted within case studies.

In parallel, research topic analysis was used to establish how far the framework programme actions addressed new or fast-growing research topics. Subject to availability of monitoring data, each H2020 project was linked to these topics and a score calculated. This 'FET' (future and emerging tech) score captures the extent to which different H2020 projects address new and growing R&I topics.

5. Interviews

The primary purpose of the interviews was to collect evidence from the different actors concerned by the framework programme. This would give an objective assessment of what has happened by taking into account the different points of view. This method was used in particular in case studies and international benchmarks. Interviews were also conducted to confirm and complement the data collection, with a view to drafting the findings and conclusions. Some 1 403 interviews were conducted (including some with the same actors on different topics), gathering the perspectives of Commission staff, Member States, associated countries, and a large range of stakeholders (universities, companies, umbrella organisations, etc.)

6. Targeted surveys

Different surveys were designed to collect data on the framework programme:

a) Survey of successful and unsuccessful applicants participating in parts of the **Excellent Science** programme parts

The survey programme in the Excellent Science evaluation study consisted of six online questionnaires designed to collect data on the opinions and perceptions of successful and unsuccessful applicants to Horizon 2020. In total, 5 417 complete and 449 partial responses were received.

The following groups were surveyed:

- Horizon 2020 beneficiary organisations (including beneficiary organisations that participated in MSCA, SEWP, INFRA and SwafS)
- Horizon 2020 unsuccessful applicant organisations (organisations that unsuccessfully applied for MSCA, SEWP, INFRA and SwafS)

- Horizon 2020 MSCA IF fellows
- Unsuccessful Horizon 2020 MSCA IF applicants
- Horizon 2020 ERC principal investigators
- Unsuccessful Horizon 2020 ERC applicants.

b) For the evaluation study on the European Framework Programmes for Research and Innovation for addressing Global Challenges and Industrial Competitiveness – Focus on activities for the **Digital and Industrial Transition**: Survey of H2020 LEIT applicants/participants, successful applicants

A single questionnaire was drawn up. It targeted all stakeholders, namely all partners in the projects funded (successful applicants) as well as all partners in proposals that were not funded even though the proposals reached scores above the threshold ('high-quality' proposals). A total of 1 342 valid responses to the survey were received, giving an overall response rate of 7%.

c) For the evaluation study on the European Framework Programmes for Research and Innovation for addressing Global Challenges and Industrial Competitiveness – Focus on activities related to the **Green Transition**

The survey of successful applicants was designed during the inception phase and further enriched and developed to take into account various factors. In total, the survey received 1 333 entries, with 771 of respondents reaching the end of the survey. The analysis (Annex 7 to the study) was organised by societal challenge for relevance, effectiveness and EU added value and for all societal challenges together for the evaluation criterion of efficiency. The analysis was also organised by topic within each evaluation criterion and included corresponding graphs.

The studies on Resilient Europe and Innovative Europe did not have a survey in their methodology.

7. Network analysis

Network analysis performed in the Excellent Science and Innovative Europe evaluation studies involved analysis of the structuring effect of framework programme funding, which was based on author networks. It also included analysis of funding concentration in Horizon 2020.

8. Patent analysis

This analysis – in the Innovative Europe study – served to explore patent productivity under the H2020 programme. Preparation of the Horizon 2020 patents dataset involved the download of data from the Cordis database[38]. It contained 2 003 unique applications for 1 714 unique patent families. Applications that covered the same or similar inventions were grouped into families; the technical content of these families is considered (almost) identical, and was therefore treated as a unique patent family, a unit of analysis. Subsequently, Cordis patents were matched with patents on the PATSTAT[39] database. A total of 36 patents in Cordis patents data were not found on the PATSTAT database, leaving 1 678 patent families. Only patents whose priority date was after

[38] https://data.europa.eu/data/datasets/cordish2020projects?locale=en
[39] https://www.epo.org/searching-for-patents/business/patstat.html

the start of the project were considered (referred to as 'foreground' patents). Removing patents with a priority date earlier than the start of the project left 445 patent families. Therefore, the 455[40] foreground patents constitute the basis for the analysis.

The analysis looked at the following key metrics:

- patent productivity, i.e. number of foreground patents produced by the H2020 pillar and programme;
- patent quality metrics based on: (a) number of forward citations; (b) patent family size; (c) number of claims/CPC classes by foreground H2020 patents;
- H2020 patents that are triadic, i.e. patents registered with the European, US and Japanese patent offices.

9. Bibliometric analysis

This method was used in the Excellent Science study and in the Digital and Industrial transition study to assess the Excellent Science indicators in Horizon 2020, using the key impact pathways (KIP) framework of Horizon Europe, in particular KIP No 1: 'Creating High-Quality New Knowledge', the aim being to be able to compare later on the evolution of these indicators over time. KIP1 proposes the use of several indicators that capture and benchmark the productivity and impact of the sponsored scientific outputs and in particular high-quality peer-reviewed publications influential in their field and worldwide.

The first indicator is a quantity- and productivity-focused indicator, measured by the number of peer-reviewed scientific publications. Based on the EC administrative and monitoring data submitted by Horizon participants combined with Scopus and Web of Science databases, data and values for this indicator were disaggregated by: type of scientific publication; Horizon pillar, cluster and component; type of Horizon Europe action; programme year; and field of science.

The second indicator is the impact and quality indicator. It uses the citations accrued by each of the above validated publications: field- or category-weighted (normalised) citation impact indicators are one of the most sophisticated indicators in the modern bibliometric toolkit[41]. A 'field-normalised' citation score (such as MNCS/CNCI/FWCI) calculates an indication of the citation impact of a publication. It is calculated by comparing the number of citations received by a publication with the number of citations expected for a publication of the same publication year and subject field. A citation impact score of more than 1.00 indicates that the publications in the treatment sample have been cited more than would be expected based on the global average for similar publications (the control). Based on Web of Science and Scopus information, data and values for this indicator can be disaggregated by: type of scientific publication; Horizon pillar, cluster and component; type of Horizon Europe action; programme year; and field of science.

The third indicator also looks at impact but tries to define world-class science. It does this by using the accrued citations to calculate the number and share of peer-reviewed publications resulting from the projects funded by the EC-funded programmes and that are core contributions to scientific fields, calculated

[40] Note that two patents were under two different projects, and these two projects were under two different pillars; this affects the sum of the totals in the tables. Patent IDs 68536640 and 62002358.

[41] Normalised citation impact indicators account for differences in citation accrual over time, differences in citation rates for different document ages (e.g. older documents are expected to have accrued more citations than more recently published documents), document types (e.g. reviews typically attract more citations than research articles) and subject fields (e.g. publications in medicine accrue citations more quickly than publications in mathematics).

as a percentage of top cited publications (PPTop1%)[42]. This indicator is similar to the second indicator, except for the citation threshold introduced to differentiate between highly cited publications and the remaining less cited and un-cited publications. Based on Web of Science and Scopus information, data and values for this indicator can be disaggregated by: Horizon pillar, cluster and component; type of Horizon Europe action; programme year; and field of science. As the PPTop 1% and 10% indicator is generally accepted, this indicator was calculated using either the platform CNCI (Web of Science) or the FWCI (Scopus).

Table 10: List of key metrics and dimensions

KEY METRICS	DESCRIPTIONS
Number of publications	Number of peer-reviewed scientific publications (indexed by Web of Science) resulting from the programme
Number of projects	Number of projects funded by the programme
Publications with at least one citation	The number of publications that have been cited at least once
Top 1% most cited publications	The top 1% highly cited publications
Field-normalised citation impact	Field-normalised citation score of peer-reviewed publications resulting from the programme
Open access publications	n/a
Dimensions	**Descriptions**
Call closure year	Call closure year
Project status	The status of the project, including ongoing, closed or cancelled project types
Thematic priority	EU.0 – EU.5 and Euratom
H2020 PILLARS	The three pillars of H2020, i.e. Excellent Science, Industrial Leadership and Societal Challenges
H2020 programme	Funding programmes under each pillar
Scientific discipline	250 Web of Science research areas are classified into 7 scientific disciplines, following the method proposed by CWTS[43]

In addition, in **the green transition evaluation study**, bibliometrics strategies have been deployed to measure the effectiveness of research activities in this area, at scale across thousands of SC2- to SC5-funded projects.

Descriptive findings, which provide bibliometric findings for selections of funded projects (in case studies) or partnerships measure absolute achievements by research area or thematic area relative to selected comparators. These analyses serve to uncover where H2020 support in green transition calls stands out relative to other EU research not funded by the framework programme. Any outstanding performance under H2020 could relate to the programme

[42] Bornmann, L., L. Leydesdorff and R. Mutz (2013), 'The use of percentiles and percentile rank classes in the analysis of bibliometric data: opportunities and limits', *Journal of Informetrics*, 7(1), 158–165.
[43] https://www.cwts.nl/pdf/nowt_classification_sc.pdf.

having successfully selected for projects/awardees that stand out from the reference populations and/or to the programme having exerted a positive effect on the performance of awardees. To assess the relative contribution of the latter factor in observed difference, a counterfactual analysis was performed (see below). In this context, it should be kept in mind that descriptive findings are not able to tell us whether any strong performances recorded by supported researchers were induced by H2020 support itself, or whether the supported researchers would have attained these achievements otherwise, with other funding opportunities. Demonstrations of high-calibre work for any indicator may reflect H2020 support, the peer-reviewed selection process of researchers, or neither or both of these causes.

In the **study on the proposal evaluation system for the EU R&I framework programme**, bibliometric analysis was used to analyse the predictive power of funding decisions by looking at whether proposal evaluation processes are effective in selecting the 'best' applicants in terms of their subsequent bibliometric performance. The analysis also addressed bias by analysing differences in bibliometric performance levels before and after the award, for success overall and for groups characterised by gender and country. To do this, the study identified the publication output of 3 815 applicants between 2009 and 2019 in the Web of Science databases; output including publications from before and after applications were submitted from 2014 to 2016. Research performance before and after application was analysed in terms of output (number of publications) and impact (metrics based on the number of citations). The change in performance was compared with the outcome of the application (successful or unsuccessful). A further consideration was whether gender or country affected the outcome of applications.

10. Counterfactual analysis

Introduction

A counterfactual analysis assesses the existence of a causal relationship between an observed outcome (e.g. the employment growth of a firm) and the intervention (for instance, Horizon 2020) and provides an estimate of the impacts compared to what would have happened in the absence of the intervention.

Before providing more details on the use of the methods for the *ex post* evaluation of Horizon 2020, we provide some relevant definitions using Crato and Paruolo (2019)[44].

Causality

This is the sufficient link from one factor or event, the cause, to another factor or event, the effect. In econometric methods, a plausible establishment of causality requires some type of experiment or the construction or identification of some counterfactual situation (see below 'Counterfactual impact evaluation (CIE)'). This allows for a reasonable comparison of what happened in the presence of a given factor with what happened or can be reasonably accepted as likely to have happened in the absence of the same given factor.

Control group

This is a group adequate for comparison with the group of units that were subject to a given policy (or treatment group, in statistical terminology). Prior to the policy intervention, the control group should display average characteristics that were otherwise similar to those of the group of individuals subject to

[44] Crato, N., & Paruolo, P. (2019), *Data-Driven Policy Impact Evaluation*, Springer Nature.

the measures. The identification of a control group is critical for measuring the effect of a policy intervention, as it indicates what the situation would be for the group subject to the policy intervention had the intervention not been implemented. (See also 'Counterfactual impact evaluation (CIE)'.)

Counterfactual impact evaluation (CIE)

This refers to statistical procedures for assessing the effect of a policy measure and gauging the degree to which it attained its intended consequences. In randomised control trials, one compares the outcomes of interest of those having benefited from a policy or programme (the 'treated group') with those of a group that are similar in all respects to the treatment group (the comparison or 'control group') except in that it has not been exposed to that policy or programme. The comparison group seeks to provide information on what would have happened to the members subject to the intervention had they not been exposed to it – the counterfactual case. The difference in the outcome of interest between the treated and control groups provides information about the effect of the policy.

Randomisation

This refers to the assignment of individuals to a group or groups (such as treated and control groups) at random.

Differences in differences (DiD)

This CIE technique estimates the average treatment effect by comparing the changes in the outcome variable for the treated group with those for the control group, possibly controlling for other observable determinants of the outcome variables. As this technique compares the changes and not the attained levels of the outcome variable, it is intended to eliminate the effect of the differences between the two populations that derive from potentially different starting points. Take, for example, an impact evaluation of the relative impacts of two different but simultaneous youth job-training programmes in two different cities. One should not look at the net unemployment rate at the end of the programmes, because the starting values for the unemployment rate in the two cities may have been different. A difference-in-differences (DiD) approach instead compares the magnitudes of the changes in the unemployment rate in the two cities. A basic assumption of DiD is the common trend assumption, namely that treated and control groups would show the same trends across time in the absence of policy intervention. Hence the change in the outcome variable for the control group can be used as an estimate of the counterfactual change in the outcome variable for the treated group.

The difference-in-differences (DiD) method was used to measure SMEs' performance in terms of employment, turnover and labour productivity. The control group of firms included non-funded framework programme applicants just below the funding threshold that never received H2020 funding due to budgetary constraints (i.e. their applications passed the minimum proposal quality thresholds). The Orbis database was used to retrieve longitudinal financial data for the panel analysis. In Orbis, longitudinal data can be retrieved for up to 10 years, which means that information on turnover, employment and labour productivity are available for the period 2013-2021. The analysis focused on private SMEs, i.e. firms that were flagged as private for-profit entities and SMEs in the CORDA database, which are validated via the Orbis database as being for-profit firms. In addition, the Orbis size classification was also applied to build the sample. Firms with inactive status variable in Orbis were removed (either because the firm has been dissolved or entered into bankruptcy or liquidation, or has been subject to a merger or takeover).

Regression discontinuity design (RDD)

This CIE technique exploits situations in which eligibility for the programme depends on certain observable characteristics, such as a requirement to be above (or below) an age threshold such as 40 years of age. Individuals close to the threshold on either side are compared, and the jump of the expected outcome variable at the threshold serves as an estimate of the local average treatment effect. As an example, consider an EU regulation that applies to firms above a certain size; regression discontinuity design (RDD) can be used to compare the outcome of interest, such as the profit margin, of treated firms above but close to the firm-size threshold with the same figure for control firms below but also close to the firm-size threshold. Firms that lie around the cut-off level are supposed to be close enough to be considered similar except for treatment status. RDD requires policy participation assignment to be based on some observable control variable with a threshold. RDD is considered a robust and reliable CIE method, with the additional advantage of being easily presentable with the help of graphs. Since the observations that contribute to identifying the causal effect are mainly those around the threshold, RDD may require large sample sizes.

Propensity score matching (PSM)

This CIE technique compares the outcome variable for treated individuals with the outcome variable for matched individuals in a control group. Matching units are selected such that their observed characteristics (controls) are similar to those of treated units. The matching is usually operationalised via a propensity score, which is defined as the probability of being treated given a set of observable variables. As an example, imagine that one needs to evaluate the impact of an EU-wide certification process for chemical firms on firms' costs. This certification process is voluntary. Because the firms that applied for the certification are more likely to be innovative enterprises, one should compare the results for the treated firms with those for similar untreated firms. One possibility is to define the control group by matching on the level of R&D spending. PSM requires a (comparatively) large sample providing information on many variables, which are used to perform the matching.

Counterfactual analysis in the *ex post* evaluation of Horizon 2020

It is important to stress that for such analyses a longer time frame would be ideal, not only due to the nature of innovation policies, which take longer to materialise than other fields, but also due to data reporting delays. Hence, a positive observed result at this stage might be an underestimation of the actual result observed over a longer timeframe. For the same reason, the absence of positive results should not be alarming at this stage.

Firms

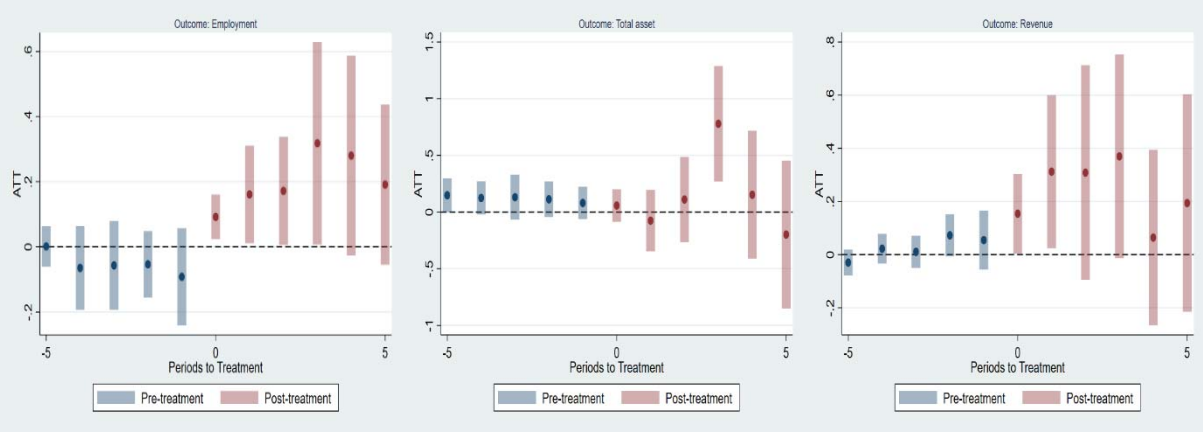
The overall causal impact of the Horizon 2020 on firm-level outcomes has been assessed by the mean of a difference-in-differences (DiD) approach[45], comparing the changes in outcomes for successful applicants to the changes in outcomes for unsuccessful applicants.[46] The study employs information on participants retrieved from CORDA and from Orbis balance sheets data from 2010 to 2022. To increase comparability between the treatment and control group, the analysis excludes unsuccessful applicants with low quality proposals, leading to a sample of about 41 000 unique private companies that applied for Horizon 2020 funding. The counterfactual results suggest that firms receiving H2020 grants increased on average their employment level by about 20% (compared to non-funded firms) and their total assets and revenues by about 30% in the years following the receipt of the first grant (Figure 6). Effects are

[45] As developed by Callaway, Brantly, & Pedro HC Sant'Anna (2021), 'Difference-in-differences with multiple time periods', *Journal of Econometrics*, 225(2), 200-230. Allowing for variation in treatment timing and heterogeneous treatment effects.

[46] Mitra, Alessio and Niakaros, Konstantinos (2023), *The Horizon Effect: A Counterfactual Analysis of EU R&I Grants,* https://data.europa.eu/doi/10.2777/584781.

present even after 2.5 years (the average duration of a project in our sample). Such a result confirms the positive and causal impact of the framework programme on beneficiary companies' growth.

Figure 6: DiD estimates on the effect of Horizon 2020 on firms' outcomes



Source: Mitra, Alessio, and Niakaros, Konstantinos (2023), *The Horizon Effect: A Counterfactual Analysis of EU R&I Grants*, https://data.europa.eu/doi/10.2777/584781
Note: Confidence intervals at 99% level. Doubly robust DiD estimates incorporate individual and time-fixed effects, NACE and country-fixed effects, as well as the number of times companies have applied to Horizon 2020 calls.

A counterfactual analysis[47] covering Horizon 2020 for-profit SMEs found effects on the employment and turnover of Horizon 2020 beneficiaries. The study employed a difference-in-differences (DiD) method. The control group included those programme applicants that were above the threshold (so they could have received EU funding) but did not receive it due to budgetary constraints.

A crucial assumption in a DiD setting is that in the absence of H2020 participation, the economic performance of the treatment group follows the same evolution of the control group ('the parallel trend assumption'). It is important to stress that for analysis, using the DiD method a longer time lag would be needed to claim causality with certainty; however, the study team did not have access to earlier data.

When looking at the whole programme, the employment level of the treated firms grew by more than 4% after 2016 compared to the control group, at an increasing rate until 2020. Similarly, the treatment group experienced a higher growth of turnover than the firms in the control group after 2014. After 2017, the treated firms grew more than 10% compared to the control firms. When restricting the analysis to the industrial leadership, firms in the treatment group experienced a higher growth of employment compared to the firms in the control group after 2014. In 2017, the treated firms grew 5% more than the control firms. The results for turnover are in line with the results for employment: firms in the treatment group experienced a higher growth of turnover than the firms in the control group after 2014. In 2018, the treated firms grew 12% more than the control firms. The study found no effect on productivity.

[47] Innovative Europe study (2023), Annex 4, https://data.europa.eu/doi/10.2777/467162.

When restricting the analysis to societal challenges, firms in the treatment group experienced a higher growth of turnover than the firms in the control group after 2014. In 2015, the treated firms grew 6% more than the control firms. The study found no effect on employment or productivity.

SME Instrument

A paper[48] focusing on the first 3 years of the SME instrument, phase II, studies various firm-level outcomes using an RDD approach, comparing successful applicants close to the threshold for funding.

The findings suggest that these grants lead to an increase in subsequent firm investment, particularly in intangible assets. They also result in a boost in innovation output, as indicated by a rise of between 15% and 31% in citation-weighted patents, which occurs both through the intensive and extensive margins. In other words, R&D grants not only affect firms already involved in innovative activities but also lead to more firms engaging in patenting. Additionally, R&D grants are a catalyst for subsequent equity investments, with firms experiencing over a 100% increase in likelihood to receive private equity, leading to more significant funding rounds and a higher number of deals. Moreover, these grants have a positive impact on the rate of firm growth (28-56%) and reduce the probability of failure by over 100%.

European Innovation Council Pilot

An assessment of the European Innovation Council (EIC) Pilot used a comparative and counterfactual analysis to compare beneficiaries' performance before and after the support and against a comparator group. Matching difference-in-difference (M-DiD) was applied to accelerator calls that took place in 2018.

The analysis only considered projects approved in 2018 since company performance needs to be observed at least 2 years after the treatment to consider projects' state of advancement. The analysis assessed company performance between 2015 and 2020. The years between 2015 and 2017 constitute the pre-treatment period, 2018 the treatment period, and the years between 2019 and 2020 are the post-treatment period. The control group was built using propensity score matching (PSM)[49].

Companies that received EIC support performed better than other applicants when compared for some key performance parameters. Data show that on average, before accessing the EIC, beneficiary companies were smaller and on a growth path that strengthened after the EIC support. This result can be interpreted as a positive sign of the programme's capacity to spot and select entrepreneurial and innovative talent. The counterfactual analysis results show a positive causal relationship between the EIC support and the companies' capacity to generate additional jobs.

However, it is important to stress that a more revealing analysis of economic impacts should be based on a longer time horizon than was possible for this evaluation. The short-term positive impact on beneficiary companies' turnover and staff reveals the immediate effects of the grant and cannot be considered a sign of successful product commercialisation.

Researchers: FP7 long-term impact

[48] Santoleri et al., *The Causal Effects of R&D Grants: Evidence from a Regression Discontinuity*.
[49] EIC Pilot study, technical annex, https://data.europa.eu/doi/10.2777/645064.

A recent paper[50] estimates the causal impact of receiving a European Research Council (ERC) grant on researchers' productivity, excellence, research networks and the ability to obtain additional funding up to 9 years later. The authors collected information on winning and non-winning ERC applicants between 2007-2013 as well as information on all their publications on Scopus until April 2021.

When looking around the funding threshold (in a regression discontinuity design fashion), i.e. at researchers ranked last among those funded compared with those who ranked first among the non-funded, this study[51] finds that obtaining an ERC grant does not improve researchers' productivity (number of publications), excellence (h-index, publications in top 1% or top 10% ranked journals) or the research network. Nevertheless, those receiving an ERC advanced or starting grant acknowledge on average more EU funds (the 'Matthew effect') than the rejected applicants do, in particular in the fields of physical science and engineering and of social sciences and humanities. However, when the authors look at the total number of funds acknowledged (both EU and all others) there are no significant differences.

Moreover, comparing the evolution of bibliometric outcomes before and after receiving the ERC grant between beneficiaries and non-beneficiaries (in a difference-in-difference fashion) the study finds that overall ERC grants increased research productivity in the long term, namely up to 9 years after receiving the grant (i.e. on. H-Index and publications in top 1% and top 10% ranked journals). When looking at different academic fields, some areas, like universe and earth sciences, chemistry, medicine, human mind studies and institutions and behaviour, showed positive effects on productivity and excellence, depending on the measure used (i.e. number of papers, number of paper in top 10 % or top 1% ranked journals, H-index) and type of grant received (i.e. starting or advanced grant). The results of the DiD model also confirmed the evidence of a 'Matthew effect' across all fields with researchers who received an ERC grant. They were more likely to obtain other EU grants by themselves (or through their co-authors) even if the total number of funds they received was similar to that of non-beneficiaries (i.e. they compensate by seeking other types of funds and in the 9 years after applying to the ERC).

11. Benchmarks

Benchmarking activities provided evidence to inform evaluation questions set out in the Terms of Reference for the impact area evaluation studies. They identified lessons learnt from best practices worldwide supporting research and innovation and they put in perspective the framework programme's performance in the area covered by the study. As a minimum, the benchmarks were based on data analysis and document review, completed by interviews with relevant stakeholders. The following benchmarks were used in the staff working document:

Table 11: Benchmarks

International benchmark	Comparison with:
Evidence from the benchmarking exercises demonstrated that the publication citation scores of Horizon 2020 were higher than all the other international funders in most of the analysed disciplines – both in terms of the share of top 1% most cited publications and average normalised citation score of its publications. [Excellent Science study]	NOW (the Netherlands), the French National Research Agency (ANR), the Australian Research Council (ARC), the FCT (Portugal), the Austrian Science Fund (FWF), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the National Science Foundation (USA)
Benchmarking related to the direct leverage was also conducted cautiously by DG RTD, to compare between same types of leverage (in this case direct leverage, and not investments	National Science Foundation (USA) and ERDF funding for SME competitiveness (EU)

[50] Ghirelli C., Havari E., Meroni E. and Verzillo S. (2023) *The Long-Term Causal Effects of Winning an ERC Grant*, JRC133001.
[51] Ghirelli C., Havari E., Meroni E. and Verzillo S. (2023) *The Long-Term Causal Effects of Winning an ERC Grant*, JRC133001.

after the projects), and similar technology readiness levels (TRLs). Similar direct leverage factors were found. In particular, - The U.S. National Science Foundation generally does not allow voluntary committed cost sharing in its proposals. This means a funding rate of 100%, and hence a direct leverage factor of 0, similar to Horizon 2020 for this type of research (accounting for a third of Horizon 2020 funding). - ERDF funding for SME competitiveness has a leverage factor of 0.43. However, this funding is distributed to the Member States and regions, rather than directly to the SMEs. For Horizon 2020, the leverage factor of funds going to SMEs is 0.34.	

12. Case studies

Overall, 154 case studies were conducted, covering the different programme parts, as well as specific aspects of Horizon 2020 such as cross-cutting issues, the EIC Pilot and partnerships. The impact area evaluation studies had 15 case studies each, while the study on relevance and internal coherence had 20 case studies, the study on external coherence – 23, the study on cross-cutting issues – 14, the EIC Pilot evaluation – 15, and the study on the proposal evaluation system for the R&I programme – 7.

13. Policy workshops

Some 20 policy workshops were conducted to support this evaluation. The workshops were implemented in the context of the independent external studies. They were used to consolidate and increase the robustness of the findings and conclusions arising from the data collection conducted through other methods, addressing evidence gaps whenever needed.

14. Public consultation

The public consultation on the *ex post* evaluation of Horizon 2020 was part of a larger joint consultation exercise looking at the past present and future of the R&I framework programmes (*ex post* evaluation Horizon 2020, interim evaluation Horizon Europe and the 2025-2027 strategic plan). In full compliance with the Better Regulation requirements, the online questionnaire was published, among other places, on the Have your Say portal[52], also offering the possibility to submit position papers. It ran from 1 December 2022 until 23 February 2023.

Excluding the respondent characteristics questions, the section on the *ex post* evaluation of Horizon 2020 included 20 questions. Among the 20 questions, there were 5 questions where respondents could give further insights in an open answer box. In total, the Commission received 2 788 responses to the questionnaire, with 1 818 replies received for the Horizon 2020 section. Statistical analysis of closed questions was performed to explore differences in opinion between types of respondents. The affiliations of respondents (e.g. SME, academia, public authority) are self-reported, and were not verified. The analysis of the open questions followed a qualitative method of approach. The questions were analysed either with the use of basic qualitative analysis (i.e. grouping respondents into broad groups and reading the responses to get an overview of the key themes) or with the use of a word cloud function (the function is used to indicate the most frequently used words in the qualitative responses and present the results graphically).

[52] https://ec.europa.eu/info/law/better-regulation/have-your-say_en

In addition to the online questionnaire, 229 position papers were received as part of the public consultation. After the compilation of all the position papers and the first screening and the removal of duplicates, campaigns and documents not addressing the Horizon 2020 programme directly (e.g. promotional material), 21 papers were analysed. The factual summary report and position papers have been published on Have your Say portal[53]. The analysis followed a qualitative method of approach. Based on a sample of position papers, a coding frame of broad themes was constructed. The final analysis per theme and any emerging sub-themes was conducted by type of respondent: academia, research organisations, public authorities, businesses, NGOs, citizens and others.

Overall limitations of the Horizon 2020 *ex post* evaluation

Methodological and data limitations were identified (listed below). Thanks to thorough checks ensuring that data is robust, these limitations did not affect the overall reliability of the analysis and the findings. Nevertheless, the evaluation faced the following challenges and limitations:

a) The ongoing implementation of 40% of projects represents a challenge for assessing impact (a challenge faced also by the *ex post* evaluation of FP 7 when 50% of projects were still ongoing). This is compounded by the long period of time needed to contribute to impact in the field of R&I. However, the legal basis determined when the evaluation must be done - subsequent evaluations can follow up and assess the long-term impact of Horizon 2020.
b) Some parts of the programme, such as the EIC Pilot, were implemented at the end of the programme, and so only future analysis can provide more extensive information on its impacts.
c) As noted already in the interim evaluation, Horizon 2020 indicators refer only to parts of the programme's intervention logic. There are limitations on data on the programme's outcomes and impact (for example, most Horizon 2020 indicators focus on input/results but not on the uptake of the results or their impact). The set of official programme indicators did not cover the entire intervention logic equally across impact areas: economic effectiveness was thus easier to assess as official indicators focused on contribution to company turnover, employment and GDP. Similar indicators are not available for assessing contributions to the Innovation Union flagship or other EU policies.
d) Indicators are defined in a suboptimal way, as they are not systematically accompanied by baseline values (i.e. values before the programme) or by target values (i.e. expected values at the end of the programme). They are also sometimes ambiguous, particularly when presented in short form (e.g. KPIs 9, 10, 11).
e) Some cross-cutting issues did not have accompanying indicators, while others are so complex that the selected KPIs cannot really provide a complete picture of progress (i.e. ERA, Innovation Union, Widening participation).
f) Some indicators addressed only actions supported by a single DG, programme part or type of action, and their data could not be aggregated with data collected for other indicators (which addressed another target group, for example). This led to challenges in 'telling the story' of what the programme achieved as a whole, without delving into its parts. There were also challenges regarding: (i) the aggregation of datasets (for example, most indicators are collected for specific programme parts only and not for the whole programme, and monitoring data covering the entire programme come from various data sources, which are difficult to aggregate); and (ii) the disaggregation of datasets (for example, to see the results of partnerships alone).
g) Where possible, key performance indicators were to be calculated ad hoc for the evaluation, in most cases from Commission monitoring systems. For a few indicators (KPIs 1, 4, 9-10-11, 22-23), figures were provided by other Commission departments and implementing authorities. Occasionally, data from the 2022 programme statement for the framework programme are used, as publication of the Horizon 2020 data in the programme statement of 2023 was suspended.

[53] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13444-Horizon-2020-programme-final-evaluation/public-consultation_en

h) Monitoring data recorded in the Commission IT systems can minimise but not completely exclude cases of multiple counting. This is particularly true for indicators reported in aggregate form, such as innovations and dissemination activities. Granular reporting on intellectual property rights and publications is provided voluntarily by beneficiaries. This may result in inaccuracies, such as under-reporting (especially for patents) and poor formatting of data, which detract from the accuracy of counting and matching to external data sources. Both these points are examined more in depth below in this section.

i) Some specific weaknesses were identified for external impact evaluation studies:
   - The steering committees agreed that the data collected were adequate for their intended use and robust, despite being somewhat limited. (i.e. not all data is available in eCorda or Innovation Radar). In some areas of the studies, the evaluators collected too little additional data/evidence, in addition to what was provided by the Commission and the implementing bodies.
   - In evaluation studies, the analysis of data on IPR outputs was suboptimal as it did not systematically filter out obvious reporting errors.
   - Use of external data sources: presentation of figures from Orbis, Crunchbase and Dealroom databases could have acknowledged the match rate and explained issues in more detail, e.g. in terms of geographical representation.
   - Evaluation studies included several attempts to identify causal effects of participation in the framework programme. However, expert review highlighted critical points weakening the relevance of their findings. Typical shortcomings include: no distinction made between mono-beneficiary and multi-beneficiary schemes; short time series, with no data on firm performance available to the study team before 2013; not enough transparency on the characteristics of the control group and on limitations connected to matching to external data sources.
   - The analysis of equity raised could have been more granular, with reference to the type of funding entities, with particular attention to other public funding, and to the origin of such funding and to the type of entities funded. Limitations of matching to external sources should also be acknowledged more precisely. For the analysis on equity funding rounds, as no all-encompassing databases exist, contractors could have cross-checked the validity of the results with other data sources such as Crunchbase and Zephyr.
   - Occasional uneven thematic coverage in some areas of the programme: for example, findings and conclusions in the area of Societal Challenge 1 were too exclusively focused on research into pharmaceutical and medicinal results, with findings of research into demographic change and well-being remaining extremely limited (e.g. research related to mental health); also, findings and conclusions in digital and industrial technologies were highly developed for the LEIT programme parts, but weaker for coverage of other programme such as Pillar I bottom-up schemes.

A **monitoring system based on self-reporting has inherent limitations**. It is naturally prone to inaccuracies, especially when reporting questions may be interpreted differently by project participants. This limits the usability of figures reported in aggregate form by project beneficiaries, such as non-IPR innovation outputs, knowledge spillovers to other entities, and dissemination and exploitation activities.

Systems allowing for granular reporting, such as the one in place for publications and IPR, are less affected by the issue above, as they allow for easier identification and quality control of unique outputs. However, they remain prone to discretionary under-reporting, which could be temporary (delayed reporting) but could also be permanent. For example, since there is no legal obligation to declare IPR outputs supported by EU funding, applications linked to framework programme projects may well never be reported. At the same time, the monitoring system suffers from a specific type of over-reporting:

participants indicate IPR applications filed before or around the start date of the project. These '**background patents**' (see Glossary), which are an input of research rather than its output, are in fact a common occurrence, especially at the beginning of a new framework programme[54].

In this staff working document, we report figures on IPR from the monitoring system 'as they are' to ensure consistency with baselines and with other monitoring reports such as yearly programme statements[55]. Filtering out 'background patents' is an exercise subject to interpretation, as using the project date alone is not a guarantee that the IPR declared is a genuine project output[56].

Much of the analysis on innovation diffusion from the framework programme is based on analysis of patents and other IPR. However, **IPR productivity is an indicator to monitor in the longer term**. First, there is a considerable time lag between achieving research and innovation results and applying for protection. Evidence from earlier framework programmes shows that participants report them generally towards the end of the projects, and often well after project activities are finished[57]. This is even more important if the subject of interest is **awarded IPRs**: as also remarked in the Horizon 2020 interim evaluation, the European Patent Office may take up to 5 years to grant a patent[58]. With such a long time lag, it is difficult at this stage to assess basic patent quality indicators, such as the number of citations or their economic value.

Second, **IPR figures obtained right after the end of a framework programme – even 2 years later, as for this evaluation – are far from final**. As shown in Section 4.1.5 of the staff working document, the number of reported IPR applications in FP7 is currently much higher than known at time of the *ex post* evaluation for FP7. The difference with the *ex post* evaluation is not only composed of applications filed from 2015 onwards, but also of delayed project reporting. A sizeable number of patent applications (around 1 200) were indeed filed before 2015, but were reported by applicants later, and are hence not included in our FP7 baseline.

As regards the public consultation, the views represented by the respondents are **not representative** of the EU population due to self-selection bias.

To overcome/mitigate these limitations, the evaluation report is transparent in indicating its data sources. Evaluation results have not been based on one data source, but findings were triangulated using various data sources.

[54] European Commission, 'Patents in the Framework Programme – From Horizon 2020 to Horizon Europe', *R&I monitoring and evaluation flash*, August 2020, p. 5.
[55] European Commission, Programme Statement 2022, COM(2021) 300, June 2021, https://commission.europa.eu/system/files/2022-07/ps_db2023_he_h1_1.pdf
[56] The referenced Commission report on patents in the FP ('Patents in the Framework Programme – From Horizon 2020 to Horizon Europe', 2020) considers 'background' applications filed until one year after project start.
[57] European Commission, Directorate-General for Research and Innovation, *Patents in the Framework Programme: from Horizon 2020 to Horizon Europe*, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/789674.
[58] European Commission, *Interim evaluation of Horizon 2020*, 2017, p. 133, https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/interim-evaluation-horizon-2020-key-documents_en.

ANNEX III. EVALUATION MATRIX AND, WHERE RELEVANT, DETAILS ON ANSWERS TO THE EVALUATION QUESTIONS (BY CRITERION)

Horizon 2020 official indicators are highlighted in blue in the matrix below. For more information, see the following publication: European Commission, Directorate-General for Research and Innovation, *Horizon 2020 indicators: assessing the results and impact of Horizon*, Publications Office, 2015, https://data.europa.eu/doi/10.2777/71098

Indicators marked in orange come from Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1291

1. Effectiveness

Evaluation questions	Judgement criteria: *extent to which…*	Indicators and where available – targets	Main data sources
1.1. How effective was Horizon 2020 implementation?	Horizon 2020 strengthened Europe's science base	Share of researchers in the total labour force	Eurostat (RD_P_PERSLF), Professional position: Researchers, Percentage of population in labour force – numerator in FTE
		% of publications from ERC-funded projects which are among the top 1% highly cited [**KPI 1**, no baseline – new under Horizon 2020, target: 1.8%, achieved value: 6.4%]	European Research Council Executive Agency, Annual Activity Report 2022, p. 6
		% of publications published in the top 10% impact ranked journals at FET level [**KPI 2**, no baseline – new under Horizon 2020, target: 25 publications per EUR 10 million funding, achieved value: 25.4 publications per EUR 10 million funding]	Commission monitoring system (CORDA), data on 24 April 2023
		Number of researchers undertaking (a) international mobility under the MSCA, and (b) mobility between academic and non-academic sectors [**KPI 4**, baseline: 50 000 researchers (2007-2013) – out of which 20% PhD, target: for the MSCA: 65 000 researchers – out of which 25 000 PhD candidates, achieved value: 49 475 *unique* researchers – of which 25 676 PhDs]	Excellent Science study, Section 4.4.3, Table 19. Figure based on CORDA data, updated on 19 January 2023
		KPI 5: Number of researchers who have physical or remote access to research (e)infrastructures • Physical access: baseline: 22 000 researchers, target: 20 000 additional researchers, achieved value: 24 235 • Share of researchers with access to e-infrastructures: no baseline or target, achieved value: 35.6%	Commission monitoring system (CORDA), data on 24 April 2023
		Number of joint public-private publications – LEIT [**KPI 8**, no baseline – new under Horizon 2020, no target, achieved value: 10 907]	Commission monitoring system (CORDA), data on 24 April 2023

		Science with and for Society – SWAFS: Number of institutional change actions promoted by the programme [**KPI 21**, no baseline – new under Horizon 2020, target: 100, achieved value: 381 (total) – 348 (Member States only)]	Commission monitoring system (CORDA), data on 24 April 2023
		JRC's annual number of peer-reviewed publications in high-impact journals [**KPI 23**, baseline: 460, target: 500 in 2020, achieved value: 548]	Ex post evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020
		Publication citation scores of Horizon 2020 compared to other international funders (share of top 1% most cited publications and average normalised citation score of publications)	Excellent Science study – benchmarking exercise (based on bibliometric analysis)
		Number of awards and prizes won by ERC grantees (including the Nobel Prize, Wolf Prize and Fields Medal)	Excellent Science study
		% of public consultation respondents who responded that Horizon 2020 contributed to the planned scientific effects 'somewhat' or 'to a great extent'	Replies to stakeholders' consultation
	Horizon 2020 has spread excellence and widened participation in the programme	Spreading Excellence and Widening participation – SEWP: Evolution of publications in high-impact journals in the given research field [**KPI 20**, no baseline – new under Horizon 2020, no target: achieved value: 1 263 before EU funding, 3 098 after EU funding]	Commission monitoring system (CORDA), data at 24 April 2023
	Horizon 2020 has boosted Europe's industrial leadership and competitiveness	EU research and development expenditure relative to GDP [target: 3%]	European Commission, Programme Statements 2022
		The innovation output indicator in the context of the Europe 2020 strategy	Science, Research and Innovation performance of the EU, 2022 report
		% of FP contribution to GDP in the EU: average annual GDP gain and medium gain	Macromodelling analysis. Models: RHOMOLO (by DG Joint Research Centre), QUEST (by DG Economic and Financial Affairs), NEMESIS (by SEURECO ERASME in the Innovative Europe study)
		% of FP contribution to employment in the EU: average annual employment gain and medium gain	Macromodelling analysis. Models: RHOMOLO (by DG Joint Research Centre), QUEST (by DG Economic and Financial Affairs), NEMESIS (by SEURECO ERASME in the Innovative Europe study)
		Number of patent applications and awards in FET per EUR 10 million of funding [**KPI 3**, no baseline – new under Horizon 2020, target: 1, achieved value: 0.84 applications and 0.55 patents awarded]	Commission monitoring systems (CORDA), data on 24 April 2023, Group of Independent Experts, Assessing the Influence of ERC-funded Research on Patented Inventions (2022)

		Number of patent applications and patents awarded in the different enabling and industrial technologies per EUR 10 million of funding – LEIT [**KPI 6**, no baseline – new under Horizon 2020, target: 3, achieved value: 0.56 applications and 0.38 patents awarded]	Commission monitoring systems (CORDA), data on 24 April 2023
		Percentage of participating firms introducing innovations new to the company or to the market – LEIT [**KPI 7**, no baseline – new under Horizon 2020, target: 100% of participating firms, achieved value: 124.2%[59]]	Commission monitoring systems (CORDA), data on 24 April 2023
		Total investments mobilised by Horizon 2020's debt and equity facilities (InnovFin) [**KPI 9, KPI 10:** no baseline – new under Horizon 2020, target: EUR 25 billion investments mobilised; achieved value: EUR 77.5 billion as of April 2022 (debt and equity combined)]	EIB group estimate based on implementation data. Figures reported in European Commission, DG Research and Innovation annual activity report 2021, p. 47. Available at https://commission.europa.eu/system/files/2022-05/annual-activity-report-2021-research-and-innovation_en.pdf
		Number of organisations funded and amount of private funds leveraged by Horizon 2020's debt and equity facilities (InnovFin) [**KPI 11**, baseline: 300, target: 5 000 organisations funded and EUR 35 billion of private funds leveraged, achieved value: 37 921 as of April 2022, EUR 43.6 billion in private funding]	EIB group estimate based on implementation data, reported in annual activity report, p. 47. Available at https://commission.europa.eu/system/files/2022-05/annual-activity-report-2021-research-and-innovation_en.pdf
		Number and percentage of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus 3 years) [**KPI 12**, no baseline – new under Horizon 2020, target: 50%, achieved value: 118%]	Commission monitoring systems (CORDA), data on 24 April 2023
		Growth (turnover) and job creation in participating SMEs [**KPI 13**, no baseline – new under Horizon 2020, no target, achieved value: +4.2% turnover growth, +5.2% direct employment growth][60]	Commission monitoring systems (CORDA), data on 24 April 2023
		Number of organisations from universities, business and research integrated in the KICs [**EIT KPI 1**, baseline: 200	European Commission, Programme Statements 2022 (indicator 1 on p. 70), Innovative Europe study.

