European Research Council
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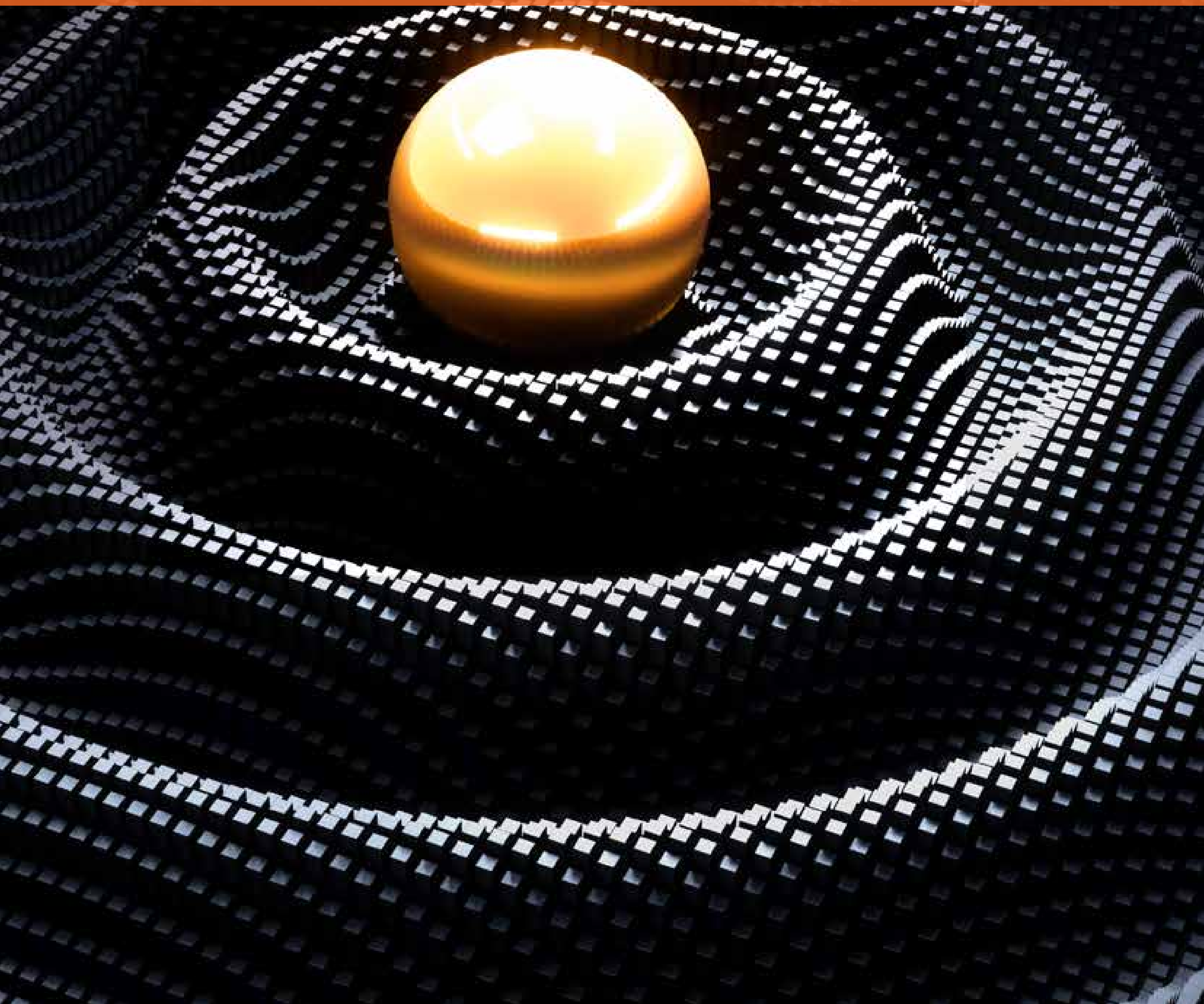
European Commission

The ERC pioneering years

Scientific assessment of completed ERC projects

FP7 review (2015-2022)



EUROPEAN COMMISSION

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Edited by:
Carlos Gálvez Fernández, Rafael Carrasco Jiménez and Josefina Enfedaque.

This report has been produced by the ERC Executive Agency (ERCEA), and reviewed by the ERC Standing Committee for Programme Impact Monitoring and Evaluation (PRIME). Chairman: Jesper Svejstrup.

Acknowledgements:
Angela Liberatore, José Labastida, Davide Innocenti, Zdravka Fournadjieva, Tiago Freitas, Manou Gomlich, Marie Huysman, Jerko Markovina, David Gallego, Luiz Alves dos Santos, Sönke Bauck; with special gratitude to the Scientific Officers of the ERCEA Scientific Department.

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Chapter one

Introduction

Foreword

Research consistently proves to be a reliable ally in tackling crises and in making our society more resilient - from navigating the complexities of the COVID-19 pandemic or confronting the climate crisis to strengthening the EU's security and harnessing the transformative potential of artificial intelligence. Researchers driven by their scientific curiosity in a variety of fields have been particularly instrumental in this respect.

If we want to ensure that the EU does not fall behind globally in an increasingly complex and competitive world, science - not least curiosity-driven fundamental research - requires continuous support from all levels of government. Much of the research we fund today will lead to impactful results in a few years, while some scientific endeavours need even more time to mature into applications, technologies or policies. Such a long-term perspective is crucial for generating knowledge that is of strategic importance for our society and for supporting emerging areas of research that will be essential for future generations. I am proud to say that the EU funds such cutting-edge frontier research in Horizon Europe, in particular through the European Research Council (ERC).

This year, we celebrate the 40th anniversary of the EU's research and innovation (R&I) framework programmes, which have been instrumental in delivering solutions to many challenges, putting European science on the map of excellent global research and boosting the EU's competitiveness.

Established in 2007 as a key component of the 7th framework programme (FP7), the ERC has empowered researchers with the freedom to explore topics that push the boundaries of knowledge, with scientific excellence as the sole selection criterion. In less than two decades, the ERC has emerged as a symbol of scientific excellence both in Europe and internationally.

To evaluate the excellence and breakthrough nature of research funded through the ERC under FP7 (2007-13), the ERC's Scientific Council launched a comprehensive review exercise. This involved a peer review process to assess the outcomes of completed projects, allowing time for the initial investment to mature and bear fruit. This unique, long-term review is essential for appreciating the depth and impact of frontier research.

The findings of this report confirm the significant impact of sustained investment in research and the exemplary achievements of the ERC programme. The report showcases several ERC projects that have had a profound impact in critical areas such as quantum computing, climate change, ageing, cancer and other health-related research - for instance the development of prosthetic transgene networks for controlling and preventing obesity and diabetes.

Sustained investment in research and innovation over extended periods is crucial for building a more resilient, prosperous and competitive future.

Iliana Ivanova

European Commissioner for Innovation,
Research, Culture, Education and Youth

Pioneering excellence

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The ERC has long been recognised as a European success story. In my role as President of this organisation and as an ERC peer reviewer before that, I have witnessed the tremendous effort it takes to achieve and maintain this success. I have seen the passion of the members of our governing body, the ERC Scientific Council, and the devotion and efficiency of the ERC Executive Agency in managing our funding schemes.

However, there is no room for complacency, which is why it remains both interesting and important to keep examining what actually comes out of this effort and investment. This critical mindset is necessary for any organisation that wants to keep delivering quality. This has always been the modus operandi of the ERC Scientific Council, which continually takes stock in several ways, one of which is the exercise that led to this report.

After nearly two decades since the launch of the ERC, it is worth asking: has the ERC effectively nurtured scientific excellence and is it delivering on its mandate and commitment to fostering frontier research in Europe?

Since 2015, annually reviewing the quality of the outcomes of the ERC-funded projects has become a mainstay. Through peer review, this ex post evaluation sheds light on how ERC grantees have contributed to scientific progress and innovation. This time around, it is a comprehensive report on the impact of the research funded in the first 7 years, under the EU's seventh framework programme.

I am pleased to see the results with a high number of breakthroughs in both fundamental and applied science: new methods, emerging fields, advances in knowledge, new concepts, as well as tangible innovation outcomes and concrete impacts on culture, economy, society and policymaking. Notable breakthroughs include contributions in attosecond science, the development of nanomaterials, the study of the origins of life and the economics of inequality.

The findings of this evaluation illustrate that ERC-funded frontier research continues to pay off, even though it is often unpredictable at the outset and performed by researchers driven by sheer scientific curiosity. However, we are unfortunately unable to fund all the excellent research proposals we receive. The ERC could indeed back twice as much excellent research in Europe without lowering its standards. Europe cannot afford losing scientific talent and breakthroughs that may hold the key to addressing pressing societal, economic and environmental challenges.

Ahead of the next framework programme, this is the right moment to reflect on this and to act. It is clear that the EU needs to up its game and invest more in excellent research if it wants to be at the scientific forefront globally.

Prof. Maria Leptin
President of the European Research Council

Executive summary

In 2015, the ERC launched a large-scale programme to perform an ex post evaluation of completed projects ('Scientific Assessment of completed Projects', SAP for short). This peer-review evaluation complements the information gathered by the ERC monitoring and evaluation strategy that monitors the impact of ERC funding by collecting:

- bibliometric parameters of publications;
- patents and start-ups generated by ERC projects;
- prizes and other honours awarded to ERC grantees (such as positions in prestigious committees, academies and scientific societies).

The SAP aimed to: (i) analyse the quality of projects funded by the ERC programme; (ii) make the ERC accountable to the scientific community and stakeholders on whether it is fulfilling its mission; and (iii) indicate to which degree the peer-review system put in place for the ERC programme selected excellent projects.

From 2015 to 2022, seven rounds of evaluation were carried out with the main features described below.

- A random sample of approximately 40% of all completed projects was examined.
- An analysis was conducted by 25 panels of independent experts, replicating the structure used in the ERC's ex ante peer-review process.
- Each panel comprised three to four distinguished scientists and scholars in the field, appointed by the ERC Scientific Council. It was a requirement that these experts had not participated in the preparation or the evaluation of any of the selected projects.

The panels were asked to classify the projects into the following four categories, according to their scientific impact:

A. Scientific breakthrough.

B. Major scientific advance.

C. Incremental scientific contribution.

D. No appreciable scientific contribution.

Scientific breakthrough was pre-defined as a revolutionary work that led to deep changes in existing paradigms or new methods opening a new stream of research.

The evaluation also analysed the outputs of the projects to identify the major outcomes in terms of:

- scientific, societal and economic impacts;
- new methods, techniques or research goals;
- contributions to the advance of interdisciplinary research;
- the extent to which the projects represented high-risk/high-gain research.

This report presents the methodology of the SAP evaluation and its findings. Some of the main conclusions are presented below.

- The evaluators reported that 78% of the projects made either a scientific breakthrough or led to major scientific advances (20% and 58%, respectively). Only 20% were found to have produced incremental or no appreciable scientific advances.
- The number of projects delivering breakthroughs increased in parallel to the growth in the ERC funding budget. There are therefore no signs of saturation in the amount of excellent science that can be funded by the ERC programme.
- The projects funded by the ERC often have a strong interdisciplinary nature, and over 70% of them either produced results that were applicable in other areas (beyond the main project goals) or brought together research fields that had previously seen little interaction.
- ERC funding made the creation of interdisciplinary research teams possible, and such interdisciplinary projects were more likely to lead to major scientific advances and breakthroughs.
- Institutions with a small number of ERC grants still made a significant contribution to excellent scientific results, only slightly below research institutions with high number of ERC grants. This finding supports the continued support for existing ERC programmes that promote and enable grant applications from regions with lower levels of participation (the visiting fellowship programme and the mentoring initiative).
- The evaluators identified about 65% of the projects funded by the ERC as high-risk/high-gain research. Such projects were more likely to produce scientific breakthroughs.
- The evaluators recommended that applicants mitigate the risk components in their proposals by adopting strategies such as the early validation of the critical hypothesis (when feasible) and the inclusion of contingency plans.
- Almost half the projects were deemed to have an impact beyond new scientific knowledge and have influenced industry, economy, society and policymaking.
- Commercial products created by the evaluated ERC projects include medical devices, innovative technologies to generate sustainable energy or food, and models for the early detection of natural disasters. Such products came to light through industrial collaboration or the creation of start-ups, often supported by ERC Proof of Concept grants.
- ERC-funded projects have influenced international debates on social and economic inequality, immigration's impact on job markets, food poverty, fertility trends and climate change. They have also had an impact on major policymaking institutions by generating knowledge on topics such as the financial crises, economic bubbles, regulation policies, payment cards and the social impact of economic depression.

In summary, the SAP led by independent experts indicates that ERC fulfilled its mission to fund excellent research. It also shows that the evaluation system put in place when the ERC was created worked effectively in selecting projects that delivered high levels of scientific impact and even impact beyond science. This is a much welcome side-effect as impact is not part of the ERC selection criteria, only scientific excellence. Overall, the evidence presented in the report strongly supports the conclusion that investment in frontier research pays off and that there are clearly more excellent researchers and ideas in Europe than those that could be funded by the ERC so far.

Key takeaways from the evaluation

Scientific achievements

> High impact: 78% of projects resulted in major scientific advances (20% breakthroughs, 58% major advances).

> Excellent frontier research funded by the ERC is only limited by the budget available.

Interdisciplinarity

> Over 70% of projects had some level of interdisciplinary research, connecting different research fields and applying findings beyond the initial goals.

> Interdisciplinary research is more likely to yield significant advances and breakthroughs.

Regional inclusion

> Excellence is widespread across European research organisations.

> Supportive measures such as the visiting fellowship programme and the mentoring initiative encourage regions with traditionally lower engagement to participate.

Societal and economic impact

Nearly half the projects influenced industry, economy, society and policymaking. They:

> supported high-value start-ups and innovation like medical devices, sustainable technologies and natural disaster early detection systems;

> shaped international debates on key issues, such as social and economic inequality, immigration and climate change;

> informed major policymaking institutions about financial crises, economic legislation and more.

Risk

> High-risk/high-gain projects are more likely to produce scientific breakthroughs.

Chapter two

Background

2.1. Funding research excellence

Almost two decades have passed since the establishment of the European Research Council (ERC), with the aim of promoting scientific excellence and generously supporting cutting-edge ideas across all scientific fields.

Today, as we pause to reflect on its first years of activity, a fundamental question emerges: has the ERC truly funded excellence and carved a distinctive niche in the European research landscape through the support of pioneering frontier research?