[59] The figure is reported as it appears in the monitoring system. Ambiguous reporting questions led beneficiaries to indicate more firms than unique participants in the programme. Since data are reported by beneficiaries in an aggregate way, no *ex post* controls on the figure are possible.

[60] Each SME is considered per each time it participated in a grant. The value reported should be intended as an average of all variations between turnover or employment at project start against the most recent value reported by the beneficiary (which may vary from project to project depending on reporting date). Turnover and employment values are used for the calculation as they are self-reported by participants and may be inconsistent with official sources.

		organisations in the 2010-2013 period, target: 1 200, achieved value: 2 153 in 2020]	
		Number of new graduates from EIT-labelled PhD and Masters programmes [**EIT KPI 2**, achieved value: 3 845]	Innovative Europe study (2023), Table 14, p. 45
		Number of business ideas incubated [**EIT KPI 3**]	Innovative Europe study
		Sum of knowledge transfers/ adoptions [**EIT KPI 4**]	Innovative Europe study
		Number of new or improved products/services/ processes launched onto the market as a direct output of a KIC activity [**EIT KPI 5**, achieved value: 1 501]	European Commission, Programme Statements 2022 (Indicator 2 on p. 71: collaboration inside the knowledge triangle leading to the development of innovative products, services and processes) Innovative Europe study
		Attractiveness of education programs: Ratio of the number of eligible applicants for EIT-labelled PhD and Masters programmes divided by the number of available places on these programmes [**EIT KPI 6**]	Innovative Europe study
		Number of start-ups and spin-offs created as a direct output of a KIC activity [**EIT KPI 7**, baseline: 33, target: 66, achieved value: 305 start-ups and spin-offs across Climate KIC, EIT InnoEnergy, EIT Digital, EIT Health and EIT Raw Materials in 2010-2016; additional 36 start-ups created by students enrolled in and graduates of EIT-labelled MSc and PhD programmes in 2017-2020; 99 start-ups created as a result of innovation projects for the indicated KICs]	European Commission, Programme Statements 2022 (Indicator 2 on p. 71: collaboration inside the knowledge triangle leading to the development of innovative products, services and processes) Innovative Europe study
		% of public consultation respondents who responded that Horizon 2020 contributed to the planned economic effects 'to a great extent'	Replies to stakeholders' consultation
	Dissemination, exploitation and communication *measures* have made it possible to reach these outcomes and impacts	Communication: % of public consultation respondents who rated 'communication activities on Horizon 2020 to attract applicants' as 'very good' or 'good'	Replies to stakeholders' consultation
		Exploitation: % of respondents who reported the following developments since the end of their grant: (a) the project results have contributed to opening a new stream of research and innovation in the institution; (b) the project results have been/will be used in other (follow-up) projects; (c) the project results have been/will be commercialised (i.e. used to create new products and/or services); (d) the project results have been/will be used to improve available products and/or services	Replies to stakeholders' consultation

		Dissemination: % of respondents who believe that various EU platforms and dashboards helped to disseminate, exploit and access research and innovation results	Replies to stakeholders' consultation
		Dissemination: Extent of compliance with the open access requirements of Horizon 2020, for both publications and research data	European Commission, *Monitoring the open access policy of Horizon 2020* (2021) Replies to stakeholders' consultation
	Horizon 2020 increased research and innovation's contribution to key ***societal challenges***	Number of publications in peer-reviewed high-impact journals per EUR 10 million funding, for societal challenges [**KPI 14**, no baseline – new under Horizon 2020, target: 20 for all societal challenges, achieved value: 7 per EUR 10 million funding]	Commission monitoring systems (CORDA), data on 24 April 2023
		Number of patent *applications* and patents *awarded* across the societal challenges, per EUR 10 million of funding [**KPI 15**, baseline: to discuss, target: 2, achieved value: 0.35 applications and 0.26 patents awarded, per EUR 10 million of funding]	Commission monitoring systems (CORDA), data on 24 April 2023
		Number of prototypes and testing activities, [**KPI 16,** no baseline – new under Horizon 2020, no target, achieved values: prototypes 262 297, testing activities 386 078[61]]	Commission monitoring systems (CORDA), data on 24 April 2023
		Number of joint public-private publications, for Societal Challenges [**KPI 17**, no baseline – new under Horizon 2020, no target, achieved value: 13 436]	Commission monitoring systems (CORDA), data on 24 April 2023
		Number of new products, processes and methods launched into the market [**KPI 18** – not legally compulsory. No baseline – new under Horizon 2020, no target, achieved values: Total number of projects introducing either a new methodology, a new process or a new product: 5 970; Total number of projects introducing a new methodology: 2 955; Total number of projects introducing a new process: 2 941; Total number of projects introducing a new product: 5 306[62]]	Commission monitoring systems (CORDA), data on 24 April 2023
		% of the overall energy societal challenge funds allocated to renewable energy, end user energy efficiency, smart grids and energy storage activities [**KPI 19**, no baseline – new approach under Horizon 2020, target: 85%, achieved value: 69.6%]	Commission monitoring systems (CORDA), data on 24 April 2023

[61] Data self-reported by beneficiaries in aggregate way: controls for e.g. duplication are not possible. The figures are reported as they appear in the monitoring system.
[62] Data self-reported by beneficiaries in aggregate way: controls for e.g. duplication are not possible. The figures are reported as they appear in the monitoring system.

		Annual number of occurrences of tangible specific impacts on European policies resulting from technical and scientific support provided by the Joint Research Centre [**KPI 22**, baseline: 248, target 330, achieved value: 513]	Ex post evaluation of the activities of the JRC under Horizon 2020 and Euratom 2014-2020 (Table 2[63], p. 69)
		% of public consultation respondents who responded that Horizon 2020 contributed to the planned societal effects 'to a great extent'	Replies to stakeholders' consultation
	international cooperation and, more specifically, association of third countries to the Horizon 2020 has made a difference in achieving its objectives	International cooperation [CCI KPI **7**]: - % of third-country participants in Horizon 2020 - % of budget of topics in the work programmes mentioning at least one third country or region	Commission monitoring data (R&I Dashboard, data on 31 December 2022)
		Level of agreement among stakeholders that Horizon 2020 enabled international collaborations that otherwise might not have come into existence	Replies to stakeholders' consultation 5 impact area evaluation studies (links in Annex 2)
	use of different instruments, including partnerships, made it possible to achieve impact for science, economy and/or society	Adequacy of the policy mix	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix
		% of public consultation respondents who reported that partnerships have been 'very much' more effective than regular collaborative research	Replies to stakeholders' consultation 5 impact area evaluation studies (links in Annex 2)
1.2. To what extent has the FP contributed to achieving the EU policy priorities?	Horizon 2020 strengthened the European Research Area	Contribution to realising the European Research Area [CCI KPI 1]: - Annual number of research positions advertised on EURAXESS Jobs - Number of national research infrastructures networked - Number and percentage of open access articles published in peer-reviewed journals - Number of projects that make scientific data accessible and re-usable and number of scientific datasets made accessible and re-usable - Number of multiannual implementation plans adopted by joint programming activities	Evaluation study on the implementation of cross-cutting issues in Horizon 2020
		Level of agreement among stakeholders that Horizon 2020 influenced the national policies	Replies to stakeholders' consultation

[63] Impact is defined as 'the use of JRC results for policy preparation (e.g. impact assessments), monitoring (e.g. COM reports), implementation (e.g. methods, materials, guidance) and evaluation'.

	enhanced participation of Horizon 2020 widening countries in the programme and supported the expansion of a pan-European R&I network	Widening participation [CCI KPI 2]: Total number of participations by EU-28 Member States	Evaluation study on the implementation of cross-cutting issues in Horizon 2020
		% of respondents who agreed or strongly agreed that 'Horizon 2020 spread excellence and widened participation in R&I'	Replies to stakeholders' consultation
	cross-cutting issues were implemented within the FP projects	SME participation [CCI KPI 3]: % of EU financial contribution committed through the SME instrument	CORDA data Evaluation study on the implementation of cross-cutting issues in Horizon 2020 Replies to stakeholders' consultation
		Social sciences and humanities: % of SSH partners in selected projects in all Horizon 2020 priorities [CCI KPI 4]	Evaluation study on the implementation of cross-cutting issues in Horizon 2020
		Science & society: % of projects where citizens, civil society organisations and other societal actors contribute to the co-creation of scientific agendas and scientific contents [CCI KPI 5]	Evaluation study on the implementation of cross-cutting issues in Horizon 2020
		% of respondents who agreed or strongly agreed that 'gender equality as a cross-cutting issue was effectively implemented'	Replies to stakeholders' consultation European Commission, 'Study on the proposal evaluation system for the EU R&I framework programme' (2022)
		Gender [CCI KPI 6]: - % of women participants in Horizon 2020 projects - % of women project coordinators in Horizon 2020 - % of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc. - % of projects taking into account the gender dimension in research and innovation content	Evaluation study on the implementation of cross-cutting issues in Horizon 2020 European Commission, 'Study on the proposal evaluation system for the EU R&I framework programme' (2022)
		Sustainable development and climate change [CCI KPI 8]: - % of EU financial contribution climate related in Horizon 2020 [target: 35%, achieved value: 32%] - % of EU financial contribution in Horizon 2020 related to sustainable development [target: 60, achieved value: 64.4%]	Evaluation study on the implementation of cross-cutting issues in Horizon 2020 Evaluation study on the relevance and internal coherence of Horizon 2020 and its policy mix (Annex C – eCorda data analysis) European Commission, 'Informing global climate action' (2022)
1.3. To what extent has the FP contributed to achieving the SDGs?	projects funded by the FP contributed to EU policy priorities and SDG implementation	Top three SDG projects contributed to, by impact area	5 impact area evaluation studies (links in Annex 2)

1.4. Did the FP successfully reach a wide and balanced range of stakeholders?	allocated funding is concentrated geographically	% of funding allocated by Member States % of funding allocated to EU-15, widening countries and associated countries	Evaluation study on the implementation of cross-cutting issues in Horizon 2020
	allocated funding is concentrated to smaller or larger projects	Comparative likelihood of smaller and larger projects to get funded	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix Replies to stakeholders' consultation

2. Efficiency

Questions	Judgement criteria: *extent to which…*	Indicators	Main data sources
2.1. How efficient have the implementation processes of the FP been, and in particular the simplification measures taken in Horizon 2020?	administration and management have been efficient	Time-to-inform Time-to-sign Time-to-grant	European Commission administrative data 5 impact area evaluation studies (links in Annex 2) Replies to stakeholders' consultation
		% of public consultation respondents who replied that cumbersome project implementation may have prevented participation in the framework programme	Replies to stakeholders' consultation
	project application and selection processes have been efficient	% of public consultation respondents who replied that less or much less effort was required for the application process than expected	Replies to stakeholders' consultation
		% of public consultation respondents who replied that the effort to participate in Horizon 2020 was similar or lower than for the previous framework programme	Replies to stakeholders' consultation
	tangible benefits have resulted from simplified / streamlined rules, procedures or processes	Tangible effects of specific key changes, e.g. reduced administrative burden, faster decision-making	5 impact area evaluation studies (links in Annex 2) European Commission administrative data
		% of public consultation respondents who replied that the following measures largely or hugely reduced the administrative burden: • alignment of funding rules applicable to all EU funds • harmonisation of processes and guidance documents across the programme • using an electronic-only grant management system • further use of the two-stage application process (for some programme parts) • using a new funding model with a single reimbursement rate and a single flat rate • selected projects funded as proposed (no negotiation during grant preparation)	Replies to stakeholders' consultation

2.2. How proportionate were the costs of application and participation borne by different stakeholders groups, taking into account the associated benefits?	administrative costs borne by applicants and participants were lower compared to the previous FP	Ranges of the average applicant's cost of applying under Horizon 2020	Replies to stakeholders' consultation
		Ranges of the average number of person days needed for proposal development under Horizon 2020	Replies to stakeholders' consultation
		Qualitative stakeholder feedback on application cost under Horizon 2020 compared to FP7	5 impact area evaluation studies (links in Annex 2) Replies to stakeholders' consultation
	barriers at application stage and during project implementation did not have negative consequences for the researchers and organisations involved	Identification of barriers Level of agreement among applicants that these barriers did not have negative consequences	5 impact area evaluation studies (links in Annex 2) Replies to stakeholders' consultation
	drivers at application stage and during project implementation had positive consequences for the researchers and organisations involved	Identification of drivers Level of agreement among applicants that these drivers had positive consequences	5 impact area evaluation studies (links in Annex 2)

3. Coherence

Questions	Judgement criteria: *extent to which…*	Indicators	Main data sources
3.1. How coherent has the R&I Framework Programme been between its programme parts, and with other EU programmes serving similar objectives and with national, regional and international initiatives?	implementation of Horizon 2020 was consistent *between programme parts*	Level of consistency/coordination of policy mix in terms of: (i) types of actions (e.g. grants, financial instruments, procurement support); (ii) forms of call implementation (e.g. calls for individual projects, use of focus areas, public-public partnerships, public-private partnerships); (iii) technological readiness levels covered; (iv) targeted beneficiaries	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix Innovative Europe study European Commission, 'Opportunities and challenges in targeted funding of Research and Innovation' (2021)
	implementation of Horizon 2020 was consistent with the European Structural and Investment Funds	Degree to which implementation of Horizon 2020 was consistent with Structural and Investment Funds' European Research and Development Fund (including through the Seal of Excellence)	Evaluation study on the external coherence and synergies of Horizon 2020 with the European research and innovation support system Special report 2022/23 of the European Court of Auditors: 'Synergies between Horizon 2020 and European Structural and Investment Funds' Replies to stakeholders' consultation

	implementation of Horizon 2020 was consistent with relevant national, regional initiatives and joint programming	Degree to which implementation of Horizon 2020 was consistent with the objectives of national policies and programmes (especially partnerships and ERANETs)	Evaluation study on the external coherence and synergies of Horizon 2020 with the European research and innovation support system Sections on ERANETs and joint programming (art. 185 initiatives) in the impact area studies
	Horizon 2020 has worked in synergy with other relevant EU programmes	Degree to which implementation of Horizon 2020 was consistent with other EU programmes such as (i) the Connecting Europe Facility; (ii) the European Fund for Strategic Investments; (iii) Erasmus+; (iv) Life	Evaluation study on the external coherence and synergies of Horizon 2020 with the European research and innovation support system Special report 2022/23 of the European Court of Auditors: 'Synergies between Horizon 2020 and European Structural and Investment Funds' Replies to stakeholders' consultation

4. EU added value

Questions	Judgement criteria: *extent to which…*	Indicators		Main data sources
4.1. What was value resulting from the FP that is additional to the value that could result from interventions which would be carried out at regional or national level?	the stakeholders could not have implemented their research and innovation in another way (i.e. through other national or regional support)	Level of stakeholder agreement that without Horizon 2020 projects would likely not have secured funding and would not have taken place at all		5 impact area evaluation studies (links in Annex 2) Replies to stakeholders' consultation
		% of respondents who stated that participation in Horizon 2020 was beneficial compared to national and/or regional R&I programmes in EU Member States (for various reasons)		Replies to stakeholders' consultation
	Horizon 2020 minimised duplications via collaboration	Level of stakeholder agreement that Horizon 2020 minimised duplication through:	- Collaborative research	Excellent Science study
			- Direct actions by JRC	Ex post evaluation of the activities of the JRC under Horizon 2020 and Euratom 2014-2020
			- EIT and its KICs	European Commission, Programme Statements 2022 Innovative Europe study
			- H2020 widening actions	Excellent science study
			- Innovation actions (demonstration and tests)	Innovative Europe study
	Horizon 2020 leveraged additional resources for R&I	Leverage factor of partnerships: additional resources mobilised by industry and Member States (absolute number in EUR)		Partnerships Biennial Monitoring Report (2022, Section III)

	Horizon 2020 created transnational cooperation	Level of support for distinctive projects that are unlike those that the Member States and their regions fund	Replies to stakeholders' consultation Impact area studies (links in Annex 2)
	Horizon 2020 increased excellence	Degree to which Horizon 2020 increased participants' competitive advantage	PPMI counterfactual analysis Mitra, Alessio, and Niakaros, Konstantinos (2023). The Horizon Effect: A Counterfactual Analysis of EU R&I Grants
		Degree to which Horizon 2020 spread excellence to lower R&I performing countries	Excellent Science study
		% of public consultation respondents who reported that stepping up support to breakthrough innovations through the introduction of the EIC Pilot strengthened the impact of Horizon 2020	Replies to stakeholders' consultation

5. Relevance

Questions	Judgement criteria: *extent to which…*	Indicators	Main data sources
5.1. How relevant has the support to innovation by the Framework Programme (FP), including partnerships, been given the stakeholders' needs and considering the scientific, technological and/or socio-economic problems and issues identified at the time of its design and over time?	the design of the FP (including partnerships) was based on the analysis of ***needs*** of groups targeted for application/participation	Existence of needs falling outside the scope of the FP	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix
		Degree to which the policy mix mobilised ***newcomers***	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix Newcomers monitoring flash
		% of respondents who reported that the FP reached its objectives	Replies to stakeholders' consultation
	the FP demonstrated that it was ***flexible*** in coping with changing circumstances in Europe and in the world	Degree to which the programme integrated lessons learnt during implementation	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix
		Degree to which the programme responded to unforeseen and emergency circumstances, such as the COVID-19 pandemic Speed of response to COVID-19 compared to Zika and Ebola crises	Evaluation study on the Relevance and Internal coherence of Horizon 2020 and its Policy Mix – case study no 21 on how Horizon 2020 and its policy mix came into play in reaction to the COVID-19 crisis Replies to stakeholders' consultation 5 impact area evaluation studies (links in Annex 2) European Commission, 'Meeting the pandemic challenges - Contribution of EU R&I funding to COVID-19 related research' (2022)

Additional details on societal effects of Horizon 2020 projects

A more complete account of societal impacts of Horizon 2020 projects is provided below and in the underlying set of evaluative studies and materials, to complement Section 4.1.2 on Effectiveness: societal impacts.

SC1 – Health, demographic change and well-being

As a minimum, some of the SC1 project publications have been effective **in shaping EU public health policy development**[64]. The effects range from project reports being cited in EU reports and the Eurosurveillance journal[65], to influencing changes in WHO guidelines. The European Centre for Disease Prevention and Control (ECDC) cited the highest number (33) of SC1 publications, followed by the Directorate-General for Health and Food Safety (DG SANTE). In total, 53 (unique) EU policy papers were found to have cited 81 (unique) SC1 project publications. The policy papers include types of documents aimed at informing public health policy and providing guidelines[66].

Case studies on SC1 actions have been able to identify with some certainty an **effect from some Horizon 2020-funded projects on the global health policy discourse**. Examples include the BEAT-AMR project, which developed clinical recommendations and a roadmap on antimicrobial coatings in healthcare settings, and members of the AMR project 'DARWIN' [67], who co-authored international recommendations for the WHO. Several partnership projects have equally contributed to shaping policies and global health advice. One such example was the AMBITION[68]-cm phase III clinical trial, whose results directly shaped an update of WHO guidelines[69].

Positive impacts were achieved by strengthening international collaboration in research between European and African countries and institutions. The public-public **European & Developing Countries Clinical Trials Partnership (EDCTP)[70]** boosted the number of clinical studies and research activities by between 30 and 40% in South Africa, Uganda and Tanzania, and increased by over half the number of studies registered in other countries. It also helped secure a critical mass of resources and expertise, particularly in sub-Saharan Africa. This international collaboration in research was particularly relevant in these areas, where the existing activities had been fragmented.[71] Globally, EDCTP2[72] was identified as the third-largest financial enabler of tuberculosis research globally and the second largest public funder.

[64] This finding is underpinned by analysis of SC1 projects cited in EU policy papers, studies supporting impact assessment, in combination with an assessment of the public health policy impacts in SC1.
[65] See for example the Eurosurveillance journal, https://www.eurosurveillance.org/.
[66] E.g. 'Eurosurveillance: special edition: advanced diagnostics to inform public health policy. March 2019.' and 'Recommendations on FAIR metrics for EOSC.'
[67] The DARWIN–AMR project co-authored international recommendations for the WHO aimed at promoting local national action plans and sociotechnical AMR mitigation options for countries around the world.
[68] The AMBITION-cm – EDCTP2 project led to the updated WHO guidelines on HIV treatment: 'New guidelines developed by WHO strongly recommend a single high dose of liposomal amphotericin B as part of the preferred induction regimen for the treatment of cryptococcal meningitis in people living with HIV'.
[69] https://www.who.int/news/item/20-04-2022-rapid-advice-new-guidelines-for-simpler-safer-treatment-for-cryptococcal-disease-in-plhiv
[70] Resilient Europe study (2023), Annex1, Section 2.3.1 and case study 2.
[71] Evaluation study of the European FPs for Research and Innovation for a Resilient Europe, p. 66.
[72] https://www.treatmentactiongroup.org/wp-content/uploads/2021/12/tb_funding_2021.pdf.

ANNEX IV. OVERVIEW OF BENEFITS AND COSTS, TABLE ON SIMPLIFICATION AND BURDEN REDUCTION

1. Benefits of Horizon 2020

Horizon 2020 gives rise to a range of benefits, presented in Section 4.1 (Effectiveness) in the context of the framework programme's structure and Intervention Logic. In the framework of Better Regulation this means Horizon 2020 generates:

1. Indirect long-term welfare benefits for EU society derived from scientific impact, and related benefits for participants

The R&I framework programmes, including Horizon 2020, **support activities that generate scientific outputs** (e.g. scientific publications) **and outcomes/results** (e.g. positive effects on researcher careers after participation), which are **direct and indirect benefits for its participants** (reported in section 4.1.1, 4.1.6, and also 4.1.2). The direct outputs of Horizon 2020 and some indirect long-term outcomes of FP7 have been quantified and are summarised below. (Table 1, I. Benefits; column: Beneficiaries).

In the long run, these effects on beneficiaries have a strong potential to lead to **indirect welfare benefits for EU society**, i.e. to positive social, environmental, or economic impacts from scientific progress (e.g. improvements in public health). These long-run benefits have not been systematically assessed and are only mentioned in Table 1 (column: Citizens/EU Society): Horizon 2020's future long-term welfare benefits are difficult to predict and may arise in yet unknown areas. The links between past R&I support programmes and currently observable welfare improvements from scientific progress are not systematically monitored. In addition, many external factors contribute to any scientific breakthrough or advancement, which makes it difficult to establish a causal link with specific instances of R&I funding.

2. Indirect wider economic benefits for EU society from diffusion of innovation, and related economic benefits for participants

Horizon 2020 supported industrial research and innovation 'from idea to market', which had the aim to improve innovation diffusion in products, processes, and services. The related **innovation outputs** (e.g IPR applications) and resulting economic **outcomes/results** (e.g. improved economic performance of firm after participation) constitute **direct and indirect economic benefits for private sector participants** (reported in section 4.1.3, 4.1.6, and also 4.1.2). Innovation outputs of Horizon 2020 and some of the indirect (micro-)economic benefits for participants have been quantified or monetised and are summarised below. (Table 1, I. Benefits; column: Beneficiaries).

In the long run, with the effects of innovations in processes and products spreading through sectors of the economy and increasing **productivity** and competitiveness, Horizon 2020 has a strong potential to lead to **indirect, wider economic benefits for the European economy as a whole** (reported in section 4.1.3), ultimately raising the welfare of EU society. Macroeconomic impacts of Horizon 2020 have been estimated in terms of GDP gain and jobs created and are reported below. (Table 1, I. Benefits; column: EU society).

Note on the effects of 'Societal Challenges' programme part: Horizon 2020 supports specific activities focused on tackling **societal challenges** by means of R&I, which have generated scientific outputs (included in benefit 1. above) and innovation outputs linked to economic benefits (included in benefit 2. above). Some activities on societal challenges are geared towards generating **positive direct, non-market effects**, such as informing the policy debate,

which are expected to contribute to **indirect, non-monetary social and environmental benefits** (e.g. positive impacts on gender equality, Europe's security and on achieving SDGs), thus **increasing the welfare of society in the long run**. Although it is considered likely that at least some of these benefits have materialised, they have not been systematically assessed by the evaluation, due to the lack of a monitoring and evaluation framework.

2. Costs of Horizon 2020

The framework programme, including the processes through which it was implemented, has given rise to four main types of costs incurred by different stakeholder groups, which also influence its efficiency:

1. Horizon 2020's operational expenditure - is the main direct cost of the framework programme. It is incurred by EU society and constitutes the input that enables the R&I activities and leads to the generation of benefits to society. The money is invested through calls and other activities (e.g. PPPs, events, studies) and comes out of the programme's voted budget. (Reported below in Table 1, II. Costs)

2. Administrative Cost of the European Public Sector – are funded separately through the Union's budget as Horizon 2020's **Administrative Expenditure**. This cost of administrating and running the framework programme is borne by the **public sector at European level**[73] (and ultimately EU society) and is the second main cost factor that affects its overall efficiency. (Reported below in Table 1, II. Costs)

Evidence collected on the **cost of the proposal evaluation process** (included in the total administrative cost) suggests that an average public sector time cost[74] for the evaluation of one proposal to arrive at between 43.6 hours (multi-stage process) and 58.6 hours (single stage process) of evaluation expert time. An approximate monetised value of the evaluation of one proposal was estimated[75] to about **€ 2 500** (multi-stage) and **€ 3 300** (single stage process), excluding administrative costs of organising the evaluation, based on the pay rate[76] of an evaluation expert.

3. Administrative costs of Horizon 2020 beneficiaries (non-additional, compensated for in operational expenditure) - The 41 575 participants[77] of Horizon 2020 spent substantial effort on the actual research and innovation activities, which generated the benefits, reported under effectiveness. In addition, participants also incurred costs (i.e. spent effort, money and time) to fulfil **Horizon 2020's administrative requirements** for each of their 178 104 participations[78]. These **administrative costs of programme beneficiaries**, while to an extent operationally unavoidable, are not directly productive in terms of benefits. They have the potential to introduce substantial inefficiencies into R&I support. Reducing the administrative costs of beneficiaries was one of the aims of the simplification measures of Horizon 2020 (see section 4.2.2)
In the **public consultation**, the majority of respondents stated that **the effort needed to participate in Horizon 2020 was 'similar' (39%; 692 respondents), or even 'greater' (17%; 303) compared to that under FP7**. Only a minority of respondents (**12%; 219**) **spent less effort** (with one-third

[73] Public sector administrative costs related to the FP at a national, regional, and local level are not covered in the evaluation.
[74] Study on the proposal evaluation system for the EU R&I framework programme. Annex (2022), p. 152.
[75] Horizon 2020's Evaluation support study on Resilient Europe; Annex1 Section 5, Table 60, p. 122.
[76] The Horizon 2020 Model Contract for Experts indicates that the expert is entitled to a fee of EUR 450 for each full day worked in accordance with Article 3(2). Calculation assumes 8-hour day. (https://ec.europa.eu/research/participants/data/ref/h2020/experts_manual/h2020-experts-mono-contract_v1.1_en.pdf).
[77] Corda dashboard data: Unique participants in signed grants, as of 1/1/2023.
[78] Corda dashboard data: Participations in signed grants, as of 1/1 2023.

of the respondents not providing an opinion). Although exact percentages differed, the overall pattern of the feedback matched that of responding EU citizens (34% similar, 13% greater, 9% lower effort) and was influenced by responses from **academic and research institutions** (41% similar, 21% greater, 12% lower effort), with over 190 respondents (over one-fifth) of this stakeholder group reporting a cost increase relative to FP7. Improvements seem to have been slightly more pronounced for the private sector, according to responses from **business associations** (44% similar, 16% greater, 28% lower effort) and **companies/business organisations** (40% similar, 12% greater, 14% lower effort).

When comparing the participation of Horizon 2020 to 'other research and innovation programmes', **a larger share considered the relative effort under Horizon 2020 'similar' or 'greater', than 'lower'.** Responses varied substantially by sub-group. Whereas approx. 20% (26) of respondents from Associated Countries reported Horizon 2020 required comparatively lower effort, this was the case for only half that share of respondents from EU Member States (EU15: 12.3%, EU13: 10.1%). compared the programme favourably to alternative sources of funding. Effort to participate in Horizon 2020 vis-à-vis other R&I programmes: among half of the respondents from both EU-associated countries as well as third countries **was greater**, compared to only 33% among EU-13 respondents. Similarly, 50% of academic institutions reported the same, along with business associations (41%), companies and business organisations (37%) as well as EU citizens (40%). A lower share of respondents, notably from NGOs (33%), non-EU citizens (31%) and public authorities (29%), indicated that the effort was higher – leading to the assumption that for these respective groups, Horizon 2020 was more accessible.

Around 300 respondents provided information on the **time cost to manage participation** in terms of the '**average number of person-days**[79] spent during the entire project', which allows for some very approximate quantification. As expected, projects of longer duration experienced higher total administrative time costs, however, particularly the 12-month (71 person-days) and 48-month (332 person-days) long projects showed **high average administrative time costs** of **6 to 7 person-days per month**. Projects of 24 months (103 p.-d.) and 36 months (157 p.-d.**)** length spent **just under 4.5 person-days per month on average**.

Expressing the two modes of average values, of 4.5 person-days/month and 7 person-days/month, as **order of magnitude money values**, would imply that the **total beneficiaries' administrative cost of Horizon 2020** amounted to between **EUR 135 million and EUR 215 million[80].** The upper bound of the range could, however, **be too low by an order of magnitude**. A spot check[81] against project reporting information suggests that projects **of 60 months duration and more** may have average monthly time costs (of tasks that constitute additional administrative burden) that **far exceed 10 person-day per months**. As the grouping of tasks into work packages and the numbering and labelling of these packages is different for each project, the reported cost information cannot be systematically used for an *ex post* assessment. The time ranges for projects of the same duration, reported in the public consultation, were in some cases vast, likely reflecting the diversity of circumstances as well as potential question design issues: The 156 respondents with projects of **36 months duration**, for instance, reported costs from **2 person-days per month to a value of 1,500 person-days per months** (even correcting for

[79] i.e expressed in multiples of working days of one person.

[80] This monetisation uses the programme's total number of project months (1 284 101 months) and is based on the wage tariffs of Better Regulation Tool 58 (footnote 836; One-In-One-Out calculator, using Eurostat and 2018 Labour Force Survey data), with an assumed 8 hour working day, European average values and the assumption that work is carried out by a person with profile ISCO 4.

[81] The average values have been spot checked for plausibility against a small number of randomly selected Horizon 2020 projects of different project durations, using reported effort by the coordinator (reported in person-months, that use 220 working days per year) The effort was taken from the work package that in each case closest matched tasks representing additional administrative burden.

outlier), the latter value suggesting that about 82 people were occupied with administrative requirements full-time. It cannot be excluded that responding beneficiaries may have interpreted the question in an unintended way, reporting too high values (including time for internal coordination or for project activities overall) or too low values (as not all time spent was perceived by them, due to the respondent's role in the project).

The uncertainty the respondents' interpretation of the question, the non-representative nature of the public consultation as such, and the small sample of respondents overall (particularly for some project types) means that there is a **very high level of uncertainty around the (time) cost values representing beneficiaries' administrative costs of participating in Horizon 2020. The presented values are insufficiently robust to inform programme design**.

4. Costs of applicants - Successful and unsuccessful applicants to the framework programme incur a one-off cost: they invest effort, time, and money to prepare proposals. Application costs are mainly determined by the specific requirements of the programme part and rise with an increase in competition between applicants. For an evaluation, from the point of view of EU society, these application costs are relevant. They have the potential to introduce substantial external inefficiencies into the R&I support, as time, effort, and money spent by unsuccessful applicants can, to a great extent, become a deadweight loss to society unless captured suggests otherwise. High application costs also drive away potential applicants and so have the potential to distort the participation of applicants with respect to relevant characteristics, such as capital constraint, lack of experience, and the availability of outside options of funding to the applicant.

How high were the costs of applicants?

The evaluation has brought together around 40 individual instances of evidence of variable but generally low levels of robustness on the actual cost of application. The cost data received suggest that actual costs seem to **vary widely by funding instrument**. They are also **influenced by the evaluation process (multi/single stage) and type of stakeholder group** targeted. **The information available is of insufficient quality to generate a robust aggregated cost of applicants for the programme. It nevertheless illustrates the order of magnitude of the costs of preparing a proposal**.

In the context of several support studies, the evaluation collected some evidence from beneficiaries on costs of applications[82] expressed in money terms. The **average monetised cost of a single proposal varies substantially by funding instrument** (and likely also by the potential grant size), with the lowest average value of **€ 6 000** for a SME Instrument phase 1 proposal[83] to over **€ 73 400** for an upper range INFRA proposal[84]. Past application cost evidence, provided by the European University Association (EUA) in the context of the Horizon 2020 interim-evaluation, can serve as a point of comparison, even though the reported range of € 10,000 to € 100 000 per proposal applies only to researchers[85].

[82] Although the evidence predominantly stems from beneficiaries, success is not assumed to be generally correlated with application costs across the FP, although it likely has some influence at the margin.

[83] Evaluation study on Innovative Europe, the reported range for SME I proposals is approx. €6 000 to € 25 000.

[84] Evaluation study on Excellent Science, the reported range for INFRA proposals is approx. €44 900 to € 73 400.

[85] European University Association (2016), estimates based on a member survey with contributions from more than 150 universities from 28 Europe countries; https://eua.eu/resources/publications/346:eua-member-consultation-a-contribution-to-the-horizon-2020-mid-term-review.html

The application costs for some instruments appear to fall closer together than for others[86] further reflecting the diversity of applications. The **average cost of one proposal for Horizon 2020 was estimated[87] to fall into the range of €18 000 to €37 000**.

This suggests that the **application costs of beneficiaries** alone, who submitted 33 806[88] successful proposals, would amount to between **€609 million and €1.25 billion**. This value is rendered very uncertain by the lack of adequate, systematically collected evidence and should be read as a **rough illustrative figure only**.

Unsuccessful proposals[89] did not directly lead to productive outputs under to Horizon 2020 but also cost effort and money to prepare. Unsuccessful applicants are a stakeholder group the evaluation has not systematically consulted. Due to a severe lack of robust evidence the estimation of this cost has to rely on strong simplifying assumptions. Two available estimates calculated in the context of the evaluation are highly uncertain but provide an idea of magnitude: the evaluation support study on Resilient Europe arrived at **totals between € 5 410 million** (based on project size weights) **and € 9 160 million** (based on consortium size weights). The evaluation support study on Excellent Science generated a range **between € 4 758 million** and **€ 9 694 million**[90]. The evaluation interprets these results as an indication that **the total application cost embodied in the large number of unsuccessful proposals is likely very substantial and may well reach a value in the order of magnitude of € 5 billion to € 10 billion**.

Evaluations of earlier framework programmes did not report estimates that could be used as direct points of comparison. Quantitative evidence available from the interim evaluation also presented wide ranges: The EUA estimated that, in the first year of Horizon 2020 alone, its members spent between € 268 million and € 2.68 billion on unsuccessful applications. Based on EUA's figures, the interim evaluation estimated that around € 1.7 billion would be spent annually on writing unsuccessful proposals, of which € 643.0 million for non-funded high-quality proposals alone[91].

Public Consultation responses provide basic **time cost ranges**[92] and show a pattern of diminishing proportions of applications as application time costs rise: Responses suggests that **56% of applications take less than 50 person-days, with 80% of applications under 100 person-days**. The study on the proposal evaluation system[93] finds that the average time spent by 'applicants' [94] on a **single-stage application was 25 person-days** and 47 person-days for

[86] For instance, relatively narrow ranges were found for ERC (approx. €19 600 to €28 700, evaluation study Excellent Science); as well as SC1 (€34 000 to €42 000, evaluation study on Resilient Europe. Wide range of application costs was reported by MSCA beneficiaries (around €11 800 to €35 600).
[87] Evaluation study on Resilient Europe estimated a range between €20 000 and €34 000 and the evaluation study Excellent Science €18 257 to €37 169 for one proposal.
[88] Dashboard, Horizon 2020, 'Retained Proposals' as of 01.01.2023
[89] Unsuccessful proposals here includes all proposals, which are effectively unsuccessful as they not lead to any funding under Horizon 2020, including those of high quality.
[90] Evaluation study Excellent Science, Annex I, https://data.europa.eu/doi/10.2777/353383.
[91] SWD on the interim evaluation of Horizon 2020, SWD(2017) 220 final, Section 7.3.2 (Application and evaluation process), p. 60. Scaling the annual value up to a seven-year total for the framework programme is not possible, in the absence of evidence on the distribution of costs over time. An (unlikely) uniform distribution would imply € 11.9 billion, a similar order of magnitude as the higher value of the range found by this evaluation.
[92] Annex 5: Cost of proposal preparation, p. 94.
[93] Study on the Proposal Evaluation System for the EU R&I framework programme, 2022, Table p. 3, https://data.europa.eu/doi/10.2777/16211.
[94] No further breakdown was reported for the question, however, beneficiaries dominate responses. The time cost of the multi-stage application captures the higher time cost of successful applicants. The vast majority of (unsuccessful) applicants only incur costs for the simplified first application stage. The overall average may therefore be expected to be at least equal if not lower than for a single stage procedure.

a (successful) multi-stage application. For **Societal Challenges 2 to 5**[95] (588 responses) lower time costs are reported, **with 47% of applications taking less than 10 person-days** to prepare and **over 80% taking under 20 person-days**.

Project size and the programme part may be two key determinants of the time cost but the evidence collected is insufficient to asses this overall. Time costs of reported LEIT proposals[96]were split by project size and suggest that costs for **projects under €500 000** had a wide range from **15 to over 30 person-days,** whereas the majority of projects of **€500 000 and above** reported time costs **over 30 person-days.** At least half of all projects in all size ranges reported time costs of over 30 person-days, including 75% of coordinators of projects with a budget of at least €5 million, 70% of projects of € 2 million to €5 million and still over 50% of projects between €500 000 and €2 million.

What does the oversubscription and low success rate mean for the efficiency of Horizon 2020?

Horizon 2020 attracted an exceedingly high number of proposals, and even the number of proposals of sufficient quality to warrant funding was a multiple of those actually funded.

In principle, oversubscription of an individual programme part primarily indicates where the resource constraint of the budget is particularly binding. The competition between applicants depends to some extent on the oversubscription of a programme, which in turn increases the likelihood that the eventually funded projects are of good quality and generate benefits and value-for-money.

Very high oversubscription rates, however, have a negative effect on the overall efficiency as **a very large proportion of the effort spent on preparing, and then evaluating, proposals does not lead to any benefits**. **Measures that ensure the costs of the application process are kept as low as possible and measures that allow successful yet unfunded proposals to be re-used in future applications at national or EU level** therefore have the potential to address the situation and increase the programme's efficiency from the point of view of society.

Were application costs 'proportionate' for applicants, taking into account the potential benefits?

The level of oversubscription of Horizon 2020 strongly suggests that up front, at the time the decision is made, the programme is relevant and attractive enough for a very large number of potential applicants to go ahead and invest effort.

Potential applicants chose up front whether to face this application cost or not (in contrast to costs imposed on citizens by a regulation). They consider factors such as how likely they are to receive a grant, the size of the grant, the expected size of the application cost, their own risk profile, their capital constraint, and any alternative routes for funding that are open to them. They may also factor-in that they plan to apply again in the future, or that they can reuse parts of a previously unsuccessful proposal.

[95] Study on the Green Transition, 2023, https://data.europa.eu/doi/10.2777/422725.
[96] Study on the Digital and Industrial Transition, 2023, Annex VI, https://data.europa.eu/doi/10.2777/882919.

Once proposals have been evaluated the situation changes. The vast majority of applicants will not receive a grant. For **unsuccessful applicants** the application costs are to a great extent lost and are unlikely proportionate. For **successful applicants** the proposal in the end leads to substantial benefits. Grants are typically vast relative to the costs of application. The fact that a beneficiary breaks even is, however, not automatically a sign that application costs had been proportionate, as the grant is meant to mainly cover R&I activities and administrative costs. The larger the grant, the higher the success rate of the call and the larger a consortium, the more likely application costs may be experienced as 'proportionate' by an applicant. In contrast, factors such as a smaller or financially weaker applicant (e.g. SME), stronger competition between applicants (low success rates) and a comparatively smaller grant size, increase the risk that the application costs were disproportionate, even for a successful applicant.

Even applicants who directly compete, and therefore face similar application costs and the same level of competition, have different characteristics (e.g. risk aversion) and thus likely consider different rates of return acceptable and different levels of application costs 'proportionate'. Quantitative evidence on what is seen as 'proportionate' by different stakeholder (sub-)groups of R&I funding is not available. Qualitative evidence from the public stakeholder consultation confirmed past feedback that the level of application costs ('cumbersome application process') and success rates ('too low to be worth applying') are seen as problematic for respondents[97].

At the level of the framework programme, in relation to the € 71 195 million of R&I support, applicants spent an indicative total of € 5 610 million (**approx. 8%)** to € 11 250 million (**approx. 16%)** of application costs. Given the insufficient level of confidence in the cost estimates it is not possible to base any firm conclusions on these values and it is a topic for further discussion, what percentage would still be acceptable and constitute 'proportionate' costs. Taken together, the available information is, however, sufficient to suggest that it cannot be ruled out that disproportionate application costs may have been an issue in Horizon 2020, particularly in some areas of the framework programme, possibly also at an aggregate level. The question of proportionality of application costs of R&I support therefore deserves continued attention.

Participation of consultancies in Horizon 2020 consortia

In the context of the evaluation, the question was discussed, whether the (perceived) common participation of 'consultancies' in consortia of Horizon 2020 can be interpreted as an indirect indicator of the framework programme's too high complexity and therefore a sign of its inefficiency. The participation of firms that could be considered consultancies is not monitored but has been assessed *ex post*. It was identified that 228 consultancy companies participated in 6.7% of all multi-beneficiary projects in Horizon 2020[98] overall. It also found that around half of the proposals submitted included a firm in the consortium (not necessarily as coordinator) that was identified by the study to fall within this category[99]. Anecdotal evidence from National Contact Points suggests that consultants frequently attend information events for the framework programme.

In of itself, the involvement of consultancies cannot be seen as an indicator for inefficiencies in the framework programme. Participants organise themselves using division of labour. Different skill sets are involved to carry out research and to prepare a proposal. The splitting of tasks may also just reflect the fact

[97] See, for instance, public consultation responses on 'reasons preventing participation in Horizon 2020', presented in Annex 5, (pp. 83 -85), Table 16,17 and 18, Figure 17.
[98] Study on Resilient Europe (2023, https://data.europa.eu/doi/10.2777/60819. These were consultancy firms 'involved' in any role in Horizon 2020 consortia. Overall, 382 firms were identified using keyword search in Technote database with cross-referencing participants. Website information used to narrow down to 228 consultancy companies.
[99] Study on Resilient Europe, 2023, p. 38, https://data.europa.eu/doi/10.2777/60819. Also Annex 1, p.140, https://data.europa.eu/doi/10.2777/57680. Their presence in the consortia was found to be correlated with a higher success rate but it is unclear whether this association is meaningful.

that consortia include individuals whose time is very valuable (e.g. top researchers, etc) and that there are costs associated with applying and fulfilling administrative obligations of projects (which is not an issue in itself, as long as these are proportionate). The involvement of consultancies in the application process would further point at the existence of economies of scale in proposal writing. Consultancies invest the hassle cost of finding relevant information and to get to know the structure of the framework programme, the rules and procedures, and may have practical experience on how to apply for it. In using this human capital, they add value to the consortium for which they get compensated. Having a niche for firms to specialise on certain tasks may just be the most efficient way for the applicants to organize themselves.

When would the current situation constitute an efficiency problem for the framework programme? - This was the case if employing one of the consultancies was effectively a necessary condition for a successful application and consultancies therefore acted as gate keepers to the framework programme. This would be particularly problematic for applicants with resource constraints (including those from countries to benefit from 'widening' or SMEs). Competition in the specialised consultancy sector (of a region/language) therefore matters. If the consultancy sector is not very competitive and substantial market power exists, consultancies can extract excess profits. Too high application costs and administrative costs of beneficiaries (particularly due to unclear and cumbersome requirements) can generate barriers and favour such a situation, which also would negatively affect the efficiency of the framework programme. Costs of applicants and beneficiaries are therefore key areas to monitor and assess in any future evaluation of the framework programme, as is the share of applicants that make use of specialised consultancies in the different programme parts.

Annex IV Table 1

Table 1. Overview of costs and benefits identified in the evaluation									
		Citizens/ EU Society		**EU Public Administration**		**Horizon 2020 Beneficiaries**		**Horizon 2020 Applicants**	
		Quantitative	Comment	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment
I. BENEFITS									
1. Indirect long-term welfare benefits for EU society from **scientific impact** & related benefits to participants (Sections 4.1.1, 4.1.2, 4.1.6)	one off	**-.-** (No estimate available**)**	**Horizon 2020 strengthened frontier research, contributed to scientific breakthroughs and advancements. It increased the human capital of researchers through furthering EU-wide career development and access to research infrastructures.** In the long run, the supported activities are expected to lead to **sizable and wide-ranging welfare benefits to EU society** (economic, social, and environmental benefits).			**1. Peer-reviewed publications** H 2020: **276 784** **3.9%** in top 1% most-cited publications **26%** on 'future & emerging research& technology fields' FP7+3yrs***: 219620** (*no FP data on % top 1% most-cited and % in future and emerging fields) FP7 (ERC): **9 yrs persistent** (+)long-term effect on **publication activity of researchers** **2. Researchers undertaking cross-sector and cross-country mobility**, incl. PhD candidate	**Direct scientific output** of Horizon 2020 **(benefit to researcher)** linked to expected long-term welfare benefits from scientific impact (Number as of 24/04/2023) **Indirect benefit of FP7 to researcher** **Direct output**		

						H 2020: **49 475**, of which PhDs: **25 676 (52%)** Target: **65 000**, of which PhDs: **25 000 (38%)** FP7: **50 000**, of which PhDs: **20%** **3. No. researchers who gained access to research (e-)infrastructures** H 2020: **24 235*** (incl. e-infrastr.: **162 810**) Target: **20 000** FP7: **22 000** (excl. e-infrastructures) **4. long-term effect on visibility, productivity, and career of scientists** FP7: **2 -5 years,** after proposal, persistent (+) effect	of Horizon 2020 **(benefit to researcher)** linked to expected long-term welfare benefits (KPI4, Number shown as of 01/01/2023; FP7 figures for 2007-2013.) **Direct output** of Horizon 2020 **(benefit to researcher)** (KPI 5; *access gained from FP support; Horizon 2020 figures as of 01/01/2023.) **Indirect benefit of FP7 to researcher**		
2. Indirect wider economic benefits for the EU economy from **diffusion of innovation** & related benefits to participants (sections 4.1.3, 4.1.6, 4.1.2)	one off	**Total impact on GDP** (2020 prices) **estimated: € 429 bn** (range: €421 bn to € 798 bn) **(2014-2040)**, of which	**Horizon 2020 supports industrial research and innovation "from idea to market**", with a view to improve innovation diffusion in products, processes and services, and thereby **improving the competitiveness of industry participants**			**5. Intellectual Property Rights applications** H 2020: **3 898** (0.57/€10m) of which patents **3 012** (77.3%, 0.44/€10m)	**Innovation output** under Horizon 2020, **(benefit to participant**) linked to expected long-term economic benefits. (IPR figures for H2020 as of 24/04/2023, expected to increase; for FP7 as of		

		309bn (€287 bn to €420 bn) over 17 years (2014 -2030) Average GDP gain of around €15.9 bn (€15.6 bn to €28.5 bn) annually over 2014 -2040 FP7: Total impact on GDP estimated 380bn over 17 year (2007-2023) --- **Peak annual impact on employment** in all sectors: **220 000 jobs created** in 2020. (NEMESIS: 229 000 jobs in 2030) Interim eval.: 110 000 to 179 000 jobs created (2014-2030)	**and ultimately boosting the productivity and competitiveness of the EU's economy as a whole.** GDP impact forecast: central scenario presented uses RHOMOLO model output; range/sensitivity uses QUEST, NEMESIS) --------- Employment impacts: central scenario presented uses RHOMOLO model output.			trademarks **499** (12.8%, 0.44/€10m) H2020 excl. ERC: **3 210** IPR appl. (0.58/€10m) FP7+2yrs excl. ERC***:** **2 266** (0.6/€10m) of which patents **1742** (77%) FP7 +9yrs: **6 328** of which patents **5545** (95.4% awarded) **6. Monetised value of one patent** ranges between **under €100 000** and **€1.1 million** depending on sector **7.Start-ups created (**EIT KICs) H2020: **440** Target: **600** Baseline 2012: **33** **8. Innovations generated** H2020: **8 000** tracked by Innovation Radar, of which **31%** new products **28.6%** significantly improved product	01/12/2015, 2 years after end of FP). *Due to monitoring limitations at the time IPR applications linked to ERC could not be reconstructed **Innovation output** under Horizon 2020, **(benefit to participant)** (EIT Knowledge & Innovation Communities (KIC) **Innovation output** under Horizon 2020 **(benefit to participant)** **Innovation output under Horizon 2020 (benefit to participant**		

						9. Access to additional private capital for SMEs Horizon 2020**:** **€9.36 billion** (LEIT) **10. Growth of firm** H 2020 (all private firms): **20%** increase in jobs compared to non-funded firms **30%** increase in total assets and revenue growth compared to non-funded firms (persistent > 2.5yrs) -- (SME Instr.ph II) **28-56%** increase in growth of firm **11. Increase in patenting (SME)** Horizon 2020: **15% -31%** increase in cite-weighted patents	**(Micro-)economic benefit for SME** (sect 4.1.3 access to risk capital) **(Micro-)economic benefit for firm** **(Micro-)economic benefits for firm**		

II. COSTS									
		Citizens/ EU Society		**EU Public Administration**		**Horizon 2020 Beneficiaries**		**Horizon 2020 Applicants**	
		Quantitative	Comment	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment
1. Direct economic cost of R&I funding to EU society (Operational Expenditure)	one off	**€62 133.6 million**	Actual paid **Operational Expenditure** of Horizon 2020 (as of 01/01/2023)						
2. Administrative costs of implementing the R&I framework programme **to EU Public Sector** (Administrative Expenditure)	one off		Costs of administrating Horizon 2020 are incurred by the public sector at European level but are ultimately a cost on EU Society.	**€ 4 292. 3 million** In year 2020: **3.37%** Target for 2020: **max 4.6%**	Actual paid **Administrative Expenditure** of Horizon 2020 (as of 01/01/2023) **Administrative expenditure as share of budget envelope** (excl. JRC, EIT; committed as of 01/01/2023)				
3. Beneficiaries' administrative costs of participation (**Not additional - already included in no.1** Operational Expenditure)	one off					**Time cost:** on average **4.5 - 7 person-days per month of project duration** **€ 135 million – € 215 million** Note: **evidence not robust**. Particularly upper bound value may be substantially higher	**Administrative costs per participation** incurred to meet requirements (e.g. reporting). Monetised order-of-magnitude estimate: A**dministrative costs of beneficiaries**		

						as projects of 60 months and more exceed 10 person-day per project months.			
4. Costs of applications Direct costs of preparing proposals **of successful and unsuccessful applicants**	one off							**€18 000 to €37 000** (evidence not robust) Successful: **€609 million to €1.25 bn** Unsuccessful: **€ 5bn to 10 bn**	**Cost per proposal** (evidence not robust) **Total cost of applications** (evidence not robust)

3. *Simplification measures - additional information on performance*

Expectations - simplification in Horizon 2020

As presented under section 4.2.2 in the discussion of efficiency, 'simplification' was a central to Horizon 2020 and efforts to simplify the programme influenced its design, its rules, financial management, and its implementation.

The ambition was comprehensive, and expectations were clearly expressed. The interim evaluation report of the Seventh Framework Programme had concluded that a more radical approach was needed to achieve a 'quantum leap' in simplification, and that the risk-trust balance needed to be redressed. The European Parliament[100] and the European Council[101] had called to radically simplify access, to simplify to boost the attractiveness and lower the associated burden of EU research funding. The 'radical overhaul' of the administration of FP was seen as the highest priority to be tackled.

The 2011 'Green Paper on a Common Strategic Framework for EU Research and Innovation Funding' picked up on these findings and requests. It identified simplification as a 'top priority' in order to make EU research and innovation funding generate more impact and be more attractive to participants; it also prompted to simplifying participation by lowering administrative burden, reducing time to grant and time to payment, as well as achieving a better balance between cost and trust based approaches.[102]

In consequence, Horizon 2020 substantially changed the set-up and management of R&I support. Previous expectations were repeated in the Regulation establishing the programme, which explicitly introduced 'simplification' as a central aim[103]. Simpler funding rules were expected to reduce the administrative costs of participation and to contribute to the prevention and reduction of financial errors[104].

Horizon 2020 performance against time cost targets (TTI, TTS, TTG)

The quantitative administrative target on time to grant shines a spotlight on one specific aspects of administrative efficiency. Horizon 2020's binding TTG target of 8 months (245 days) per call was more stringent than FP7's previous TTG target of 270 days. Even stricter TTG targets were set for the SME Instrument phase 1 calls (3 months or 92 days), SME I phase 2 calls and FTI calls (6 months or 183 days). An overview over targets and actual achieved values for Horizon 2020 and FP7 are summarised in Table 14. Table 15, and Figure 13 below. Variation across Horizon 2020 remained within a **range of average actual TTGs of 154 to 218 days** (FP7: 271-359 days) and of **74% to 98%** of agreements signed on time (FP7: 9% - 60%).

The performance was not uniform, with **in particular the initial period of the EIC pilot generating delays for companies of up to up to 12 months and considerable uncertainty**. According to the EIC pilot evaluation (2022), 'the EIC Fund was incorporated on 22 June 2020 and operations effectively

[100] 'Simplifying the implementation of the research framework programmes', European Parliament resolution of 11 November 2010 on simplifying the implementation of the Research Framework Programmes (2010/2079(INI)).
[101] Council conclusions on Europe 2020 flagship initiative: Innovation Union. 26.11.2010.
[102] GREEN PAPER From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation funding (COM(2011) 48 final).
[103] Ambition outlined in Recital 20 to Regulation No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 - the FP for Research and Innovation (2014-2020), OJ L 347, 20.12.2013, p. 104.
[104] Ibid.

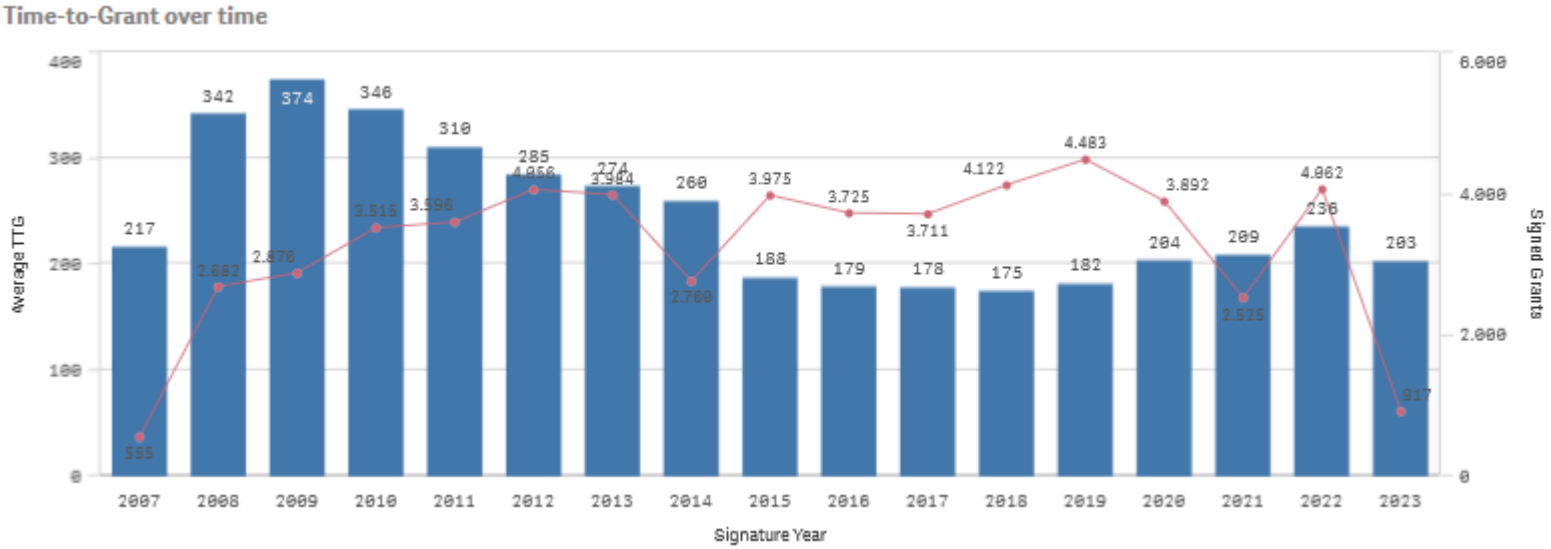
started on 1 September 2020. By that time, 140 companies had already been selected for investment support since the first call was launched in October 2019. Due diligence only started in August 2020. During this process, some companies were surprised when they were eventually offered a convertible loan instead of a full equity investment. Others were taken aback when they understood the implication of the co-investment requirement and realised, they had to look for an additional investor by themselves'.

Table 12: Actual Time-to-grant (TTG)

Programme	**FP7**	**H-2020** (excl ERC)	**H-2020** (excl. ERC, SMEI phases 1&2, FTI)	**H-2020** SMEI phase 1	**H- 2020** FTI	**H-2020** SMEI phase 2
Target [avg. days]	270 days	245 days	245 days	92 days	183 days	183 days
Actual TTG [avg. days (% < t)]	**313 (41%)**	**187 (90%)**	**208**	**92**	**194**	**152**

Source: Monitoring dashboard data frozen 1.1.2023; FP7 TTG based on an overall number of 23'122 FP7 grants, excluding JTI, RSSF and Fusion grants.

Figure 7: Actual average Time-to-Grant values of R&I support over time



Source: Monitoring dashboard data of FP7 and Horizon 20202. Average TTG values (blue bars) and number of signed R&I support grants of both FPs pooled.

In addition to the Time-to-Grant target, covering the entire period from submission of proposal to signature of grant agreement, further (non-binding) expectations on sub segments of this process were formulated for Horizon 2020:

- **Time-to-Inform (TTI) - target 5 months (153 days)** - measures the time from the deadline for submission of proposals to the notification of the applicant on the evaluation outcome.
- **Time-to-Sign (TTS) - target 3 months (92 days)** - measures the time from the notification on evaluation outcome to the signature of the grant agreement.

Horizon 2020 met expectations on time-to-inform and time-to-sign, with the **actual average TTI** (**112 days**[105]) beating the target by 41 days and the **actual average TTS** (**76 days**) by 16 days**.** This suggests that the TTS component of the time before grant signature was the more challenging period, which is also reflected that two programmes ('Societal Challenge' TTS: 99 days; 'Other priorities' TTS: 117 days) on average did not meet TTS expectations. In both the TTS period exceeded the TTI period, however, due to short average TTI periods (SC: 93; Other: 94) the overall TTG targets were met. Variation across the remaining programmes remained within a range of average actual TTIs of 79 to 139 days, and average actual TTSs of 61 to 80, meeting the expectations. A comparison to FP7 is not possible with respect to TTI and TTS as these periods were not monitored at the time.

[105] TTI and TTS monitoring dashboard data (frozen 1.1.2023). For 98.27% of the main listed proposals the TTI of Horizon 2020 stayed under 153 days. (Annual Activity report 2022)

Table 13: Actual average Time-to-Inform, Time-to-Sign and Time-to-Pay achieved under Horizon 2020

	H- 2020 TTI	H-2020 TTS	H-2020 TTG	H-2020 TTP
Target [avg.days]	153 days	92 days	245days	90 days; 30days if prefinanced
Horizon 2020	**112**[106]	**76**	187 (**90%**)	**68**; **6.7(91.5%)**
Excellent Science	139	61	199 (97%)	
Industrial Leadership	79	76	154 (84%)	
Societal Challenges	93	99	191 (83%)	
Spreading Excellence and Widening Actions	138	80	218 (98%)	
Other Priorities	94	117	211 (74%)	

Source: Horizon 2020 Dashboard data, 1.1.2023; Time-to-Pay: (ABAC) accounting data

4. Potential for further simplification - additional information

Adaptation costs linked to changes to programme design, rules and procedures, including simplification measures

The evaluation found that the complexity of the framework programme overall has remained persistently high, resulting in a burden for applicants and beneficiaries. A potential for the reduction of this burden therefore does not only stem from the characteristics of any new design, rules or processes as such (i.e. costs of a new steady state) but also from the transition period during which the changes are designed, tested, announced, introduced and rolled out. The 2018 ECA report[107] highlighted the (one off) **adaptation costs for beneficiaries from any changes to the programme** and the associated **legal uncertainty,** where changes occurred in too quick succession**.** Participants have to inform themselves about updates, interpret the changes, establish with certainty which rules apply to them at a given time and then adjust. The report therefore emphasised **the importance of stable and well-designed rules to minimise participants' administrative costs**. This implies that, even where beneficiaries' administrative costs or application costs would be lower once

[106] Calculated based on dashboard data grant numbers and pillar TTI TTS. Sum of Weighted averages/ total H2020 grant number (all excl ERC).

[107] Court of Auditors. Special Report. N.28 (2018) - Concretely, the report pointed at the introduction of simplified rules on personnel costs, which had to be adjusted again shortly after in response to negative side-effects that had emerged, leading to 'confusion and legal uncertainty'.

simplification measures have taken hold, the transition process is costly and can cancel out at least some of these positive effects. This suggests that **infrequent, carefully designed and piloted step-wise adjustments**, which pay close attention to **the participants' perspective** and are accompanied by **clear communication measures and *ex post* assessments** can have a simplification potential in of themselves.

Table 2 – Achieved simplification and burden reduction (see next page)

As a European framework programme, Horizon 2020 strives to be as simple and efficient as possible. It falls under the Regulatory Fitness Programme (REFIT) of the European Commission, seeking opportunities to simplify and reduce administrative burden for people, businesses and administrations. As presented in section 4.2.2 of the evaluation report, Horizon 2020 introduced two main strands of simplification measures:

- **Structural simplification and a general overhaul of implementation processes**, that had primarily the objective to 1) lower the direct administrative cost of applicants and beneficiaries that are associated with participating in Horizon 2020, and 2) increase the EU public sector's efficiency of administering the framework programme through accelerating all processes relating to proposal and grant management,
- **Simpler funding rules and a revised 'control and risk strategy'.** These measures primarily set out to optimise the balance between the administrative costs of beneficiaries and the benefits of reducing financial errors.

Time to grant – any potential for further simplification?

The average time-to-grant values reported outperform the targets across the programme (see Annex IV.3 above). At a first glance, a further tightening of the targets could hold further potential for simplification. However, like every target, the time to grant target is an imperfect proxy, in this case for the efficiency of activities related to the evaluation of grants and the preparation of the grant agreement. The setting (or tightening) of the target -without any accompanying measure that would make such a change plausible- is associated with the risk of generating (or increasing) negative unintended consequences, particularly when other connected administrative processes are changed at the same time. A shorter time span for grant preparation is associated with an increase in risk of errors. Considering the already material error rates of the programme, any such increase in risk would not be welcome. Furthermore, while an increased use of lump sum funding is expected to keep financial error rates in check, it will simultaneously shift some of the burden of financial checks from the reporting stage to the evaluation (of the proposed lump sums) of proposals. This will potentially reduce again the current scope to further tighten the time-to-grant target. Once a wider use of lump sums has been established, a new assessment of the performance against the target can be carried out to assess any room for manoeuvre. The evaluation therefore finds that it is not recommendable to incentivise a further shortening of the time-to-grant period until the effects of lump sum funding on the timing of the proposal evaluation and on the resulting error rate can be established.

TABLE 2: Simplification achieved and further potential

PART I: *Simplification and burden reduction (savings already achieved)*

*Simplification, burden reduction and cost savings **achieved already** by Horizon 2020, including points of comparison where available.*

	Citizens/ EU Society		EU Public Administration		Horizon 2020 Beneficiaries		Horizon 2020 Applicants	
	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment
Administrative cost savings of applicants and beneficiaries (costs associated with participating in Horizon 2020) due to the structural simplification and general overhaul of implementation processes of Horizon 2020. **Enforcement cost savings for beneficiaries**, due the introduction of a revised 'control and risk strategy'.								
One-off (change from FP7 to Horizon 2020)		.			**Approx. 2 500 unique beneficiaries** (5.74 percentage points reduction) Share of unique beneficiaries audited: H2020: 6.02 % FP7: 11.76% target: max. 7 %	**Number of beneficiaries** who experienced **enforcement cost saving** (relative to FP7 "control and risk strategy".) Evidence on administrative costs of beneficiaries are not systematically collected. Savings due to measures have not been monetised.		Evidence on costs of applicants are not systematically collected. Savings due to measures have not been quantified.
Administrative cost savings of the EU public service (costs associated with administering the framework programme) through accelerating all processes relating to proposal and grant management. The evaluation found that the introduction of the **electronic grant management workflow** and the **withdrawal of the negotiation stage** were key drivers of the acceleration								
One-off (change from FP7 to Horizon 2020)			**Time-To-Grant (TTG) reduction** Horizon 2020 saved over **9 500 years of time** in the EU public sector, relative to	**Time cost saving for public sector from accelerated**	**Start dates of beneficiaries' projects** brought forward in total by over 9 500 years of time. **.**	**Time cost saving for beneficiaries** from accelerated administrative processes.		

			what it would have taken at the speed of FP7. H2020*: **saving of 126 days per grant** on average vs. FP7. Expected saving was **100 days per grant** on average vs FP7. H2020 average TTG: **187 days** per **grant.** 90% within target*of **245 days per grant**. FP7 average TTG: **313 days per grant.** 41% within target of **270 days per grant**.	**administrative processes** (from end of deadline for proposals to grant agreement signature) * excluding ERC <u>Key drivers:</u> - electronic grant management workflow; - removal of negotiation stage.				

PART II: <u>Potential</u> simplification and burden reduction (savings)

*Identified further potential simplification and savings **that could be achieved** with a view to make the initiative more effective and efficient without prejudice to its policy objectives[108].*

	Citizens/ EU Society		EU Public Administration		Horizon 2020 Beneficiaries		Horizon 2020 Applicants	
	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment
Application of unsuccessful applicants are an area with a potential for efficiency savings for the framework programme. The evidence base of the evaluation does not allow to specify any new simplification measures to the extent, that they could be assessed in terms of their expected costs savings'. Potential existing measures that could be extended include: a targeted, carefully tested and designed use of the **two-stage evaluation processes**; and any measures that prevent the loss of the value inherent in successful-unfunded proposals (proposals above the quality threshold but that remained unfunded due to the budget constraint) and allow it to be captured for alternative funding applications at EU or national level. This may include the Seal of Excellence measure, after a detailed *ex ante* assessment.								
One-off			n/a	Public sector administrative expenditure related to proposal evaluation costs are an area with a potential for efficiency savings, to the extent that a duplication of an evaluation can be avoided.			n/a	Application costs of unfunded proposals are an area with a potential for efficiency savings for the framework programme overall.
Lump sum funding involves the paying out of pre-agreed lump sums (that were specified in the proposal by the grant beneficiary) after the completion of a work package. It renders obsolete the financial reporting (by beneficiary) and the checking of financial reports, as well as the reimbursement of detailed eligible costs by the EU public administration).The evaluation of the lump sum pilot suggests that a wider use of lump sum funding likely has some simplification potential to reduce <u>beneficiaries' administrative costs</u> and address the persistence of frequent <u>financial errors</u>, highlighted by the European Court of Auditors. The net effect on costs depends on details of implementation.								
One-off	n/a	The use of lump sums has the potential to reduce financial errors by removing financial reporting and the reimbursement on the basis of eligible costs (both sources of	n/a	Public sector administrative expenditure is expected to change due to multiple factors. The direction of the net effect on public	n/a	The use of lump sums has potential to reduce the net administrative costs of beneficiaries, who no longer	n/a	Application costs may increase, as proposals have to submit an additional budget table for the project, to justify the lump sums. The cost of generating the budget information

		financial errors in R&I funding). The extent to which a reduction of errors can be achieved, and a reduction of the error rate can be observed, depends on details of implementation, including that of *ex post* project reviews and any changes to the audit strategy. While the rationale of lump sum funding supports the assumption that financial errors will overall be reduced, the piloted projects have not yet generated any *ex post* evidence to allow for a validation of this assumption and an *ex ante* estimation of future simplification effects.		sector costs depends on implementation details that determine the additional workload of proposal evaluators and possible adjustment costs for project officers. The net effect will also be affected by beneficiaries' strategic behaviour (unintended effects) in response to the measure over the medium-term. The currently available evidence base is insufficient to assess the direction or magnitude of the net effect on public sector administrative costs.		have to report on eligible costs and resources for reimbursements, but receive shares of the lump sum, once work packages have been completed. The net effect for beneficiaries depends on details of implementation and beneficiaries' strategic behaviour (unintended effects) in the medium term.) The currently available evidence base is insufficient to assess the magnitude of the benefit to beneficiaries.		is not fully additional but to a large extent part of the baseline: Project management best practice and existing requirements of the programme mean that applicants are assumed to calculate the project budget at proposal stage already. However, adapting the budget to the format, structure and level of detail requested in the proposal template and filling in the template gives rise to additional costs. Any change will be affected by details of implementation, including the availability and user friendliness of guidance for applicants. The currently available evidence base is qualitative and does not allow a quantification of the expected effect on applicants.

[108] This assessment is without prejudice to a possible future Impact Assessment.

5. *Value-for-money for EU Society (Benefit cost ratio calculation)*

Table 14 below shows the costs and benefit figures used in the benefit cost ratio calculation presented in Section 4.2.1 of the evaluation report. The evaluation calculates a benefit cost ratio over the **period 2014-2040**. This period was chosen to allow time for the emergence of wider benefits of R&I investments. Projects will only have all ended by December 2028, eight years after the programme period came to an end in 2020. **The 2040 cut-off date allows for a minimum of 13 years for all projects to have been completed and results to feed through to impacts that affect society.**

The benefit cost ratio uses GDP impacts, as the closest proxy for the overall welfare benefits for EU society. Macroeconomic impacts have been adjusted for inflation and are reported below in current prices. (GDP impact figures in section 4.1.3 are reported in 2020 prices.) In this way they could be used in a calculation with the expenditure figures. All the three model outputs have been used to reflect uncertainty. **The results suggest that the benefit cost ratio (BCR) of Horizon 2020 is at least 5**, which means that **one euro of costs to society associated with the programme (programme costs and costs to applicants) is expected to bring about five euros of benefits for EU citizens (measured through GDP impact) in the period up to 2040.**

For comparison, a set of benefit cost ratios over the shorter period until 2030 has also been calculated, again using the three model outputs to reflect uncertainty. The three models describe different trajectories of how much and by when benefits grow and peak over time, which explains the difference in ranking (see Figure 9 in Section 4.1.3 of the evaluation report for a visualisation). During this shorter period, the total cost value does not change, as all costs are incurred at the start. As can be expected, **by 2030 the BCR values are lower**, with a **central BCR still closer to 4.** This is because in 2030, the last projects had only ended 2 years prior, and benefits had 10 years less to channel through to a marketable impact and for GDP gains to accumulate.

Table 14: Benefit Cost Ratio calculation

Costs of Horizon 2020		
(1) **Operational Expenditure** (budget, current prices)	EUR 71.195 billion	
(2) **Administrative Expenditure** (budget, current prices)	EUR 4.428 billion	
(3) **Cost of application** (Note: range of low to high average values; costs include successful and unsuccessful applicants.) Please note: evidence not robust/ low level of confidence in figures.	EUR 5.61 billion	EUR 11.25 billion
Total Cost of Horizon 2020 (low, high; current prices)	**EUR 81.233 billion**	**EUR 86.874 billion**

Benefits of Horizon 2020	
(1) **Total Benefits of Horizon 2020 - up to 2040** (Note: GDP impact used in calculation as closest proxy to welfare impact; period 2014-2040; current prices)	EUR 915.1 billion - estimated by NEMESIS model **EUR 492.0 billion - estimated by RHOMOLO model** EUR 482.3 billion - estimated by QUEST model

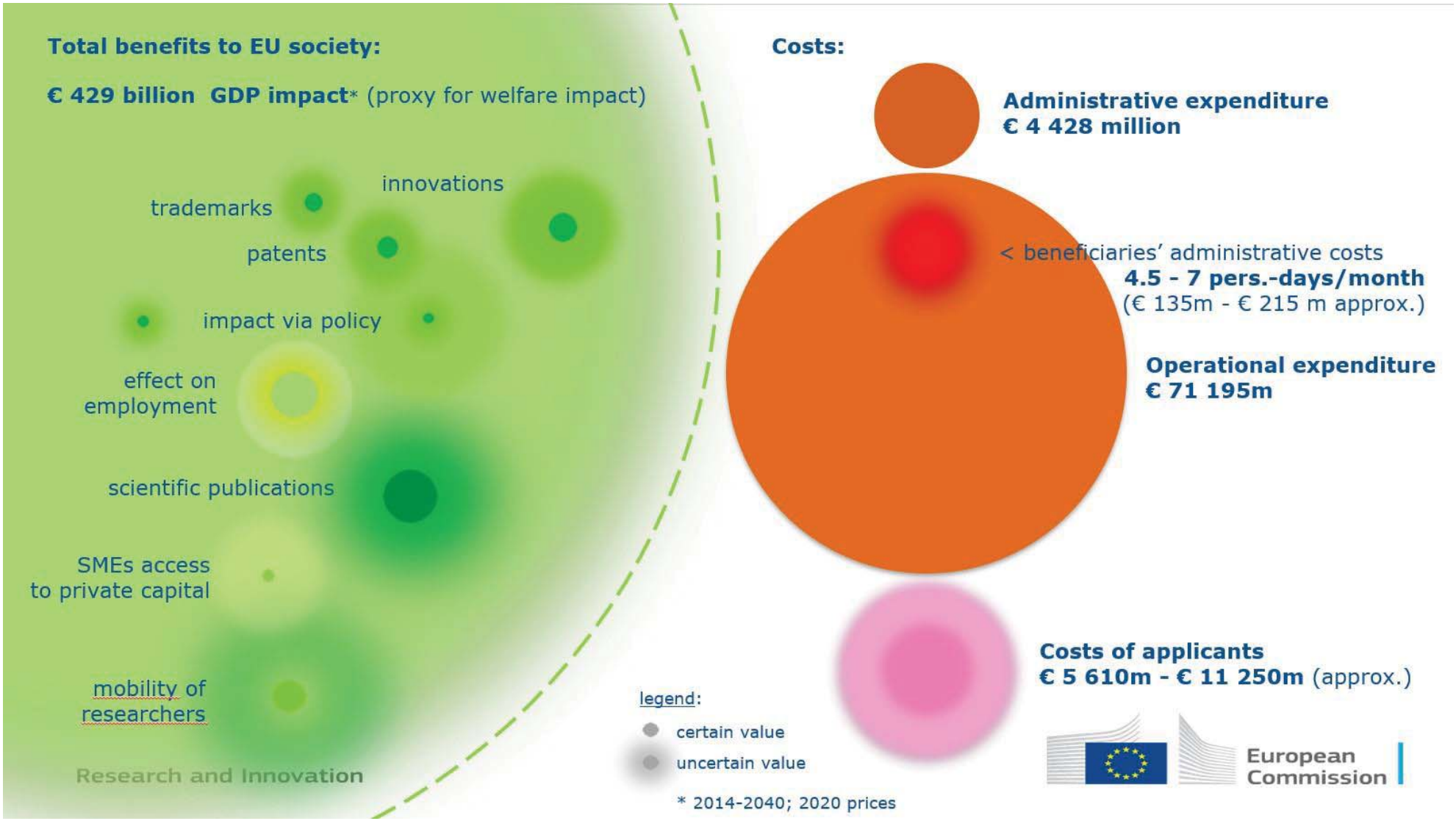
Benefit Cost Ratio (BCR) – up to 2040	**low**	**high**
NEMESIS	10.5	11.3
RHOMOLO	**5.7**	**6.1**
QUEST	5.6	5.9

Benefit Cost Ratios using a shorter 2014 - 2030 period:

Benefits of Horizon 2020	
(2) **Total Benefits of Horizon 2020 - up to 2030** (Note: GDP impact used in calculation as closest proxy to welfare impact; period 2014-2030; current prices)	EUR 481.6 billion - estimated by NEMESIS model / EUR 354.7 billion - estimated by RHOMOLO model EUR 328.9 billion - estimated by QUEST model /

Benefit Cost Ratio (BCR) – up to 2030	low	high
NEMESIS	5.5	5.9
RHOMOLO	4.1	4.4
QUEST	3.8	4.0

Figure 8: Comparison of approximate magnitudes of costs and wider economic benefit of Horizon 2020



Source: EU Commission illustration. Fuzzy edge indicates uncertainty with regards to the size of impact.

ANNEX V. STAKEHOLDER CONSULTATION – SYNOPSIS REPORT

In support of this evaluation, a broad range of consultation activities were conducted: the call for evidence, the public consultation, interviews, surveys of participants and beneficiaries as well as targeted consultations.

To ensure that all possible views are well reflected and to ensure transparency and accountability, consultations with various categories have been held in the frame of the *ex post* evaluation of Horizon 2020. The consultation process did not start from zero, as the Commission based its work on the consultations that took place in 2016 for the interim evaluation of Horizon 2020[109] which provided useful information on the mapping, priorities and views of all major interested parties.

Stakeholder mapping

Stakeholder groups that are concerned by Horizon 2020 as a whole can be broken down into the following categories: academia, businesses (including small and medium-sized enterprises), National Contact Points[110] and public authorities as well as non-governmental, research and umbrella organisations.[111]

Beyond that, the following Institutions have in the past contributed to the evaluation of the Framework Programme:

- the Council conclusions[112] on the Interim Evaluation of Horizon 2020, adopted on 01/12/2017,
- the European Parliament, which reported on the assessment of Horizon 2020[113] and the implementation in line with the interim evaluation,[114]
- the European Economic and Social Committee that provided recommendations for the Interim Evaluation of Horizon 2020,[115]
- the Committee of the Regions and the European Research Area and Innovation Committee which is a policy advisory body whose main mission is to provide strategic input on any research and innovation issue relevant to the development of the European Research Area.[116]

Other consultation activities conducted under the remit of the external evaluation studies

Next to the consultation activities that were accessible via the 'Have your say' portal, targeted consultations in the forms of workshops, interviews and surveys were conducted under the remit of the various external evaluation studies, specifically addressing applicants, participants national and regional authorities as well as business representatives.

Interviews

The main objective of conducting interviews was to gather evidence from different actors concerned by the Framework programme, offering the possibility to give an objective assessment by taking into account the different views. Interviews were particularly used in case studies as well as international benchmarks. Beyond that, interviews were conducted to confirm and complement data collection to

[109] Results of the Horizon 2020 Stakeholder Consultation, 2018, https://op.europa.eu/s/yXBt
[110] National Contact Points (NCPs) are independent organisations of different nature (e.g. Ministries, Academies of Science, Research agencies) that act as information providers to applicants in their native language. They are based in all EU countries and Associated States as well as in some non-European countries.
[111] So-called 'umbrella organisations' are industry-specific associations of EU public interest.
[112] Council conclusions 15320/17 https://www.consilium.europa.eu/media/31888/st15320en17.pdf
[113] Briefing: Interim evaluation of Horizon 2020
https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/614771/EPRS_BRI(2018)614771_EN.pdf
[114] European Parliament Report on the assessment of Horizon 2020 implementation (A8-0209/2017)
https://www.europarl.europa.eu/doceo/document/A-8-2017-0209_EN.pdf
[115] European Economic and Social Committee recommendations: interim evaluation of Horizon 2020 https://www.eesc.europa.eu/en/our-work/opinions-information-reports/information-reports/interim-evaluation-horizon-2020
[116] European Research Area and Innovation Committee,
https://www.eumonitor.eu/9353000/1/j9vvik7m1c3gyxp/vh7ej5swwyyh

support the drafting of findings and conclusions. In total, 1 403 interviews[117] were conducted in support of this evaluation – these interviews do include same actors on different topics by gathering large amounts of qualitative data among Member States' and associated countries' representatives, Commission staff and other stakeholders (as explored in the stakeholder mapping section).

Surveys

In the frame of the evaluation studies, different surveys were designed, disseminated and analysed to gather both quantitative and qualitative data on Horizon 2020.
By conducting six separate online questionnaires, successful and unsuccessful participants were surveyed under the **Excellent Science study** – in total, 5 417 complete and 449 partial responses were received. The following groups were targeted by these surveys:

- Horizon 2020 beneficiary organisations (including beneficiary organisations that participated in MSCA, SEWP, INFRA and SwafS).
- Horizon 2020 unsuccessful applicant organisations (organisations that unsuccessfully applied for MSCA, SEWP, INFRA and SwafS).
- Horizon 2020 MSCA IF fellows.
- Unsuccessful Horizon 2020 MSCA IF applicants.
- Horizon 2020 ERC principal investigators.
- Unsuccessful Horizon 2020 ERC applicants.

For the Evaluation Study on the European Framework Programmes for Research and Innovation for addressing Global Challenges and Industrial Competitiveness with a focus on activities for the activities related to the **Digital and Industrial Transition**, Horizon 2020 LEIT applicants and participants were targeted: A single questionnaire was developed that targeted all stakeholders, namely all partners in the projects funded (successful applicants) as well as all partners in proposals that were not funded even though the proposals reached scores above threshold ('high-quality' proposals). A total of 1 342 valid responses were received on the survey, reaching an overall response rate of 7%.

In view of the **Green Transition** evaluation study, a survey was conducted targeting successful applicants – this survey was designed during the inception phase and was later further enriched and developed with gateways to take into account various factors. In total, the survey received 1 333 contributions from respondents among which 771 were filled out in its entirety. The survey and following analysis was ordered by societal challenges probing for relevance, effectiveness and EU added value whereas for efficiency and the overall green transition process information was analysed at an aggregated level. Still, the analysis was further organized by topic within each evaluation criterion illustrated with respective graphs.

The studies on Resilient Europe and Innovative Europe did not conduct surveys within the frame of their methodologies.

Policy workshops

20 policy workshops were conducted in support of this evaluation. The workshops were implemented in the frame of the external evaluation studies. They aimed to consolidate and increase the robustness of findings and conclusions arising from the data collection conducted through other methods with the aim of addressing evidence gaps whenever needed.

Call for evidence

The 'call for evidence' opened on 1 July, 2022 and closed on 29 July 2022. The overall number of responses submitted was 35. This number includes two responses that were not considered in the analysis as they were out of scope, i.e. not concerning the Horizon 2020 programme. Four comments were

[117] This included 223 interviews in the frame of the Resilient Europe study, 138 for the study on Relevance, 217 in view of Digital and Industrial Transition, 224 on Excellent Science, 195 on Innovative Europe, 131 on External Coherence and 85 in view of cross-cutting issues.

submitted from the same person and have been then considered as a single contribution. Moreover, 4 organisations and one individual submitted the same response to the 'call for evidence' on the final evaluation of Horizon 2020 and the interim evaluation of Horizon Europe. Five position papers were received and all of them were considered in the scope of the consultation. As for the geographical distribution of the responses received, Germany is the country with the highest number of responses (11), accounting for more than one third of the responses, followed by France (6) and Belgium (4). In total, replies came from 11 different countries, including two non-EU Member States (the United Kingdom and Switzerland).

The findings from the feedback received during call for evidence were taken into consideration in the survey design for the public consultation. In view of content moderation, no feedback had to be unpublished as all contributions were in line with the content moderation rules. For additional content-related information, please consult the 'Supporting Information: Call for evidence' section further below.

Public consultation: scope and objectives

In line with the Better Regulation guidelines and toolbox[118], the public consultation on Horizon 2020 forms part of a combined consultation and evaluation exercise.[119] It aimed to explore stakeholders' views regarding the key aspects of the past and the present as well as the future of the EU Framework Programme for Research and Innovation, notably for the *ex post* evaluation of Horizon 2020 (2014-2020), the interim evaluation of Horizon Europe (2021-2023) as well as to receive inputs from stakeholders to be used for the definition of strategic orientations for the Horizon Europe Strategic Plan (2025-2027).

The reason for conducting a joint consultation is the relatively short time span between the legal obligation for the Horizon 2020 *ex post* evaluation and the legal obligation for the Horizon Europe interim evaluation. Additionally, another reason for conducting a joint consultation instead of reaching out to the broad public on three separate instances was to counter stakeholder fatigue, also bearing in mind that all three dimensions concern the same group of stakeholders. Nevertheless, it is important to note that this public consultation was geared towards anyone with an interest in the EU R&I Framework programmes, not only towards beneficiaries and the main stakeholder groups delineated in the section above but also unsuccessful applicants as well as independent experts.

The combined public consultation was accessible in English, French and German on the Have Your Say web portal from 01/12/23 until 23/03/23. Respondents had the possibility to submit their replies any official EU language resulting in in 2 788 responses and 265 position papers in total. For the section on Horizon 2020, 1 818 responses were submitted along with 21 position papers. The factual summary report, along with all contributions to the three dimensions covered in this public consultation as well as position papers are accessible on the Have your Say portal. Findings in this consultation did not only feed into the analysis presented on the following pages as well as highlighted in the respective sections in the main Staff Working Document but also form basis for the development of the 10th Framework Programme for Research and Innovation.

Methodology used for the analysis of the responses received through the public consultation

Quantitative analysis

Quantitative analysis was conducted by means of descriptive statistics, differentiating and comparing responses of different groups of respondents. Correct representation and interpretation of results are fundamental to drawing coherent conclusions which is why the number of respondents has been shown along with percentages. Linkages between answers and respondents' characteristics such as participation in the programme, country affiliation and type of respondent (e.g. Member State and business organisation representatives, researchers). When evident, correlations between answers given in closed

[118] Better Regulation Toolbox, notably Tool #52.
[119] Better Regulation Toolbox, Tool #50, p. 434.

questions have been explored. The summary statistics were bundled in .xml format which allowed for swift cross-comparison among the various dimensions covered in the public consultation survey.