Since 2015, the ERC has turned its gaze backwards, launching an annual ex post evaluation process to examine the impact of the projects it has funded[1]. Such evaluation exercises follow a qualitative approach that goes beyond simple bibliometrics.

These evaluations are conducted by independent experts and external peer-reviewers and serve as a critical mechanism not only to illuminate the contributions to scientific knowledge, technological advancements and societal benefits, but also to guide us beyond the mere measurement of past achievements. Through the lens of ex post evaluation, we hope to illuminate the way forward in a journey of continuous improvement.

This report compiles the results of five annual ex post evaluations of projects that were funded under FP7, spanning from 2007 to 2013. This chapter provides the background to the report, a brief overview of similar exercises around the world and a first selection of successful projects. Chapter 2 outlines the methodology used in the ex post peer-reviewed evaluations, followed by a presentation of the main findings and data in a series of graphs (Chapter 3). The report then presents an overview of developments across different scientific areas (Chapter 4) and ends with a conclusion (Chapter 5) presenting the key messages from the ex post evaluation.

The Standing Committee for Programme Impact Monitoring and Evaluation (SC PRIME)

The PRIME committee is responsible for guiding the ERC monitoring and evaluation strategy, as well as for consolidating, prioritising and presenting new proposals to the Scientific Council. Drawing on the findings from assessments of the programme's impact – such as this ex post evaluation – the PRIME committee then recommends updates to the ERC scientific strategy.

"As we examine the findings of these independent ex post evaluations, we gain valuable insight, not only into the impact of the ERC's pioneering years, but also into the trajectory of future frontier research."

Jesper Svejstrup, Chair of PRIME

[1] https://www.nature.com/articles/535477a

2.2. The global context

A comparative assessment of research programmes' ex post evaluations across the world is challenging because research funding organisations (RFO) are very varied in their structures, processes, funding portfolios, and the quality measurement instruments they use[2]. Annex IV (page 79) shows a non-exhaustive sample of such evaluations performed by funding agencies offering online information.

Within the ecosystem of RFOs, a variety of approaches have been identified to measure the quality and impact of funded research. Some RFOs (for example, the Novo Nordisk Foundation) are pursuing a quantitative approach where bibliometric indicators are used as the main markers of funded projects' impact. Other institutions, such as the Max-Planck-Society, implement regular monitoring or continuous ex post evaluation with a permanent advisory board. Among organisations regularly assessing the whole programme's operations, process and management, the National Science Foundation (NSF) is an example of transparency and accountability. Here, each of the recommendations receive a public response from the NSF. An example of an external analysis is the report commissioned by the Austrian Science Fund on Ex-Post Evaluation and Performance of FWF Funded Research Projects (2005). One of its goals was to identify the interrelation between ex ante and ex post evaluations. It includes a study on the impact of science and tentative indicators to measure the impact. In contrast, the approach by the Swedish Research Council consists of a mixed panel that looks at only one discipline at a time and analyses it through a sample of publications, e.g. in physics, and rates them on their scientific and societal impact.

In this context, the ERC scientific assessment of completed projects arguably represents a unique and multidimensional approach, evaluating a very large sample of projects, using peer-review panels that cover all the scientific disciplines funded. We have so far been unable to identify other RFOs that evaluate such a large set of projects with dedicated panels of independent experts years after the end of the project.

2 For example, many RFOs validate the final reports of projects when they are finished. However, the actual practice could not be verified for each of the organisations mentioned since this is usually internal information and not publicly accessible. At the Swiss National Science Foundation, for example, the referee who evaluated the proposal (if still on the panel) validates the final report. If they were based on a peer-reviewed evaluation within an organised panel, this information would likely be accessible.

2.3. A glimpse into the groundbreaking world of ERC projects

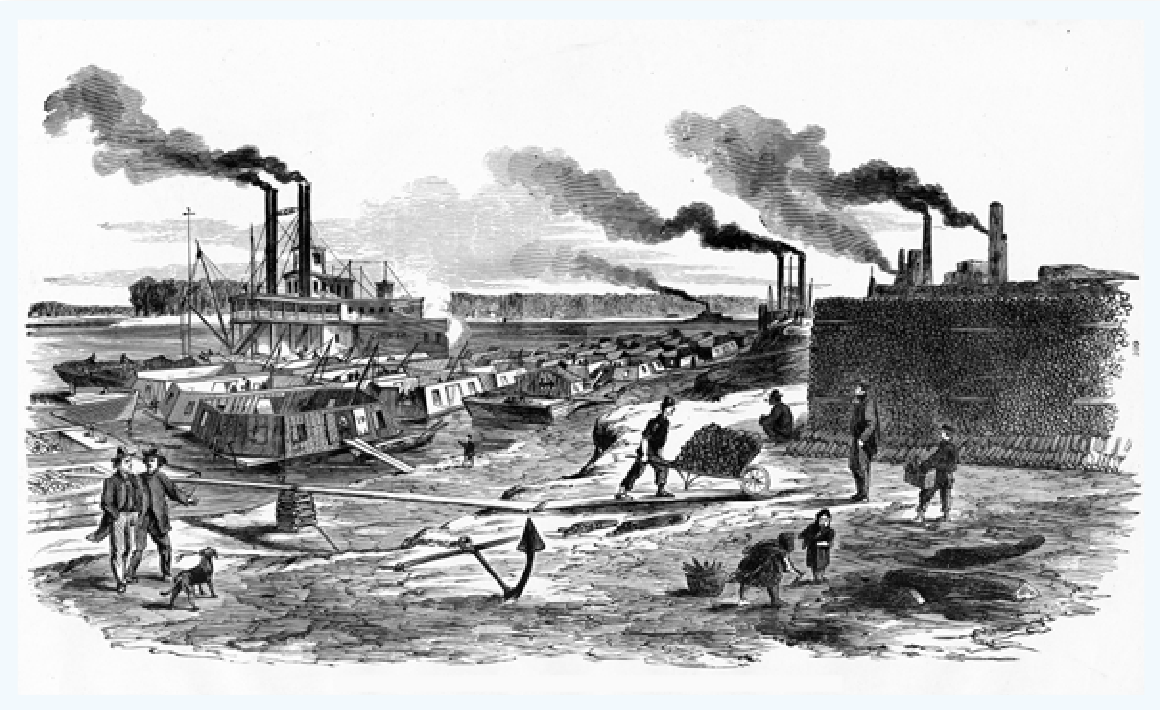
What did ERC grantees discover in the early phase of ERC funding (2008-2015), and how did ERC funding help them do so? The examples below briefly describe projects assessed by independent experts as breakthroughs and how the ERC funding contributed to these achievements.

PUZZLE_CELL: Solving an evolutionary jigsaw puzzle: a next-generation genomics approach to trace the origins of the eukaryotic cell

Led by Thijs Ettema this project produced groundbreaking findings on fundamental questions about the origin of life, prompting significant changes in textbooks. It has provided several key insights into the early evolution of the eukaryotic cell, notably the discovery of the Asgard archaea, which largely settled the debate between the 2- and 3-domain tree of life in favour of the 2-domain evolutionary model. This major discovery has profound implications for our understanding of the evolution of life on Earth and stands as one of the notable scientific breakthroughs in microbiology and evolutionary biology in recent years.

'My ERC Starting Grant has helped me to support and structure my scientific career. It allowed me to focus on a challenging scientific problem for an extended period of time and with significant financial support. I was able to build a team of motivated researchers around me and provide training to a large number of students and postdocs.'

Principal investigator: Thijs Ettema
Host institution: Uppsala University, Sweden
Funding scheme: Starting Grant 2012



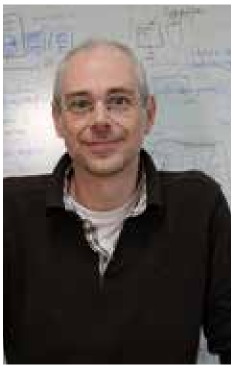
TITAN: Transition into the Anthropocene: learning about the climate system from the 19th and early 20th century

This project, led by Gabriele Hegerl, answered many major questions about recent climate change and the role of forcing factors during the early Anthropocene. This was an exceptionally successful research project, which also made major contributions to climate change reports such as the Intergovernmental Panel on Climate Change (IPCC), the US Academy of Science and the Royal Academy climate change reports. The study of early Anthropocene climate change has now been adopted as a major research topic, and some of the approaches developed in the project have been generally adopted by the scientific community.

'TITAN was a game changer for my career. ... The results of my project have spawned interest in the consequences of severe extreme events early in the record and highlighted the risk of irreversibility or highly damaging impacts where a climate anomaly causes cascading consequences.

I am now involved in addressing future climate risk, co-leading a lighthouse project of the world climate research programme that considers cascading consequences of extreme events and tipping points, which has been motivated by the results of my grant.'

Principal investigator: Gabriele Clarissa Hegerl
Host institution: The University of Edinburgh, United Kingdom
Funding scheme: Advanced Grant 2012



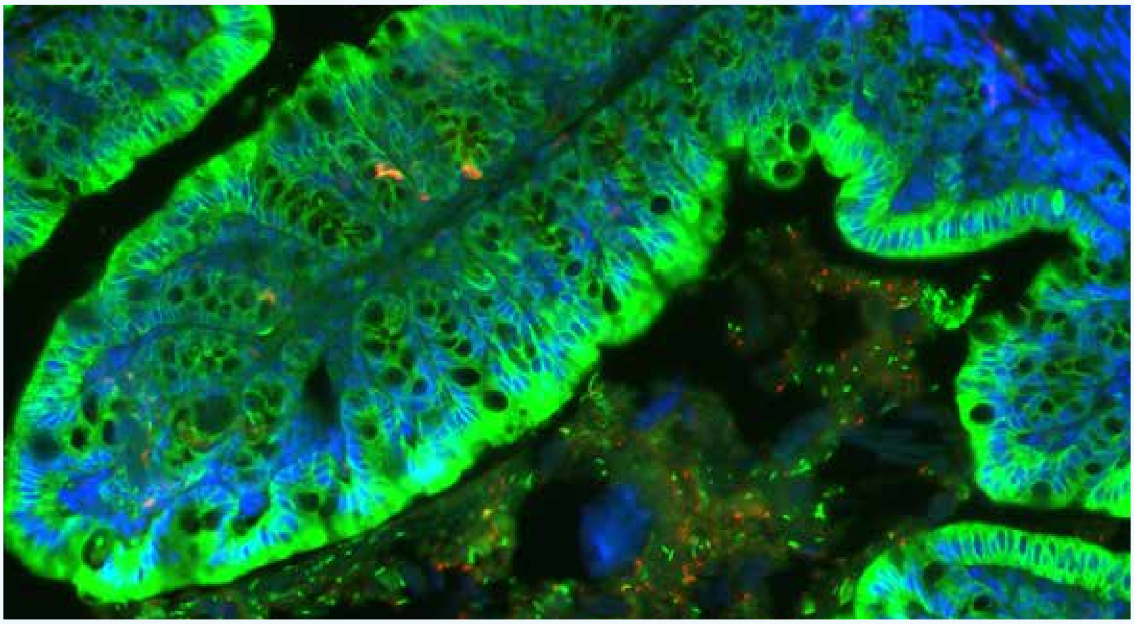
CREAM: Cracking the emotional code of music

Led by Jean-Julien Aucouturier, this project pioneered innovative voice-transformation technology, catalysing a paradigm shift in the study of vocal and musical emotions and opening the potential to decode social emotional interaction. With strong ties to real-world applications in both industry and society, the project offered tools like communication smoothers to alleviate stress in social interactions.

'The ERC allowed me to start a research programme in a field, cognitive neuroscience, in which I had very little pedigree at the time of funding. Much of the available research funding outside of ERC favours projects and applicants who already have a consolidated track record and not, for example, promising ideas to apply a methodology from one field to a problem in another.

The ERC gave me the extraordinary freedom to reinvent myself as an experimental scientist, a rare and invaluable opportunity for which I am forever grateful.'

Principal investigator: Jean-Julien Aucouturier
Host institution: CNRS, France
Funding scheme: Starting Grant 2013

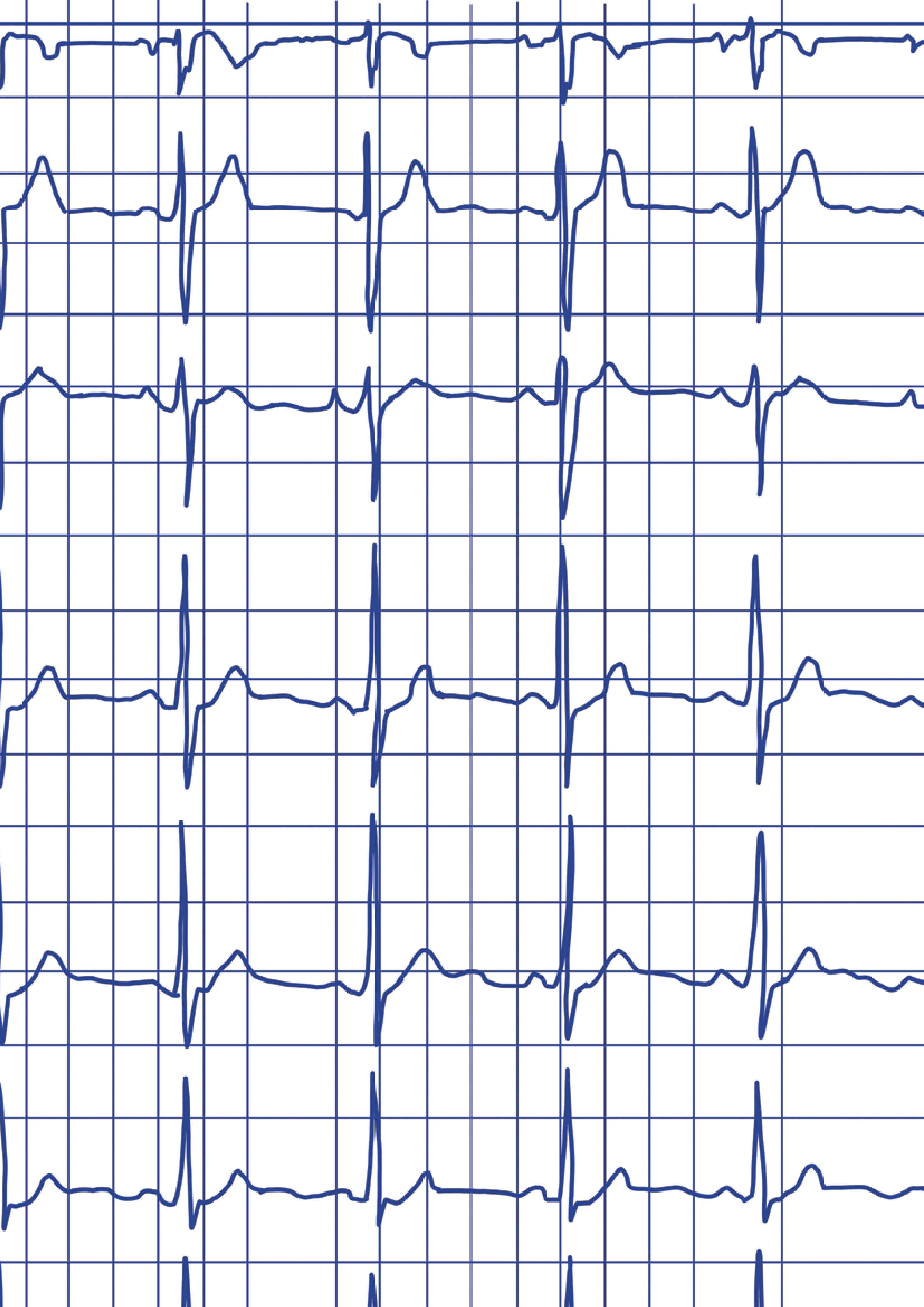


© Hubert Plovier & Patrice Cani, WELBIO

ENIGMO: Gut microbiota, innate immunity and endocannabinoid system interactions link metabolic inflammation with the hallmarks of obesity and type 2 diabetes

This project was led by Patrice Daniel Cani. It achieved something quite difficult: identifying a bacterial species that would be of relevance for obesity and diabetes, based on a solid experimental model. The project demonstrated that administering bacteria of the species Akkermansia muciniphila was safe and feasible. The European Food Safety Authority (EFSA) granted it with the label of novel food, the first next generation bacteria to get this recognition. The resulting start-up, through a family of five patents, was based on this grant and on a subsequent ERC Proof of Concept grant.

Principal investigator: Patrice Daniel Cani
Host institution: Catholic University of Louvain, Belgium
Funding scheme: Starting Grant 2013



Chapter three

Methodology

The ERC Scientific Council and the ERC Executive Agency (ERCEA) designed a multidimensional approach to assess the ERC programme's impact. It is based on a peer-review of a significant sample of finalised projects from the Seventh Framework Programme (FP7) 2007 to 2013 calls. The bottom-up methodology covers all scientific domains and areas by randomly selecting projects from every ERC assessment panel.

Project selection

The SAP evaluations carried out between 2015 and 2022 assessed approximately 40% of the ERC projects funded under FP7. The projects, with a typical duration of 5 years, were evaluated 2 years after their finalisation to allow for some perspective on their impact. The sample only covers the ERC's individual grant calls, not Synergy calls.

The projects in the sample were selected using stratified random sampling to ensure that they were representative of grant types and panels. Only a small fraction of projects had to be excluded from the pool due to unusual circumstances, such as unexpected early termination.

Although the Starting Grants calls were divided into Starting and Consolidator Grants in the last year of FP7, the SAP evaluation groups them together in the 2013 call, for the sake of consistency.

Table 1 summarises the number of eligible projects in every exercise, the criteria applied and the size of the representative sample.

Panels and evaluators

The qualitative evaluation of completed ERC projects was organised in 25 panels, reflecting the structure of the ex ante ERC evaluation. Panels were composed of three to four distinguished scientists and scholars, selected by the ERC Scientific Council based on their scientific merits and broad expertise. When specialised expertise was needed for a better assessment of a project, the panels were assisted by external experts. The number of panel members involved in evaluations between 2015 and 2022 was 471, some of them participating several times (see Table 2). Their work was supported by 434 external evaluators.

Evaluation year	Project pool size	Projects assessed	End-date range
2015	199	199	1/2007 - 6/2014
2016	238	155	1/2007 - 6/2014
2017	470	223	7/2014 - 6/2015
2018	631	225	7/2015 - 6/2016
2019	753	225	7/2016 - 6/2017
2020	807	225	7/2017 - 6/2018
2022	1 118	450	7/2018 - 6/2020
All years	4 216	1 702	1/2007 - 6/2020

Table 1: Number of eligible projects, actual sample size and temporal criteria.

Two profiles of panel members were selected:

- experts with at least one participation as a panel member in past ERC calls;
- experts who had never served as a panel member in past ERC evaluations, were never grantees and had not applied for an ERC grant in the previous 5 years.

At least one member in every panel was selected among candidates in the second category to benefit from the vision of experts who were not influenced by previous interactions with the ERC. In addition to the standard ERC rules on conflicts of interest, all evaluators were excluded from evaluating projects for which they had participated in the funding decision. Further details can be found in Annex II.

Although not set out as one of the SAP requirements, the geographical distribution of experts largely matches the distribution in ERC research calls (see Table 3).

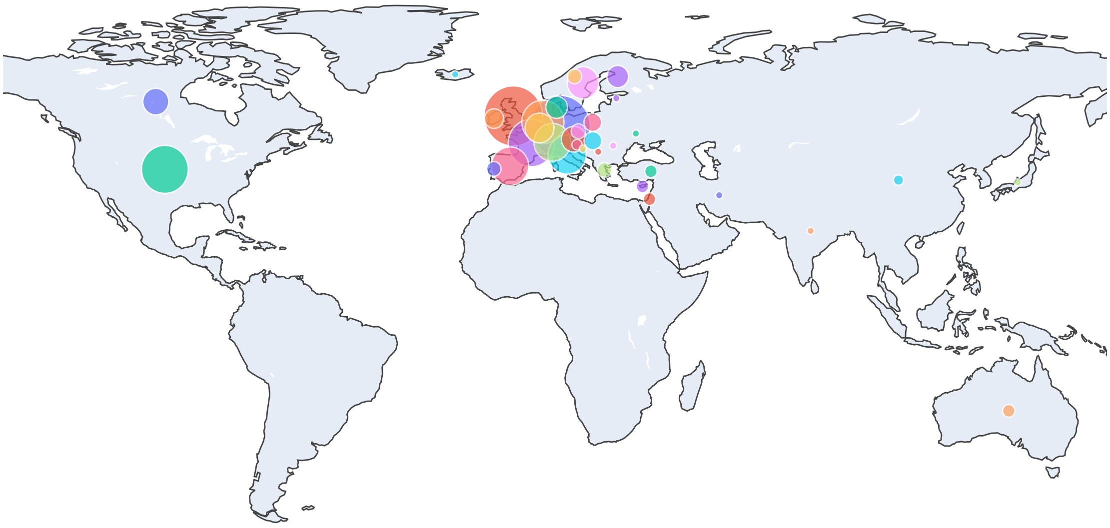


Figure 1: Distribution of panel members by host institution country.

Expert	LS	PE	SH	All
Panel members	163	189	119	471
External evaluators	81	166	187	434

Table 2: Number of experts participating in the ex post evaluation
(LS=life sciences, PE=physical sciences & engineering, SH=social sciences & humanities).

Continent	FP7 *ex ante*	FP7 *ex post*
Europe	85%	81%
America	10%	15%
Asia & Oceania	5%	4%

Table 3: Distribution of panel members by continent of affiliation.

Implementation

Every panel worked autonomously to decide which experts should evaluate each project and, if additional input was needed, which external experts should be recruited.

Each evaluation round was organised during a calendar year in the following two steps.

- Step 1: every panel member evaluated the projects assigned to them, answered the questions listed below and drafted an individual report for each project. If the panel considered that additional expertise was needed to evaluate a project, external evaluators were also asked to conduct an assessment.
- Step 2: panel members met for 1 or 2 days to discuss the projects assigned to the panel and to write a consolidated evaluation report for each of them. They also compiled recommendations to improve the SAP exercise.

The evaluators were given some information as initial input:

1. the description of work submitted by the researcher;
2. the final scientific report prepared by the principal investigator at the end of the project, which describes the project achievements and output (such as publications, awards and patents);
3. a bibliometric analysis of the output listed in the final report, supported by the ERIS[3] platform;
4. if applicable, Proof of Concept grants awarded to the project, including the description of work and the final report.

Evaluators were urged to use the bibliometric analysis only as a support in their assessment. The primary focus was therefore on the qualitative assessment of the reported results, and, most importantly, the scientific content of the publications. Evaluators were also asked to consider public information available online, such as the content of publications, outputs generated after the finalisation of the project where ERC funding was acknowledged or relevant references to the results.

The questionnaire

The evaluation questionnaire (see Annex I) had two parts: the first part aimed to measure several project characteristics and impact. Evaluators used a 5-level scale (with an additional 'not applicable' option when needed) to answer the questions below.

Q1. To what extent has the project resulted in new important scientific advances of knowledge?

Q2. Have the project findings opened a promising new research agenda (i.e. a set of new research questions, new hypotheses to be tested) or a possible paradigm shift?

Q3. Has the project developed new research methods or instruments?

Q4. Has the research performed found recognition or applicability outside its main field?

Q5. Are the results of the research bringing together areas that previously did not have much interaction?

Q6. Taking into account the state of the field at the time of funding, would you agree that this is a high-risk/high-gain project?

Q7. Do you consider that the risk component influenced the overall project results?

Q8. In addition to its scientific impact, to what extent has the project had other types of impact (e.g. on the economy, on society, on policymaking, on industry)?

Q9. In addition to its scientific impact, in your opinion, could the project have other types of impact (e.g. on the economy, on society, on policymaking, on industry) in the future?

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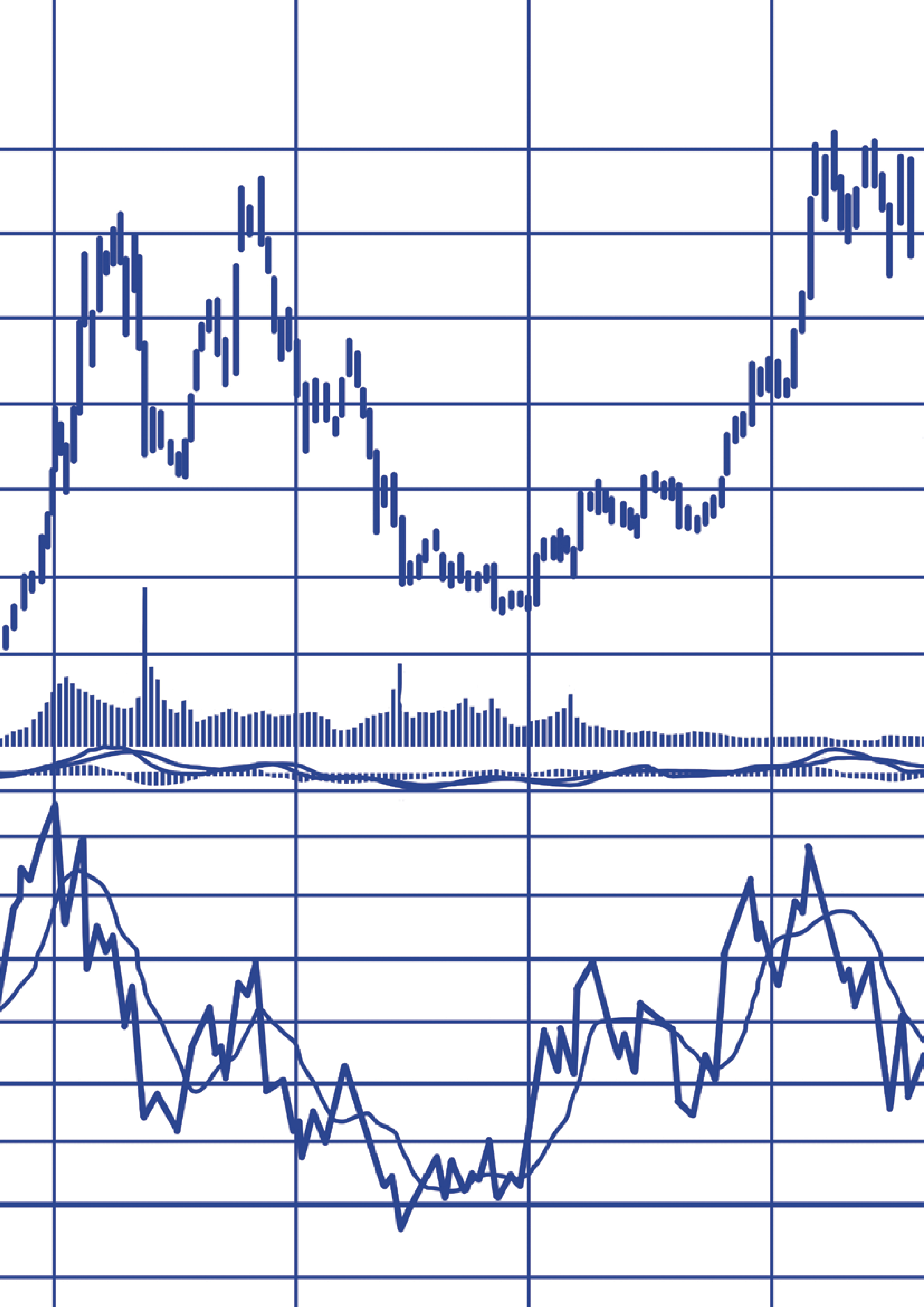
[3] ERIS (ERC Research Information System) is an IT system for data exploration of ERC funding projects. https://erc.europa.eu/projects-statistics/erc-research-information-system

The evaluators assessed the scientific results of the project using the following scale:

- **A.** Scientific breakthrough.
- **B.** Major scientific advance.
- **C.** Incremental scientific contribution.
- **D.** No appreciable scientific contribution.

In this evaluation, the following definition of a breakthrough was given to evaluators:

> “*A breakthrough should represent revolutionary work that has led to a conceptually new paradigm, or to a rapid and profound change in widely accepted paradigms, or to findings or the development of tools that have swept through a field and led to entirely new modes of work and discovery.*”



Chapter four

Main findings

4.1. Results of the assessment

Figure 2 shows the results of the overall assessment in the seven exercises organised from 2015 to 2022. The proportion of projects classified by evaluators as scientific breakthroughs (A) ranges between 16% and 25%. The rate of projects delivering excellent results, that is, projects classified as breakthroughs or major scientific advances (A and B), ranged from 72% to 81%.

If all the exercises are considered together, the evaluators concluded that, on average, 20% of the projects led to a scientific breakthrough (A) and 58% to a major scientific advance (B). On the other hand, 20% of the projects were categorised as incremental (C), and 2% were considered as providing no appreciable scientific contribution (D).