Qualitative analysis

Key messages were extracted from qualitative contributions, primarily position papers and open questions present in the public consultation survey. Same holds true for the analysis of the feedback contributions received for the call for evidence. As only 21 position papers exclusively addressed Horizon 2020, instead of using tools such as Nvivo or Python, contributions were clustered by topics and specific aspects raised in both position papers and open questions by means of using Excel, presenting findings in a contribution matrix.

Content moderation according to Better Regulation Tool #54[120]

In view of content moderation, only three contributions were unpublished: all three were taken into consideration content-wise, however in two cases GDPR-related concerns led to unpublishing on the Have your say portal. Another respondent reached out to the support team of the public consultation via the indicated functional mailbox asking to unpublish the contribution as a wrong attachment was uploaded as a position paper – for the analysis, the newer position paper was taken into account.

Identification of campaigns[121]

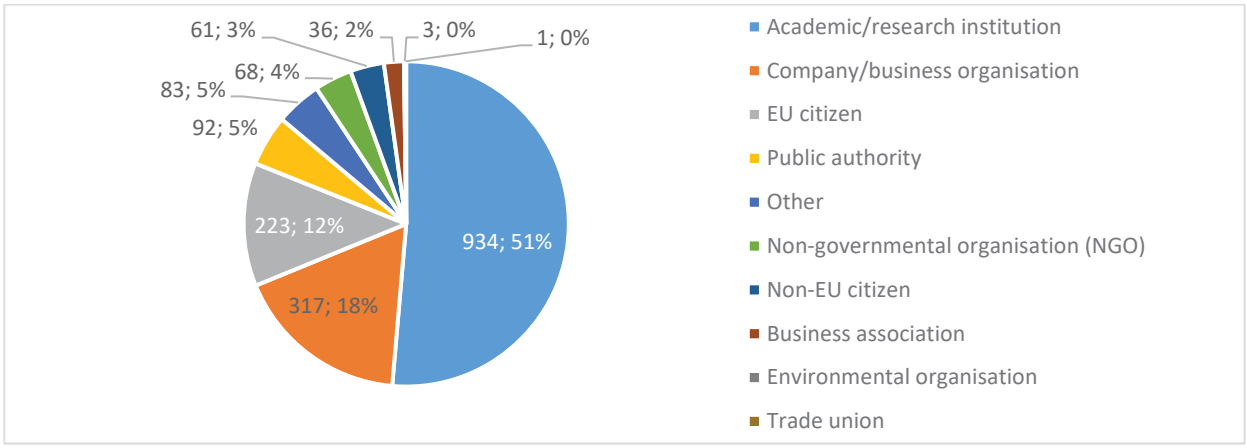
Although there was some coordination between some of the respondents (e.g., those participating in the same network, cluster, or country), as testified by the uploading of the same position paper by multiple respondents, the analysis of the consultation results does not indicate any campaign affecting the overall results.[122]

[120] Better Regulation Tool #54, p. 478.
[121] Better Regulation Tool #54, p. 476.
[122] Overall, 23 campaigns (coordinated responses to the survey by more than one respondent and up to 8). The 23 campaigns include responses by 70 respondents, representing 3.9% of all responses.

Public consultation: Participants

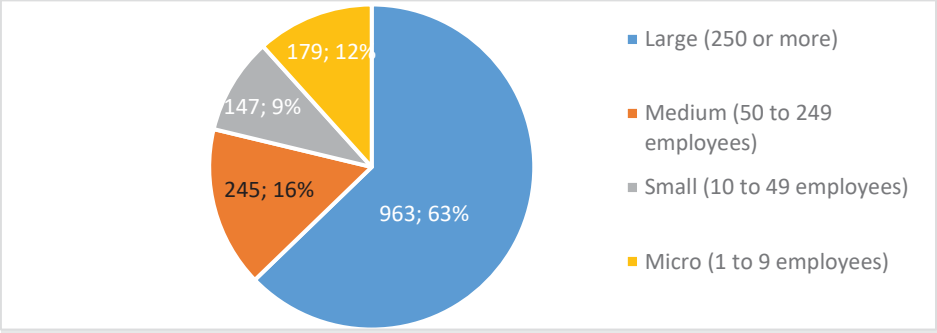
In total, **1 818** chose to complete the section of the consultation on Horizon 2020 programme. **Contributions were received from a wide range of actors**. 51% (934) of the respondents are part of academic or research institutions, 18% (317) are companies or business organisations, and 16% (284) are citizens (EU and not EU). The remaining 16% (283) of respondents cover different types of stakeholders (e.g., public authorities, NGOs, business associations, environmental organisations, trade unions). Among the 92 public authorities that responded, 38 represent the national level, 21 the international level, 19 the regional level and 14 the local level.

Figure 9: I am giving my contribution as… (N=1 818)



Two-thirds (1 191) of the respondents provided personal views, whereas one-third (586) contributed as a representative of an organisation or institution. Two-thirds (963) of organisations that responded were large, while one-third of respondents comprised micro (179), small (147) or medium (245) size organisations.

Figure 10: What is the size of your organisation? (N=1 534)



Geographical coverage

The consultation gathered responses from **74 different countries, including all 27 EU Member States + UK**[123]. 89% (1 620) of the contributions came from respondents based in **EU28 Member States**, 8% (139) from Horizon 2020 Associated Countries, and 3% (59) from Third Countries[124]. The largest number of contributions came from Italy (13%; 244), followed by Spain (12%; 212), Germany (12%;

[123] An EU Member State when Horizon 2020 was implemented.

[124] The responses received from Third Countries are from: Argentina (3), Australia (2), Bangladesh (1), Belarus (1), Brazil (6), Canada (3), Cape Verde (1), China (4), Colombia (4), Congo (1), Egypt (2), El Salvador (1), Ethiopia (1), Guatemala (1), India (5), Japan (1), Jordan (1), Kenya (2), Kosovo (1), Lebanon (1), Mexico (1), Mozambique (1), New Zealand (1), Pakistan (1), Palestine (1), Philippines (1), Russia (1), South Africa (1), Taiwan (1), Uganda (1), United States (5), Venezuela (1), Yemen (1).

211) and France (10%; 183). Looking at non-EU countries, the largest number of contributions came from Switzerland (2.3%; 42), Norway (1.8%; 32) and Turkey (1.3%; 24).

Figure 11: What is your country of origin? – EU 28 Member States (N=1 620)

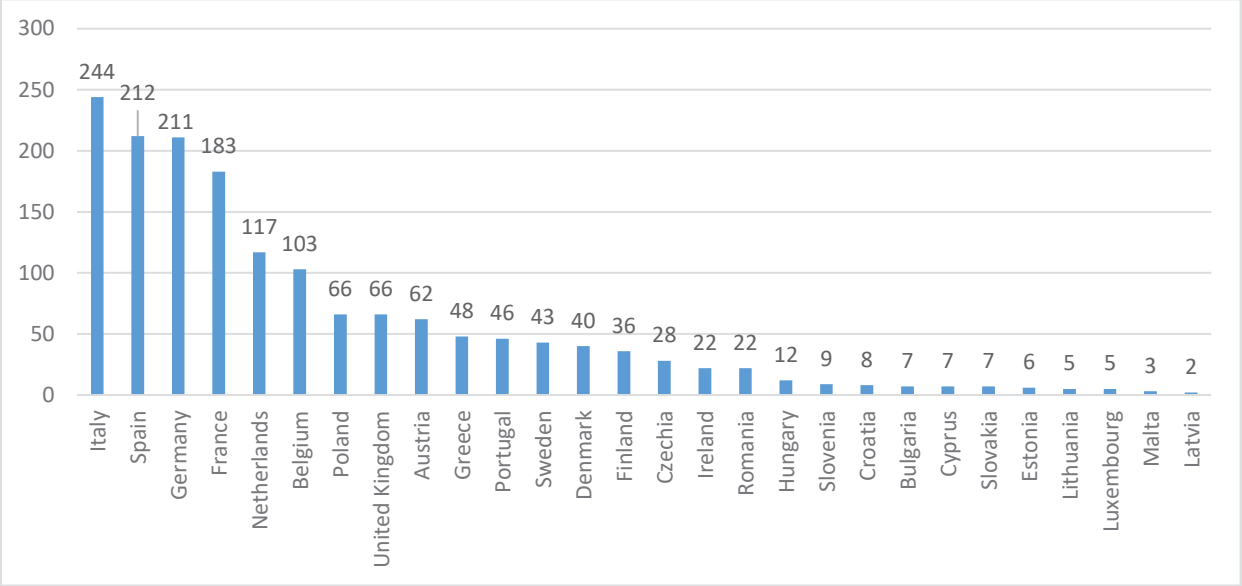
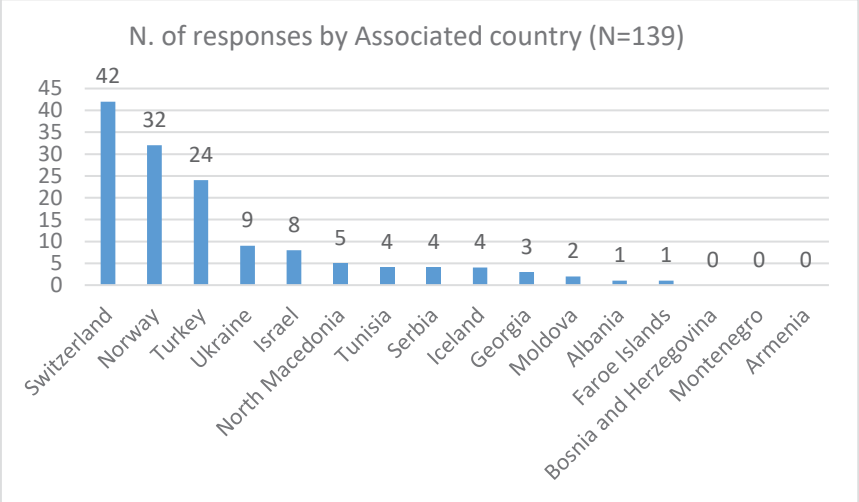


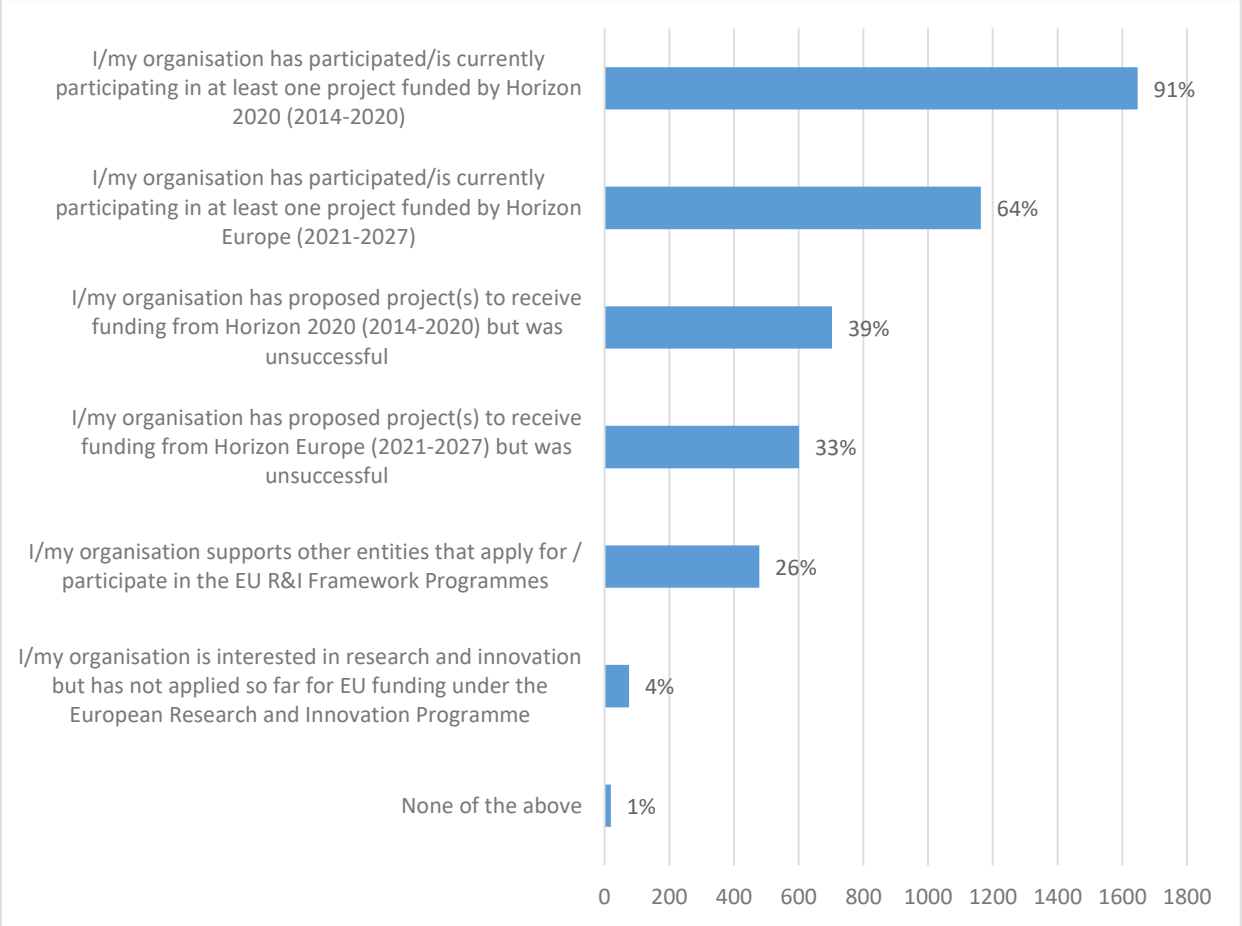
Figure 12: What is your country of origin? – Horizon 2020 Associated Country (N=139)



Experience with the framework programmes

The respondents were asked to select one or more options describing their experience with Horizon 2020 and Horizon Europe.[125] 91% of respondents (1 648) **participated in Horizon 2020**[126] and 64% (1 163) are **Horizon Europe beneficiaries.**[127] 39% (703) of respondents stated that they 'proposed project(s) to receive funding from Horizon 2020 but were **unsuccessful**'. However, considering that the same respondent could select multiple options, only 2.5% (45) of respondents applied for Horizon 2020 funding and were never successful.[128] Respondents also include **organisations supporting other entities** that apply for or participate in the EU R&I framework programmes (26%; 478) and **organisations that have never applied** for funding but are interested in R&I (4%; 76).

Figure 13: Please select the option(s) that best describe(s) your experience with the European Research and Innovation programmes (N=1 818; multiple answers possible)



The majority of respondents (73%; 1321) were mainly active or interested in the part of Horizon 2020 concerning **societal challenges** (Pillar III) and more than one-third of them participated or were interested in **Excellent Science actions** (Pillar I), namely the Marie Skłodowska-Curie Actions (MSCA)

[125] 'Please select the option(s) that best describe(s) your experience with the European Research and Innovation programmes)'. The question allowed multiple answers. Therefore, the same organisation could be, for instance, a beneficiary of both Horizon 2020 and Horizon Europe, or an unsuccessful applicant of Horizon 2020 but a beneficiary of Horizon Europe, or both an unsuccessful applicant and a beneficiary of Horizon 2020, if it submitted multiple proposals with different outcomes.

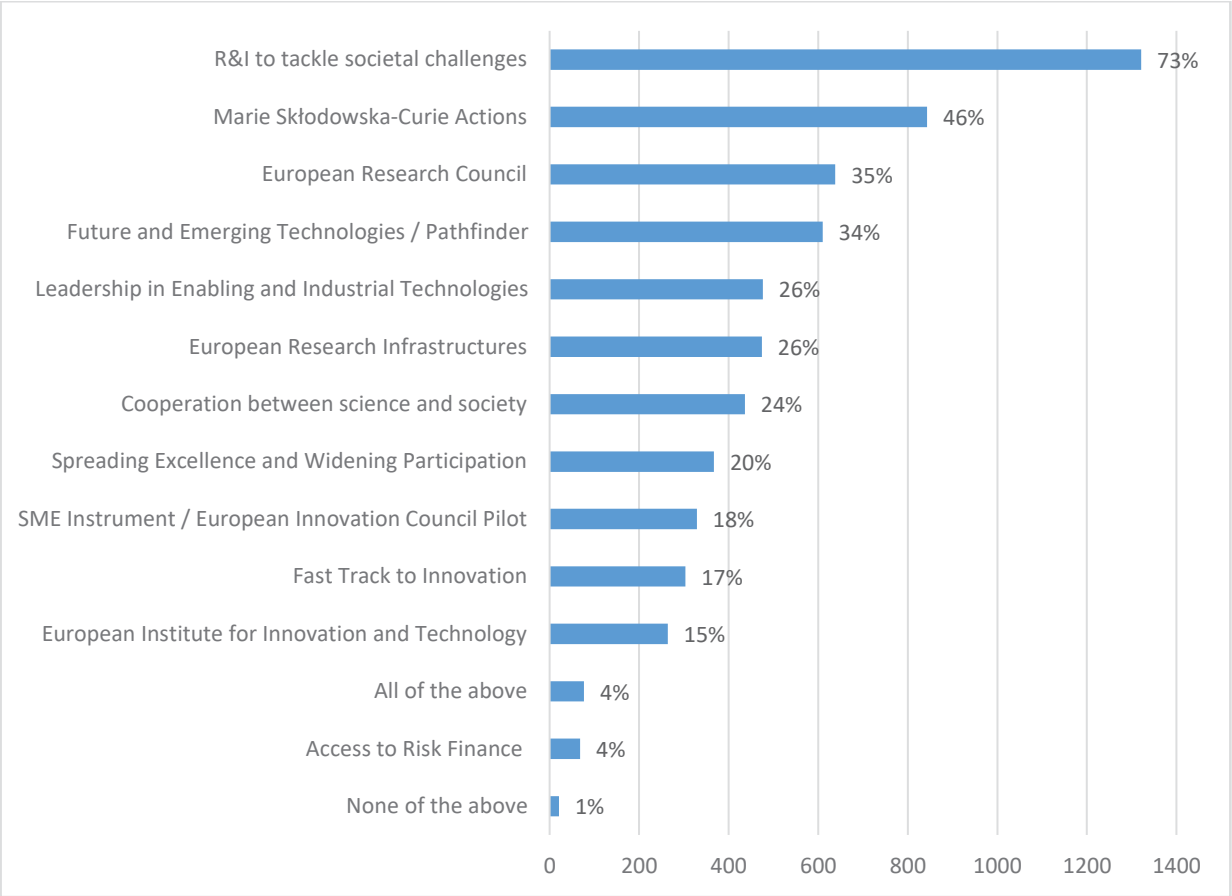
[126] They selected the response option 'I/my organisation has participated/is currently participating in at least one project funded by Horizon 2020 (2014 – 2020)'.

[127] They selected the response option 'I/my organisation has participated/is currently participating in at least one project funded by Horizon Europe (2021 – 2027)'.

[128] They selected the response option 'I/my organisation has proposed project(s) to receive funding from Horizon 2020 (2014 – 2020) but was unsuccessful' alone or with other response options, but they did not select 'I/my organisation has participated/is currently participating in at least one project funded by Horizon 2020 (2014 – 2020)'.

(46%; 843), the European Research Council (ERC) (35%; 638) and Future and Emerging Technologies / Pathfinder (34%; 310).

Figure 14: In which of the following areas of Horizon 2020 are you or your organisation mainly active and or interested in? (N=1 818; multiple answers possible)



Overview of position papers

21 position papers uploaded in response of this consultation included content relevant to the part of the consultation on Horizon 2020. Among the 21 position papers, 8 were written by academic or research institutions, 6 by non-governmental organisations and 3 by business associations. The largest number of position papers came from Belgium (5) and France (3).

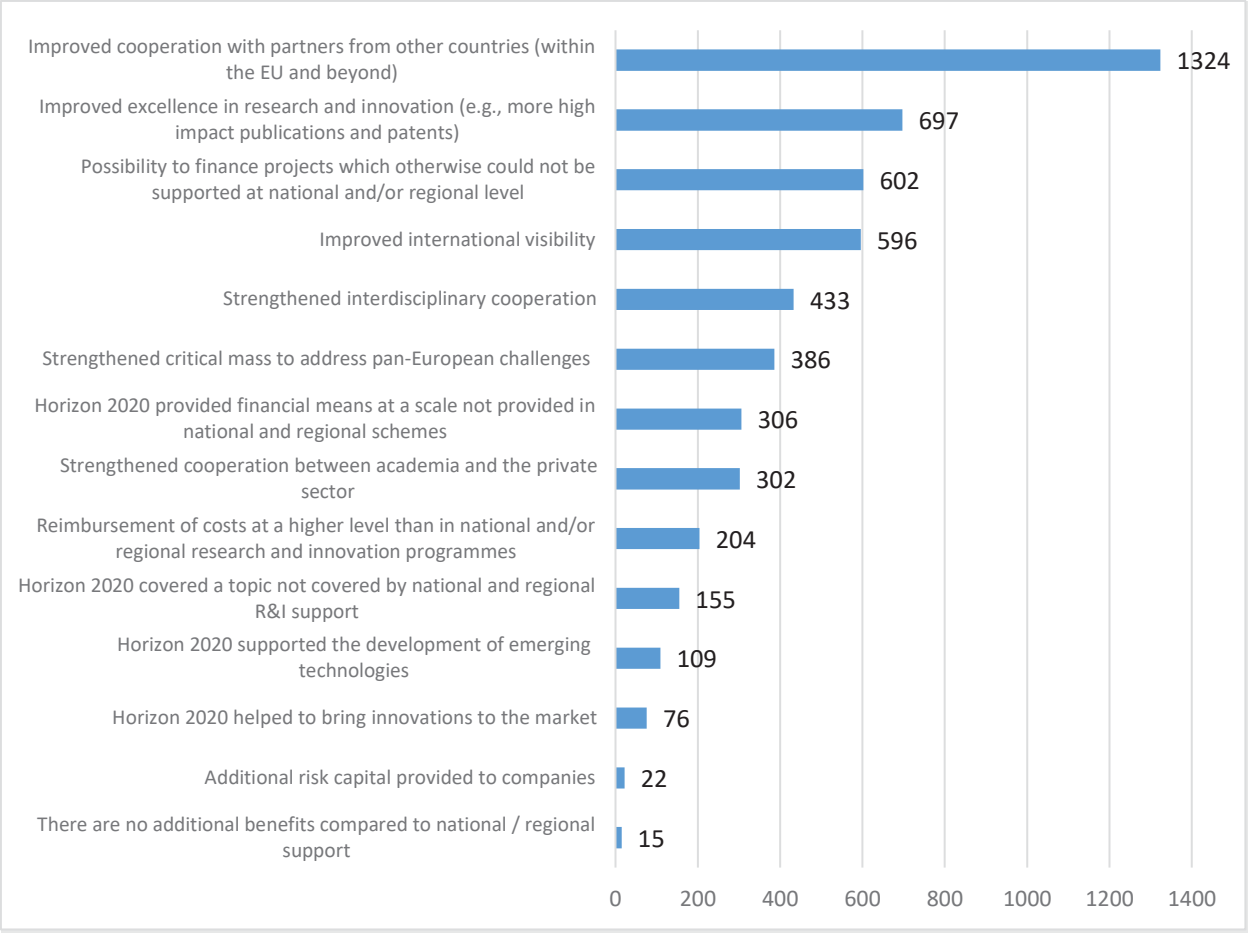
Results of the consultation

The respondents' experience with Horizon 2020

The benefits of participating in Horizon 2020

The majority of respondents (74%; 1 324) agreed that participating in Horizon 2020 'improved cooperation with partners from other countries (within the EU and beyond)', 39% (697) agreed that Horizon 2020 'improved excellence in research and innovation' compared to other programmes available in EU Member States or Associated Countries, and 34% (602) agreed that Horizon 2020 brought the 'possibility to finance projects which otherwise could not be supported at national and/or regional level'. Less than 1% (0.08%; 15) of respondents stated that there was 'no additional benefit' in participating in Horizon 2020 compared to other national and/or regional R&I programmes.

Figure 15: According to you, what are the main benefits of participating in Horizon 2020 compared to national and/or regional R&I programmes in EU Member States or Associated countries? Select maximum 3 answers (N=1 790)



The analysis by country group shows that, although the ranking of response options is aligned, certain benefits are considered particularly relevant for some country groups:

- 76.6% of respondents from EU Associated Countries selected 'improved cooperation with partners from other countries' compared to 74% of respondents from EU15, 73.3% from EU13 and 61% from Third Countries.
- 49.4% of respondents from EU13 and 45.3% from EU Associated Countries selected 'improved excellence in research and innovation' compared to 42.4% of respondents from Third Countries and 36.8% from EU15.
- 45.8% of respondents from Third Countries and 40% from EU13 selected 'improved international visibility' compared to 38.7% of respondents from EU Associated Countries and 31.4% from EU15.
- 23.6% of respondents from EU15 selected 'strengthened critical mass to address pan-European challenges' compared to 19% of respondents from EU Associated Countries, 12.8% from EU13 and 6.8% from Third Countries.

Table 15: According to you, what are the main benefits of participating in Horizon 2020 compared to national and/or regional R&I programmes in EU Member States or Associated countries? Select maximum 3 answers (EU15 N= 1 414; EU13 N= 180; EU Associated Countries

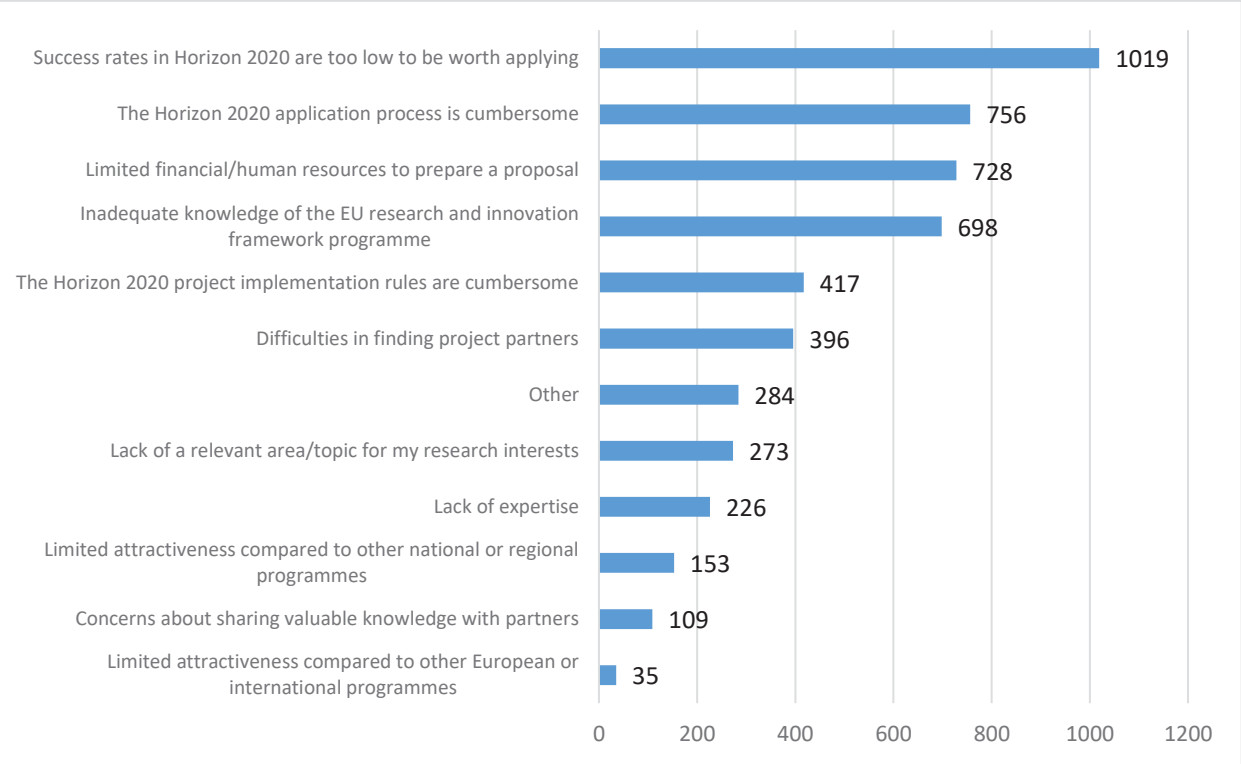
RESPONSE OPTION	EU15	EU13	EU ASSOCIATED COUNTRIES	THIRD COUNTRIES
Improved cooperation with partners from other countries (within the EU and beyond)	74.0%	73.3%	76.6%	61.0%
Improved excellence in research and innovation (e.g., more high impact publications and patents)	36.8%	49.4%	45.3%	42.4%
Possibility to finance projects which otherwise could not be supported at national and/or regional level	35.3%	28.3%	25.5%	28.8%
Improved international visibility	31.4%	40.0%	38.7%	45.8%
Strengthened interdisciplinary cooperation	24.3%	22.8%	23.4%	28.8%
Strengthened critical mass to address pan-European challenges	23.6%	12.8%	19.0%	6.8%
Horizon 2020 provided financial means at a scale not provided in national and regional schemes	17.3%	19.4%	11.7%	18.6%
Strengthened cooperation between academia and the private sector	16.7%	15.0%	19.7%	20.3%
Reimbursement of costs at a higher level than in national and/or regional research and innovation programmes	11.9%	9.4%	10.2%	8.5%
Horizon 2020 covered a topic not covered by national and regional R&I support	8.3%	10.0%	11.7%	5.1%
Horizon 2020 supported the development of emerging technologies	6.2%	6.7%	4.4%	6.8%
Horizon 2020 helped to bring innovations to the market	4.2%	2.8%	5.8%	5.1%
Additional risk capital provided to companies	1.3%	1.7%	0.7%	0.0%
There are no additional benefits compared to national / regional support	1.0%	0.0%	0.0%	1.7%

The reasons preventing participation in Horizon 2020

The **main reasons that held back potential beneficiaries** from Horizon 2020 were all linked to application costs, namely the **low success rates of applicants**, which both successful and unsuccessful applicants agree on (57%; 924 and 69%; 31 respectively), the **cumbersome application process** (42%; 681 among successful and 53%; 24 among unsuccessful applicants, and 50%; 67 respondents from associated countries), as well as the **lack of resources:** Interestingly, a larger fraction of successful applicants (41%; 670) than unsuccessful candidates (27%; 12) deemed the potential applicant's lack of resources to prepare a proposal as a reason negatively affecting participation. Compared to EU-13 respondents, respondents from associated countries are 10 percentage points less likely to identify limited resources as a deterring factor for participation.

Low success rates were also considered a further deterring factor to participation by 59% (830) of EU-15 respondents, 64% (115) of EU-13 respondents and 40% (54) of respondents from associated countries. Other deterring reasons mentioned by the respondents[129] are: difficulties in finding a project coordinator, difficulties in involving industrial partners, concerns about sharing valuable knowledge with partners (especially for businesses), lack of expertise to prepare a proposal and high costs for hiring external consultants for proposal preparation.

Figure 16: In your view, what are the main reasons that may have prevented potential beneficiaries from participating in Horizon 2020? Select maximum 3 answers. (N=1 781)



[129] Question: "if other, please specify".

The top four reasons selected by successful and unsuccessful applicants are the same, albeit with some variation:

Table 16: Top 4 for answers for 'In your view, what are the main reasons that may have prevented potential beneficiaries from participating in Horizon 2020? Select maximum 3 answers' (Successful applicants N= 1 622; Unsuccessful applicants N= 45)

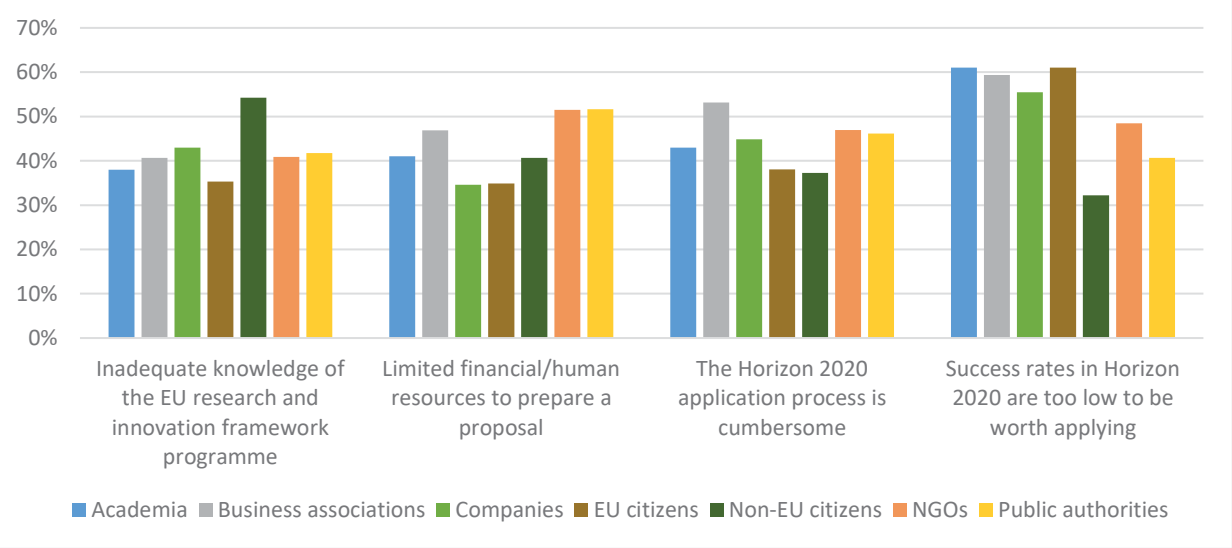
RESPONSE OPTION	HORIZON 2020 SUCCESSFUL APPLICANTS	HORIZON 2020 UNSUCCESSFUL APPLICANTS
Success rates in Horizon 2020 are too low to be worth applying	57.0%	68.9%
The Horizon 2020 application process is cumbersome	41.9%	53.3%
Limited financial/human resources to prepare a proposal	41.3%	26.7%
Inadequate knowledge of the EU research and innovation framework programme	39.3%	33.3%

Looking at disaggregation by country and stakeholder group for these top four reasons:

Table 17: Top 4 answers for 'In your view, what are the main reasons that may have prevented potential beneficiaries from participating in Horizon 2020? Select maximum 3 answers' (EU15 N= 1 407; EU13 N= 179; EU Associated Countries N= 136; Third Countries N= 59)

RESPONSE OPTION	EU15	EU13	EU ASSO. COUNTRIES	THIRD COUNTRIES
Success rates in Horizon 2020 are too low to be worth applying	59.1%	64.2%	40.4%	28.8%
The Horizon 2020 application process is cumbersome	44.2%	25.7%	50.0%	33.9%
Limited financial/human resources to prepare a proposal	40.2%	50.8%	39.0%	32.2%
Inadequate knowledge of the EU research and innovation framework programme	38.0%	36.3%	49.3%	54.2%

Figure 17: Stakeholder breakdown of top four reasons preventing participation in Horizon 2020
up to three responses allowed, environmental organisations and trade unions not represented due to low response rate (3 or fewer)

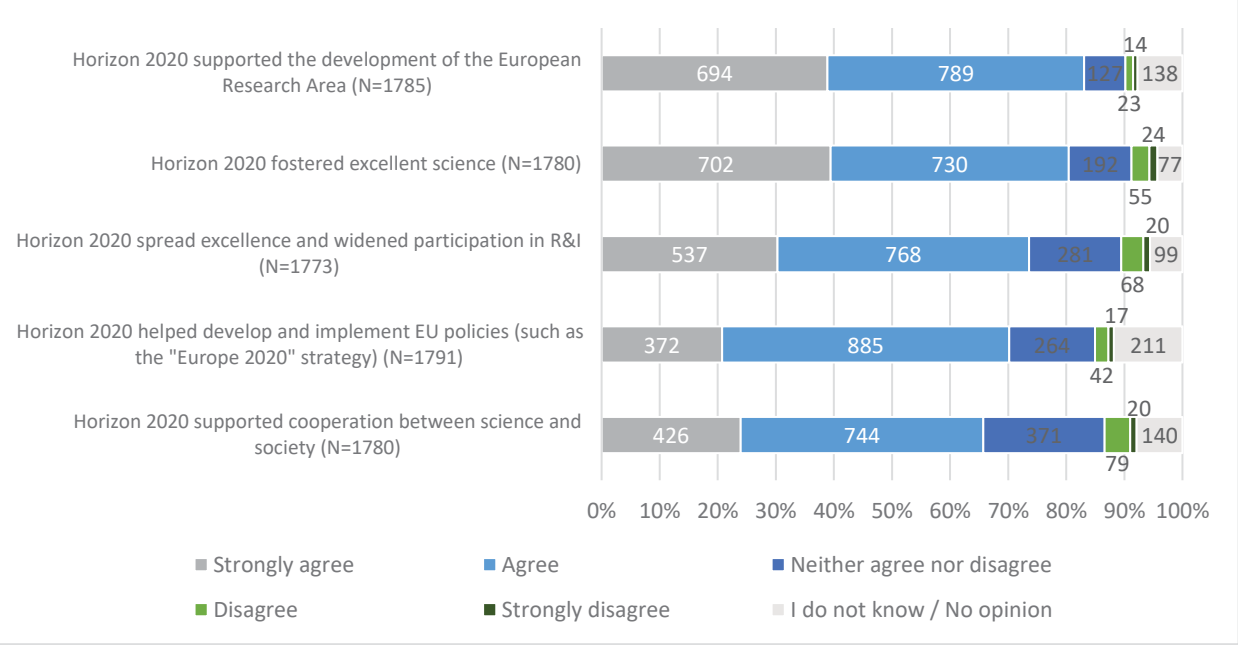


Priorities and objectives

Assessing the achievement of the Horizon 2020 objectives

Respondents generally expressed positive opinions concerning the achievement of the Horizon 2020 objectives. Most respondents agreed that 'Horizon 2020 supported the development of the European Research Area' (83%; 1 483), 'fostered excellence science' (80%; 1 432), 'spread excellence and widened participation in R&I' (74%; 1 305), and 'helped develop and implement EU policies' (70%; 1 257). The most controversial aspect was the ability of Horizon 2020 to 'support cooperation between science and society', with 6% (99) of respondents maintaining that the programme did not do enough to support such cooperation.

Figure 18: To what extent do you agree with the following statements concerning the objectives of Horizon 2020?



Development of the European Research Area

Similarly, EU citizens and respondents from academic and research organisations (both respectively 84%; 775, 184) either agreed or strongly agreed that Horizon 2020 supported the development of the European Research Area. Same as shown with regard to fostering excellent science, 88% (52) of non-EU respondents indicated that Horizon 2020 supported the development of the European Research Area, showing that the views regarding the scientific dimension of Horizon 2020 are coherent.

Excellent Science

Overall, 80% (1 432) of respondents to the consultation support the claim that Horizon 2020 encouraged excellent science: this view is held by 82% (760) of respondents from academic and research organisations and 65% (20) from business associations, 84% (175) of EU citizens and 88% (53) of non-EU citizens. Among all other stakeholder groups (including, among others, companies, public authorities, trade unions, NGOs and environmental organisations, 77% (424) agreed or strongly agreed with this view.

Spread excellence and widen participation

In total, 74% (1 305) of respondents agreed or strongly agreed in the stakeholder consultation with the notion that Horizon 2020 spread excellence and widened participation in R&I. This view was held by 81% (677) of respondents from business associations, 75% (26) of respondents replying on behalf of companies and businesses, 74% (677) of respondents from academia and 73% (48) of respondents replying on behalf of NGOs. At the same time, 73% of non-EU citizens agreed or strongly agreed (43), compared to 68% of EU citizens (148). Breaking down the responses of all respondents by countries, it becomes clear that 77% (138) of respondents from EU-13 countries, 74% (1 027) of EU-15 countries, 73% (99) of associated countries and 70% (41) of third countries agree or strongly agree with the notion that Horizon 2020 spread excellence and widened participation in R&I.

Develop and implement EU policies

Overall, 70% of respondents (1 483) in the stakeholder consultation conducted for this evaluation agreed or strongly agreed that **'Horizon 2020 helped develop and implement EU policies'** (such as the 'Europe 2020' strategy). The strongest support for this statement has been shown among public authorities (78%; 72), followed by business associations (75%; 24), companies (73%; 229) and academia (70%; 644). Only NGOs (66%; 44), EU citizens (66%; 145) and non-EU citizens (60%; 36) have indicated a lesser agreement with the statement, either agreeing or strongly agreeing that Horizon 2020 helped to develop and implement EU policies.

Overall, few respondents (2%; 37) across all stakeholder groups expressed unfavourable opinions regarding the capacity of Horizon 2020 to help develop and implement EU policies indicating that across all stakeholder groups are indeed overwhelmingly positive about the development and implementation of EU policies by means of Horizon 2020.

Building R&I capacity in EU countries lagging behind

Only 62% (1 097) of respondents believed that Horizon 2020 helped building R&I capacity in EU countries lagging behind: this view was primarily shared by non-EU citizens (70%; 41), environmental organisations (67%; 2), companies and businesses (64%; 199), academia / research organisations (62%; 566) followed by EU citizens (61%; 132). The views of business associations were less favourable, only having 55% (17) supporting the claim that the programme helped building R&I capacity in EU countries lagging behind, whereas 23% (199) of respondents replying on behalf of businesses indicated that the effect of Horizon 2020 in this endeavour was neutral. Nevertheless, other stakeholder groups held more favourable views, with less respondents deeming the effect neutral, e.g. 11% of academia (200) and 10% of companies (31). Overall, only a small fraction of respondents indicated that it had no effect at all: 3% of businesses (8) and companies and 1.5% of academia (14).

Supporting cooperation between science and society

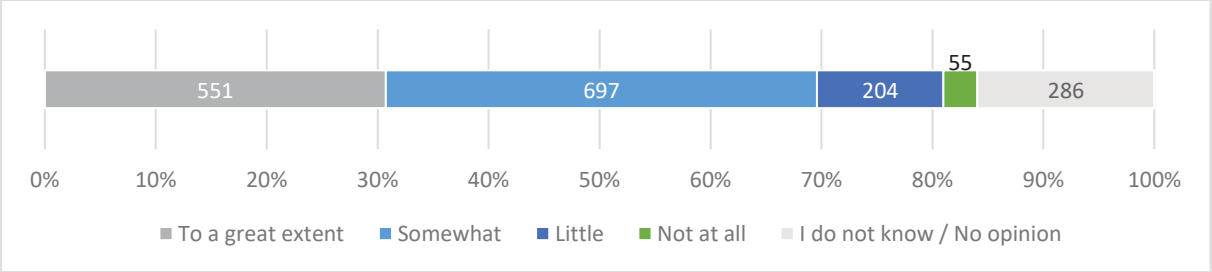
'Horizon 2020 supported cooperation between science and society': 6% of respondents (99) maintained that the programme did in fact not do enough to support said cooperation. Nevertheless, this constitutes only a small fraction of respondents within each stakeholder group. It is important to note that the majority of responses were rather favourable, suggesting an overall positive sentiment towards the support of cooperation between science and society.

Among the various stakeholder groups, favourable views were shared the most on behalf of NGOs 71% (47), whereas business associations (59%; 19) were the least favourable compared to other stakeholder groups indicating that they either agree or strongly agree with the fact that Horizon 2020 supported cooperation between science and society.

Flexibility to respond to unforeseen events

The majority of participants (70%; 1 248) stated that Horizon 2020 was flexible enough to respond to unforeseen emergencies such as the COVID-19 pandemic or Zika. Only 3% (55) expressed the opposite opinion. One position paper also appreciated the flexibility of Horizon 2020 in delivering a response to the COVID-19 pandemic.