Historical results for the exercises

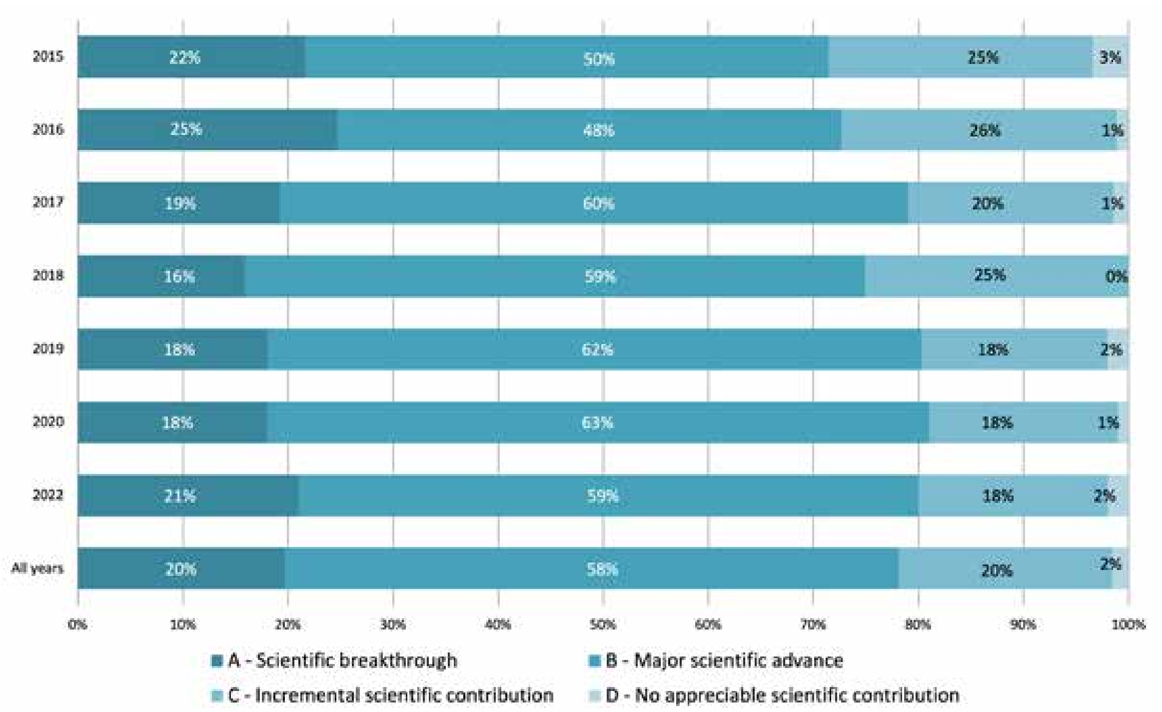


Figure 2: Overall results of the exercises organised between 2015 and 2022.

A deeper look into project achievements

Project achievements were analysed in terms of their contribution to new important scientific advances in knowledge (Q1), opening a promising new agenda or a possible paradigm shift (Q2) and the development of new research methods or instruments (Q3).

Nearly 75% of projects produced new important scientific advances of knowledge to an exceptional or significant extent.

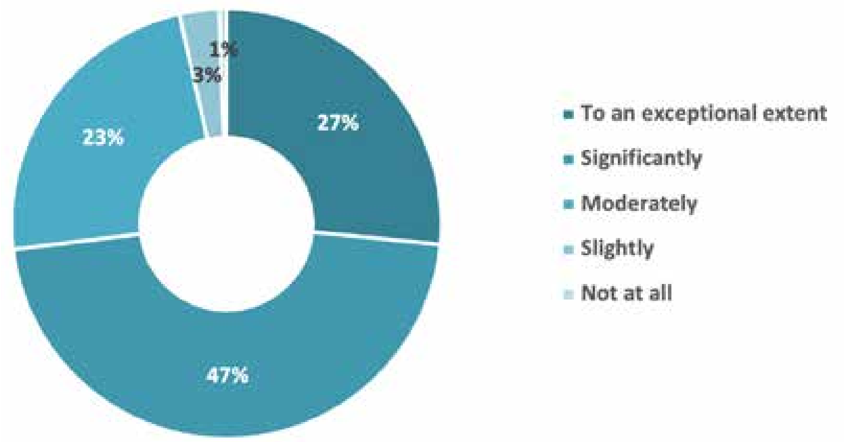


Figure 3: Answers to Q1: To what extent has the project resulted in new important scientific advances of knowledge?

Over 60% of projects opened a promising new research agenda or a possible paradigm shift to an exceptional or significant extent.

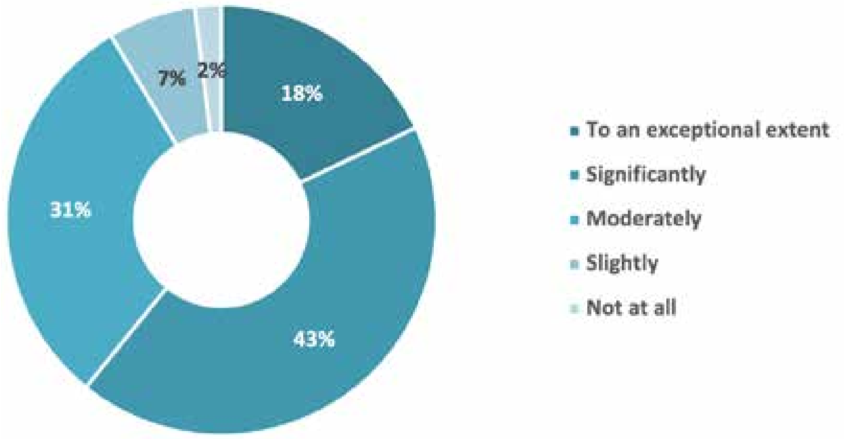


Figure 4: Answers to Q2: Have the project findings opened a promising new research agenda (i.e. a set of new research questions, new hypotheses to be tested) or a possible paradigm shift?

About 60% of the projects achieved this objective to an exceptional or significant extent.

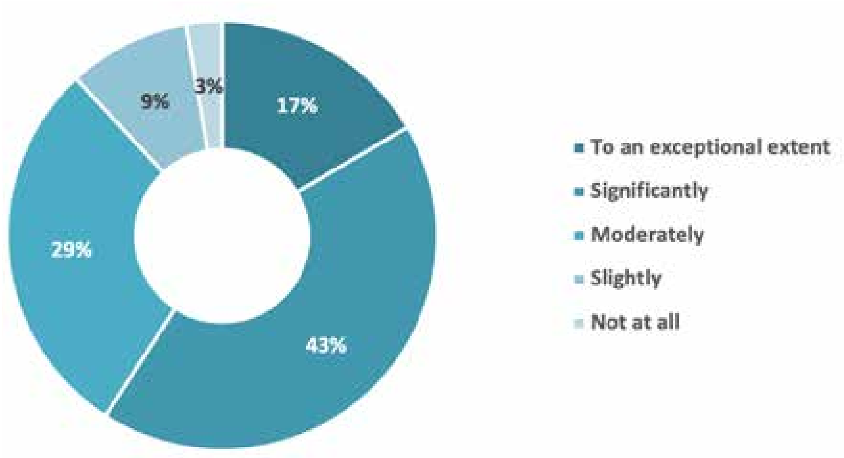


Figure 5: Answers to Q3: Has the project developed new research methods or instruments?

Interdisciplinarity

Interdisciplinarity is addressed in this study through questions 4 and 5: has the research achieved recognition or applicability outside the project's main field (Q4) or has it brought together areas that previously did not have much interaction (Q5).

As shown in Figures 6 and 7, over 70% of the evaluated projects were at least moderately interdisciplinary, and over 35% were interdisciplinary to a significant or exceptional extent.

Interdisciplinary projects often included collaborations with many research groups to bring together the required expertise. However, the evaluators also identified numerous projects that gathered complementary expertise in the main team thanks to ERC funding.

The impact on other scientific fields was recognised by high-impact publications that either appeared in journals covering other disciplines or were significantly cited by researchers working in other fields. The knowledge and technology transfer to other disciplines was also identified by analysing patents granted, collaborations with companies, and the creation of start-ups (sometimes with the support of a Proof of Concept project).

Examples of research areas with a frequent impact on other disciplines are 'cancer and its biological basis', 'systems evolution, biological adaptation, phylogenetics and comparative biology', 'materials engineering' and 'cognitive and experimental psychology'.

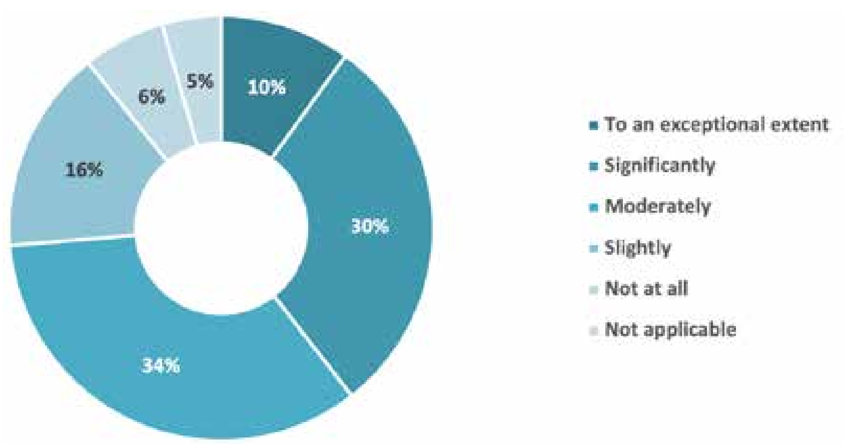


Figure 6: Answers to Q4: Has the research performed found recognition or applicability outside its main field?

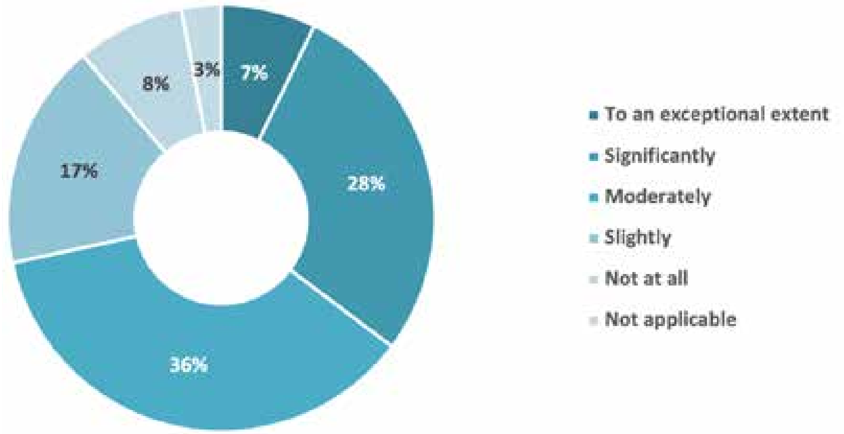


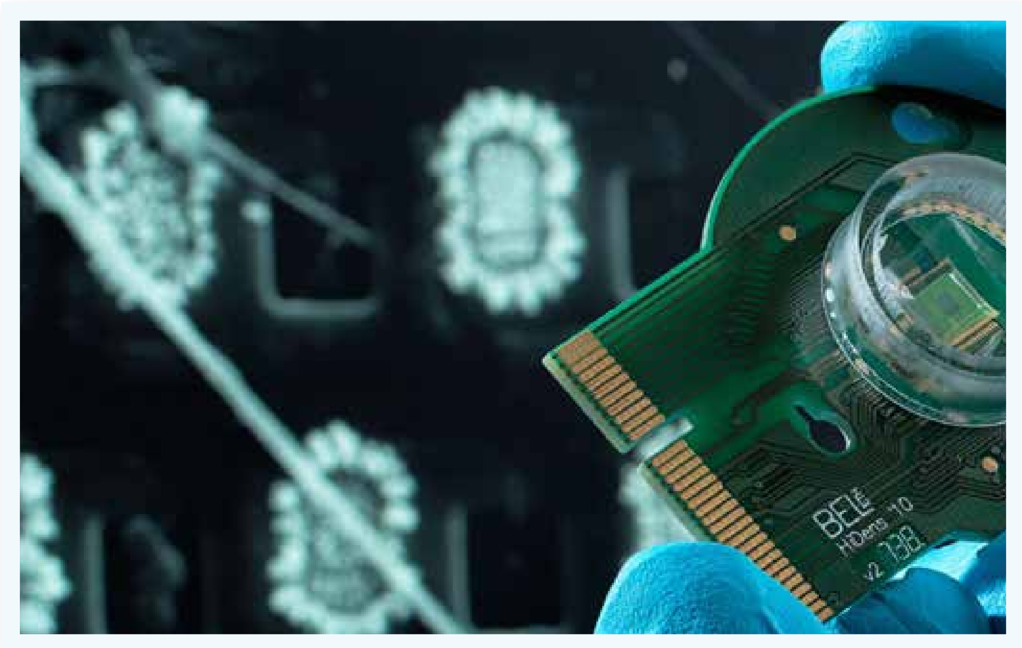
Figure 7: Answer to Q5: Are the results of the research bringing together areas that previously did not have much interaction?

PRONET: Prosthetic Transgene Networks for the Treatment of Metabolic Disorders

Led by Martin Fussenegger, this was an unusually innovative, almost futuristic project, combining cybernetics, mind-control and optogenetics with synthetic biology. It aimed to generate impressive new medical applications. It developed prosthetic transgene networks for controlling and preventing obesity and diabetes.

'ProNet's substantial funding and support to pursue a bold research endeavour, employing cell engineering strategies beyond conventional boundaries, have unleashed unexpected translational research potential, profoundly altering my research vision forever.'

Principal investigator: Martin Anton Fussenegger
Host institution: Federal Institute of Technology Zurich, Switzerland
Funding scheme: Advanced Grant 2012



The ERC Synergy Grant

Established initially in 2012 for two years under FP7 and reintroduced in 2018, the ERC Synergy Grant supports small groups of two to four principal investigators with up to EUR 14 million over six years.

This grant aims to facilitate collaboration among several research groups to tackle ambitious research problems that individual principal investigators and their teams could not solve alone. These research teams typically have exceptional combinations of knowledge and skills.

The transformative research funded by Synergy Grants should drive significant advances at the frontiers of knowledge and has the potential of becoming a benchmark on a global scale.

Risk dimension

Question 6 addresses the degree of high-risk/high-gain[4] of the research carried out in the projects. Until 2024, this criterion was used in the ex ante assessment of research proposals. Approximately 65% of projects were assessed as high-risk/high-gain and 28% of them as high-gain with a moderate risk. Only 7% of the projects were considered as low gain (see Figure 8).

Different risks were identified by evaluators, mainly in connection with technical and methodological challenges. Some projects were risky from the beginning because they opened up a new research area or dealt with difficult theoretical problems far beyond the state of the art. In other cases, the research plan covered many interdependent tasks and did not always include mitigation plans.

Projects of a high interdisciplinary nature were sometimes identified as risky because their dependency on several disciplines was not fully covered by the available expertise (within the research team or in the associated research groups). Some projects showed risks associated to field work, which, for example, required access to conflict areas or locations where there was only weak cooperation with local authorities. Other risks were related to the accessibility of resources (such as the recruitment of a large enough sample of patients) or to constraints in data acquisition (for example, interviews). The evaluators recommended that applicants be asked to describe how they would mitigate the risk component of their proposals through the adoption of risk-management strategies. Strategies could include performing preliminary work to support their hypotheses, identifying potential weaknesses in their methodology or drawing up a robust workplan by designing low interdependency work packages or setting out a contingency plan for each objective.

The evaluators were also asked to assess the influence (positive or negative) of projects' risk components (Q7). The results indicate that this influence was at least moderate for around 70% of the projects (Figure 9).

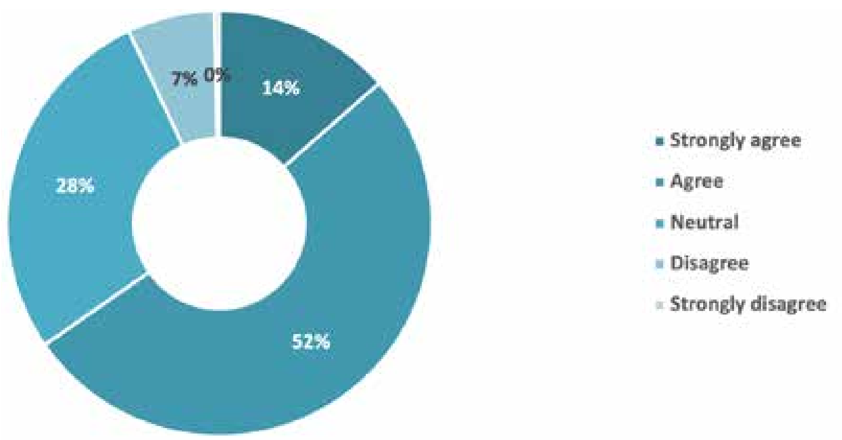


Figure 8: Answers to Q6: Would you agree that this is a high-risk/high-gain project?

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4 A project is considered high-risk when, at the time of funding, it was not clear if the project could achieve its goals despite the best efforts of the principal investigator. The project is considered high-risk/high-gain if in addition to being high-risk, it has the potential for research outcomes with a significant impact.

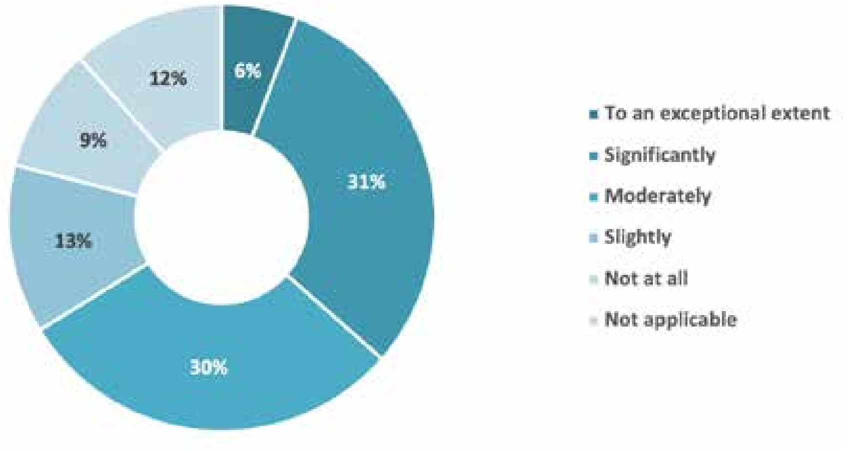
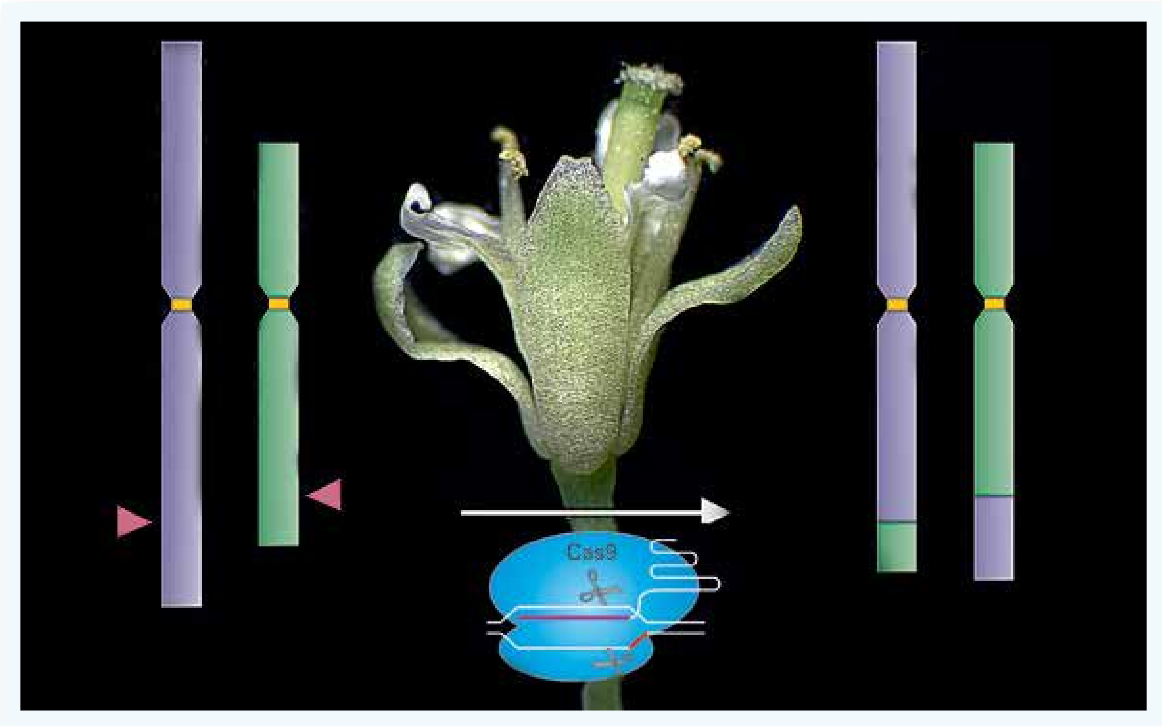


Figure 9: Answers to Q7: Do you consider that the risk component influenced the overall project results?



© Karlsruhe Institute of Technology

COMREC: Designed Plant Breeding by Control of Meiotic Recombination

This project, led by Holger Puchta, contributed to an early adoption of the CRISPR genome editing technology for plants. By facilitating genetic modifications through gene editing techniques for crop plant improvement, its potential for having an impact on industry is considerable.

'The COMREC grant increased tremendously my visibility in the scientific community outside of my own area of research. It also enabled us to be one of the very few groups to continue this kind of research in Europe. Since 2018, hardly any grant calls have been published for research in plant gene editing Europe-wide. Due to the generous funding of the ERC, we were able to not only keep up with the international progress but also achieve a major breakthrough for breeding by establishing plant chromosome engineering.'

Principal investigator: Holger Alexander Puchta
Host institution: Karlsruhe Institute of Technology, Germany
Funding scheme: Advanced Grant 2010

Impact beyond science

Looking at other kinds of impact (Figures 10 and 11), the answers to question 8 reveal that in nearly 50% of the projects, the research carried out had an impact on other fields beyond science (such as the economy, society, policymaking and industry), and over 70% of them were predicted to have an impact in the future (Q9).

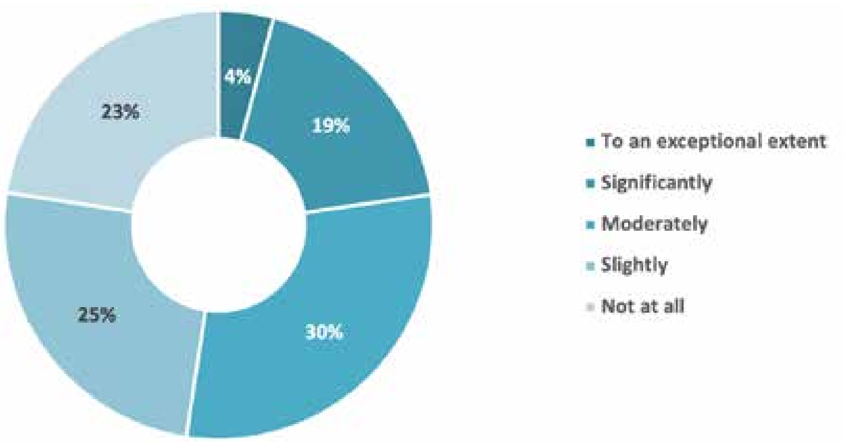


Figure 10: Answers to Q8: In addition to its scientific impact, to what extent has the project had other types of impact?

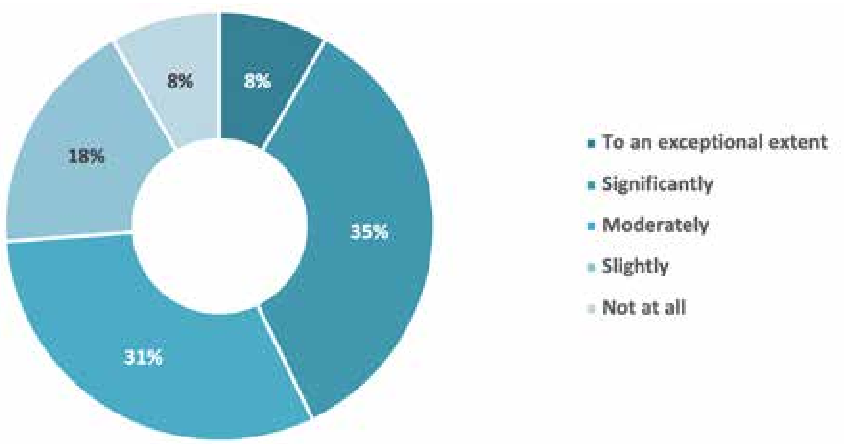
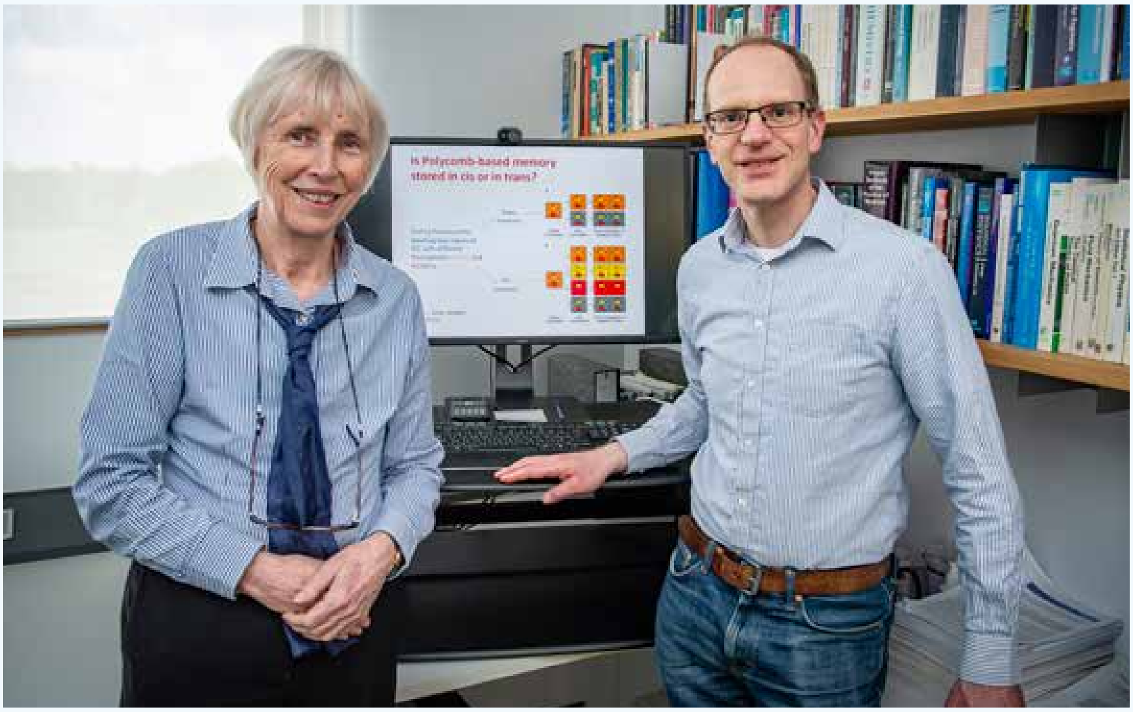


Figure 11: Answers to Q9: In addition to its scientific impact, in your opinion, could the project have other types of impact?

Impact on policy and society

Some ERC projects made essential contributions to support international organisations or to influence global debates in fields such as social and economic inequality, immigration’s impact on job markets, food poverty, fertility trends, human rights, the environmental effect of engineered nanoparticle emissions and climate change impact on sea level. Other projects contributed to classifying some areas in Asia as UNESCO World Heritage Sites, located and documented more than 800 new archaeological sites in the north of Africa or increased knowledge transfer on malaria in West Africa. Another group of projects influenced major economic policymaking institutions in areas such as the financial crises, economic bubbles, regulation policies, payment cards and the impact of economic depression on society.



ENVGENE: Dissection of environmentally-mediated epigenetic silencing

MEXTIM: Measurement of temperature exposure and integration over time

The ENVGENE and MEXTIM projects, led by Caroline Dean, enabled blue-sky collaboration with Martin Howard (John Innes Centre). They examined several complex molecular mechanisms used by plants to register natural fluctuations in temperature during winter. The resulting knowledge improves the understanding of plant adaptation to climate change, which has a potential impact on the economy.

‘The ERC funding was instrumental in establishing this interdisciplinary research that could not have been achieved by either group alone. It has produced breakthroughs with huge implications for life in a changing climate.’