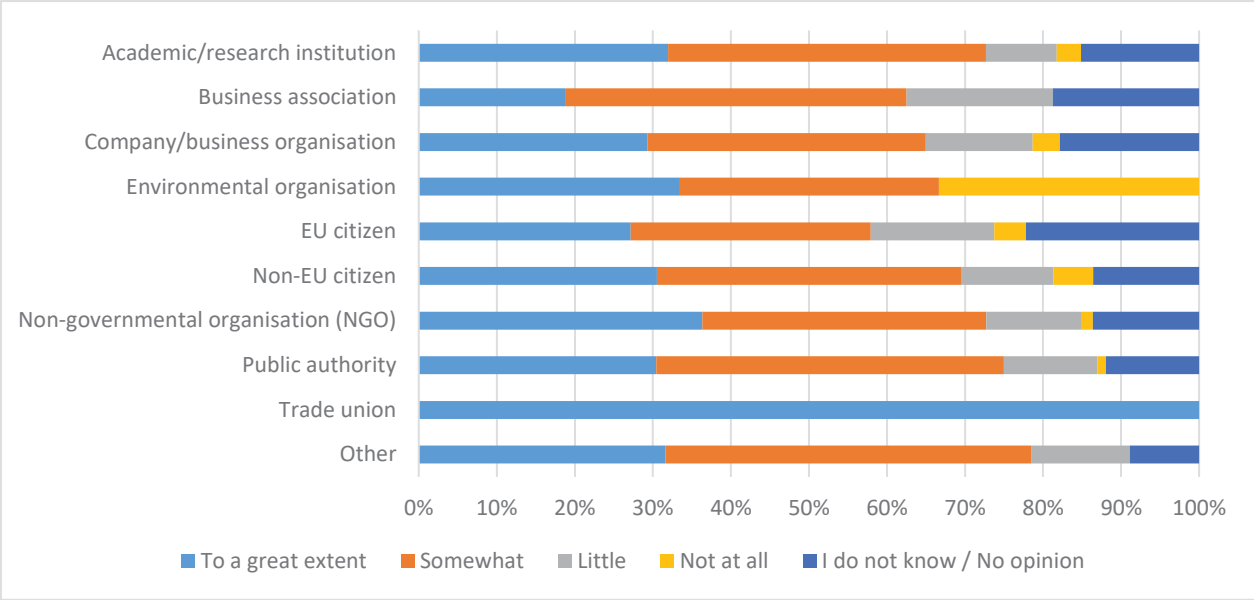
Figure 19: To what extent was Horizon 2020 flexible enough to respond to unforeseen emergencies such as the COVID-19 pandemic, Zika, etc. (N=1 793)



Overall, 70% (1 248) of respondents stated that 'Horizon 2020 is flexible enough to respond to unforeseen emergencies such as the COVID-19 pandemic, Zika and others'. Respondents that shared views on behalf of an institution or organisation agreed to a greater extent (76%; 435) with this statement compared to respondents that shared their views in an individual capacity (67%; 788).

Among the various stakeholder groups, respondents generally perceive Horizon 2020 as being flexible enough to respond to emergencies like the COVID-19 pandemic, Zika and others. Most respondents were positive about the flexibility of the programme with 32% of academia (296), 31% of non-EU citizens (18), 30% of public authorities (28), 29% of companies (92), 30% of public authorities (28) and 27% of EU citizens (60) strongly agreeing. The percentages of respondents sharing a more sceptical view on the matter were relatively low. Still, the 'I don't know / no opinion' option was chosen by 12% (public authorities, 11) to 18% (business associations, 6) of respondents.

Figure 20: Stakeholder breakdown - flexibility to respond to unforeseen emergencies (N= 1 793)

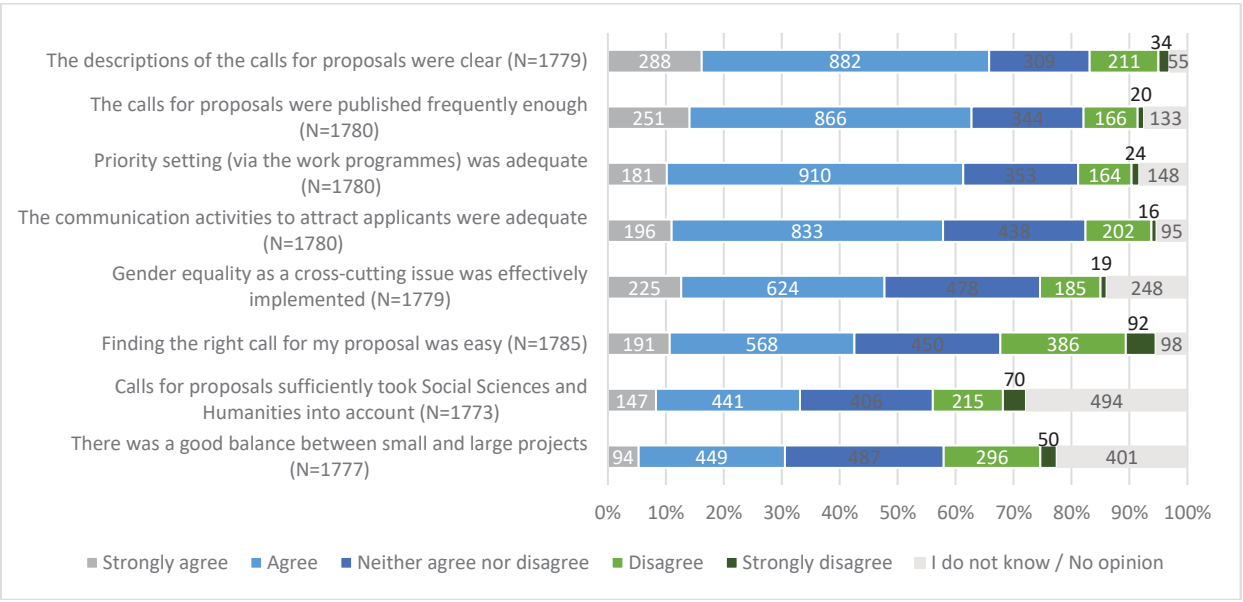


Implementation and administrative procedures

Design and implementation of the calls for proposals

Most respondents agreed that 'the descriptions of Horizon 2020 call for proposals were clear' (67%; 1 170) and frequent enough (63%; 1 117), that 'the priority setting via the work programmes was adequate' (61%; 1 091) and that 'the communication activities to attract applicants were adequate' (58%; 1 029). However, 27% (478) of respondents maintained that finding the right call for proposals was difficult.

Figure 21: To what extent do you agree with the following statements concerning the calls for proposals under Horizon 2020?



Among the different types of stakeholders, 31% (286) of research institutions as well as business associations **found it hard to find the right call**, whereas companies and business organisations indicated that they had slightly less difficulties (26%; 81). Likewise, 42% (384) among research institutions, 50% (16) among business associations and 47% among companies and business organisations found it easy to find the right call for their proposals, presenting a relatively even split between the views of whether calls were designed in a clear way.

Figure 22: Stakeholder breakdown - priority setting via the work programmes was adequate (N= 1 780)

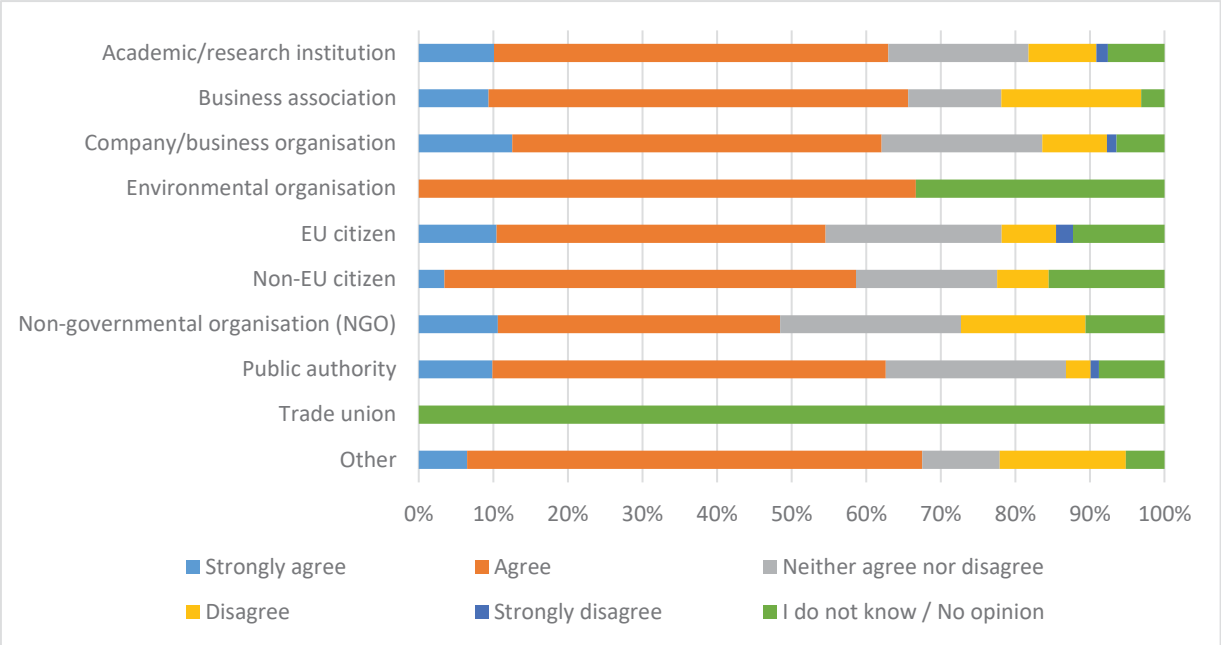
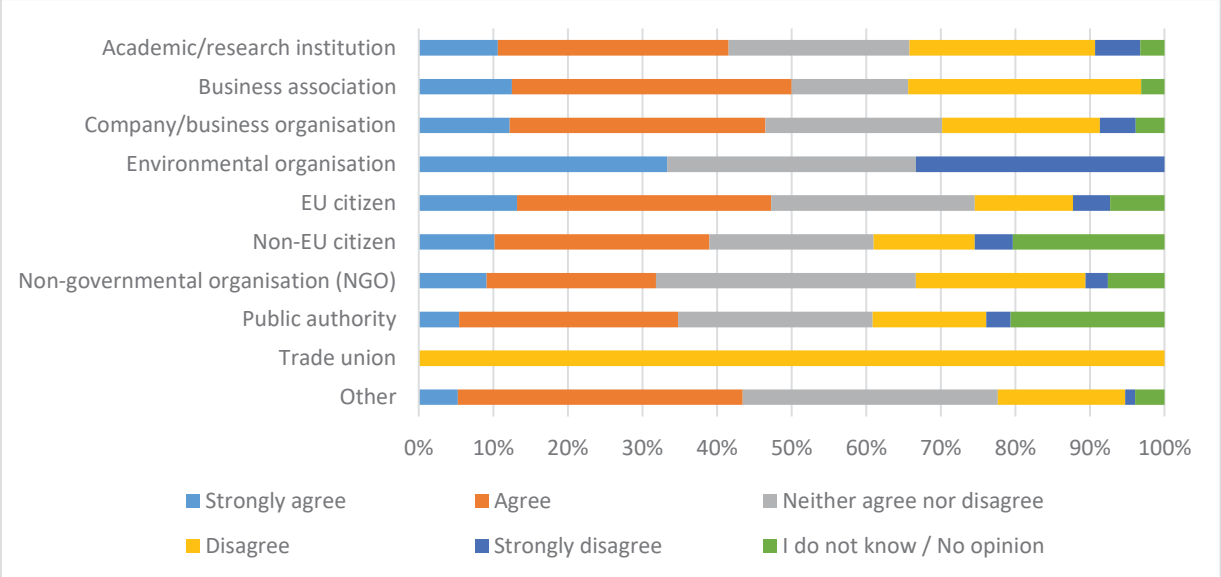


Figure 23: Stakeholder breakdown - finding the right call for my proposal was easy (N= 1 785)

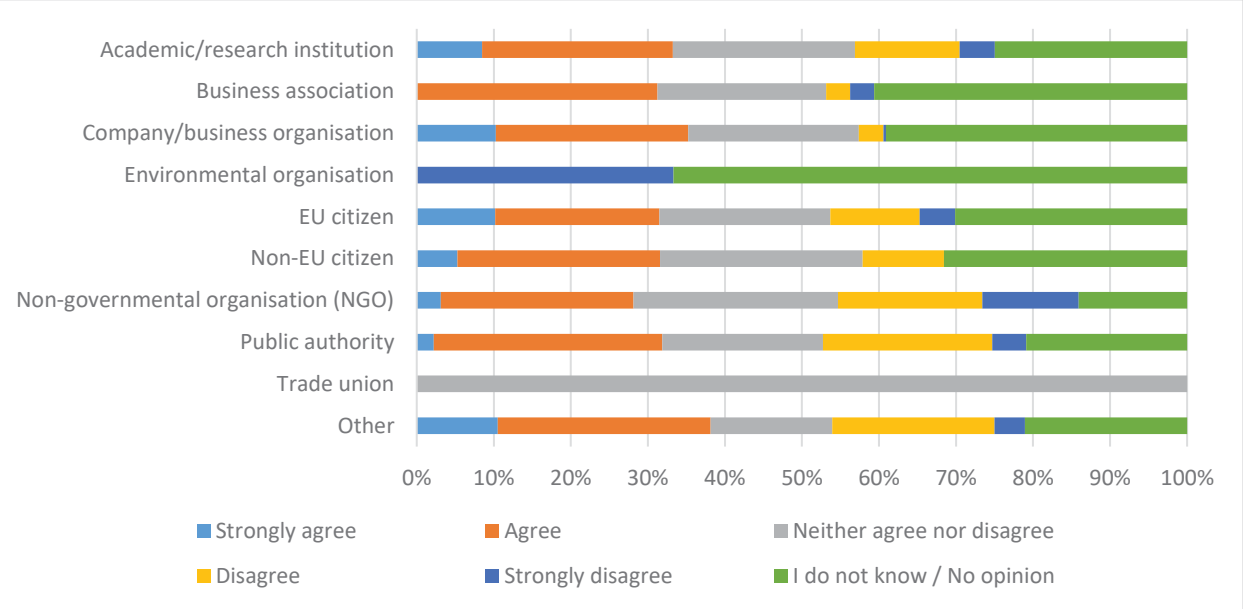


Social Sciences and Humanities

Overall, 37% (656) of respondents indicated in the public consultation that they either agree or strongly agree with the notion that calls for proposals sufficiently took Social Sciences and Humanities into account. It is important to mention that 29% (527) of respondents did not answer this survey question or indicated that they do not know or have no opinion. This indicates that a significant share of respondents has rather limited knowledge of the integration of Social Sciences and Humanities in the programme. Bearing this caveat in mind, 35% of respondents representing companies and businesses, 33% (110), 33% (306) of respondents from academia, 32% (29) of respondents from public authorities deemed that the calls for proposals did indeed sufficiently take Social Sciences and Humanities into account. Among both EU and non-EU citizens, 30% believe Social Sciences and Humanities were sufficiently taken into account (68 and 18 respectively). Still, respondents that neither agree nor disagree with the abovementioned statement include representatives from NGOs (26%; 17), research institutions (24%; 218), companies and business associations (both 22% 7 and 69 respectively). Notably NGOs (31%; 20)

and public authorities (26%; 24) either disagree or strongly disagree with the notion that Social Sciences and Humanities were sufficiently taken into account.

Figure 24: Stakeholder breakdown - calls for proposals sufficiently took Social Sciences and Humanities into account (N= 1 773)

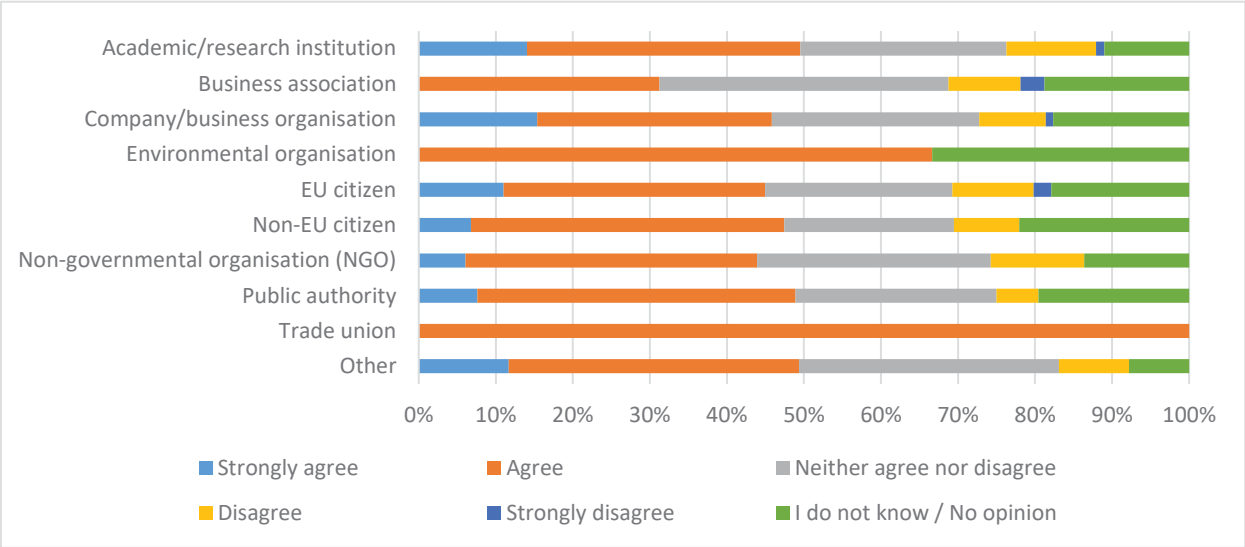


Gender equality

48% of respondents (849) either agreed or strongly agreed that gender equality as a cross-cutting issue has been effectively implemented. 27% (478) neither agreed nor disagreed, while 11% (204) disagreed or disagreed strongly. 14% (248) did not express an opinion.

The stakeholder groups that were most positive about the implementation of gender equality as a cross-cutting issue were academia (50%; 455), followed by public authorities (49%; 45), companies (47%; 143) and non-EU citizens (47%; 28). EU citizens (45%; 98), NGOs (44%; 29) and business associations (31%; 11) on the other hand were less positive: the difference between academia and business associations showed a 19 percentage point difference which might be rooted in the smaller variation within the stakeholder group – only 32 business associations replied to the related question overall whereas the figure was significantly higher for respondents from academia (919).

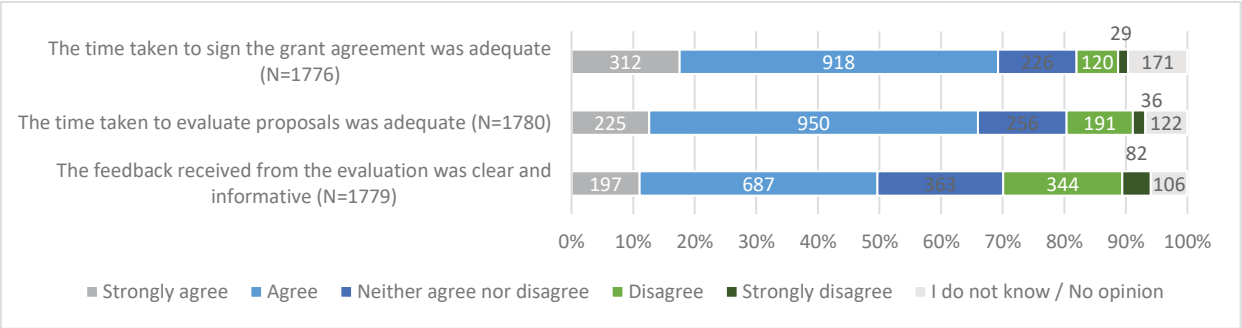
Figure 25: Stakeholder breakdown - gender equality has been effectively implemented as a cross-cutting issue (N= 1 779)



Evaluation of proposals

Most respondents agreed or strongly agreed that the 'time to evaluate the proposals' (66%; 1 175) and the 'time to sign the grant agreement' (69%; 1 230) was 'adequate'. Whilst 50% (884) of respondents think that the feedback received from the evaluation was 'clear and informative', 24% (426) of respondents disagreed or strongly disagreed with this statement.

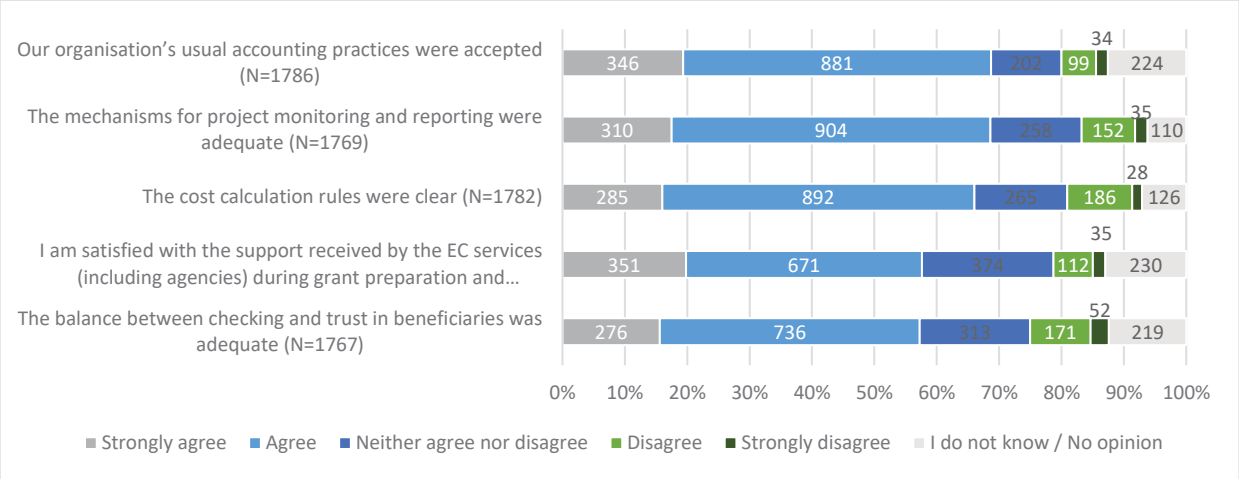
Figure 26. To what extent do you agree with the following statements concerning proposal evaluation under Horizon 2020?



Project implementation

Most respondents agreed or strongly agreed that their 'organisation's usual accounting practices were accepted' (69%: 1 227), that 'the mechanisms for project monitoring and reporting were adequate' (69%; 1 214), that 'the cost calculation rules were clear' (66%; 1 177). The majority of respondents were 'satisfied with the support received by the EC services (including agencies) during grant preparation and implementation' (58%; 1 022) and agreed or strongly agreed that 'the balance between checking and trust in beneficiaries was adequate' (57%; 1 012).

Figure 27. To what extent do you agree with the following statements concerning the project implementation under Horizon 2020?



A large majority of respondents 'agreed' or 'strongly agreed' that their 'organisation's **usual accounting practices** were accepted' (69%; 1 227). The agreement among respondents from NGOs and companies was even higher with both at 74% (49; 651) respectively. EU citizens (61%; 135) and non-EU citizens (51%; 30) agreed to a lesser extent. Only a small fraction of respondents found that their usual accounting practices were not accepted, namely public authorities (2%; 2), NGOs (8%; 3), companies (7%; 23), business associations (6%; 2) and academia (8%; 77).

Beyond that, stakeholders agreed that '**the mechanisms for project monitoring and reporting were adequate**' (69%; 1 214), showing the highest level of agreement among companies (74%; 226), followed by respondents from academia (70%; 634), business associations (68%; 21), EU citizens (66%; 143), non-EU citizens (60%; 35) and NGOs (58%; 38) and business associations (68%; 21). At the same time, another fraction of respondents from academia were of the opinion that the monitoring and reporting mechanisms were not adequate (10%; 93), followed by NGO-associated respondents (17%; 11), respondents on behalf of companies (9%; 28) and business associations (3%; 1).

Overall, respondents agreed with the statement that '**the cost calculation rules were clear**' (66%; 1 177). Nevertheless, there was some variation between the different stakeholder groups: business associations agreed to the greatest extent (74%; 23), followed by companies (72%; 224), academia (68%; 620), NGOs (62%; 41), EU citizens (61%; 120), public authorities (57%; 52) and non-EU citizens (54%; 37) respectively. At the same time, the level of dissatisfaction with the clarity of cost calculation rules varies to a smaller extent among the different types of stakeholders, ranging from 9% of companies (27), up to 13% for academia (118), public authorities (12) and business associations (4) respectively.

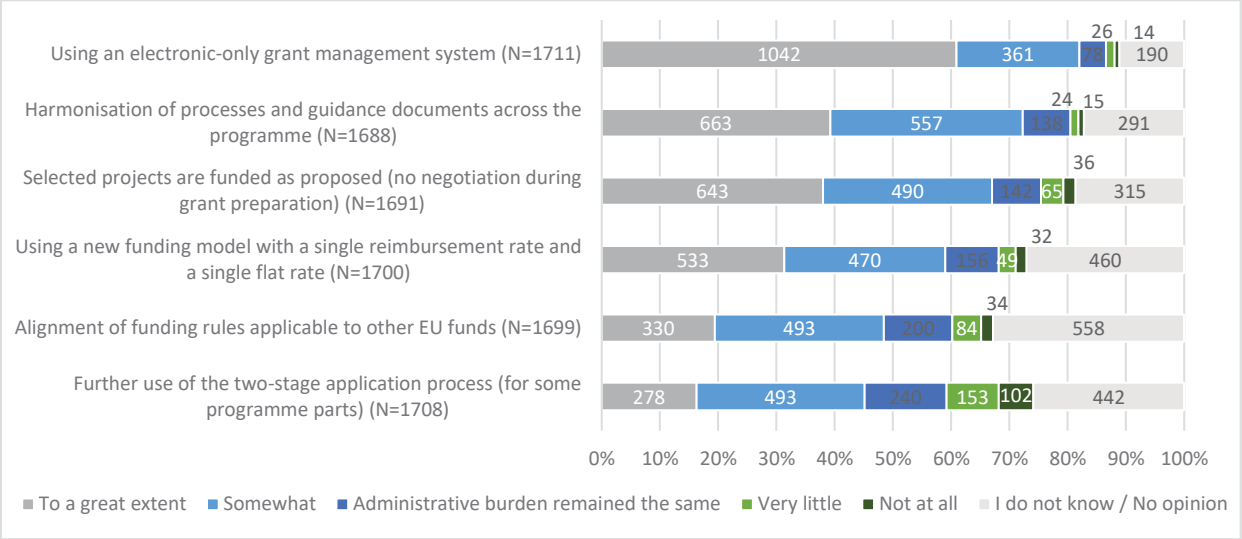
More than half of respondents were **'satisfied with the support received by the EC services (including agencies) during grant preparation and implementation**' (58%; 1 022): business associations are beyond the average of all respondents satisfied with the support received by the EC services (67%; 21), along with companies (64%; 199). At the same time, respondents from academia (57%; 524) and NGOs (48%; 32) were less satisfied. Interestingly, the level of satisfaction between EU citizens and non-EU citizens differs: **non-EU citizens** (64%; 27) **are less satisfied[401] with the support received by the EC services, compared to EU citizens** (55%; 122).

The effects of simplification measures

Most respondents stated that 'using an electronic-only management system' (82%; 1 403) and having 'harmonised processes and guidance documents across the framework programme' (72%; 1 220) reduced their administrative burden – somewhat or to a great extent. Likewise, most respondents think that removing the negotiation stage during grant preparation (67%; 1 133) and 'using a funding model with a single reimbursement rate and a single flat rate' (59%; 1 033) are effective simplification

measures. Although positive responses (771) outnumber negative ones (255), the simplification measures that received the highest number of negative responses is 'further use of the two-stage application process'.

Figure 28: Based on your experience, to what extent did the following simplification measures, introduced in Horizon 2020, help reduce your administrative burden?



Specifically regarding the implementation processes of the calls, stakeholders indicated that '**Using an electronic-only management system**' (82%; 1 403) and having '**harmonised processes and guidance documents across the framework programme**' (72%; 1 220) were understood to have reduced at least 'somewhat' the administrative burden for respondents. Likewise, most respondents think that **effective simplification measures** included: **removing the negotiation stage** during grant preparation (67%; 1 133) and '**using a funding model with a single reimbursement rate and a single flat rate**' (59%; 1 033)**.**

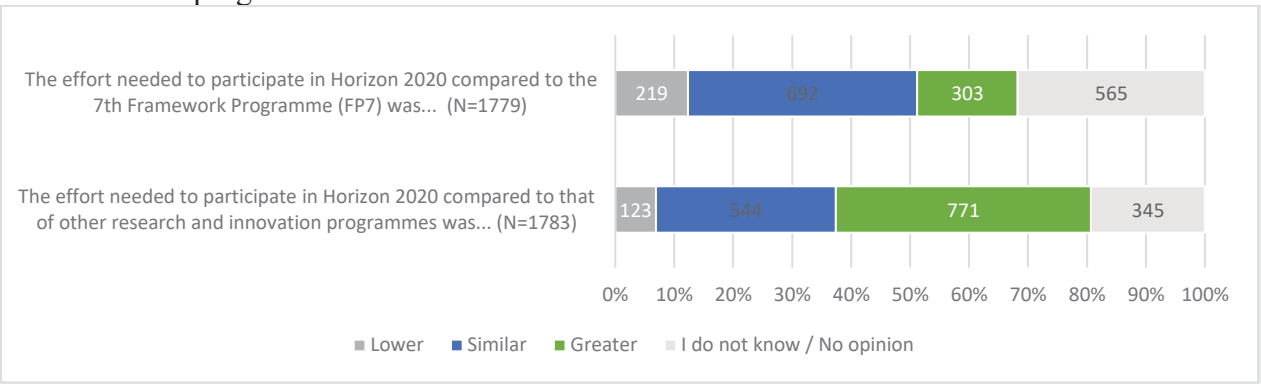
The simplification measure with the **highest number of negative views** was the 'further use of the **two-stage application process**'. Although positive responses (42%; 711) still outnumber the negative ones (15%; 255), the majority of respondents agrees with the notion of further expanding the two-stage application process for some programme parts. Notably respondents from academia (56%; 433), non-EU citizens (52%; 27), public authorities (49%; 36), business associations (48%; 11) and EU citizens (48%; 87) were in favour of furthering the use of the two-stage application process for some programme parts.

The effort to participate in Horizon 2020

Views on whether the effort needed to participate in Horizon 2020 was lower **compared to FP7** were not uniform: 39% (692) of respondents think that the effort was similar (the largest share across all country and stakeholder groups), 17% (303) that it was greater and 12% (219) that it was lower. One-third of respondents (565) do not have an opinion.

On the other hand, **relative to other research and innovation funding programmes**, the effort to participate in Horizon 2020 is deemed greater (43%; 771, particularly academic and research institutions) or similar (39%; 692) by most, across all stakeholder groups. Only a small minority of respondents (7%; 219) consider it lower.

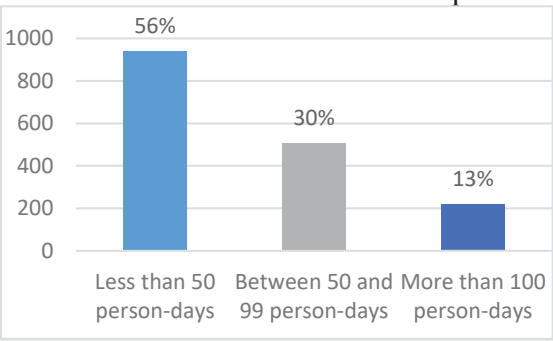
Figure 29: The effort needed to participate in Horizon 2020 compared to the 7th Framework Programme and other R&I programmes



Costs of proposal preparation

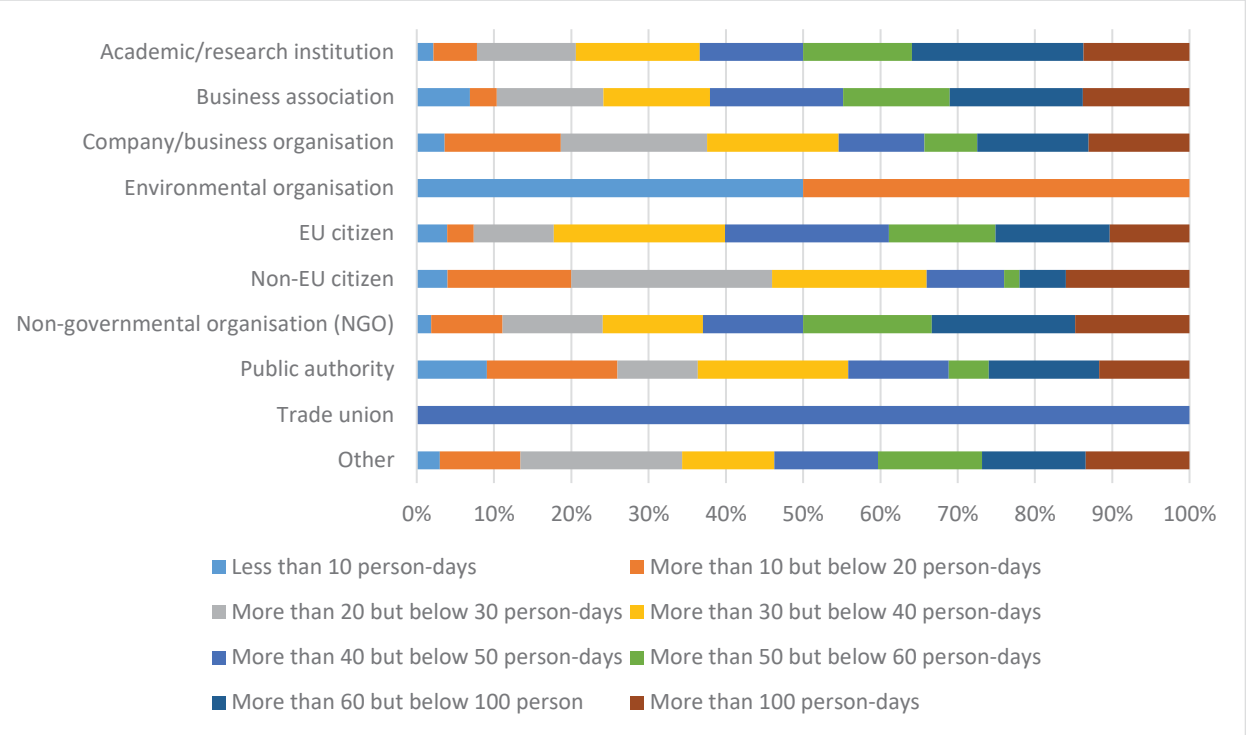
Most (56%; 939) of the consultation respondents declared that their 'proposal preparation for Horizon 2020' took overall less than 50 days (across all stakeholder groups, especially public authorities – 70% and companies – 65%). This is followed by 30% of respondents (505) who stated that the proposal preparation took 'more than 50 but less than 100 days' and 13% (219) who said 'more than 100 days'. Considering the different types of respondents, academic, research institutions and NGOs reported to spend more time preparing proposals than companies, business organisations or public authorities.[130]

Figure 30. Approximately, how much time did the proposal preparation for Horizon 2020 take overall? Please indicate the total number of person-days. (N= 1 663)



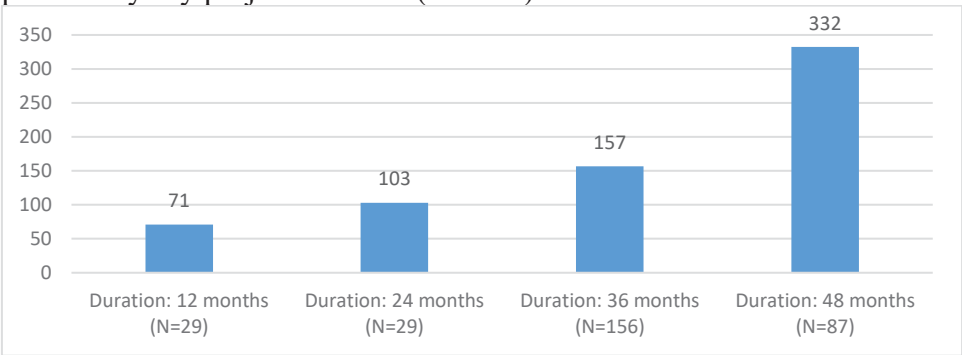
[130] The share of respondents spending less of 50 days for proposal preparation is 50% in the first group, whereas it is more than 65% for the second group.

Figure 31: Stakeholder breakdown – How much time did the proposal preparation for Horizon 2020 take overall? (N =1 663)



The consultation also asked participants about the 'time spent managing participation'. The analysis of responses cannot be conclusive because there is great variability in the responses in terms of who provided information or not, which programme parts the respondents were linked to and their specific role in the projects.[131] The chart below shows the information that was provided on 'average number of person-days spent during the entire project', by project duration.

Figure 32. Approximately, how much time does your project spend on managing participation in Horizon 2020? Total number of person-days spent overall on managing participation. Average estimate of person-days by project duration (N= 301)



The results to the open question 'Approximately, how much time does your project spend on managing participation in Horizon 2020?' can only be interpreted with caution because of the following:

- 332 responses could not be processed because respondents did not provide the required information (could not provide an estimate or when they did it was not in the required format).
- Comparability is difficult because respondents interpreted the question in different ways (e.g., some respondents included in the estimate the time spent for the internal project coordination, others provided an estimate of the time that it took for the whole project activities).

[131] For example, among projects with a duration of 36 months, the estimates range from 2 person-days to 1,500 person-days (after the outliers were removed).

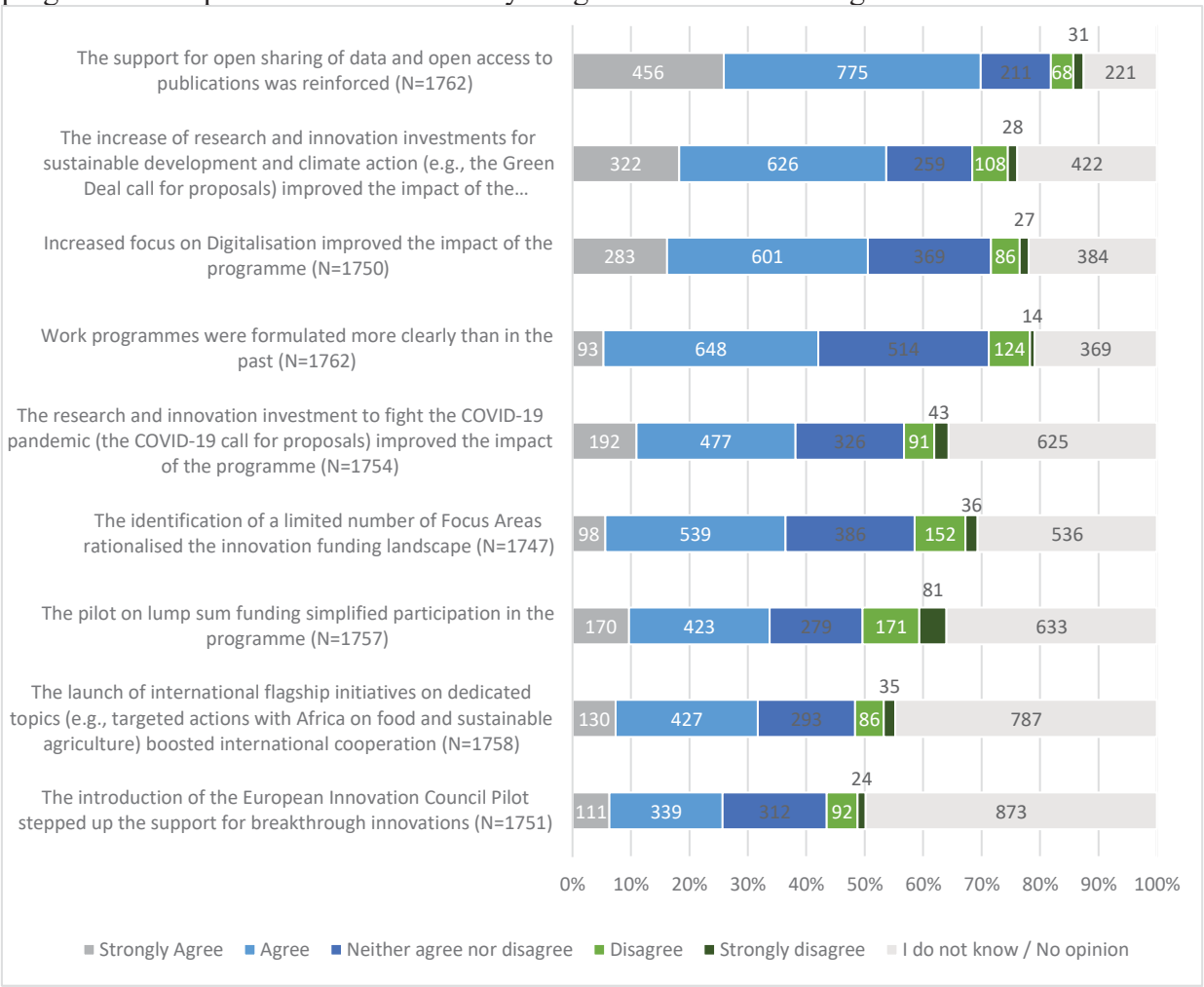
- The resources spent on managing participation largely depended on the type of action (i.e., Research & Innovation Action or Coordination and Support Action), the role of the respondent in the project (i.e., coordinator or partner), and the project size.

Effectiveness of the novelties introduced for the period 2018 – 2020

The consultation results show varying degrees of familiarity with the novelties introduced by the programme. 70% (1 231) of the respondents agreed or strongly agreed that reinforcing the 'support for open sharing of data and open access to publications' increased the framework programme's impact. Similarly, the majority of respondents see positive impacts from 'increasing the research and innovation investments for sustainable development and climate action' (54%; 948) and from 'increasing the focus on digitalisation' (50%; 884).

On the other hand, more than one-third of the respondents did not express an opinion on novelties such as the introduction of the European Innovation Council (EIC), the launch of international flagship initiatives, the introduction of the lump sum funding and the investments to fight COVID-19. The analysis by type of respondent does not highlight significant differences among the stakeholders' groups as the distribution of responses among the different options is similar.