Principal investigator: Caroline Dean
Host institution: John Innes Centre, United Kingdom
Funding scheme: Advanced Grant 2008 and 2013

Economic impact

Research outputs from projects often lead to impacts on the economy and industry. Some projects have fostered industrial collaboration, often established during their lifetime, while others preferred creating their own start-ups. In both approaches, the principal investigators frequently submitted patent applications to protect their intellectual property. The evaluators identified projects at different stages of potential economic impact: submitting or granting patents, setting out a business model for commercialisation (frequently supported by the ERC Proof of Concept scheme), producing a prototype and launching commercialisation. Rather remarkable cases of commercial success include a start-up created after a successful ERC project with a market value over EUR 150 million.

A large number of commercial products were created based on ERC-funded projects. For example, new diagnostic methods and therapy strategies were devised to fight against specific illnesses (leukaemia, Alzheimer's, Parkinson's, cancer and cardiovascular diseases). Innovative technologies or approaches were also developed to increase the sustainable productivity of agricultural areas. New efficient processes were created to produce sustainable fuel or green hydrogen; to reduce carbon footprints; or to purify water through the removal of heavy metals. Outcomes in environmental disciplines include forecasting techniques for the early detection and mitigation of natural disasters (such as earthquakes or volcanic eruptions) and models to predict forest response to environment changes.

Innovation

Science is a major contributor to industrial innovation, but scientific knowledge has some characteristics that result in the private sector under-investing in it. To carefully consider the ERC's relationship with the industrial/business sector, the ERC Scientific Council established the Working Group on Innovation. Since its creation, the Working Group has been very active in investigating and establishing good relations with industry in frontier research.

"*Public sector investment in frontier research is fundamental. The risks are certainly high but so are the socio-economic rewards. ERC funding helps us consolidate a robust R&I system that propels economic growth, addresses societal challenges and ensures our competitive edge in the global market.*

Sylvie Lorente, Chair of the Working Group on Innovation"

Proof of Concept funding

Frontier research often generates radically new ideas that drive innovation and business inventiveness and tackle societal challenges. To facilitate exploring the commercial and social innovation potential of ERC-funded research, the ERC Scientific Council decided to create the Proof of Concept grants in 2011. This grant is available as complementary funding for principal investigators with an active or recently completed ERC main grant. Each Proof of Concept grant has a financial contribution of EUR 150 000 for 18 months.

2DnanoCaps: Next Generation of 2D-Nanomaterials: Enabling Supercapacitor Development

Led by Valeria Nicolosi, the project introduced a new process for making 2D-nanolayers from materials such as graphene or chalcogenides through exfoliation in liquids. The project extends the exfoliation method to create better electrodes for batteries and supercapacitors. It also developed a novel ink-jet printing process to produce thin-film supercapacitors that opened new possibilities for energy storage devices. These achievements, partially supported with three ERC Proof of Concept grants, attracted industry partnerships, indicating its real-world impact.

'2DNanoCaps was a project that changed my career and became a huge driver of all the research that followed. With this ERC grant, I had the chance to start my own independent research: I hired my first five team members, and within a few years, my group grew to over 30 scientists.

My research today, almost a decade after the project ended, still builds upon what we built back then, and that shows the lasting impact of the 2DNanoCaps achievements'.

Principal investigator: Valeria Nicolosi
Host institution: Trinity College Dublin, Ireland
Funding scheme: Starting Grant 2011

4.2. Analysis of the results

This section highlights several key takeaways that are statistically significant[5] and are derived from the evaluation data.

Interdisciplinarity pays off

As shown in Figure 12, projects that are recognised or applied beyond their main field are more likely to deliver excellent results. Projects in category A, scientific breakthrough, tend to be of a significant interdisciplinary nature. In contrast, projects classified as C, incremental scientific contribution, tend to have only slight or moderate levels of interdisciplinarity.

The relationship between the interdisciplinary nature of projects (Q4) and their future economic or societal impact (Q9) was also analysed. The data indicate a positive correlation between both types of categories. As shown in Figure 13, projects with a high potential for applicability peak around significant interdisciplinarity, while those with an expected low impact accumulate around slight interdisciplinarity.

Applicability beyond the project main field

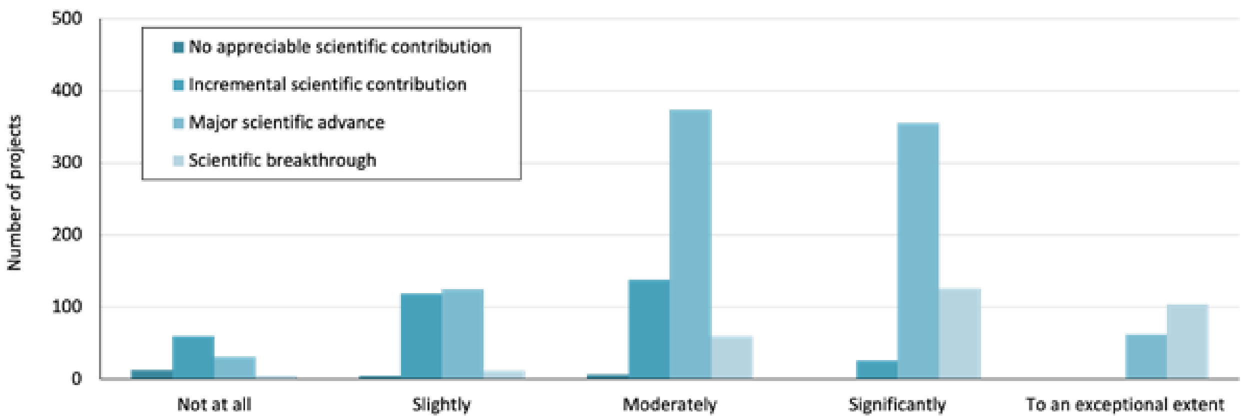


Figure 12: Recognition or applicability of the project beyond its main field (Q4).

Applicability beyond the project main field and impact beyond science

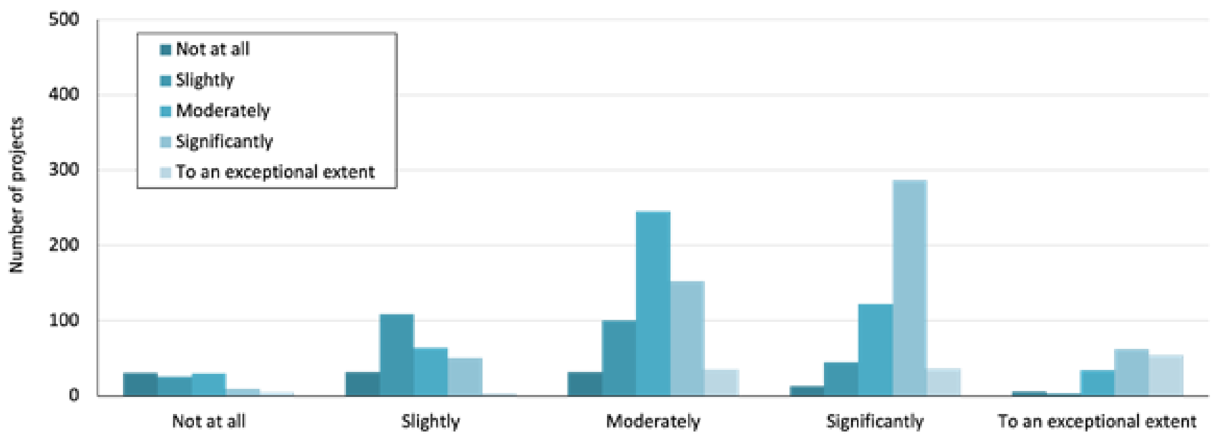


Figure 13: Recognition or applicability of the project beyond its main field (Q4) and the future impact of the project beyond science (Q9)

[5] A statistically significant correlation is accepted at 95% confidence level (p-value = 0.05).

Science excellence and the acceptance of risk

According to the answers to question 6, 'would you agree that this is a high-risk/high-gain project?' most projects considered to be groundbreaking (A) addressed high-risk/high-gain research as 83% were in the 'agree' or 'strongly agree' response groups. This is also the case for projects considered to result in major scientific advances (B) (Figure 14). This means projects with a high-risk/high-gain component showed a stronger probability of producing breakthrough results.

There is also a considerable number of C and D projects (which represent incremental or no scientific contribution) with a high-risk component. This shows that the ex ante evaluation panels accepted a moderate amount of risk. Given that some risky projects are likely to fail, an absence of projects with incremental or no scientific contribution in the high-risk categories of Q6 would arguably indicate a certain unwillingness of the ex-ante evaluation panels to take enough risk when making their funding recommendations.

High-risk/high-gain nature of projects

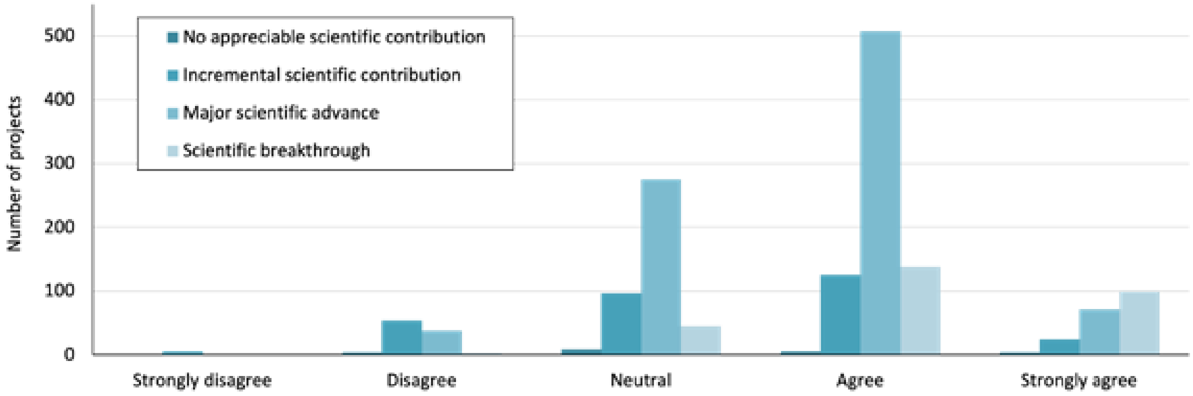
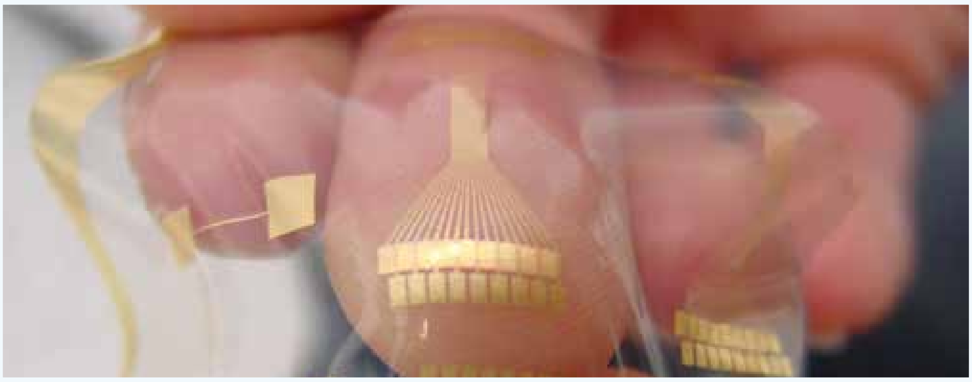


Figure 14: High-risk/high-gain nature of the projects (Q6).



© ESKIN. Medical Device Developments 2011

ESKIN: Stretchable Electronic Skins

The ESKIN project, led by Stephanie Lacour has made significant advances in materials engineering to create a viable interface between soft tissue and electronic sensors and implants. The project was very ambitious as soft tissue matched materials were not yet developed for electronic implants at the time. This high-risk project ended up with high-scientific gain and having a big impact on biomedical applications.

Principal investigator: Stephanie Lacour
Host institution: EPFL, Switzerland
Funding scheme: Starting Grant 2010

Impact beyond science

There is a positive correlation between the project score and their current (Q8) and future (Q9) economic and societal impact, especially for the expected impact (see Figure 15). Projects classified as A and B (major scientific advance or breakthroughs) tend to show a significant level of impact while projects classified as C (incremental contribution) centre around a lower level. Excellent research has therefore a societal and economic impact.

Project impact beyond science

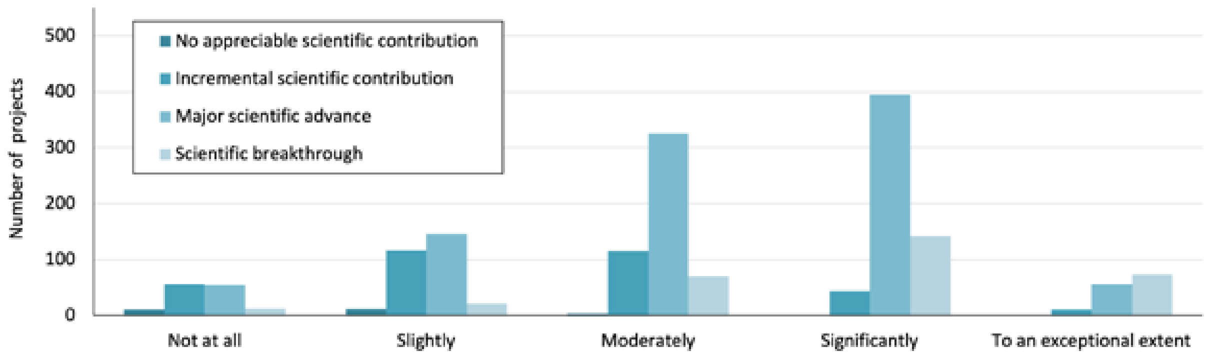


Figure 15: The future impact of the project beyond science (Q9).

High-risk research often opens up new research agendas

There is also a significant relationship between projects classified as high-risk/high-gain in Q6 and those that opened up new promising research agendas according to Q2 (see Figure 16).