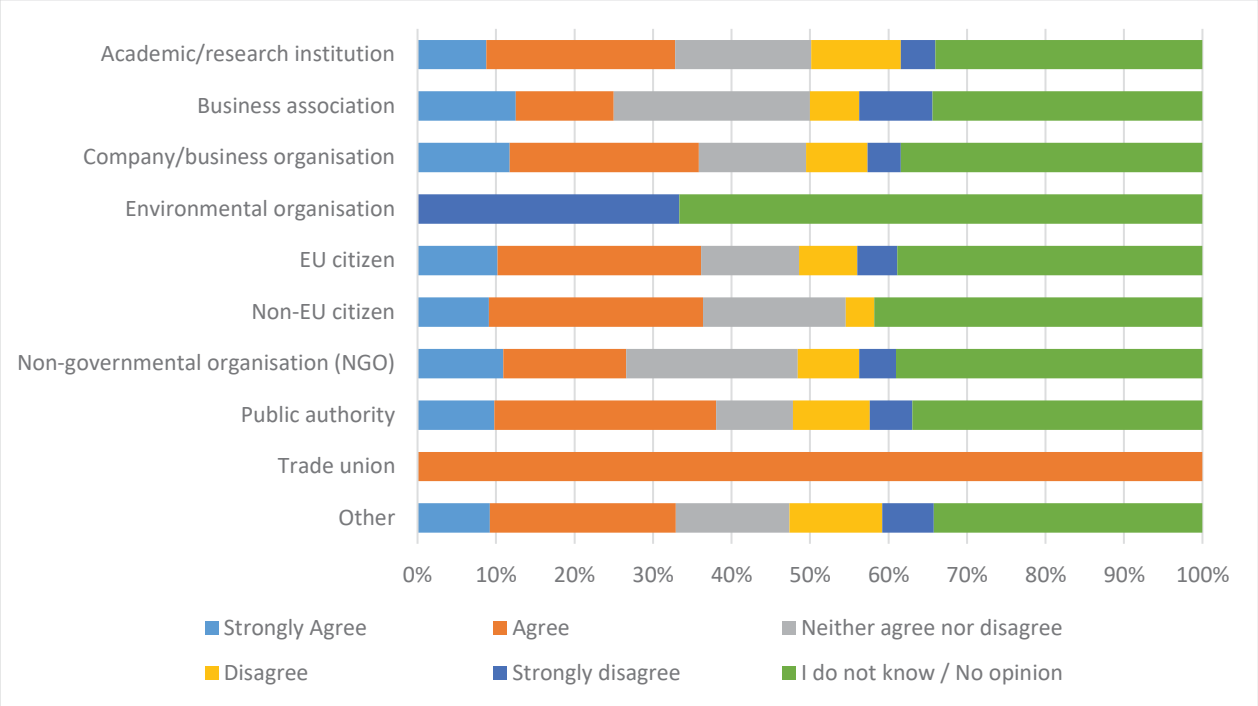
Figure 33. For the period 2018-2020, a number of novelties were introduced to increase the programme's impact. To what extent do you agree with the following statements?



Across all stakeholder groups, the support for the lump sum pilot is held the most with respondents associated with public authorities (38%; 35), which is followed by respondents from companies (36%; 110). Respondents from companies favour the introduction of the lump sum pilot to a greater extent compared to respondents from academia (33%; 299) however not significantly (only 3 percentage

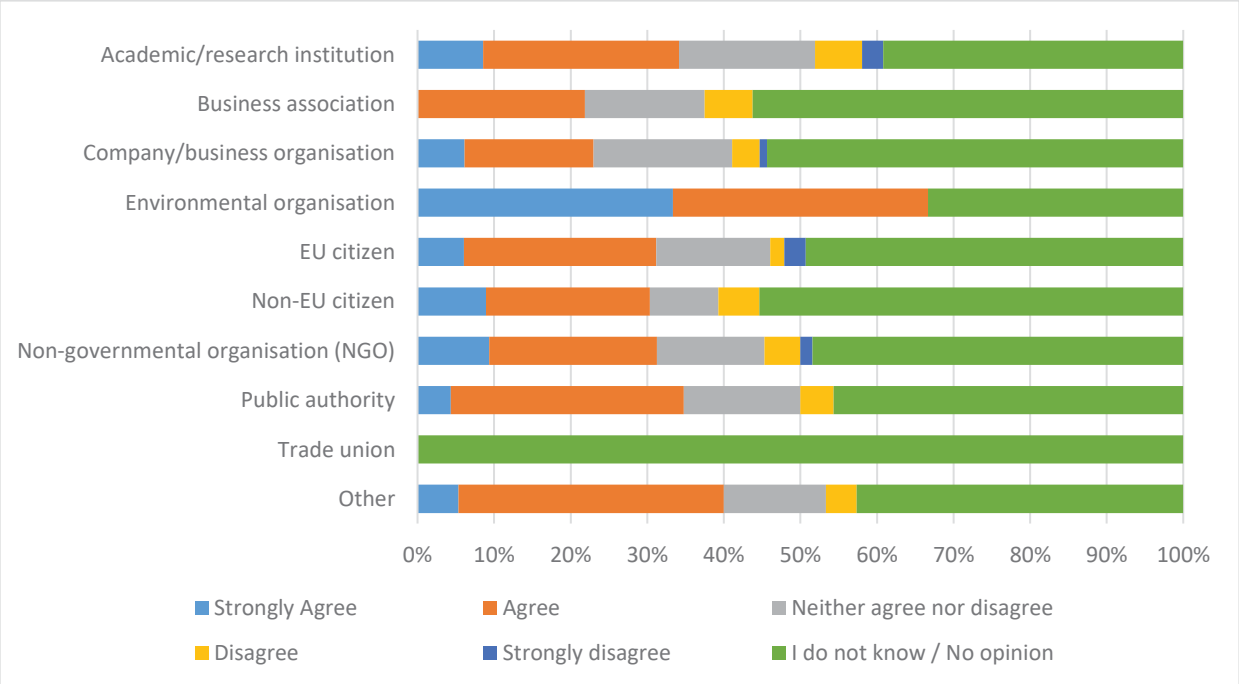
points). Similarly, 16% of respondents from academia (144) are negative about the introduction of the lump sum pilot, compared to 13% of respondents from companies (37) once again showing a difference of 3 percentage points.

Figure 34: Stakeholder breakdown - "The pilot on lump-sum funding simplified participation (N= 1 757)



According to 35% (32) of public authorities, 34% of academia (311), 31% of NGOs (20) and 23% of companies (71) deem that the **introduction of international flagship initiatives have boosted international cooperation**. However, around half of the respondents said that they do not know or do not have an opinion on this matter.

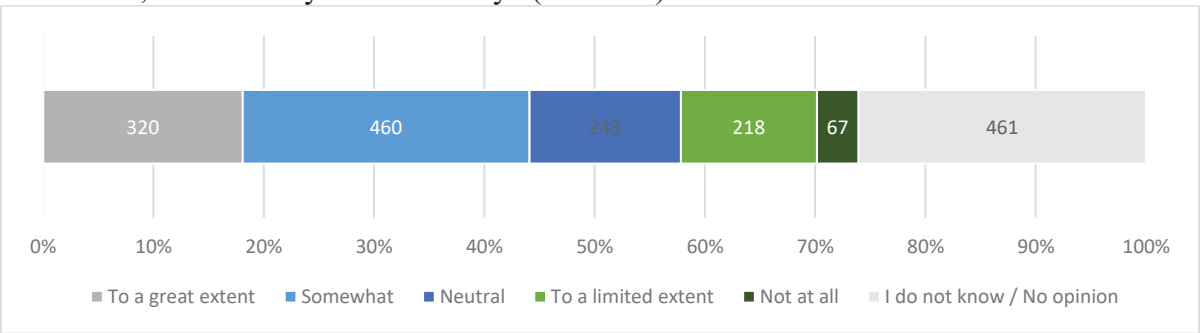
Figure 35: Stakeholder breakdown - launch of flagship initiatives boosted international cooperation (N= 1 758)



Effectiveness of the Horizon 2020 partnerships

44% (780) of respondents stated that the public-public or public-private partnerships were 'more effective than regular collaborative research in achieving impact for science, the economy and/or society'. Only 16% (285) of them selected that partnerships were not more effective, or they were more effective only 'to a limited extent'. However, more than 26% (461) of respondents did not express any opinion.

Figure 36: In your opinion, to what extent have public-private and public-public Partnerships supported by Horizon 2020 been more effective, compared to regular collaborative research in achieving impact for science, the economy and/or society? (N=1 769)

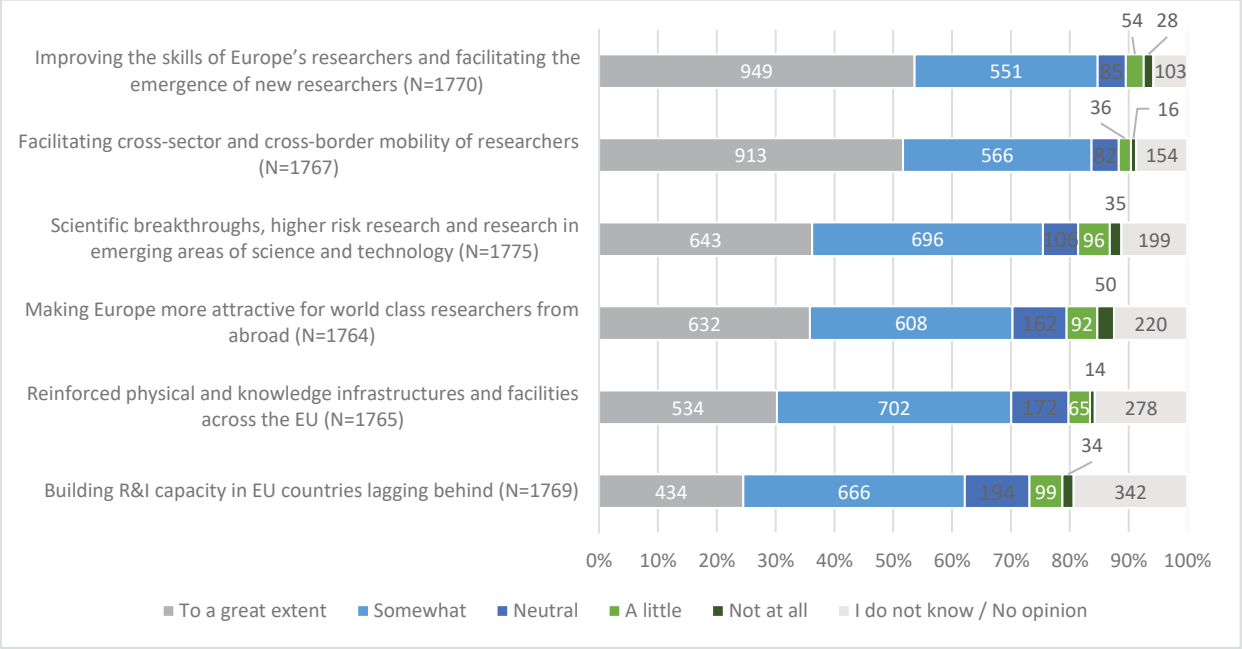


Among the different types of respondents, businesses and business organisations have a more positive opinion than academic / research institutions. 42.2% (386) of academic and research institutions answered 'to a great extent' or 'somewhat' compared to 63.6% (21) of business association respondents and 53.5% (167) of companies and business organisations.

Scientific effects

More than 60% of the respondents agree that Horizon 2020 produced the expected scientific effects listed in the consultation, for instance, by improving the skills of Europe's researchers and by facilitating the emergence of new researchers (85%; 1 500) or by making Europe more attractive for world-class researchers from abroad (70%; 1 240).

Figure 37. In your view, to what extent did Horizon 2020 produce the following scientific effects?



78% (711) of respondents from academic and research institutions, 75% (24) of business associations and 73% (226) of respondents from companies, Horizon 2020 fosters **scientific breakthroughs, higher**

risk research and research in emerging areas of science and technology. This claim was supported by EU citizens (76%; 163) and an even greater share of non-EU citizens (86%; 59).

More respondents agreed or strongly agreed that Horizon 2020 **improved the skills of Europe's researchers and facilitated the emergence of new researchers** (85%; 1 500): 92% of non-EU citizens (54), 88% of respondents from academia (803), 82% of respondents from NGOs (61) and 81% of respondents from business associations (26) supported this claim.

In terms of **facilitating cross-sector and cross-border mobility of researchers**, 88% of respondents from academia (804), 76% of respondents from companies (235) as well as 71% of business associations (22) agreed or strongly agreed that Horizon 2020 had a positive effect. Similarly, 73% of respondents from academia (666), 67% of respondents from business associations (20), as well as 60% of companies (90) deemed that the programme is **making Europe more attractive for world class researchers from abroad.** Still, this claim is only supported by 66% of non-EU citizens (52), contrasting 88% of EU citizens responding (164).

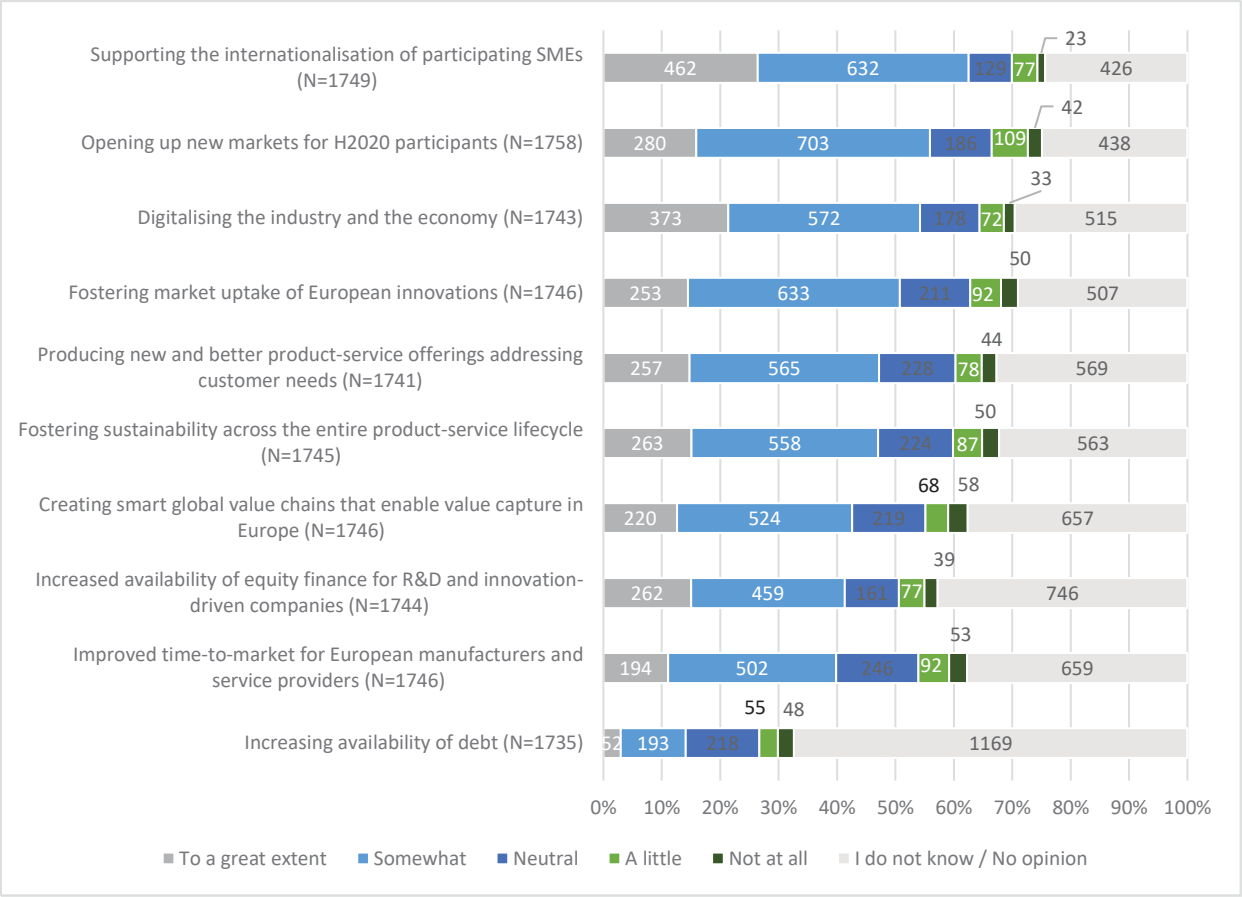
Among academia and research institutions, 30% (913) agreed to a great extent that Horizon 2020 **reinforced physical and knowledge infrastructures and facilities** across the EU which is similar to views of public authorities (32%; 91). Figures were lower for NGOs (28%; 65) and companies (27%; 309).

Only 62% (1 097) of respondents believed that Horizon 2020 **helped building R&I capacity in EU countries lagging behind**: this view was primarily shared by environmental organisations (67%; 2), companies and businesses (64%; 199) and academia / research organisations (62%; 566). The views of business associations were less favourable, only having 55% (17) supporting the claim that the programme helped building R&I capacity in EU countries lagging behind, whereas 23% (199) of respondents replying on behalf of businesses indicated that the effect of Horizon 2020 in this endeavour was neutral. Nevertheless, other stakeholder groups held more favourable views, with less respondents deeming the effect neutral (e.g. academia 11%; 200, companies 10%; 31). Overall, only a small fraction of respondents indicated that it had no effect at all (3%; 8 businesses and companies and 1.5%; 14 of academia).

Economic effects

Around one-third of respondents did not express any opinion on the economic effects produced by Horizon 2020. Nonetheless, most of the respondents stated that the programme fostered market uptake of European innovations (51%; 886), digitalised the industry and the economy (54%; 945), opened up new markets for participants (56%; 983) and supported the internationalisation of SMEs participating in Horizon 2020 (63%; 1 094). As for the other economic effects, the respondents with a positive opinion outnumber those with a negative opinion. Only 518 respondents expressed an opinion on whether Horizon 2020 increased the availability of debt financing.

Figure 38. In your view, to what extent did Horizon 2020 produce the following economic effects?



The following graphs provide a stakeholder breakdown for the top three effects identified by respondents:

Figure 39: Stakeholder breakdown – 'Horizon 2020 supported the internationalisation of participating SMEs' (N= 1 749)

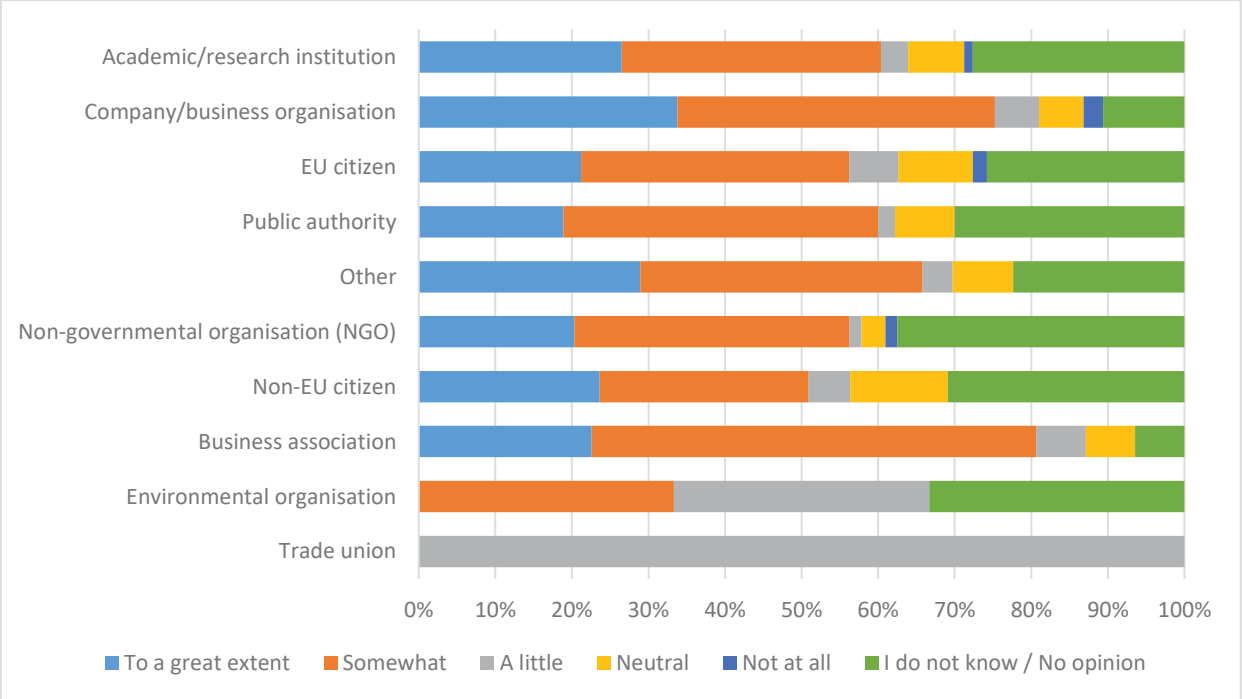


Figure 40: Stakeholder breakdown – 'Horizon 2020 opened up new markets for programme participants' (N = 1 758)

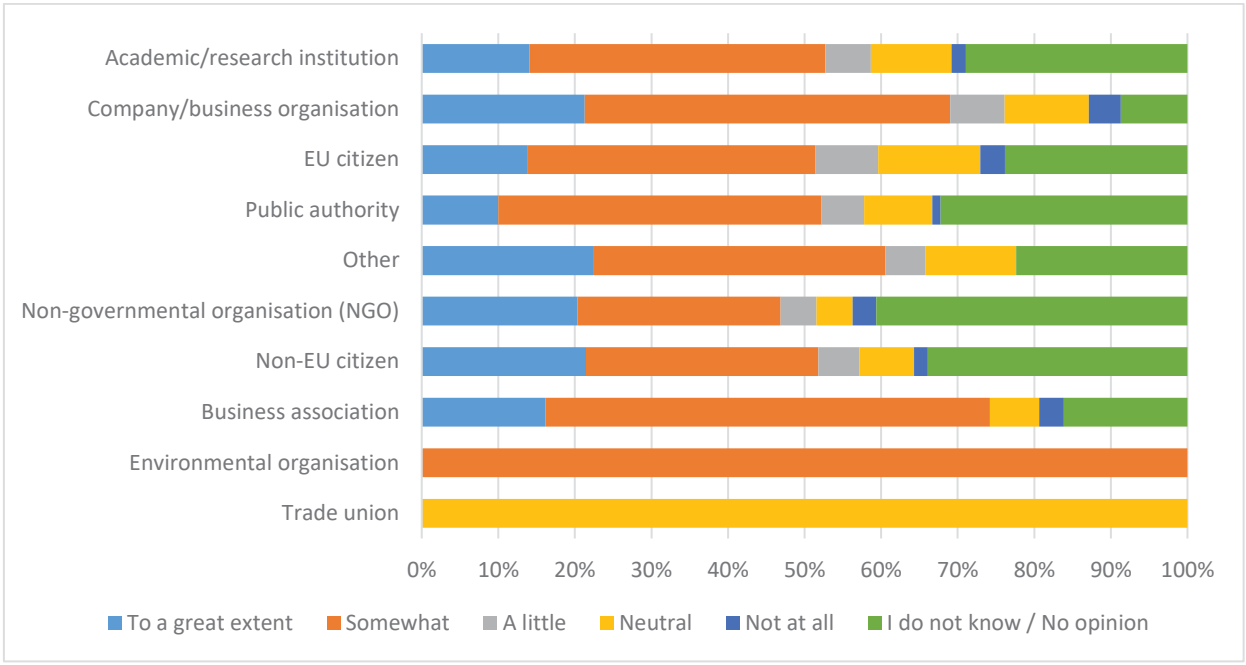
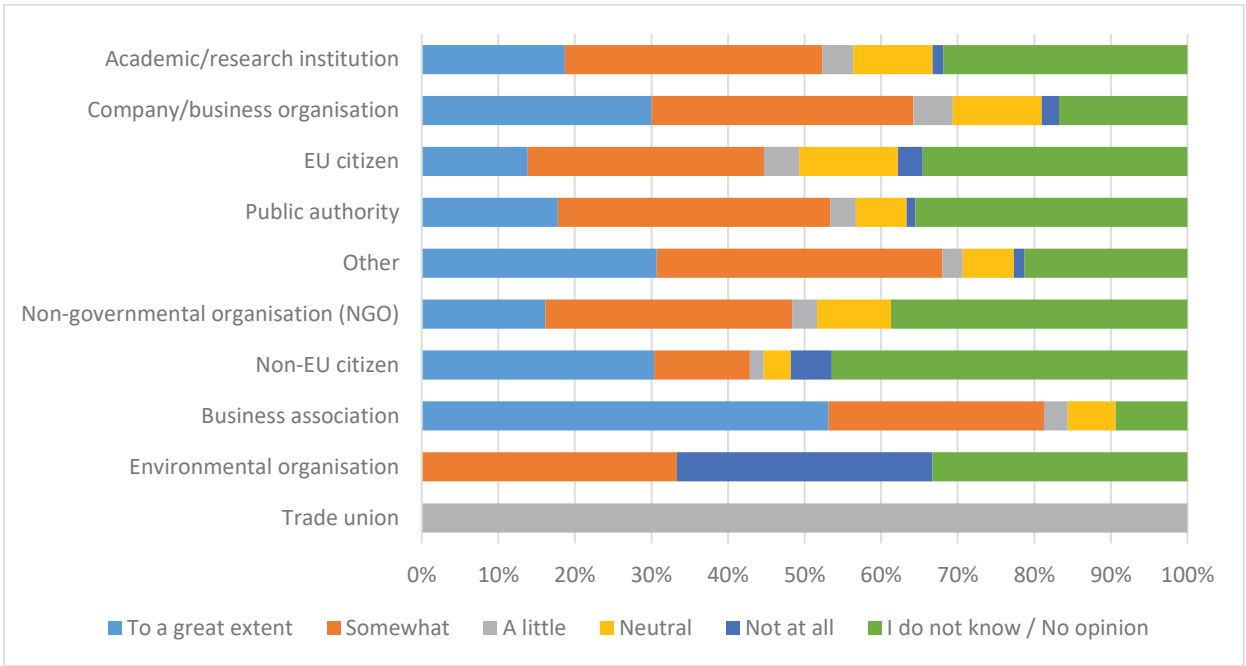


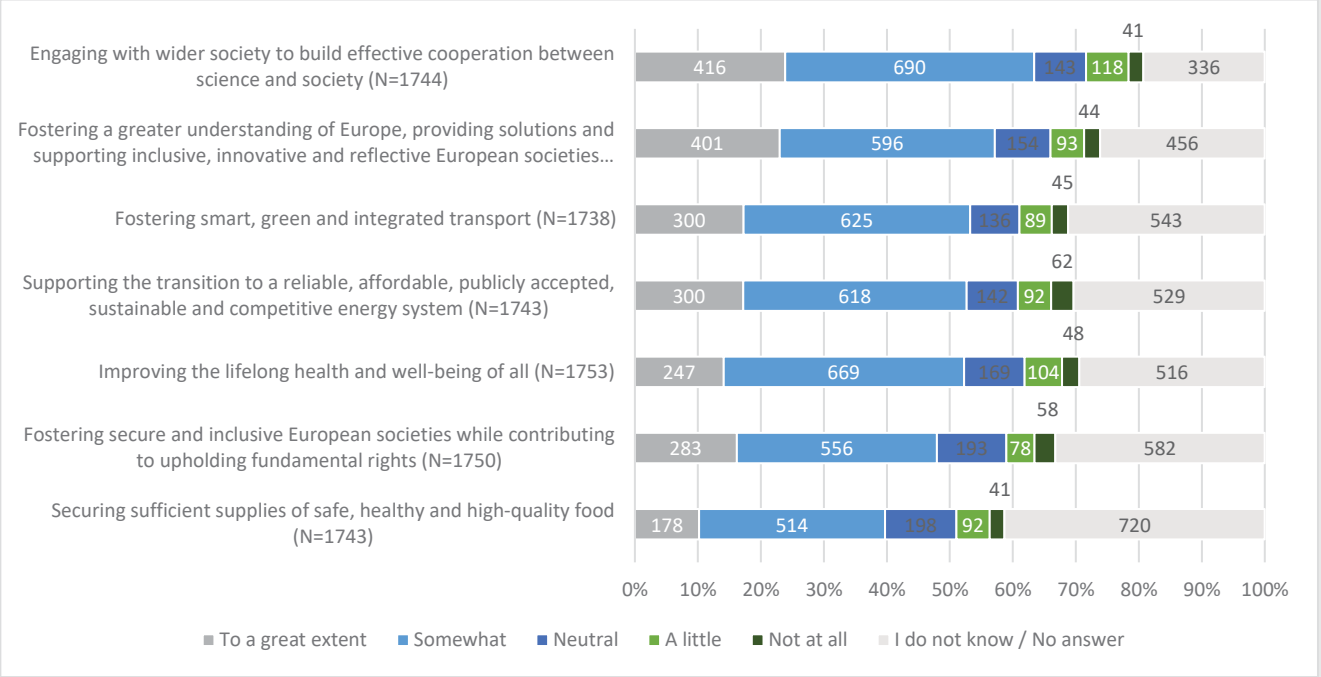
Figure 41: Stakeholder breakdown – 'Horizon 2020 digitalised the industry and the economy' (N = 1 743)



Societal effects

Respondents generally reported that Horizon 2020 produced positive societal effects. These effects included 'improving lifelong health and well-being of all' (52%; 916), 'supporting the transition to a reliable, affordable, publicly accepted, sustainable and competitive energy system' (53%; 918), 'fostering smart, green and integrated transport' (53%; 925), 'fostering a greater understanding of Europe' (57%; 997), and 'engaging with wider society to build effective cooperation between science and society' (63%; 1,106). More than 40% of respondents (720) did not express an opinion on whether Horizon 2020 contributed to 'securing sufficient supplies of safe, healthy and high-quality food'.

Figure 42: In your view, to what extent did Horizon 2020 produce the following societal effects?



66% (1 170) of respondents in the stakeholder consultation conducted for this evaluation agreed or strongly agreed that '**Horizon 2020 supported cooperation between science and society**'. 6% of respondents (99) maintained that the programme did *not* do enough to support said cooperation. Nevertheless, this constitutes only a small fraction of respondents within each stakeholder group. It is important to note that the majority of responses were rather favourable, suggesting an overall positive sentiment towards the support of cooperation between science and society. Among the various stakeholder groups, favourable views were shared the most on behalf of NGOs 71% (47), whereas business associations (59%; 19) were the least favourable compared to other stakeholder groups. Non-EU citizens found that Horizon 2020 supported cooperation between science and society to a greater extent (67%; 39) compared to EU citizens (60%; 129).

The following graphs provide a stakeholder breakdown for the top three effects identified by respondents:

Figure 43: Stakeholder breakdown – 'Horizon 2020 engaged with wider society to build effective cooperation between science and society' (N = 1744)

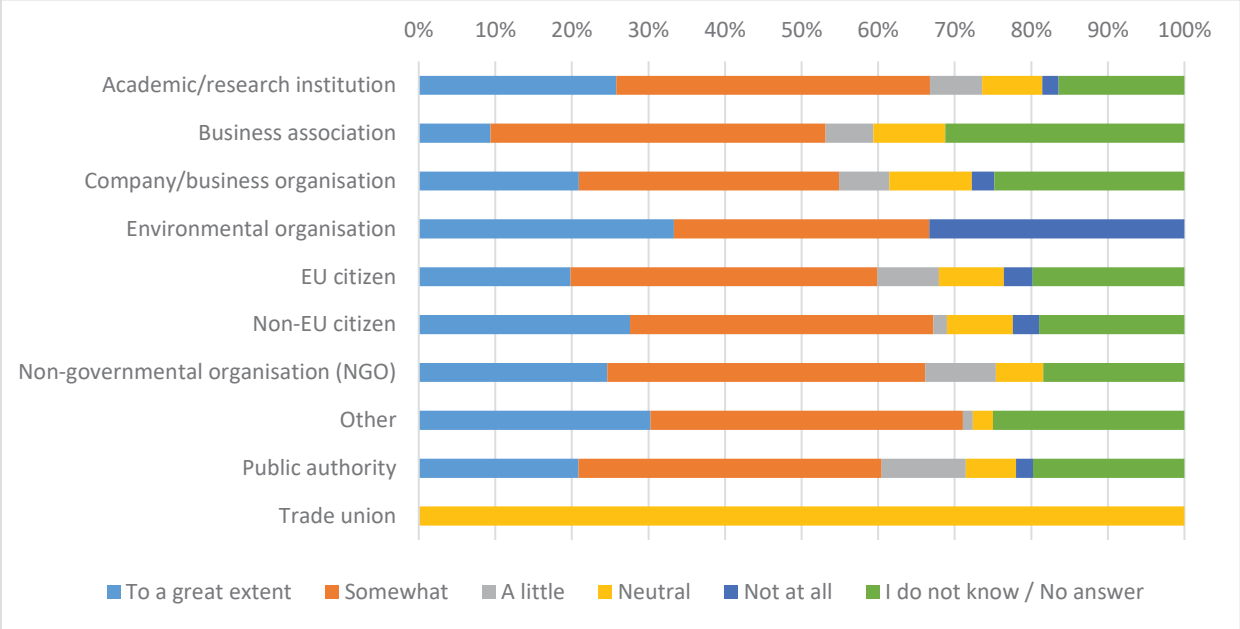


Figure 44: Stakeholder breakdown – 'Horizon 2020 fostered a greater understanding of Europe, providing solutions and supporting inclusive, innovative and reflective societies' (N= 1 744)

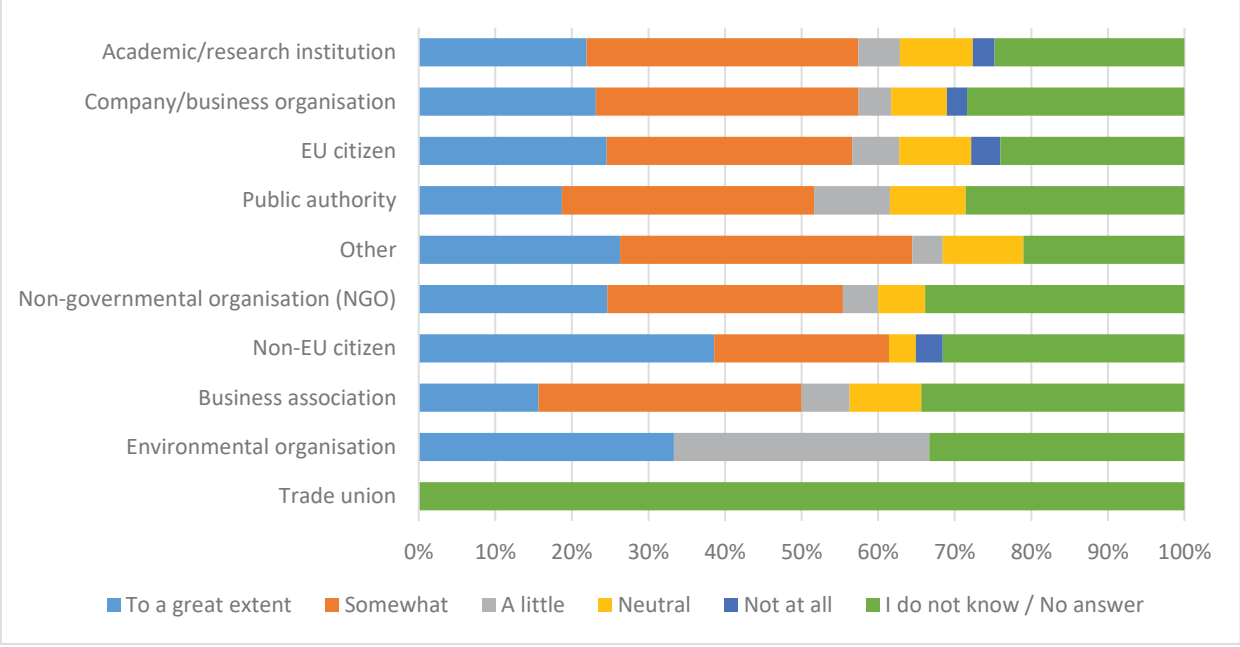
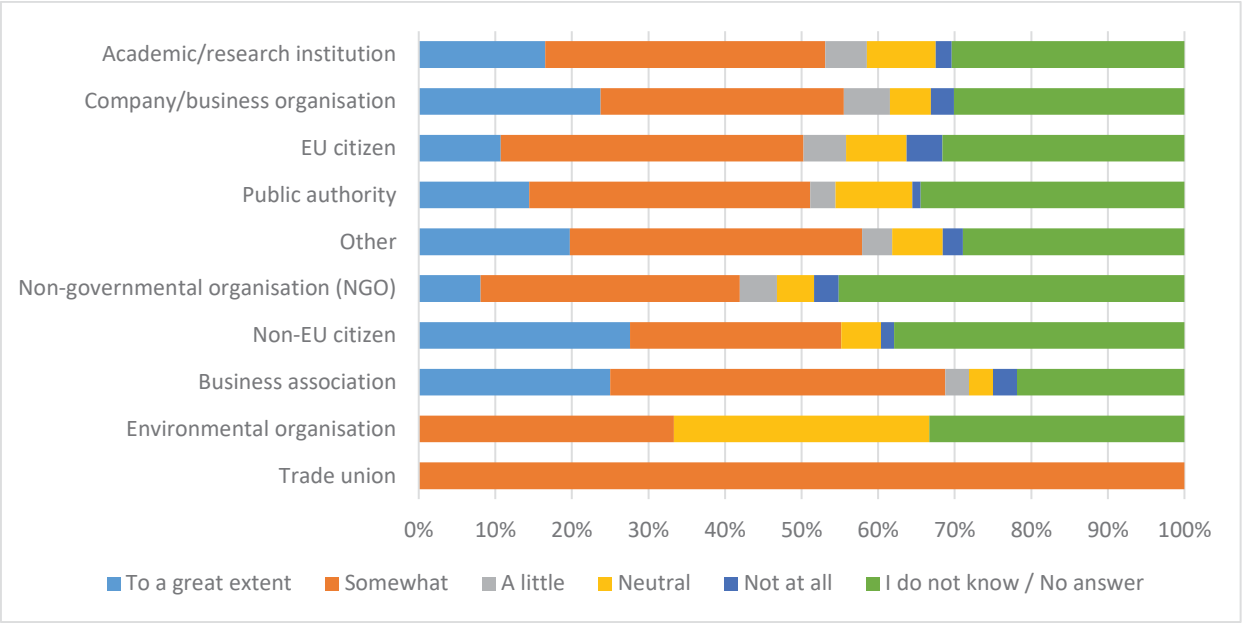


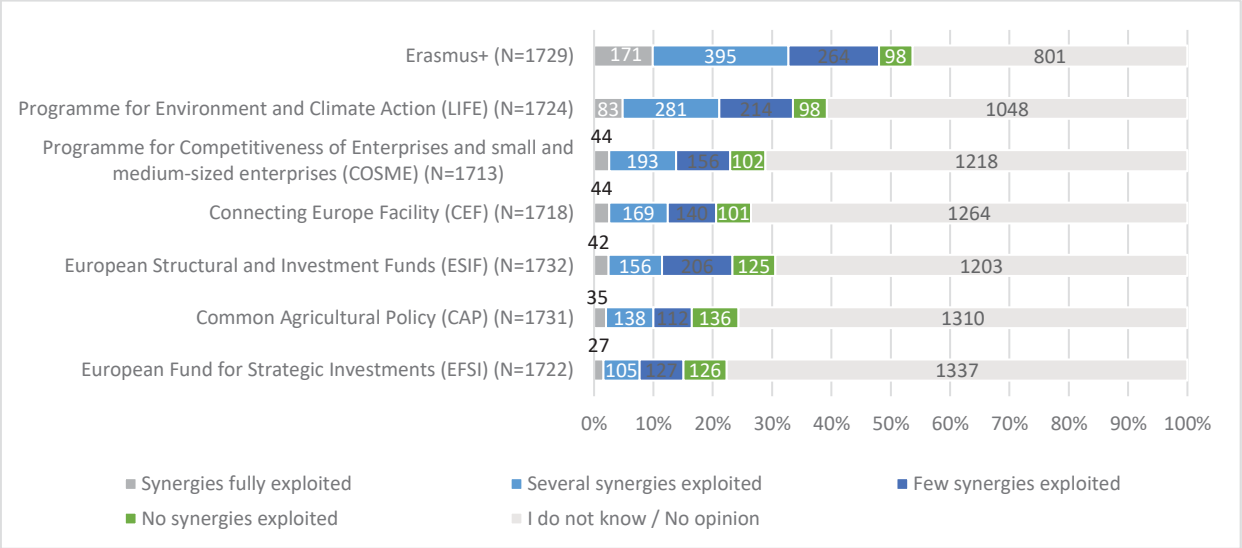
Figure 45: Stakeholder breakdown – 'Horizon 2020 fostered smart, green and integrated transport' (N = 1 738)



Synergies with other EU programmes

54% of respondents expressed an opinion on the synergies between Horizon 2020 and Erasmus+. Between 22% and 39% of all the respondents expressed an opinion on the synergies between Horizon 2020 and other EU programmes. The majority of respondents selected that 'synergies were exploited' or 'fully exploited' with Erasmus+ (61%; 566 out of 928) and the Programme for Environment and Climate Action (LIFE) (54%; 364 out of 676). Conversely, the majority of respondents selected that 'few' or 'no synergies were exploited' with the Programme for Competitiveness of Enterprises and Small and Medium-sized Enterprises, COSME (52%; 258 out of 495), Connecting Europe Facility (CEF) (53%; 241 out of 454), Common Agricultural Policy (CAP) (59%; 248 out of 421), the European Structural and Investment Funds (ESIF) (63%; 331 out of 529)[132], and the European Fund for Strategic Investments (EFSI) (66%; 253 out of 385).

Figure 46: How did the following EU programmes work in synergy (complement and reinforce) Horizon 2020?



[132] Respondents from EU13 countries have a more positive opinion on the synergies with the ESIF compared to respondents from EU15 countries.

As the Erasmus+ programme as well as LIFE stand out positively across all respondents, further analysis revealed that non-EU citizens (48%; 27) and respondents from the field of academia indicated that synergies with Erasmus+ were either fully or partly exploited (36%; 326), whereas the figure is lower among EU citizens (32%; 67), companies (21%; 65) and business associations (16%; 5). This leads to the assumption that the field of academia leaves greater room for synergies. This should not come as a surprise considering that the two programmes in view of academia have a strong link.

In view of LIFE, a similar trend can be seen: 22% of non-EU citizens (12), 21% of EU citizens (43) as well as 21% of respondents associated with academia (191), 18% of respondents associated with a company or business (56) and 13% of respondents associated with business associations (4) indicate that synergies were either fully or partly exploited. At the same time, 20% of respondents from academia (178), 22% of respondents from business associations (7) and 13% of respondents associated with a company or business (41) indicated that either few or no synergies were exploited.

Figure 47: Stakeholder breakdown - Synergies between Horizon 2020 and Erasmus+ (N= 1 729)

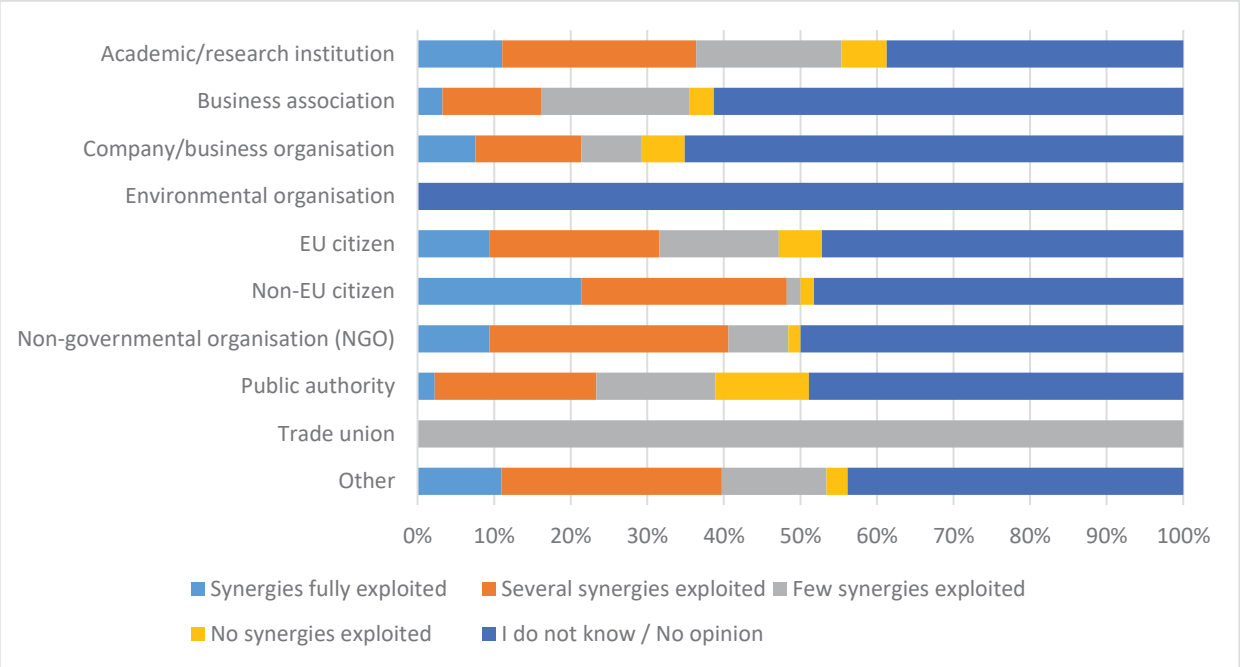
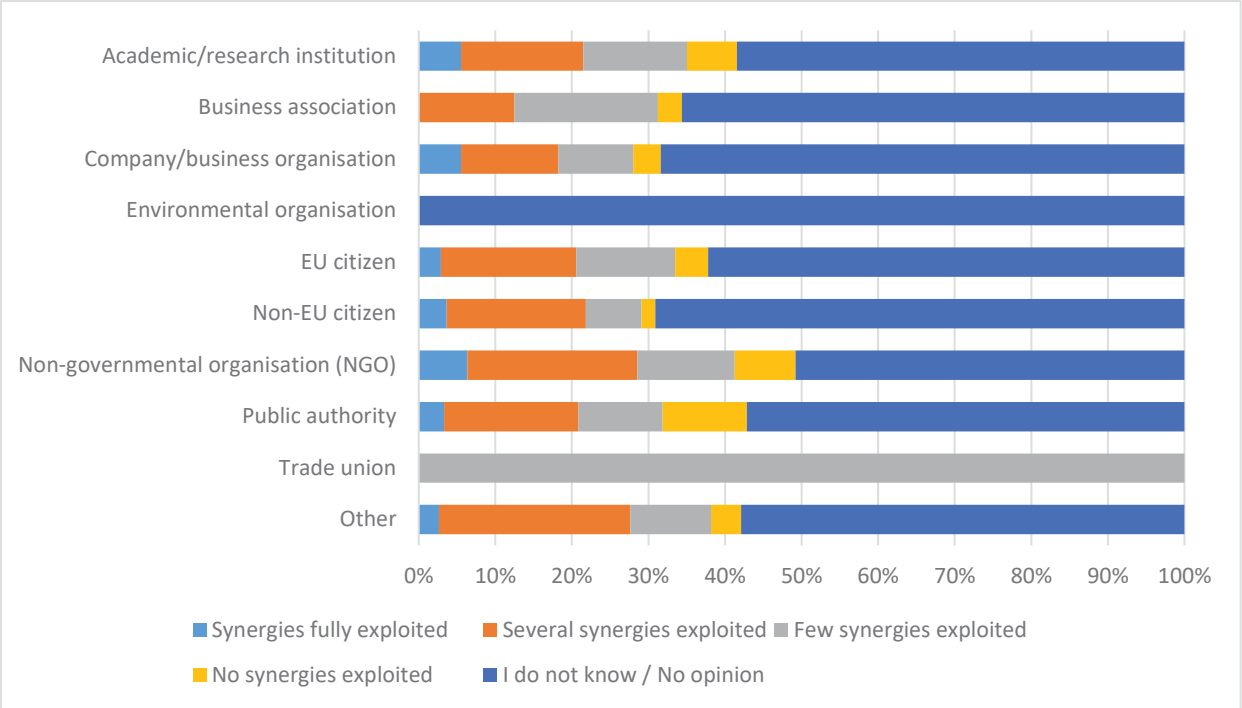


Figure 48: Stakeholder breakdown - Synergies between Horizon 2020 and LIFE (N = 1724)



Exploitation and dissemination of results

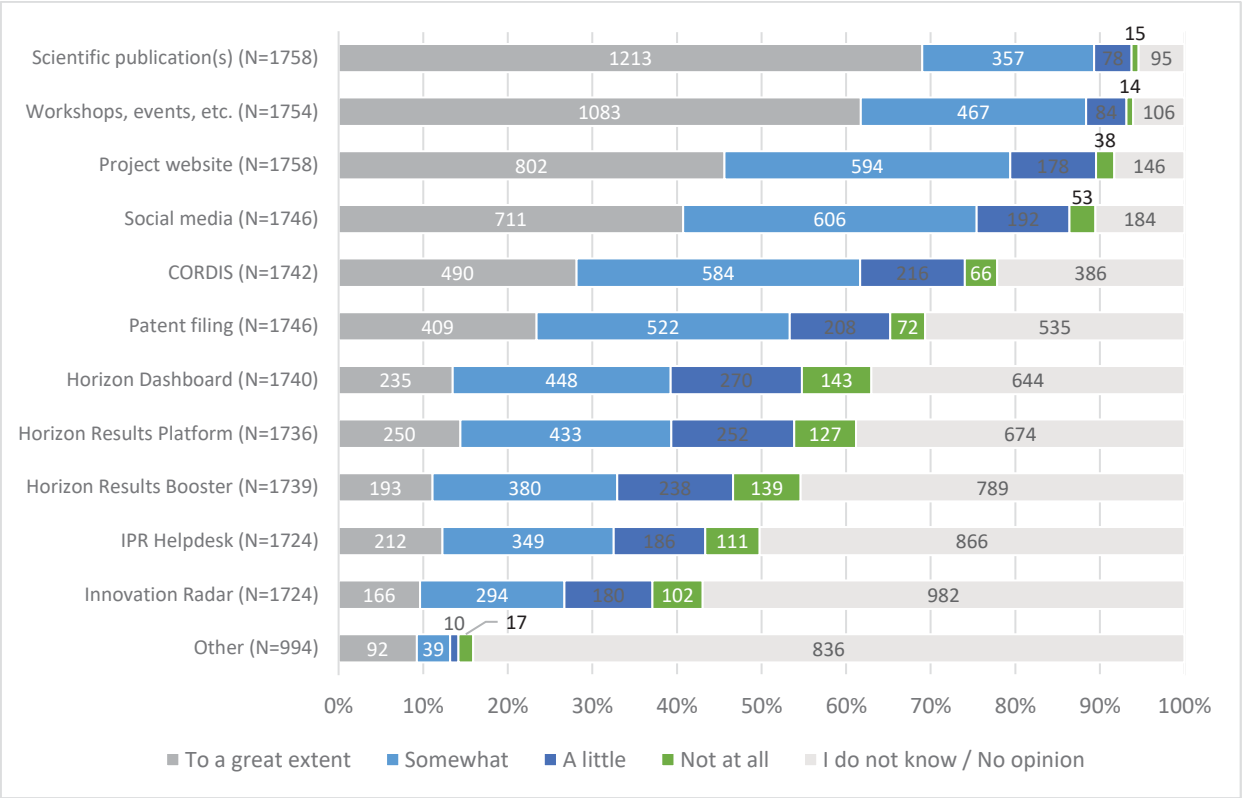
Respondents indicated scientific publication(s), workshops or other events, project website and social media (especially LinkedIn) as the initiatives of Horizon 2020 that mostly helped dissemination, exploitation and access to research and innovation results. In particular, 69% (1 213) and 62% (1 083) of respondents respectively stated that scientific publication(s) and workshops or other events[133] 'helped disseminate, exploit and access research and innovation results' to a great extent.

In the open comments to the question, participants mentioned 'personal contacts' and 'direct networking' as useful instruments to disseminate, exploit and access research and innovation results. Other comments highlighted the beneficial role of creating consortia under Horizon 2020 projects and the multi-actor approach that supports interaction between research providers and users within consortia. According to the comments, this approach helped find European innovation partners with similar long-term strategic goals, which was beneficial for cooperation beyond the duration of the supported project. Traditional media (TV, radio) and non-scientific publications (such as press releases, whitepapers, and books) were mentioned as other initiatives that strongly helped the dissemination, exploitation of R&I results and access to them.

Regarding the helpfulness of EU-wide dissemination and exploitation support services initiated by the Commission, a significant share of respondents did not have an opinion or did not know: over 50% for the Innovation Radar and IPR Helpdesk, 30-40% for the Horizon Dashboard, Horizon Results Platform and Horizon Results Booster, and 22% for CORDIS. For publications, the project website, social media and workshops, this share is 6-11%.

[133] Such as scientific conferences and congresses, events dedicated to sharing results such as the Road Transport Research Days and the Transport Research Arena, specific events organised by national contact points or agencies.

Figure 49: To what extent have the following initiatives helped disseminate, exploit and access research and innovation results?



Overall, this indicates that particularly in view of the **Innovation Radar** and the **IPR Helpdesk**, stakeholders are not sufficiently convinced of these tools' usefulness for dissemination and exploitation. Nevertheless, while EU citizens (15%; 31), non-EU citizens (14%; 8) and respondents from academia (12% 111) favour the IPR Helpdesk over the Innovation Radar (7%; 15, 11%; 6 and 9%; 80 respectively), only 16% of business associations (5) and 12% of companies (36) hold the belief that the IPR Helpdesk fosters dissemination and exploitation of results to a great extent.

Figure 50: Stakeholder breakdown - Extent to which the **IPR Helpdesk** helped to disseminate, exploit and access research and innovation results (N = 1 724)

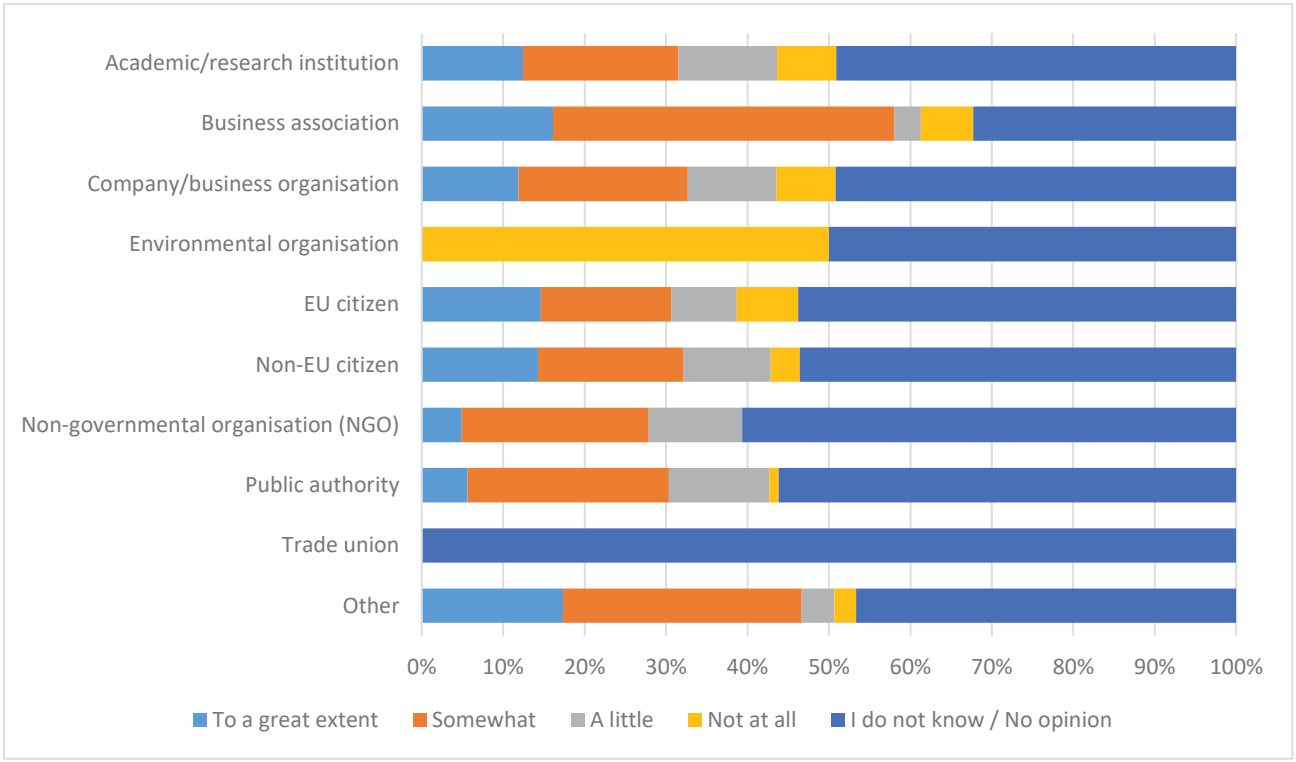
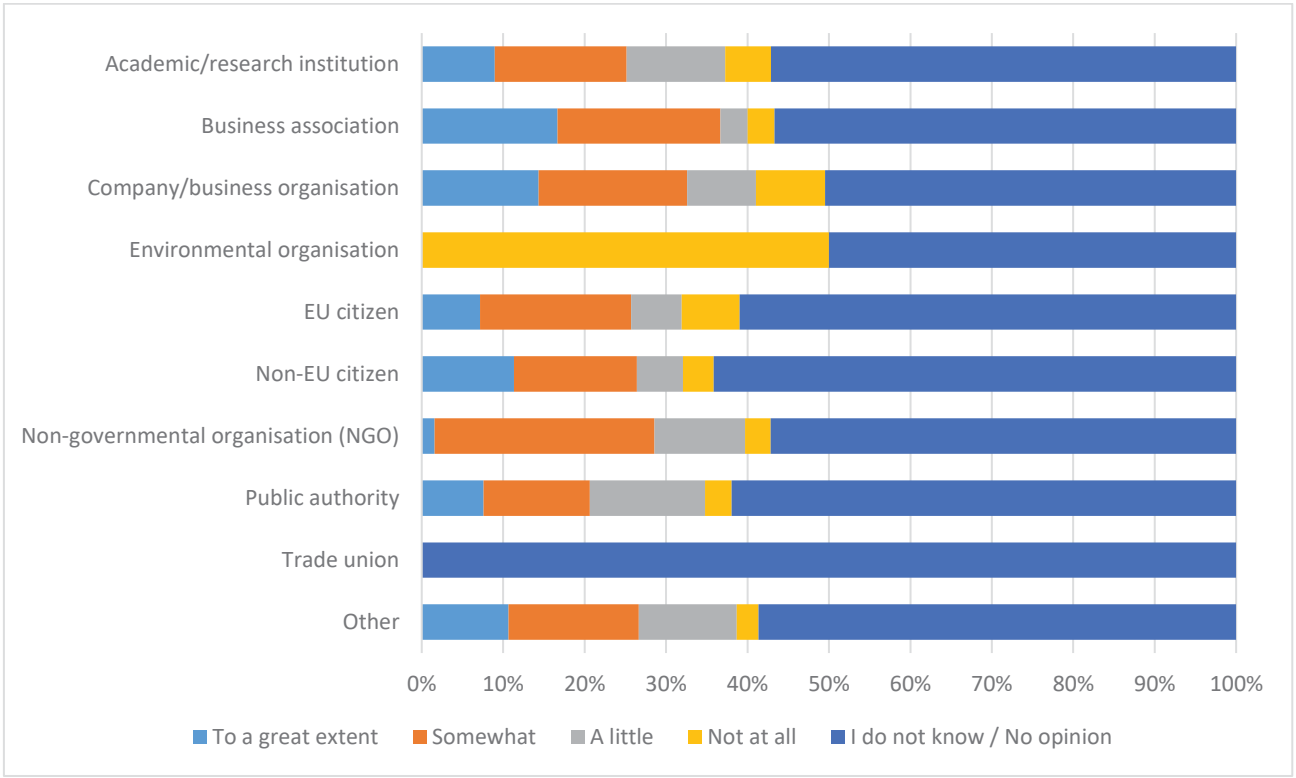
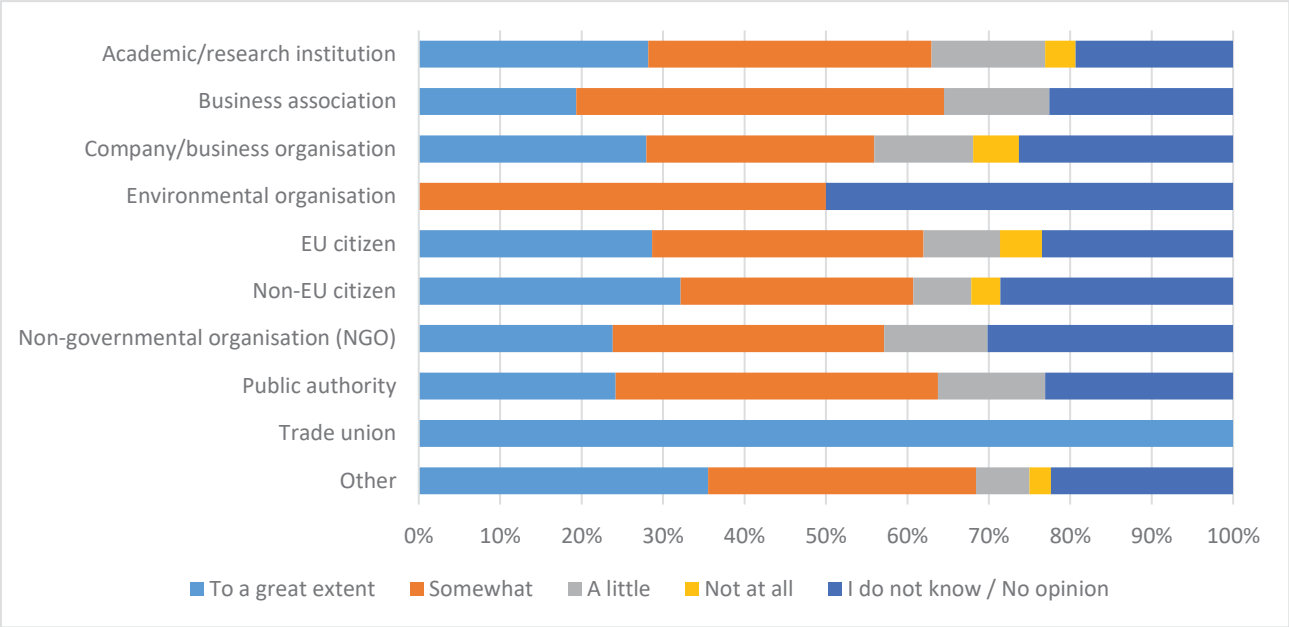


Figure 51: Stakeholder breakdown - Extent to which the **Innovation Radar** helped to disseminate, exploit and access research and innovation results (N = 1 724)



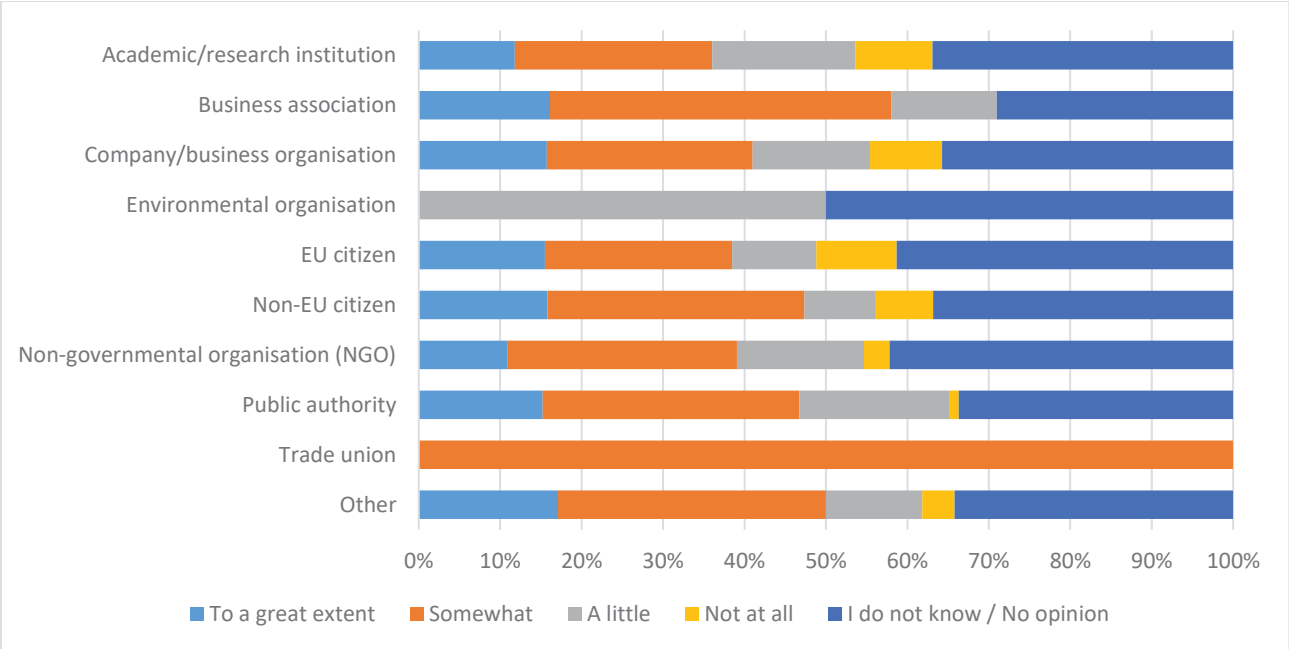
Among all stakeholder categories, **CORDIS** is deemed the most relevant EU-wide exploitation support service: 32% of non-EU citizens (18), 29% of EU citizens (61), 28% (255) of respondents from academia, 28% (85) from companies and 24% (22) from public authorities indicated that CORDIS helped disseminate and exploit results to a great extent.

Figure 52: Stakeholder breakdown - Extent to which **CORDIS** helped to disseminate, exploit and access research and innovation results (N = 1 724)



Following CORDIS, the **Horizon Dashboard** is most used among business associations (16%; 5), companies (16%; 48), non-EU citizens (16%; 9), EU citizens (15%; 33) and public authorities (15%; 14), similar to the **Horizon Results Booster** which was assessed by business associations (16%; 5), NGOs (14%; 9), non-EU citizens (14%; 8), companies (13%; 38) and EU citizens (12%; 25) as helpful to a great extent.

Figure 53: Stakeholder breakdown - Extent to which the **Horizon Dashboard** helped to disseminate, exploit and access research and innovation results (N = 1 740)



Although respondents from research or academia favoured the effectiveness of the Horizon Results Platform over the Horizon Results Booster (14%; 122) by 4 percentage points, which is a similar trend also pronounced in the responses of companies (16%; 48) by 3 percentage points.

Figure 54: Stakeholder breakdown - Extent to which the **Horizon Results Platform** helped to disseminate, exploit and access research and innovation results (N = 1 736)

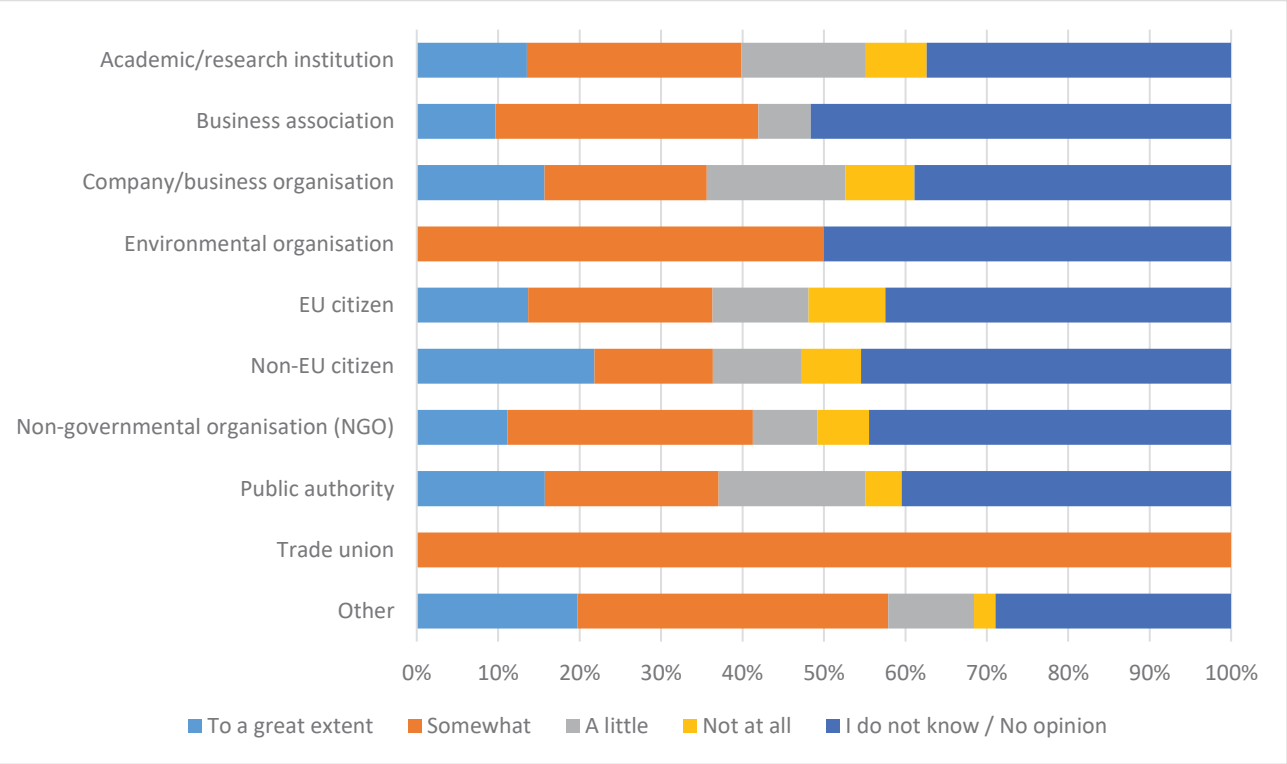
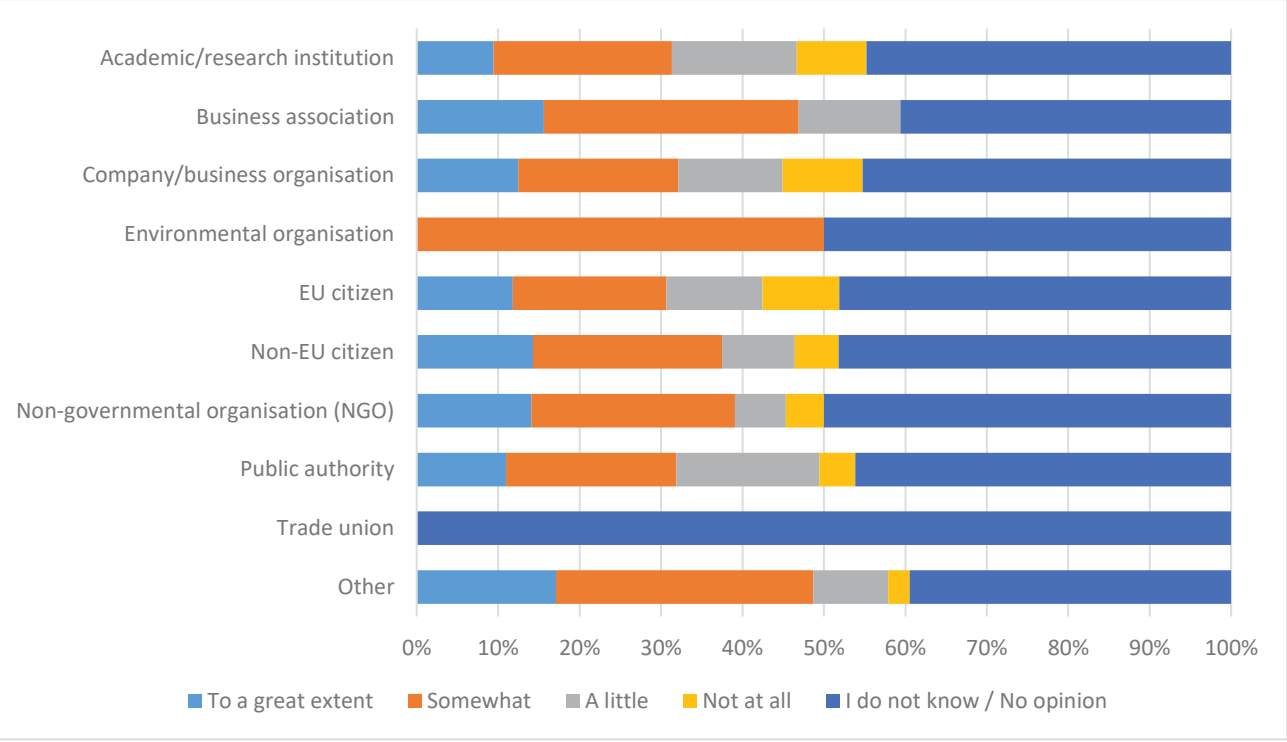


Figure 55: Stakeholder breakdown - Extent to which the **Horizon Results Booster** helped to disseminate, exploit and access research and innovation results (N = 1 739)



Design of Horizon 2020

General comments: Several comments from different stakeholder groups acknowledge that Horizon 2020 successfully contributed to stimulating research and innovation in the EU and provided the framework to enhance collaboration in R&I projects. However, some respondents also raised concerns about the changes to the Framework Programme's budget due to the annual inter-institutional negotiations as well as about the redistribution of the budget among different priorities during the programme's implementation. Another concern regarded the role of Horizon 2020 in facilitating complementarities and synergies among EU, Member States and international initiatives.

Type of funded R&I actions and Technology Readiness Levels (TRL) coverage: Respondents from NGOs, academia and research institutions perceived that Horizon 2020's project portfolio was not balanced in supporting projects at different TRLs, whereas focusing more on projects on technology deployment (TRL 7-9), rather than on projects on observations of basic principles, formulation of technology concepts, and experimental Proof of Concept (POC) (TRL 1-3). According to some respondents, this tendency was linked to the increasingly impact-oriented approach of Horizon 2020 that negatively affected the balance between Research and Innovation Actions (RIA) and Innovation Actions (IA). The Horizon 2020 Green Deal call was mentioned as an example of additional funding targeting projects with a high TRL, rather than basic research – although the issue should be addressed at all levels of research. At the same time, bigger and continuous support was suggested for technology validation and demonstration in relevant environments (TRL 4-6) to tackle the 'innovation valley of death' that sometimes threatens innovation uptake. Finally, one respondent from academia questioned the choice of funding incremental research in addition to breakthrough research through Horizon 2020.

Approach for topics / calls for proposals: Respondents from academia appreciated the bottom-up approach applied by the European Research Council, the Marie Skłodowska-Curie Action and the European Innovation Council Pathfinder. One respondent pointed out that narrow and restrictive calls limit the chances of developing research across different fields of science, reduce research creativity, and lead to limited innovation. Likewise, one SME stakeholder observed that targeted calls of proposals with a very narrow scope, limit the possibility for SMEs to participate as, compared to large companies, it is harder for SMEs to adjust their R&I activities to fit the specific topic. On the other hand, some stakeholders asked for more targeted calls on specific topics (e.g. research on paediatric cancer, Lyme disease).

Some stakeholders appreciated that the same or similar topics are addressed in several calls as it ensured coherence and strengthened the long-term vision of the work programme.

Horizon 2020 Key Performance Indicators: Some stakeholders are not convinced by the KPIs chosen to evaluate the impact of Horizon 2020 projects and consider them too focused on short-term, quantitative outputs (e.g., number of publications, number of patents, number of dissemination activities) and not on the broader societal impact or on the further exploitation of projects' results.

Horizon 2020 Implementation

Publication of the calls for proposal: There were concerns about the timing of the calls for proposals. According to various stakeholders, a large number of calls were announced too close to the deadline, which made it challenging to form a consortium and write a high-quality proposal. It was recommended to extend the call for proposal deadlines and to arrange them at regular intervals to facilitate long-term application planning, and to launch open calls for continuous submission over one year.

Proposal evaluation: Several respondents recommended to improve the scoring bandwidth in order to better reflect differences in the quality of the proposals. With the current system, respondents noted that there is very little variation in the final score between successful and unsuccessful, high-quality proposals. Some respondents expressed their frustration about proposals scoring very high but not being selected for funding. This could be tackled by increasing synergies with other EU-funded programmes (i.e. financing excellent but unsuccessful proposals through other programmes). Another recommendation was to offer lump sums to proposals reaching a certain threshold, instead of asking to improve and submit the proposal under another call. The review process of some programmes (e.g. the ERC) is appreciated more than that of others (e.g. SME instrument) – with respect to the different composition of evaluation panels.

Dissemination of projects' results: The dissemination of the projects' results was pointed out as a major area for improvement - some project beneficiaries required more support from the European Commission services in communicating the projects' results to attract additional funding for further development and, ultimately, for market uptake. Results and data sharing were considered important to advance research, especially in the scientific (e.g. medical) field.

Administrative burden for applicants and participants

Application process: Respondents appreciated the simplifications operated under Horizon 2020 for the preparation and submission of proposals compared to the Seventh Framework Programme (FP7). However, feedback suggests that respecting the page limit of the proposal template created some difficulties, especially when the projects did not focus on a single technology or product but were more complex and encompassed several aspects (e.g., for R&I infrastructures). Applicants found it difficult and time-consuming to describe in a short section the projects' activities and expected outcomes. According to one SME, the application process is particularly demanding for SMEs, which have limited resources for proposal writing and can leverage fewer connections to be part of large consortia. Respondents pointed out that the Funding and Tenders Portal required previous knowledge and experience with EU funding.

Grant agreement and project reporting: The preparation of Grant Agreement amendments was raised as particularly tedious for participants. Some respondents complained about an excessive, time-consuming request for administrative documents in this phase. There are contrasting views on whether the documentation effort for project reporting was reasonable. Finally, in some instances, project officers were reportedly too slow to respond to requests concerning project report amendment and validation, thus generating additional workload for project coordinators.

Audit procedures: Various respondents consider the period to receive feedback from auditors as too long, while the time allowed to comply with their demands was too short. A prompter publication of audit reports would contribute to improving the follow-up and would allow beneficiaries to quickly take auditors' comments into consideration. According to some stakeholders, financial reporting requirements were too complex. Overlaps between the different types of audits under Horizon 2020 were reported, pointing to a lack of coordination between the Commission and the contracted audit firms. According to one contribution, the rules and guidelines for Horizon 2020 financial reporting were interpreted in different ways by the auditing institutions, leading to inconsistencies and duplications. More consistency and better coordination between the different types of audits and the institutions involved (the European Commission, the European Court of Auditors, the European Anti-Fraud Office and external audit firms) could have avoided overlaps.

Widening participation

Access and participation from associated and non-associated third countries: It was recommended to increase access and participation from associated and non-associated third countries. This would lead to a wider dissemination of Horizon 2020 project results in these countries.

International collaboration: One respondent expressed disappointment about the lower level of support for international collaboration under Horizon 2020, in particular for Low and Medium Income Countries (LMICs), where funding decreased compared to the FP7 programming period. Participants perceived Horizon 2020 as primarily focused on strengthening the EU's competitiveness rather than tackling global challenges through international cooperation.

Applications to the programme

(Source: CORDA data – cut-off date: 1 January 2023)

Over **1 million applications** were submitted through over **285 000 eligible proposals**. Organisations located in EU28 Member States account for 88% of all applications, followed by associated countries (8.3%) and non-associated third countries (3.7%).

More detail is available on the tables that follow, on applications and success rates by country by organisation type and by pillar.

Table 18: Applications and success rates by type of organisation

Type of Organisation	Applications in eligible proposals	% of all applications	Applications in retained Proposals	Success rate of application	EU contribution requested in retained proposals (in million EUR)	%
Higher Education Institutions (HES)	357 364	35.6%	50 330	14.1%	24 950	38.6%
Research Organisations (REC)	171 199	17.0%	31 987	18.7%	16 405	25.4%
Private for-profit entities (PRC)	404 260	40.2%	55 684	13.8%	19 118	29.5%
Public bodies (PUB)	33 232	3.3%	8 234	24.8%	2 222	3.4%
Other (OTH)	38 544	3.8%	7 392	19.2%	2 007	3.1%
Total	**1 004 599**	**100%**	**153 627**	**15.3%**	**64 702**	**100%**

Table 19: Applications by country and type of participating organisation in Horizon 2020 *(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 applications in eligible proposals over 2014-2020	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other
				Number of applications					% of applications of the country by pillar					% of all applications per pillar				
Austria	AT	EU-15	25,663	8,577	5,770	9,795	300	1,221	33%	22%	38%	1%	5%	2%	3%	3%	3%	3%
Belgium	BE	EU-15	40,307	13,760	7,459	17,001	306	1,781	34%	19%	42%	1%	4%	4%	3%	5%	3%	4%
Bulgaria	BG	EU-13	6,695	963	1,644	3,452	166	470	14%	25%	52%	2%	7%	0%	1%	1%	2%	1%
Cyprus	CY	EU-13	6,654	1,474	1,432	3,020	322	406	22%	22%	45%	5%	6%	0%	1%	1%	3%	1%
Czechia	CZ	EU-13	10,441	3,515	2,399	3,588	302	637	34%	23%	34%	3%	6%	1%	1%	1%	3%	2%
Germany	DE	EU-15	108,127	44,214	24,892	33,683	1,214	4,124	41%	23%	31%	1%	4%	12%	11%	9%	12%	10%
Denmark	DK	EU-15	23,934	10,912	4,064	7,848	198	912	46%	17%	33%	1%	4%	3%	2%	2%	2%	2%
Estonia	EE	EU-13	5,754	1,192	1,418	2,636	198	310	21%	25%	46%	3%	5%	0%	1%	1%	2%	1%
Greece	EL	EU-15	34,570	7,037	9,392	16,259	207	1,675	20%	27%	47%	1%	5%	2%	4%	5%	2%	4%
Spain	ES	EU-15	110,661	34,922	28,703	41,953	496	4,587	32%	26%	38%	0%	4%	9%	13%	12%	5%	11%
Finland	FI	EU-15	22,055	7,039	6,118	7,901	200	797	32%	28%	36%	1%	4%	2%	3%	2%	2%	2%
France	FR	EU-15	77,950	34,598	16,716	23,500	527	2,609	44%	21%	30%	1%	3%	9%	8%	7%	5%	6%
Croatia	HR	EU-13	4,848	1,084	781	2,523	196	264	22%	16%	52%	4%	5%	0%	0%	1%	2%	1%
Hungary	HU	EU-13	10,580	2,620	2,571	4,643	154	592	25%	24%	44%	1%	6%	1%	1%	1%	1%	1%
Ireland	IE	EU-15	17,906	6,396	4,364	6,125	134	887	36%	24%	34%	1%	5%	2%	2%	2%	1%	2%
Italy	IT	EU-15	109,623	34,594	27,267	42,711	783	4,268	32%	25%	39%	1%	4%	9%	12%	12%	8%	11%
Lithuania	LT	EU-13	4,161	923	899	1,819	149	371	22%	22%	44%	4%	9%	0%	0%	1%	1%	1%
Luxembourg	LU	EU-15	3,271	797	1,011	1,287	47	129	24%	31%	39%	1%	4%	0%	0%	0%	0%	0%
Latvia	LV	EU-13	3,480	707	874	1,573	129	197	20%	25%	45%	4%	6%	0%	0%	0%	1%	0%
Malta	MT	EU-13	1,626	332	275	838	65	116	20%	17%	52%	4%	7%	0%	0%	0%	1%	0%
Netherlands	NL	EU-15	55,954	24,054	9,719	19,595	457	2,129	43%	17%	35%	1%	4%	6%	4%	5%	4%	5%
Poland	PL	EU-13	18,251	5,203	4,259	7,531	412	846	29%	23%	41%	2%	5%	1%	2%	2%	4%	2%
Portugal	PT	EU-15	25,382	8,279	5,691	9,804	561	1,047	33%	22%	39%	2%	4%	2%	3%	3%	5%	3%
Romania	RO	EU-13	10,640	1,852	2,422	5,389	311	666	17%	23%	51%	3%	6%	0%	1%	2%	3%	2%
Sweden	SE	EU-15	29,542	12,169	6,291	9,737	325	1,020	41%	21%	33%	1%	3%	3%	3%	3%	3%	3%
Slovenia	SI	EU-13	10,458	2,513	2,596	4,485	228	636	24%	25%	43%	2%	6%	1%	1%	1%	2%	2%
Slovakia	SK	EU-13	4,459	930	1,094	1,966	175	294	21%	25%	44%	4%	7%	0%	0%	1%	2%	1%
United Kingdom	UK	EU-15	100,607	53,560	16,175	27,198	684	2,990	53%	16%	27%	1%	3%	14%	7%	8%	7%	7%
Total EU-28			883,599	324,216	196,296	317,860	9,246	35,981	37%	22%	36%	1%	4%	86%	90%	88%	89%	89%
Total EU-13			*98,047*	*23,308*	*22,664*	*43,463*	*2,807*	*5,805*	24%	23%	44%	3%	6%	*6%*	*10%*	*12%*	*27%*	*14%*
Total EU-15			*785,552*	*300,908*	*173,632*	*274,397*	*6,439*	*30,176*	38%	22%	35%	1%	4%	*80%*	*79%*	*76%*	*62%*	*75%*
Associated countries			83,377	30,948	19,917	27,892	1,048	3,572	37%	24%	33%	1%	4%	8%	9%	8%	10%	9%
Thrid countries			37,623	20,774	2,592	13,474	48	735	55%	7%	36%	0%	2%	6%	1%	4%	0%	2%
Total Horizon 2020			**1,004,599**	**375,938**	**218,805**	**359,226**	**10,342**	**40,288**	**37%**	**22%**	**36%**	**1%**	**4%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 20: Applications by country and type of participating organisation in Horizon 2020 (*(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 applications in eligible proposals over 2014-2020	HES	PRC	PUB	REC	OTH	HES	PRC	PUB	REC	OTH	HES	PRC	PUB	REC	OTH
				Number of applications					% of all applications per country					% of all applications per organisation type				
Austria	AT	EU-15	25,663	8,686	10,000	513	5,348	1,116	34%	39%	2%	21%	4%	2%	2%	2%	3%	3%
Belgium	BE	EU-15	40,307	12,417	13,800	915	6,554	6,621	31%	34%	2%	16%	16%	3%	3%	3%	4%	17%
Bulgaria	BG	EU-13	6,695	1,077	3,239	416	1,278	685	16%	48%	6%	19%	10%	0%	1%	1%	1%	2%
Cyprus	CY	EU-13	6,654	2,153	3,474	364	317	346	32%	52%	5%	5%	5%	1%	1%	1%	0%	1%
Czechia	CZ	EU-13	10,441	4,101	3,940	290	1,656	454	39%	38%	3%	16%	4%	1%	1%	1%	1%	1%
Germany	DE	EU-15	108,127	36,497	42,313	1,864	24,553	2,900	34%	39%	2%	23%	3%	10%	10%	6%	14%	8%
Denmark	DK	EU-15	23,934	11,932	8,777	1,131	1,477	617	50%	37%	5%	6%	3%	3%	2%	3%	1%	2%
Estonia	EE	EU-13	5,754	2,032	2,665	299	332	426	35%	46%	5%	6%	7%	1%	1%	1%	0%	1%
Greece	EL	EU-15	34,570	9,473	13,676	1,262	9,012	1,147	27%	40%	4%	26%	3%	3%	3%	4%	5%	3%
Spain	ES	EU-15	110,661	26,164	47,704	4,932	27,929	3,932	24%	43%	4%	25%	4%	7%	12%	15%	16%	10%
Finland	FI	EU-15	22,055	8,940	8,442	600	3,534	539	41%	38%	3%	16%	2%	3%	2%	2%	2%	1%
France	FR	EU-15	77,950	16,468	32,738	1,816	23,822	3,106	21%	42%	2%	31%	4%	5%	8%	5%	14%	8%
Croatia	HR	EU-13	4,848	1,571	1,811	432	825	209	32%	37%	9%	17%	4%	0%	0%	1%	0%	1%
Hungary	HU	EU-13	10,580	2,525	5,679	497	1,447	432	24%	54%	5%	14%	4%	1%	1%	1%	1%	1%
Ireland	IE	EU-15	17,906	8,362	7,900	525	591	528	47%	44%	3%	3%	3%	2%	2%	2%	0%	1%
Italy	IT	EU-15	109,623	34,126	50,045	3,547	18,381	3,524	31%	46%	3%	17%	3%	10%	12%	11%	11%	9%
Lithuania	LT	EU-13	4,161	1,349	1,671	382	518	241	32%	40%	9%	12%	6%	0%	0%	1%	0%	1%
Luxembourg	LU	EU-15	3,271	641	1,838	82	535	175	20%	56%	3%	16%	5%	0%	0%	0%	0%	0%
Latvia	LV	EU-13	3,480	984	1,476	295	502	223	28%	42%	8%	14%	6%	0%	0%	1%	0%	1%
Malta	MT	EU-13	1,626	589	764	149	72	52	36%	47%	9%	4%	3%	0%	0%	0%	0%	0%
Netherlands	NL	EU-15	55,954	23,274	22,296	1,350	6,891	2,143	42%	40%	2%	12%	4%	7%	6%	4%	4%	6%
Poland	PL	EU-13	18,251	6,067	7,472	774	3,252	686	33%	41%	4%	18%	4%	2%	2%	2%	2%	2%
Portugal	PT	EU-15	25,382	6,631	9,898	1,248	6,477	1,128	26%	39%	5%	26%	4%	2%	2%	4%	4%	3%
Romania	RO	EU-13	10,640	2,713	4,626	935	1,627	739	25%	43%	9%	15%	7%	1%	1%	3%	1%	2%
Sweden	SE	EU-15	29,542	14,606	11,177	1,181	2,040	538	49%	38%	4%	7%	2%	4%	3%	4%	1%	1%
Slovenia	SI	EU-13	10,458	2,308	4,674	546	2,452	478	22%	45%	5%	23%	5%	1%	1%	2%	1%	1%
Slovakia	SK	EU-13	4,459	1,338	2,135	240	489	257	30%	48%	5%	11%	6%	0%	1%	1%	0%	1%
United Kingdom	UK	EU-15	100,607	58,910	32,045	2,246	5,196	2,210	59%	32%	2%	5%	2%	16%	8%	7%	3%	6%
Total EU-28			**883,599**	**305,934**	**356,275**	**28,831**	**157,107**	**35,452**	**34.6%**	**40.3%**	**3.3%**	**17.8%**	**4.0%**	**86%**	**88%**	**87%**	**92%**	**92%**
Total EU-13			*98,047*	*28,807*	*43,626*	*5,619*	*14,767*	*5,228*	*29.4%*	*44.5%*	*5.7%*	*15.1%*	*5.3%*	*8%*	*11%*	*17%*	*9%*	*14%*
Total EU-15			*785,552*	*277,127*	*312,649*	*23,212*	*142,340*	*30,224*	*35.3%*	*39.8%*	*3.0%*	*18.1%*	*3.8%*	*78%*	*77%*	*70%*	*83%*	*78%*
Associated countries			**83,377**	**32,017**	**36,462**	**3,172**	**9,678**	**2,048**	**38.4%**	**43.7%**	**3.8%**	**11.6%**	**2.5%**	**9%**	**9%**	**10%**	**6%**	**5%**
Thrid countries			**37,623**	**19,413**	**11,514**	**1,229**	**4,414**	**1,044**	**51.6%**	**30.6%**	**3.3%**	**11.7%**	**2.8%**	**5%**	**3%**	**4%**	**3%**	**3%**
Total Horizon 2020			**1,004,599**	**357,364**	**404,251**	**33,232**	**171,199**	**38,544**	**35.6%**	**40.2%**	**3.3%**	**17.0%**	**3.8%**	**100%**	**100%**	**100%**	**100%**	**100%**