Promising new reseach agenda and high risk/high gain nature of the projects

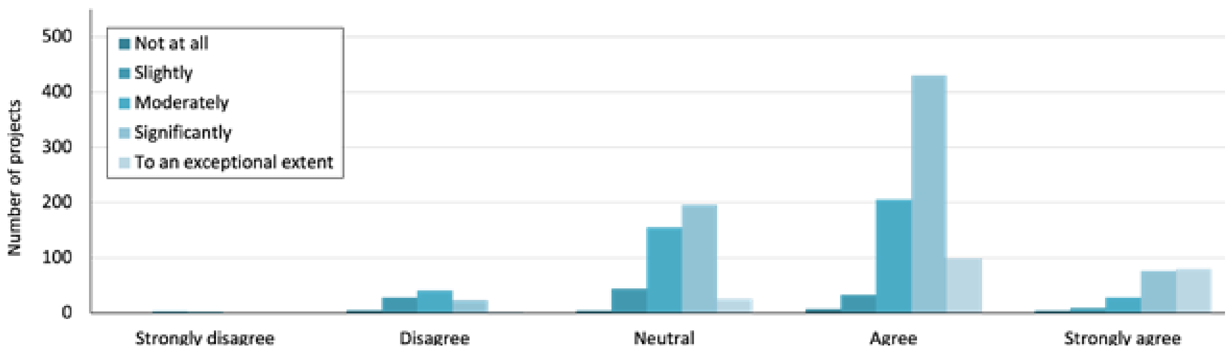
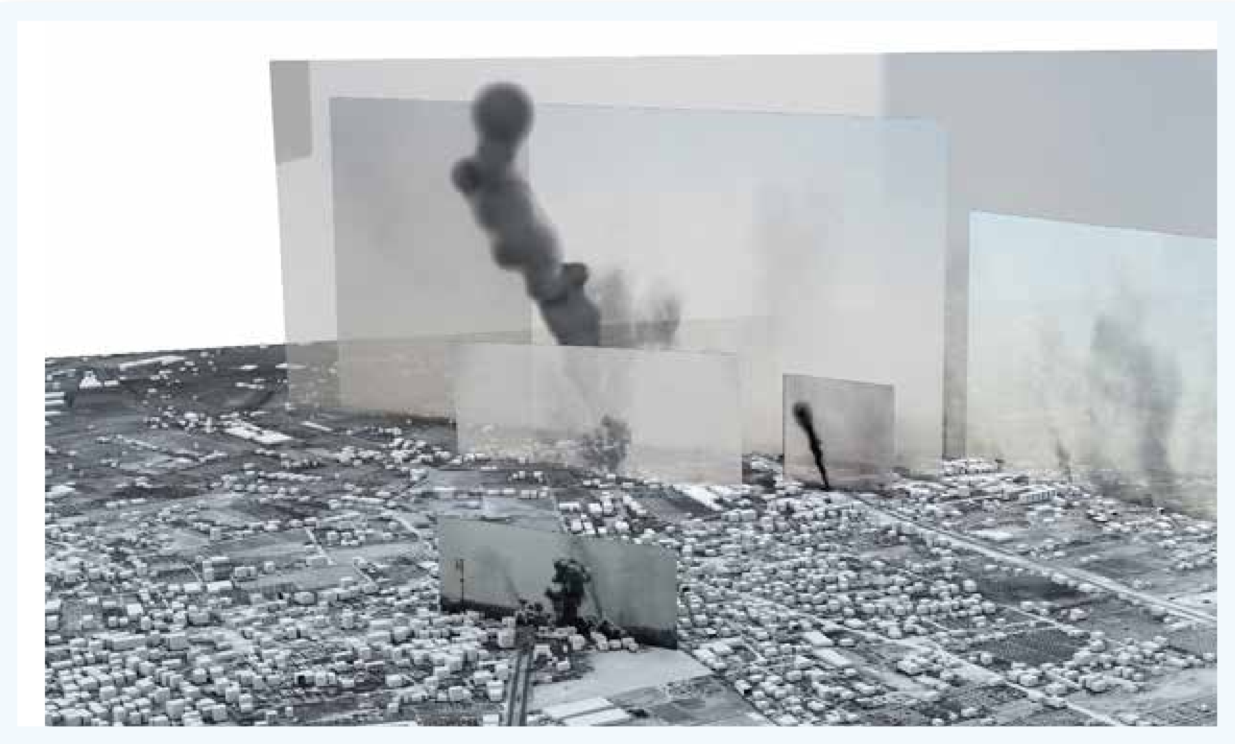


Figure 16. High-risk/high-gain nature of the projects (Q6) and promising new research agendas (Q2)



© Forensic architecture 2015

FASLW: Forensic architecture: The space of law in war

The FASLW project, led by Eyal Weizman, successfully embarked on a study of urban-built spaces as sites of violence and evidence of such. Adopting advanced digital modelling techniques, it facilitated the use of evidence in law courts and by NGOs and human rights organisations. This project has gained critical and international recognition and has been of great value to academics and activists.

'With FASLW it was possible to begin to expand, test and explore the fringes of this new theoretical framework, forensic architecture, in the rapidly changing social and technological conditions of the early 2010s. It enabled us to turn this series of small, connected research projects, roundtables and publications into a multidisciplinary team …, the foundation upon which the future success of forensic architecture developed.

[This ERC project helped us] to win awards across the arts, architecture, design, technology and journalism, to exhibit our work nearly 300 times, to publish over 100 investigations, and have an impact on legal processes in over a dozen countries and nearly every international jurisdiction.'

Principal investigator: Eyal Weizman
Host institution: Goldsmiths' College, United Kingdom
Funding scheme: Starting Grant 2010

With additional funding, the ERC could enable more equally excellent science

The number of ERC projects funded each year grew gradually in FP7 from nearly 300 in 2007 to 900 in 2013.

Figure 17 compares the number of projects funded each year and the percentage considered to be a breakthrough (A). The percentage of A-graded projects remains essentially stable throughout the years. The fluctuation in the early years may be attributed to the unique circumstances of the time as there was only one Starting Grant call in 2007 followed by an Advanced Grant call in 2008. The stable rate of A-graded projects could imply that the number of breakthroughs has grown proportionally to the number of grants awarded, with no signs of saturation. Therefore, it is reasonable to expect that an increase in the ERC's budget would continue to result in a higher number of highly successful projects.

Percentage of breakthroughs by funding year

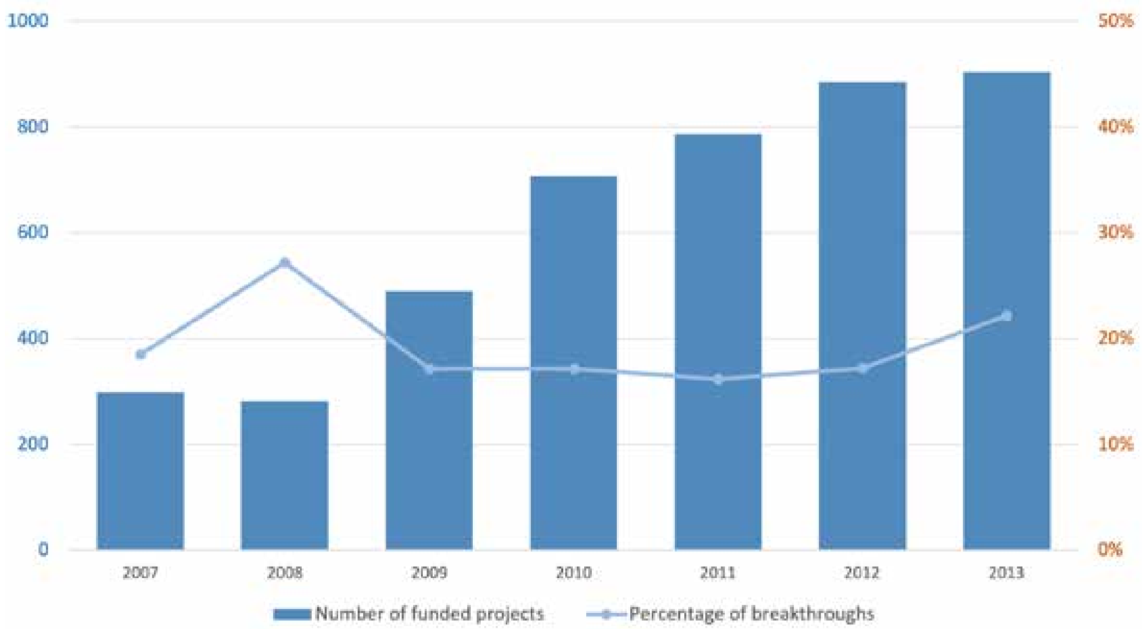


Figure 17: Funded projects per call year and percentage of breakthroughs.

What is a breakthrough?

In the SAP evaluation, the following definition of a breakthrough was provided to the independent evaluators:

> “*A breakthrough should represent revolutionary work that has led to a conceptually new paradigm, or to a rapid and profound change in widely accepted paradigms, or to findings or the development of tools that have swept through a field and led to entirely new modes of work and discovery.*”

See Chapter 2 for more insights on the methodology.

Excellence is widespread across European research organisations

It is interesting to analyse whether the percentage of breakthroughs is higher in institutions with a high number of ERC grants than in institutions with lower numbers of grants. For simplicity, they will be referred in this section as large and small institutions, respectively.

Table 4 shows the percentage of breakthroughs and grants for the 50, 100 and 150 largest institutions (orange) compared to the smaller institutions (blue). This information is mapped to the plot in Figure 18. Although the rate of breakthrough projects in large institutions was slightly higher, institutions receiving a lower number of grants also contribute with a significant number of breakthroughs.

Cut-off	Institution rank	%A	% grants
50	1 - 50	21%	48%
	51 – 430	17%	52%
100	1 - 100	20%	66%
	101 - 430	17%	34%
150	1 - 150	20%	76%
	151 - 430	16%	24%

Table 4: Rate of A projects in large and small institutions.

Breakthroughs (A) by the largest HI (number of grants awarded)

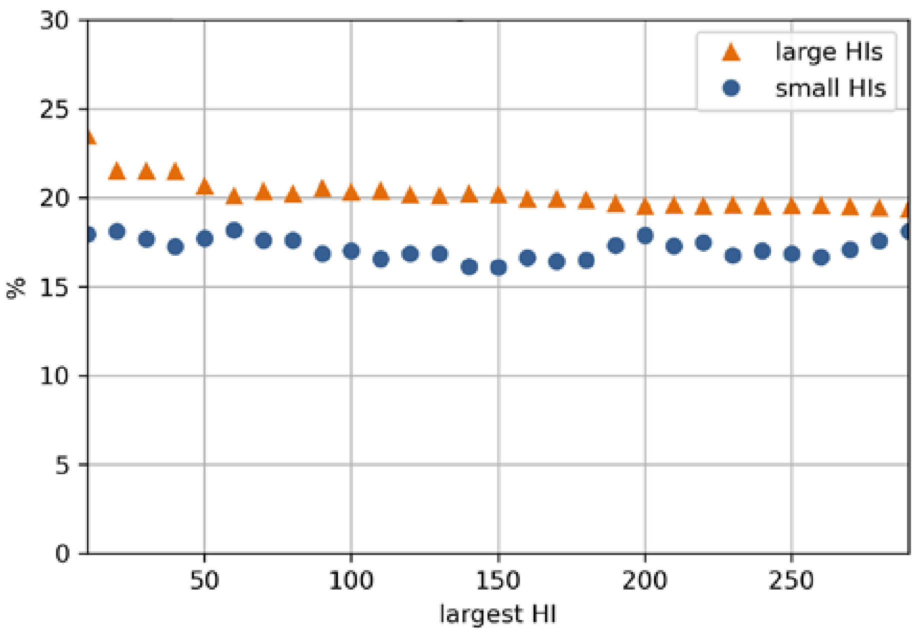


Figure 18: Rate of breakthroughs by institutions receiving a high number of ERC grants ('large' host institutions (HIs)) and by institutions not in that group ('small' HI, receiving low number of ERC grants).

Figures 19 and 20 present the percentage of excellent projects at the most successful host institution countries. The value at the top of each bar shows the number of funded projects. This number is low for some countries (especially if they only submitted few applications), therefore, in such cases, statistical uncertainties are larger. The results support the ERC's efforts to increase the participation of countries with lower numbers of grants through the visiting fellowship programme or the mentoring initiative[6].

Projects assessed as A per HI country

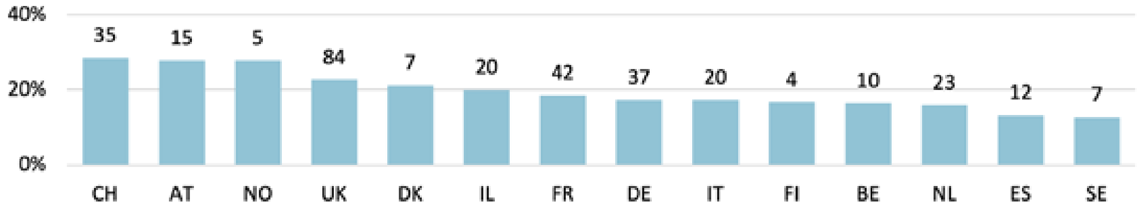


Figure 19: Percentage of A projects by the most successful host institution countries.

Projects assessed as A or B per HI country

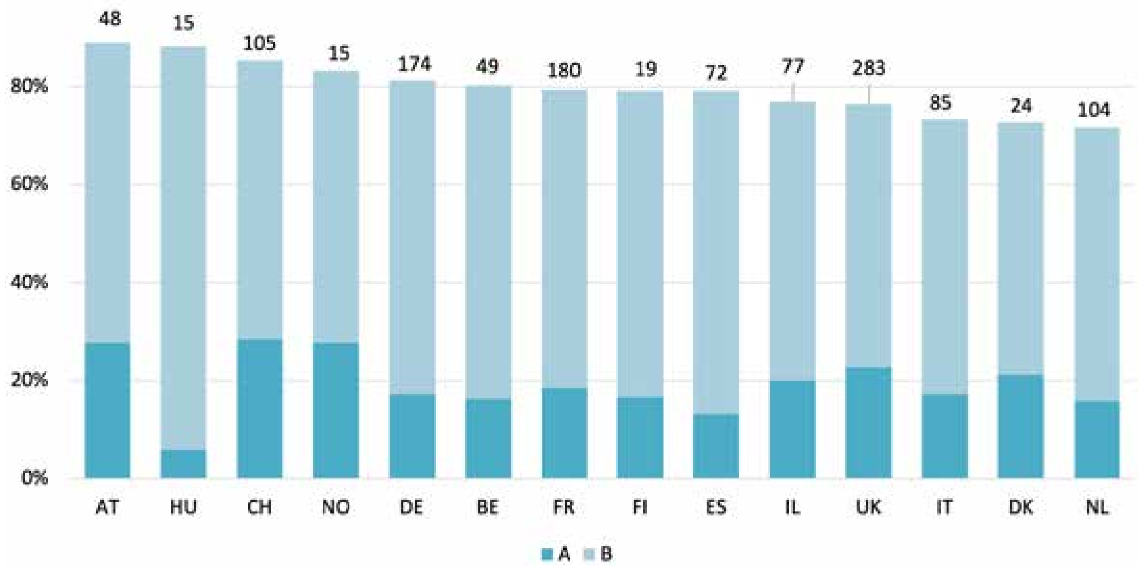


Figure 20: Percentage of A and B projects by the most successful host institution countries.