Legend:

HES - Higher Education Institutions

REC- Research Organisations

PRC - Private-for-profit entities

PUB - Public bodies

OTH - Other

Table 21: Applications by country and success rates of application in Horizon 2020 *(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 applications in eligible proposals over 2014-2020	% of total	Horizon 2020 applications in eligible proposals per year	Horizon 2020 applications in high quality proposals	% of high quality applications	Retained Applications	Success rate of application in Horizon 2020	'000 of scientists and engineers per country*	Share of scientists and engineers in EU-28	Applications per '000 of scientists and engineers in the population	European Innovation Scoreboard Country Group (2014)	European Innovation Scoreboard Country Group (2020)
Austria	AT	EU-15	25,663	2.6%	3,666	15,440	60.2%	4,449	17.3%	329.22	1.9%	78	FOLLOWER	STRONG
Belgium	BE	EU-15	40,307	4.0%	5,758	26,097	64.7%	7,623	18.9%	466.96	2.7%	86	FOLLOWER	STRONG
Bulgaria	BG	EU-13	6,695	0.7%	956	2,673	39.9%	848	12.7%	191.5	1.1%	35	MODEST	MODEST
Cyprus	CY	EU-13	6,654	0.7%	951	3,608	54.2%	881	13.2%	26.18	0.2%	254	FOLLOWER	MODERATE
Czechia	CZ	EU-13	10,441	1.0%	1,492	5,704	54.6%	1,620	15.5%	331.22	1.9%	32	MODERATE	MODERATE
Germany	DE	EU-15	108,127	10.8%	15,447	66,661	61.7%	18,216	16.8%	3090.6	18.0%	35	LEADER	STRONG
Denmark	DK	EU-15	23,934	2.4%	3,419	15,069	63.0%	3,615	15.1%	282.94	1.6%	85	LEADER	LEADER
Estonia	EE	EU-13	5,754	0.6%	822	2,887	50.2%	791	13.7%	44.44	0.3%	129	FOLLOWER	STRONG
Greece	EL	EU-15	34,570	3.4%	4,939	19,267	55.7%	4,817	13.9%	250.76	1.5%	138	MODERATE	MODERATE
Spain	ES	EU-15	110,661	11.0%	15,809	61,970	56.0%	15,829	14.3%	1380.32	8.0%	80	MODERATE	MODERATE
Finland	FI	EU-15	22,055	2.2%	3,151	11,922	54.1%	3,122	14.2%	277.42	1.6%	80	LEADER	LEADER
France	FR	EU-15	77,950	7.8%	11,136	48,926	62.8%	13,622	17.5%	1739.62	10.1%	45	FOLLOWER	STRONG
Croatia	HR	EU-13	4,848	0.5%	693	2,282	47.1%	657	13.6%	96.66	0.6%	50	MODERATE	MODERATE
Hungary	HU	EU-13	10,580	1.1%	1,511	5,132	48.5%	1,353	12.8%	260.3	1.5%	41	MODERATE	MODERATE
Ireland	IE	EU-15	17,906	1.8%	2,558	10,546	58.9%	2,657	14.8%	231.44	1.3%	77	FOLLOWER	STRONG
Italy	IT	EU-15	109,623	10.9%	15,660	56,469	51.5%	14,245	13.0%	1043.38	6.1%	105	MODERATE	MODERATE
Lithuania	LT	EU-13	4,161	0.4%	594	1,976	47.5%	541	13.0%	97.28	0.6%	43	MODERATE	MODERATE
Luxembourg	LU	EU-15	3,271	0.3%	467	1,955	59.8%	541	16.5%	26.94	0.2%	121	FOLLOWER	LEADER
Latvia	LV	EU-13	3,480	0.3%	497	1,567	45.0%	477	13.7%	47.54	0.3%	73	MODEST	MODERATE
Malta	MT	EU-13	1,626	0.2%	232	812	49.9%	227	14.0%	16.02	0.1%	101	MODERATE	MODERATE
Netherlands	NL	EU-15	55,954	5.6%	7,993	35,717	63.8%	9,666	17.3%	834.52	4.9%	67	FOLLOWER	LEADER
Poland	PL	EU-13	18,251	1.8%	2,607	8,959	49.1%	2,483	13.6%	1169.98	6.8%	16	MODERATE	MODERATE
Portugal	PT	EU-15	25,382	2.5%	3,626	13,924	54.9%	3,296	13.0%	371.82	2.2%	68	MODERATE	STRONG
Romania	RO	EU-13	10,640	1.1%	1,520	4,868	45.8%	1,389	13.1%	534.36	3.1%	20	MODEST	MODEST
Sweden	SE	EU-15	29,542	2.9%	4,220	17,619	59.6%	4,538	15.4%	581.6	3.4%	51	LEADER	LEADER
Slovenia	SI	EU-13	10,458	1.0%	1,494	4,996	47.8%	1,248	11.9%	78.36	0.5%	133	FOLLOWER	MODERATE
Slovakia	SK	EU-13	4,459	0.4%	637	1,951	43.8%	593	13.3%	104.44	0.6%	43	MODERATE	MODERATE
United Kingdom	UK	EU-15	100,607	10.0%	14,372	61,534	61.2%	15,382	15.3%	3280.05	19.1%	31	FOLLOWER	STRONG
Total EU-28			**883,599**	88.0%	**126,228**	**510,531**	**57.8%**	**134,726**	**15.2%**	**17185.87**	**100.0%**	**51**	FOLLOWER	STRONG
Total EU-13			*98,047*	*9.8%*	*14,007*	*47,415*	*48.4%*	*13,108*	*13.4%*	*2998.28*	*17.4%*	*33*		
Total EU-15			*785,552*	*78.2%*	*112,222*	*463,116*	*59.0%*	*121,618*	*15.5%*	*14187.59*	*82.6%*	*55*		
Associated countries			83,377	8.3%	11,911	45,876	55.0%	12,139	14.6%					
Thrid countries			37,623	3.7%	5,375	25,376	67.4%	6,762	18.0%					
Total Horizon 2020			**1,004,599**	100.0%	**143,514**	**581,783**	**57.9%**	**153,627**	**15.3%**					

* Source = Eurostat

Funding allocation and participants in signed grants *(Source: CORDA data – cut-off date: 1 January 2023)*

EUR 68.3 billion were allocated through **35 426 grants**. In total, **41 575 different organisations** benefited from Horizon 2020 funding, some participating in several Horizon 2020 projects.

Figure 57: Funding per type of organisation

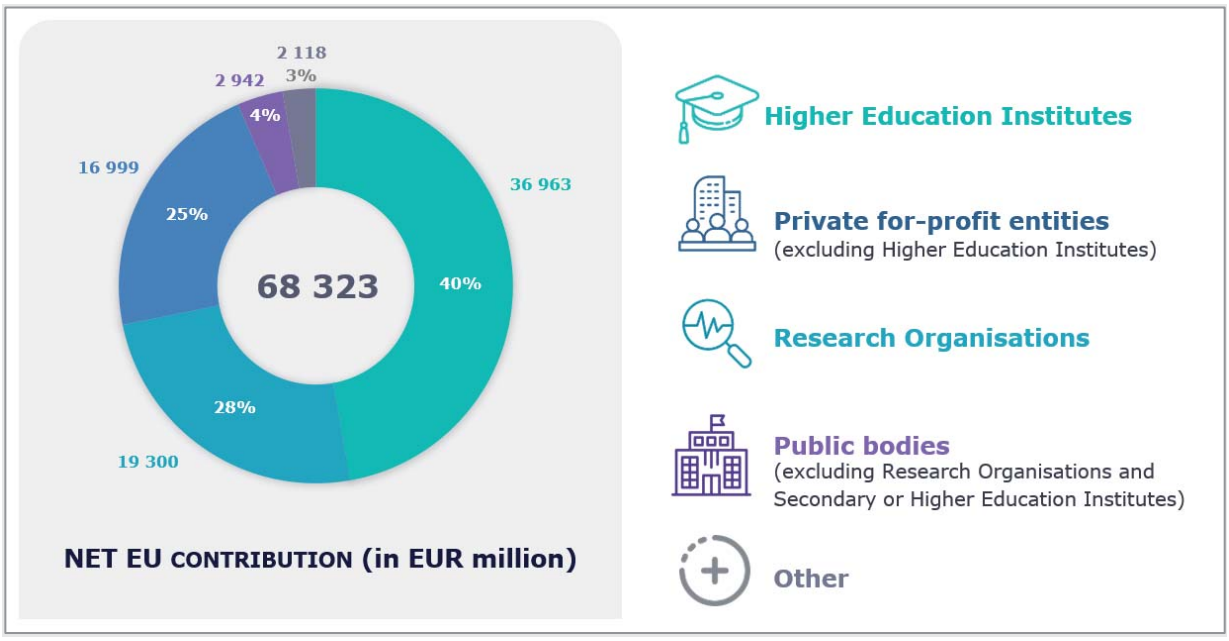


Figure 58: Funding by Member State (in EUR million)

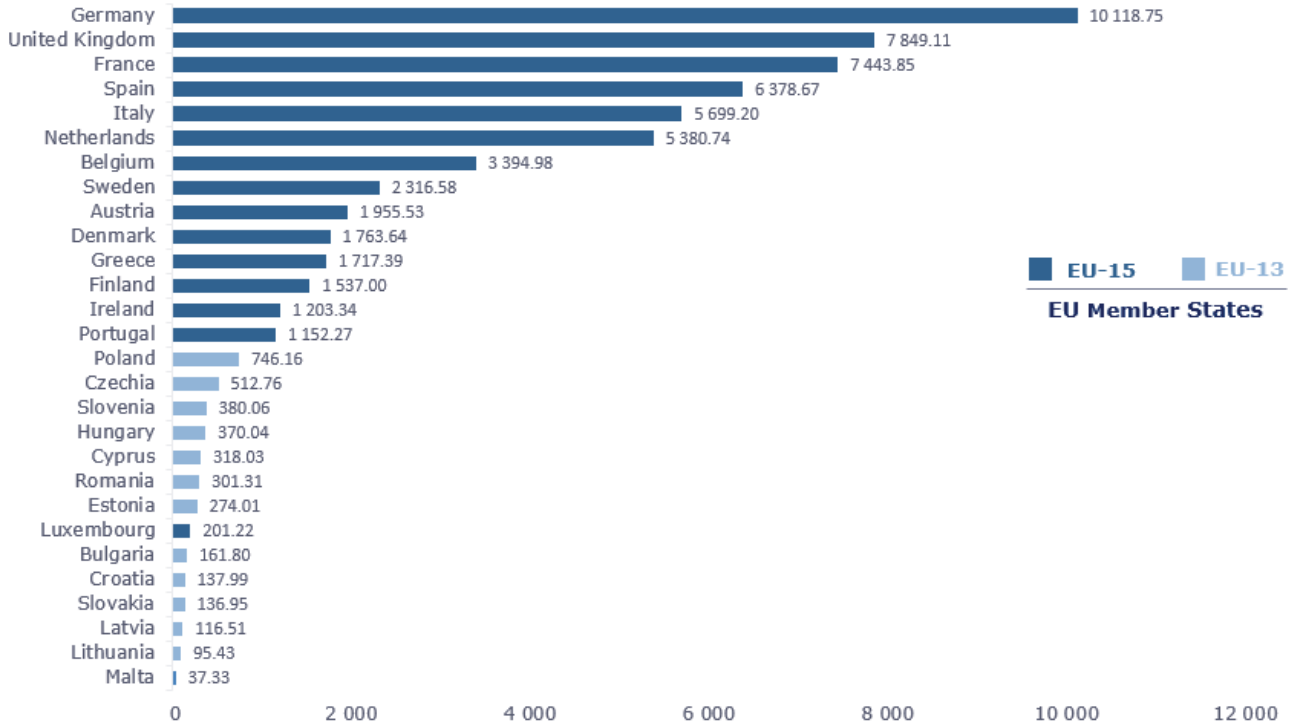


Figure 59: Funds received by Member States (by EUR million GERD)

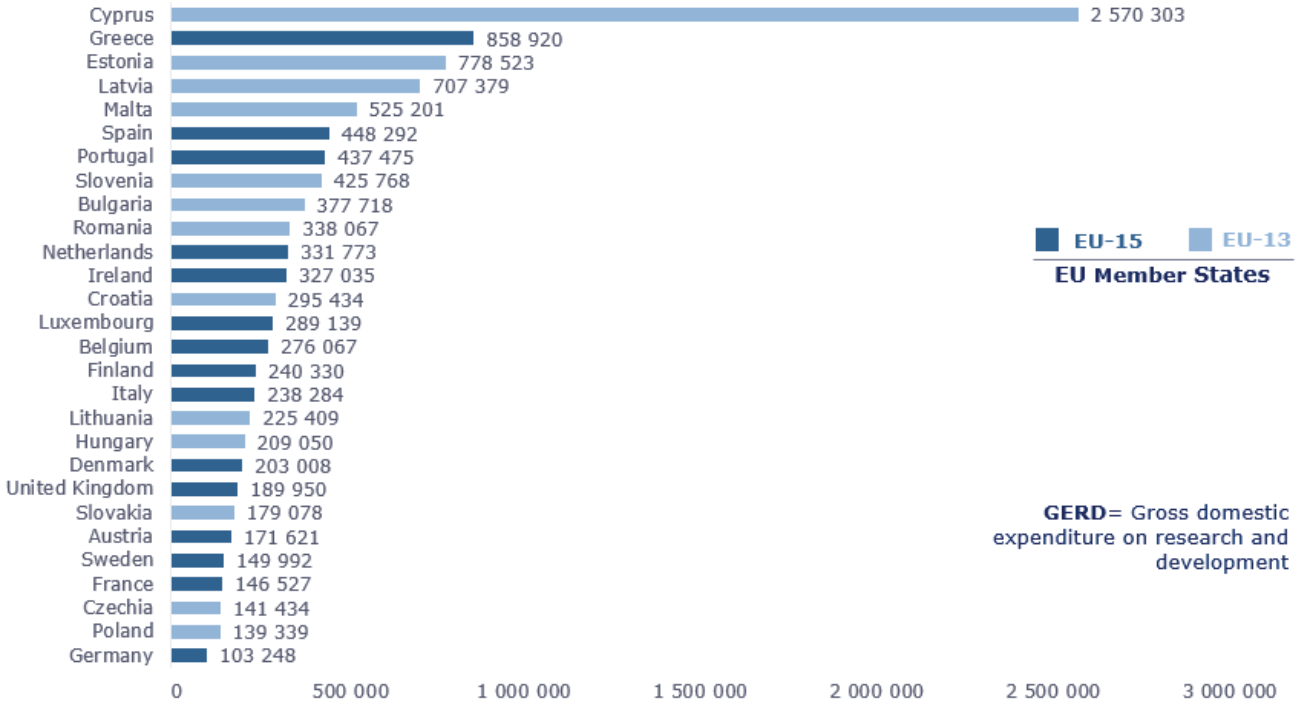


Figure 60: Funding allocation per pillar

Figure 61: Participation by country group

178 104 participations were registered in Horizon 2020, a same organisation participating sometimes in several projects.

(Source: CORDA data – cut-off date: 1 January 2023)

More detail is available in the tables that follow on Horizon 2020 investment (a) by pillar, (b) by organisation type, and (c) by country.

Table 22: Horizon 2020 investments by country and by pillar of Horizon 2020 *(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 investments in signed grants (EUR million)	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other	Excellent Science	Industrial Leadership	Societal challenges	Spreading excellence and widening participation	Other
				Investment by pillar					% of H2020 investments by country and by pillar					% of all investments in the same pillar				
Austria	AT	EU-15	1,956	706	448	742	12	48	36%	23%	38%	1%	2%	3%	3%	3%	1%	39%
Belgium	BE	EU-15	3,395	913	686	1,409	267	120	27%	20%	42%	8%	4%	4%	5%	5%	26%	97%
Bulgaria	BG	EU-13	162	22	25	76	30	9	14%	15%	47%	19%	6%	0%	0%	0%	3%	8%
Cyprus	CY	EU-13	318	60	55	107	88	8	19%	17%	34%	28%	3%	0%	0%	0%	9%	7%
Czechia	CZ	EU-13	513	162	91	177	50	32	32%	18%	35%	10%	6%	1%	1%	1%	5%	26%
Germany	DE	EU-15	10,119	3,942	2,178	3,558	44	396	39%	22%	35%	0%	4%	16%	16%	13%	4%	322%
Denmark	DK	EU-15	1,764	735	276	701	5	48	42%	16%	40%	0%	3%	3%	2%	3%	0%	39%
Estonia	EE	EU-13	274	38	49	128	53	6	14%	18%	47%	19%	2%	0%	0%	0%	5%	5%
Greece	EL	EU-15	1,717	289	560	829	6	34	17%	33%	48%	0%	2%	1%	4%	3%	1%	28%
Spain	ES	EU-15	6,379	1,767	1,625	2,797	9	181	28%	25%	44%	0%	3%	7%	12%	11%	1%	147%
Finland	FI	EU-15	1,537	457	413	601	15	52	30%	27%	39%	1%	3%	2%	3%	2%	1%	42%
France	FR	EU-15	7,444	2,763	1,569	2,856	16	239	37%	21%	38%	0%	3%	11%	11%	11%	2%	195%
Croatia	HR	EU-13	138	29	17	75	10	6	21%	12%	55%	7%	5%	0%	0%	0%	1%	5%
Hungary	HU	EU-13	370	116	70	139	25	20	31%	19%	38%	7%	5%	0%	1%	1%	2%	16%
Ireland	IE	EU-15	1,203	416	301	431	6	50	35%	25%	36%	0%	4%	2%	2%	2%	1%	40%
Italy	IT	EU-15	5,699	1,713	1,295	2,459	15	218	30%	23%	43%	0%	4%	7%	9%	9%	1%	177%
Lithuania	LT	EU-13	95	14	26	40	5	10	15%	27%	42%	6%	10%	0%	0%	0%	1%	8%
Luxembourg	LU	EU-15	201	46	64	84	5	2	23%	32%	42%	2%	1%	0%	0%	0%	0%	2%
Latvia	LV	EU-13	117	12	21	51	28	4	10%	18%	44%	24%	4%	0%	0%	0%	3%	3%
Malta	MT	EU-13	37	7	5	20	4	1	19%	14%	52%	11%	4%	0%	0%	0%	0%	1%
Netherlands	NL	EU-15	5,381	2,158	892	2,218	12	101	40%	17%	41%	0%	2%	9%	6%	8%	1%	82%
Poland	PL	EU-13	746	197	217	244	60	28	26%	29%	33%	8%	4%	1%	2%	1%	6%	23%
Portugal	PT	EU-15	1,152	316	245	454	102	34	27%	21%	39%	9%	3%	1%	2%	2%	10%	28%
Romania	RO	EU-13	301	46	49	183	11	12	15%	16%	61%	3%	4%	0%	0%	1%	1%	10%
Sweden	SE	EU-15	2,317	887	412	945	13	60	38%	18%	41%	1%	3%	4%	3%	4%	1%	49%
Slovenia	SI	EU-13	380	69	84	181	26	19	18%	22%	48%	7%	5%	0%	1%	1%	3%	16%
Slovakia	SK	EU-13	137	26	20	64	18	9	19%	15%	47%	13%	6%	0%	0%	0%	2%	7%
United Kingdom	UK	EU-15	7,849	4,106	965	2,542	35	201	52%	12%	32%	0%	3%	16%	7%	10%	3%	163%
Total EU-28			61,701	22,013	12,657	24,114	969	1,948	36%	21%	39%	2%	3%	88%	92%	91%	95%	1584%
Total EU-13			*3,589*	*800*	*729*	*1,486*	*409*	*165*	22%	20%	41%	11%	5%	*3%*	*5%*	*6%*	*40%*	*134%*
Total EU-15			*58,112*	*21,213*	*11,928*	*22,627*	*560*	*1,783*	37%	21%	39%	1%	3%	*85%*	*86%*	*86%*	*55%*	*1450%*
Associated countries			6,094	2908	1106	1893	48	139	48%	18%	31%	1%	2%	12%	8%	7%	5%	113%
Thrid countries			528	104	36	382.5	0	5.5	20%	7%	72%	0%	1%	0%	0%	1%	0%	4%
Total Horizon 2020			**68,323**	**25,025**	**13,799**	**26,389**	**1,017**	**123**	**37%**	**20%**	**39%**	**1%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 23: Horizon 2020 investments by type of organisation *(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 investments in signed grants (EUR million)	HES	PRC	PUB	REC	OTH	HES	PRC	PUB	REC	OTH	HES	PRC	PUB	REC	OTH
				Investment by type of organisation					% of investments in a country by org. type					% of investments to an org. type, by country				
Austria	AT	EU-15	1,956	776	623	24	428	104	40%	32%	1%	22%	5%	3%	3%	1%	3%	4%
Belgium	BE	EU-15	3,395	1,097	736	69	790	704	32%	22%	2%	23%	21%	4%	4%	3%	5%	24%
Bulgaria	BG	EU-13	162	41	52	11	47	10	25%	32%	7%	29%	6%	0%	0%	1%	0%	0%
Cyprus	CY	EU-13	318	133	129	10	35	12	42%	41%	3%	11%	4%	0%	1%	0%	0%	0%
Czechia	CZ	EU-13	513	227	149	16	99	22	44%	29%	3%	19%	4%	1%	1%	1%	1%	1%
Germany	DE	EU-15	10,119	3,622	2,737	138	3,337	286	36%	27%	1%	33%	3%	13%	14%	6%	20%	10%
Denmark	DK	EU-15	1,764	1,048	444	103	106	62	59%	25%	6%	6%	4%	4%	2%	5%	1%	2%
Estonia	EE	EU-13	274	133	92	18	7	25	48%	34%	6%	2%	9%	0%	0%	1%	0%	1%
Greece	EL	EU-15	1,717	473	511	35	665	34	28%	30%	2%	39%	2%	2%	3%	2%	4%	1%
Spain	ES	EU-15	6,379	1,394	2,171	297	2,291	226	22%	34%	5%	36%	4%	5%	11%	14%	13%	8%
Finland	FI	EU-15	1,537	652	400	41	390	55	42%	26%	3%	25%	4%	2%	2%	2%	2%	2%
France	FR	EU-15	7,444	1,128	2,596	200	3,254	266	15%	35%	3%	44%	4%	4%	13%	9%	19%	9%
Croatia	HR	EU-13	138	45	39	13	35	7	32%	28%	9%	25%	5%	0%	0%	1%	0%	0%
Hungary	HU	EU-13	370	98	122	18	83	49	27%	33%	5%	22%	13%	0%	1%	1%	0%	2%
Ireland	IE	EU-15	1,203	689	416	46	32	21	57%	35%	4%	3%	2%	3%	2%	2%	0%	1%
Italy	IT	EU-15	5,699	1,901	2,108	169	1,363	157	33%	37%	3%	24%	3%	7%	11%	8%	8%	5%
Lithuania	LT	EU-13	95	28	32	11	13	12	29%	33%	11%	14%	12%	0%	0%	1%	0%	0%
Luxembourg	LU	EU-15	201	63	86	7	36	9	31%	43%	3%	18%	5%	0%	0%	0%	0%	0%
Latvia	LV	EU-13	117	47	33	12	17	7	40%	28%	11%	14%	6%	0%	0%	1%	0%	0%
Malta	MT	EU-13	37	18	9	7	2	1	48%	25%	19%	6%	3%	0%	0%	0%	0%	0%
Netherlands	NL	EU-15	5,381	2,666	1,313	111	1,000	291	50%	24%	2%	19%	5%	10%	7%	5%	6%	10%
Poland	PL	EU-13	746	206	190	49	211	90	28%	25%	7%	28%	12%	1%	1%	2%	1%	3%
Portugal	PT	EU-15	1,152	301	322	57	437	35	26%	28%	5%	38%	3%	1%	2%	3%	3%	1%
Romania	RO	EU-13	301	63	111	20	79	29	21%	37%	7%	26%	9%	0%	1%	1%	0%	1%
Sweden	SE	EU-15	2,317	1,324	600	165	192	34	57%	26%	7%	8%	1%	5%	3%	8%	1%	1%
Slovenia	SI	EU-13	380	72	135	25	139	9	19%	36%	7%	37%	2%	0%	1%	1%	1%	0%
Slovakia	SK	EU-13	137	48	54	7	19	10	35%	39%	5%	14%	7%	0%	0%	0%	0%	0%
United Kingd	UK	EU-15	7,849	5,420	1,464	178	632	156	69%	19%	2%	8%	2%	20%	8%	8%	4%	5%
		Total EU-28	**61,701**	**23,713**	**17,674**	**1,854**	**15,738**	**2,722**	38%	29%	3%	26%	4%	**88%**	**92%**	**88%**	**93%**	**93%**
		Total EU-13	*3,589*	*1,158*	*1,147*	*217*	*785*	*282*	32%	32%	6%	22%	8%	*4%*	*6%*	*10%*	*5%*	*10%*
		Total EU-15	*58,112*	*22,555*	*16,527*	*1,638*	*14,953*	*2,440*	39%	28%	3%	26%	4%	*84%*	*86%*	*77%*	*88%*	*83%*
		Associated countries	6,094	**3,030**	**1,558**	**222**	**1,134**	**150**	50%	26%	4%	19%	2%	**11%**	**8%**	**10%**	**7%**	**5%**
		Thrid countries	528	**221**	**68**	**41**	**127**	**70**	42%	13%	8%	24%	13%	**1%**	**0%**	**2%**	**1%**	**2%**
		Total Horizon 2020	**68,323**	**26,964**	**19,300**	**2,118**	**16,999**	**2,942**	39%	28%	3%	25%	4%	**100%**	**100%**	**100%**	**100%**	**100%**

Legend:

HES - Higher Education Institutions

REC- Research Organisations

PRC - Private-for-profit entities

PUB - Public bodies

OTH - Other

Table 24: Participation in Horizon 2020 by country *(Source: CORDA data – cut-off date: 1 January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 participations in signed grants over 2014-2020	% of total	Horizon 2020 participations in signed grants per year	000 scientists and Engineers	Share of scientists and engineers in EU28	Participations per '000 scientists and engineers in the population	Number of Horizon 2020 projects with at least 1 participant from the countr	% of total
Austria	AT	EU-15	5,092	2.9%	727	329.22	1.9%	15.5	3,232	9.1%
Belgium	BE	EU-15	8,452	4.7%	1,207	466.96	2.7%	18.1	5,056	14.3%
Bulgaria	BG	EU-13	998	0.6%	143	191.5	1.1%	5.2	666	1.9%
Cyprus	CY	EU-13	986	0.6%	141	26.18	0.2%	37.7	736	2.1%
Czechia	CZ	EU-13	1,883	1.1%	269	331.22	1.9%	5.7	1,398	3.9%
Germany	DE	EU-15	20,787	11.7%	2,970	3090.6	18.0%	6.7	9,937	28.1%
Denmark	DK	EU-15	4,002	2.2%	572	282.94	1.6%	14.1	2,910	8.2%
Estonia	EE	EU-13	899	0.5%	128	44.44	0.3%	20.2	701	2.0%
Greece	EL	EU-15	5,502	3.1%	786	250.76	1.5%	21.9	2,901	8.2%
Spain	ES	EU-15	18,885	10.6%	2,698	1380.32	8.0%	13.7	8,808	24.9%
Finland	FI	EU-15	3,512	2.0%	502	277.42	1.6%	12.7	2,243	6.3%
France	FR	EU-15	17,155	9.6%	2,451	1739.62	10.1%	9.9	8,005	22.6%
Croatia	HR	EU-13	820	0.5%	117	96.66	0.6%	8.5	584	1.6%
Hungary	HU	EU-13	1,555	0.9%	222	260.3	1.5%	6.0	1,144	3.2%
Ireland	IE	EU-15	2,966	1.7%	424	231.44	1.3%	12.8	2,161	6.1%
Italy	IT	EU-15	17,176	9.6%	2,454	1043.38	6.1%	16.5	7,893	22.3%
Lithuania	LT	EU-13	619	0.3%	88	97.28	0.6%	6.4	504	1.4%
Luxembour	LU	EU-15	629	0.4%	90	26.94	0.2%	23.3	539	1.5%
Latvia	LV	EU-13	551	0.3%	79	47.54	0.3%	11.6	437	1.2%
Malta	MT	EU-13	263	0.1%	38	16.02	0.1%	16.4	192	0.5%
Netherlanc	NL	EU-15	11,131	6.2%	1,590	834.52	4.9%	13.3	6,178	17.4%
Poland	PL	EU-13	2,855	1.6%	408	1169.98	6.8%	2.4	1,959	5.5%
Portugal	PT	EU-15	3,961	2.2%	566	371.82	2.2%	10.7	2,447	6.9%
Romania	RO	EU-13	1,619	0.9%	231	534.36	3.1%	3.0	1,056	3.0%
Sweden	SE	EU-15	5,214	2.9%	745	581.6	3.4%	9.0	3,408	9.6%
Slovenia	SI	EU-13	1,480	0.8%	211	78.36	0.5%	18.9	1,016	2.9%
Slovakia	SK	EU-13	697	0.4%	100	104.44	0.6%	6.7	516	1.5%
United King	UK	EU-15	17,458	9.8%	2,494	3280.05	19.1%	5.3	10,517	29.7%
		Total EU-28	**157,147**	88.2%	**22,450**	**17185.87**	**100.0%**	**9.1**	**32,552**	91.9%
		Total EU-13	*15,225*	*8.5%*	*2,175*	*2998.28*	*17.4%*	*5.1*	*6,374*	*18.0%*
		Total EU-15	*141,922*	*79.7%*	*20,275*	*14187.59*	*82.6%*	*10.0*	*31,364*	*88.5%*
		Associated countries	13,669	7.7%	1,953				7,958	22.5%
		Thrid countries	7,288	4.1%	1,041				3,221	9.1%
		Total Horizon 2020	**178,104**	**100.0%**	**25,443**				**35,426**	**100.0%**

Table 25: Horizon 2020 investments by country *(Source: CORDA data – cut-off date: 1January 2023)*

EU-28 Member State	Country code	Country group	Horizon 2020 investments in signed grants (EUR million) over 2014-2020	% of total H2020 investment	% of H2020 investment in EU-28	Horizon 2020 investments in signed grants (EUR million) per year	GERD (in EUR million*	Horizon 2020 investment in EUR per EUR million of GERD	European Innovation Scoreboard Country Group (2014)	European Innovation Scoreboard Country Group (2020)
Austria	AT	EU-15	1,956	2.9%	3.2%	279	11394.48271	17,162	FOLLOWER	STRONG
Belgium	BE	EU-15	3,395	5.0%	5.5%	485	12297.66929	27,607	FOLLOWER	STRONG
Bulgaria	BG	EU-13	162	0.2%	0.3%	23	428.3682857	37,772	MODEST	MODEST
Cyprus	CY	EU-13	318	0.5%	0.5%	45	123.7331429	257,030	FOLLOWER	MODERATE
Czechia	CZ	EU-13	513	0.8%	0.8%	73	3625.455286	14,143	MODERATE	MODERATE
Germany	DE	EU-15	10,119	14.8%	16.4%	1,446	98004.74043	10,325	LEADER	STRONG
Denmark	DK	EU-15	1,764	2.6%	2.9%	252	8687.528429	20,301	LEADER	LEADER
Estonia	EE	EU-13	274	0.4%	0.4%	39	351.96	77,852	FOLLOWER	STRONG
Greece	EL	EU-15	1,717	2.5%	2.8%	245	1,999.48	85,892	MODERATE	MODERATE
Spain	ES	EU-15	6,379	9.3%	10.3%	911	14,228.82	44,829	MODERATE	MODERATE
Finland	FI	EU-15	1,537	2.2%	2.5%	220	6,395.40	24,033	LEADER	LEADER
France	FR	EU-15	7,444	10.9%	12.1%	1,063	50,802.01	14,653	FOLLOWER	STRONG
Croatia	HR	EU-13	138	0.2%	0.2%	20	467.09	29,543	MODERATE	MODERATE
Hungary	HU	EU-13	370	0.5%	0.6%	53	1,770.11	20,905	MODERATE	MODERATE
Ireland	IE	EU-15	1,203	1.8%	2.0%	172	3,679.56	32,703	FOLLOWER	STRONG
Italy	IT	EU-15	5,699	8.3%	9.2%	814	23,917.67	23,828	MODERATE	MODERATE
Lithuania	LT	EU-13	95	0.1%	0.2%	14	423.37	22,541	MODERATE	MODERATE
Luxembou	LU	EU-15	201	0.3%	0.3%	29	695.91	28,914	FOLLOWER	LEADER
Latvia	LV	EU-13	117	0.2%	0.2%	17	164.70	70,738	MODEST	MODERATE
Malta	MT	EU-13	37	0.1%	0.1%	5	71.08	52,520	MODERATE	MODERATE
Netherlanc	NL	EU-15	5,381	7.9%	8.7%	769	16,218.14	33,177	FOLLOWER	LEADER
Poland	PL	EU-13	746	1.1%	1.2%	107	5,355.02	13,934	MODERATE	MODERATE
Portugal	PT	EU-15	1,152	1.7%	1.9%	165	2,633.90	43,747	MODERATE	STRONG
Romania	RO	EU-13	301	0.4%	0.5%	43	891.27	33,807	MODEST	MODEST
Sweden	SE	EU-15	2,317	3.4%	3.8%	331	15,444.75	14,999	LEADER	LEADER
Slovenia	SI	EU-13	380	0.6%	0.6%	54	892.64	42,577	FOLLOWER	MODERATE
Slovakia	SK	EU-13	137	0.2%	0.2%	20	764.74	17,908	MODERATE	MODERATE
United Kin	UK	EU-15	7,849	11.5%	12.7%	1,121	41,322.07	18,995	FOLLOWER	STRONG
Total EU-28			**61,701**	**90.3%**	**100.0%**	**8,814**	**323,052**	**19,099**	FOLLOWER	STRONG
Total EU-13			*3,589*	*5.3%*		*8,535*	*15,330*	*23,412*		
Total EU-15			*58,112*	*85.1%*		*16,864*	*307,722*	*18,885*		
Associated countries			6,094	8.9%		25,376				
Thrid countries			528	0.8%		42,195				
Total Horizon 2020			**68,323**	**100.0%**		**67,498**				

* Source: Eurostat

Funding rates and leverage

Table 26: Horizon 2020 **funding rates and direct leverage factors**, by type of action

	Funding rate, in %[134]	**Direct leverage factor** (PRC), in EUR
Horizon 2020	varies	0.23 (0.57)
Horizon 2020 excluding fundamental research (ERC, MSCA) and CSA	varies	0.35 (0.63)
RIA	100	0.05 (0.08)
IA	70 (100 for non-profit)	0.24 (0.62)
SME Instrument	-	0.43
JTIs	varies	1.08
ERA-NET Cofund	33	2.2
EJP Cofund	70	0.92
KICs	-	0.23
Art. 185	varies	0.52

Notes: Definitions provided in glossary. Data is retrieved from e-CORDA (cut-off date 07/02/2023). For Art. 185 TFEU initiatives only 40% of the cost data is available.

Table 27: Horizon 2020 direct leverage factors for Innovation Actions (IA), by programme part

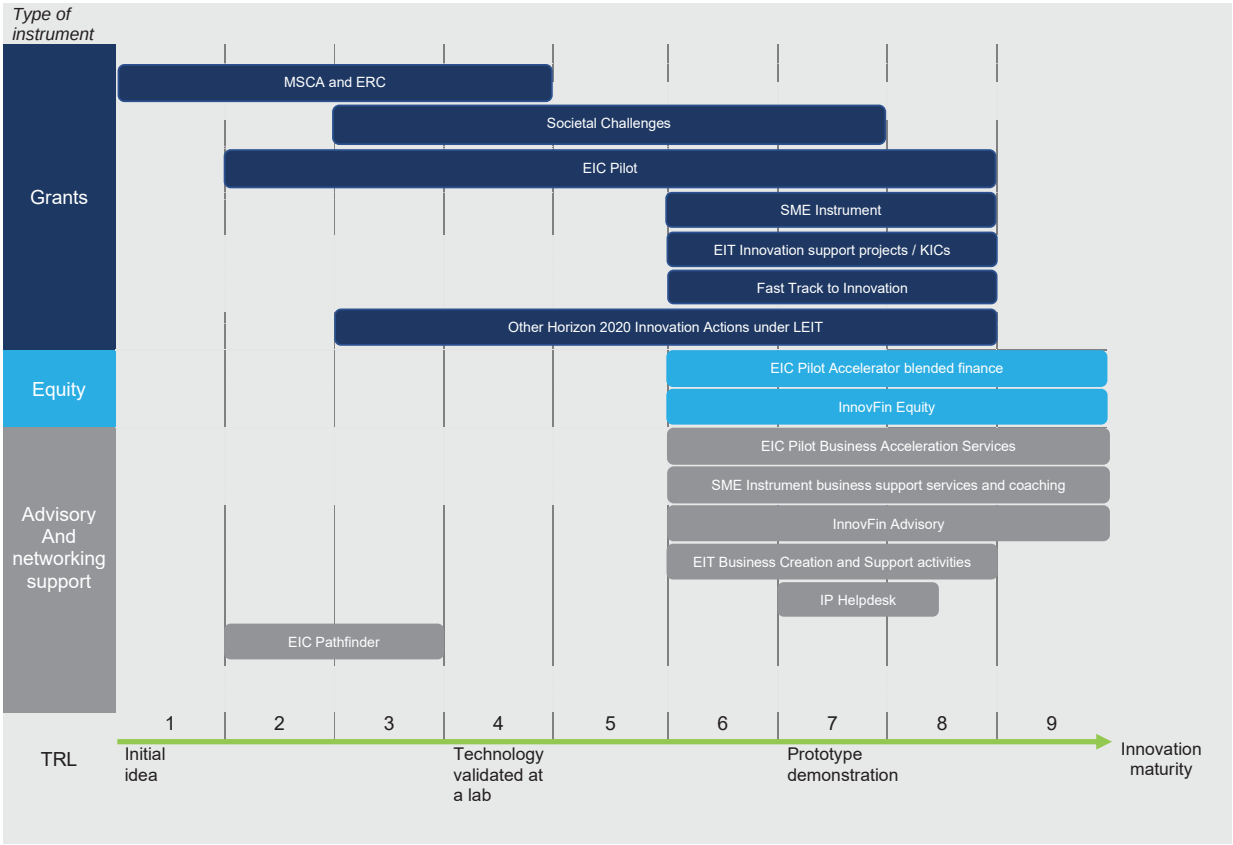
Programme part	**Direct leverage factor**, in EUR
Secure, clean and efficient energy	0.44
Smart, green and integrated transport	0.26
Secure societies - protecting the freedom and security of Europe and its citizens	0.21
Leadership in enabling and industrial technologies (LEIT)	0.2
Climate action, environment, resource efficiency and raw materials	0.15

Notes: Definitions provided in the glossary. Data from ECORDA (cut-off date 07/02/2023). Only the programme parts with the highest leverage (first five) are presented.

[134] Actual funding rate can be lower as applicants can request less funding than the maximum amount defined by the funding rate. The reasons some applicants request less funding than the maximum vary, but one is that they may receive funding from another source. Lower requested amount (lower funding rate) translates into higher direct leverage factor (see glossary for definitions and formal relationship among the two).

Level of TRLs

Figure 62: Selected features of Horizon 2020 support across the **TRL scale**



Source: European Commission, Directorate-General for Research and Innovation, Evaluation study on the European Innovation Council (EIC) pilot: final report, Publications Office of the European Union, 2022, p. 60, https://data.europa.eu/doi/10.2777/261324 - updated by PPMI for the Innovative Europe evaluation study (2023) and adapted by DG RTD in May 2023.