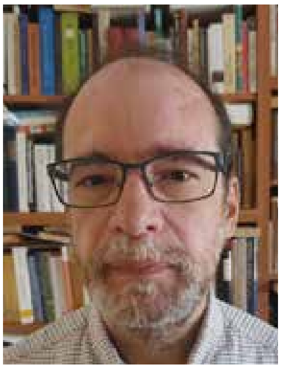
[6] https://erc.europa.eu/apply-grant/additional-opportunities

Widening European participation

The Scientific Council set up the Working Group on Widening European Participation to contribute to a truly inclusive European culture of competitiveness in science by increasing the participation of researchers in ERC calls from Europe's regions that do not perform as well in research.

The results of the SAP evaluation reveal that host institutions with lower levels of participation are significantly contributing to excellence. This finding underscores that investing in widening activities can indeed 'pay off' in bolstering excellence. In this respect, the ERC Scientific Council launched two initiatives, the visiting fellowship programme and the mentoring initiative. They are designed to increase participation and enhance the impact across all European countries, thus highlighting the potential for broader inclusion to drive higher levels of achievement.

Alice Valkárová, Chair of the Working Group on Widening European Participation



Negotiating Modernity: History of Modern Political Thought in East-Central Europe

This project was led by Balázs Trencsényi. It carried out a transnational and comparative analysis of archival material and written texts on the construction of European Modernity, demonstrating the contribution of modern political thought from Central and Eastern Europe.

Principal investigator: Balázs Trencsényin
Host institution: Centre for Advanced Study Sofia, Bulgaria
Funding scheme: Starting Grant 2007

LTDBud: Low Dimensional Topology in Budapest

Led by András Stipsicz, the project produced remarkable results in topology, solving long-standing conjectures and developing new methodologies. It had a very positive effect on nurturing talent in Hungary and abroad. The successful postdoctoral programme allowed the principal investigator to build a dynamic topological research environment in Budapest. The research monograph on the combinatorial Heegard-Floer theory has become a standard resource and been instrumental in bringing new generations of talented researchers to this vibrant and fascinating field.

'I had the opportunity to build a team of fellow topologists to share ideas and try methods I would not have been able to do by myself. … This led to some of my best publications. … I would not have been able to devote my entire time to carry on these avenues of research, and I could not build the supporting and motivating environment without the help of the grant'.

Principal investigator: András Stipsicz
Host institution: Alfréd Rényi Institute of Mathematics, Hungary
Funding scheme: Advanced Grant 2011

Breakthroughs from different angles

Figure 21 presents the distribution of breakthroughs by domain, call type and gender.

By call type, the number of breakthroughs by scholars with Advanced Grants (AdG) is higher than those with Starting Grants (StG), a small difference which is statistically significant.

By scientific domain, Life Sciences (LS) projects entail a higher share of breakthroughs than those in Social Sciences and Humanities (SH), which is statistically significant, with the share in Physical Sciences and Engineering (PE) in between.

Figure 21 also shows that the share of breakthroughs does not differ significantly by gender. The higher variability in the results for female researchers likely reflects their lower numbers (only 20% of the evaluated projects in FP7 were led by a female researcher).

Breakthroughs (A) by domain, call type and gender

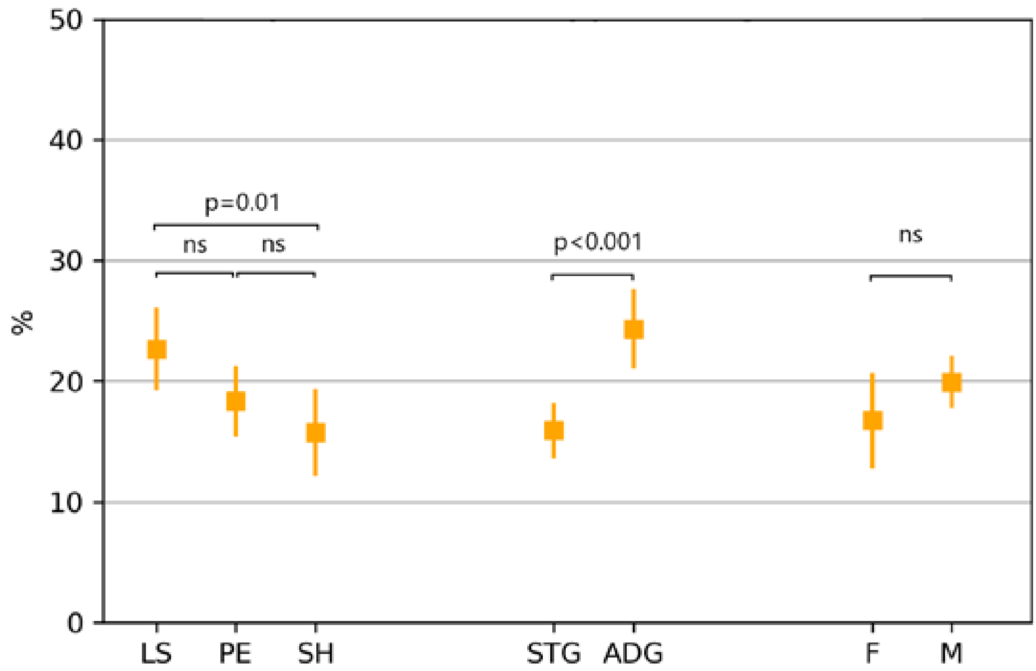


Figure 21: Percentage of A projects by domain, call type and gender.

SWAB: Shadows of Slavery in West Africa and Beyond. A Historical Anthropology

Led by Alice Bellagamba, the project compared different configurations of slavery in regions of Africa, Asia and Europe in the second half of the 19th century and the first half of the 20th century. The combination of ethnographical and archival work made it possible for the project to combine interregional comparison with attention to the complexity of individual lives and people's accounts of themselves, their past and their future. It has provided pathways for reflection on how Europe can confront its colonial past and the integration of multicultural and diverse backgrounds into its current society.

'SWAB expanded my international network and created the context to collaborate with important NGOs and organisations engaged, either in Africa or in Italy, in the struggle against poverty, labour exploitation and human trafficking. When the grant ended, further research engagements and projects blossomed. … In an age that increasingly entrusts the meaning of being human to statistical data and algorithms, 'Shadows of Slavery' has been exemplary of the contribution that qualitative, relational and above all patient research have in building up a future of mutual understanding across geographies and histories.'

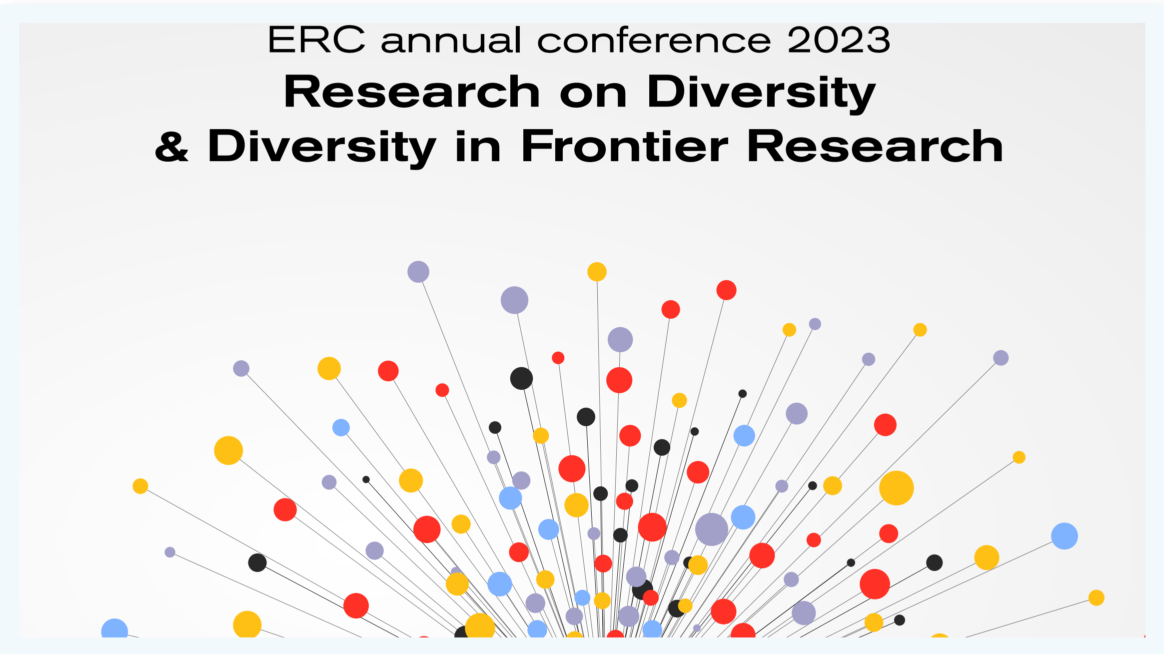
Principal investigator: Alice Bellagamba
Host institution: University of Milano-Bicocca, Italy
Funding scheme: Starting Grant 2012

Gender and diversity

Each process within the ERC is designed to give equal opportunities to everyone, regardless of gender. To monitor gender balance in ERC calls, the Working Group on Gender was set up in 2008 and extended in 2021 to Gender and Diversity with the scope to cover wider diversity issues. This is to ensure that the ERC promotes equality and prevents any form of discrimination in its structures and operations, in line with Article 21 of the EU Charter of Fundamental Rights.

“*The journey ahead to fully address gender inequality and diversity in scientific research remains significant. The Working Group on Gender and Diversity is committed to continuously monitor gender and diversity and to promote elimination of all forms of discrimination within the ERC's structures and operations.*

Geneviève Almouzni, Chair of the Working Group on Gender and Diversity”



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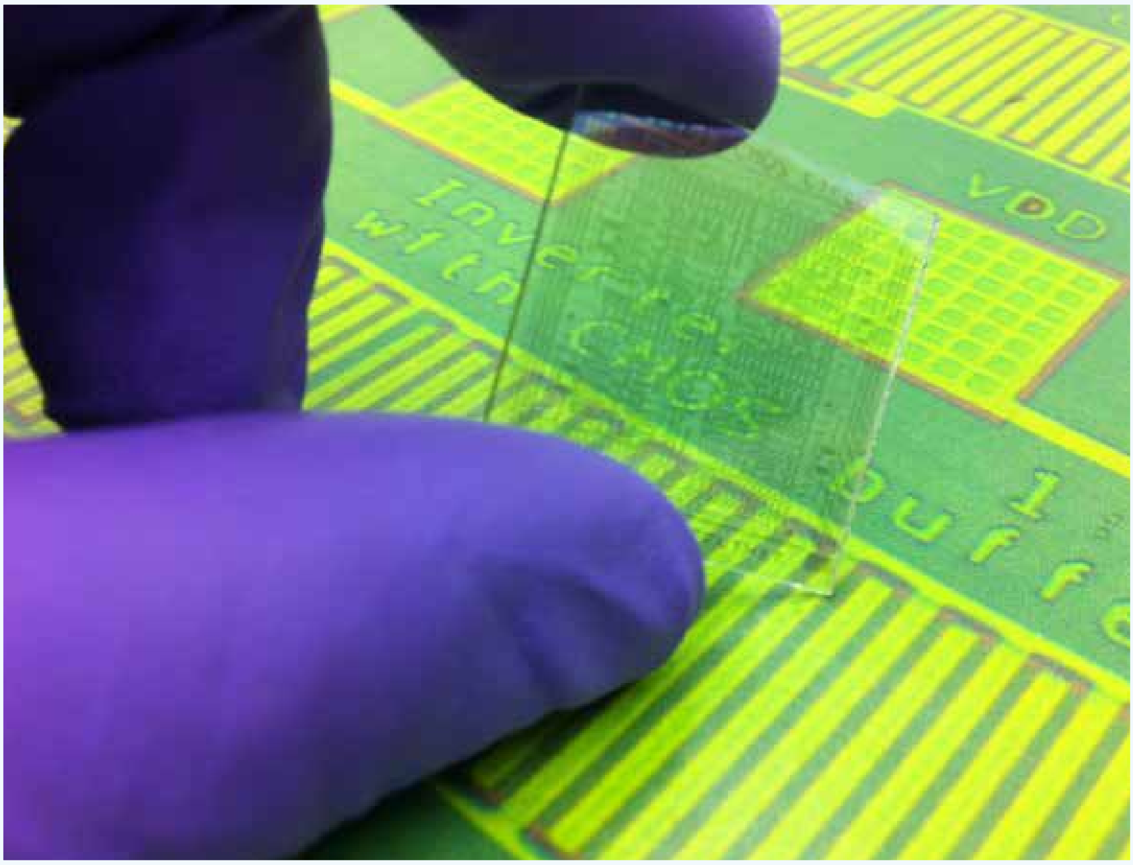


© Pedro Barquinha

INVISIBLE: Advanced Amorphous Multicomponent Oxides for Transparent Electronics

Led by Elvira Fortunato, this project developed a new class of electronic components to fabricate a novel generation of fully transparent electronic devices and circuits (using rigid or flexible substrates). This project had a significant impact on the development of industrial applications.

'More than 20 years ago, the notion of fully transparent, flexible and conformable displays was pure science fiction, like those used in the movie, Minority Report. Thanks to Hollywood's vision and the hard work of scientists, it became a reality just a few years later.

The ERC grant was very important to my scientific career as I consolidated a new area with international recognition. This project has also helped to put Portugal on the science map and has given visibility to the role of women in science.'

Principal investigator: Elvira Fortunato
Host institution: NOVA School of Science and Technology, Portugal
Funding scheme: Advanced Grant 2008

María Blasco with Mercedes Gallardo (CNIO). © AMIT

TEL STEM CELL: From telomere chromation to stem cell biology

This project, led by María Blasco, had a great impact on the fields of ageing and cancer. This study demonstrates that ageing in mice relates to telomere length: extending telomere length extends lifespans, indicating that short telomeres limit lifespans. These results are potentially important for the future development of stem cell based therapies.

'TEL STEM CELL was crucial to advance the work of my laboratory on the role of telomeres and the telomere-binding proteins (shelterins), as well the role of telomerase, in stemness and pluripotency. This served to establish important concepts in telomere biology.'

Principal investigator: María A. Blasco
Host institution: Spanish National Cancer Research Centre, Spain
Funding scheme: Advanced Grant 2008

4.3. Reasons for low performance

Nearly 20% of projects were assessed as incremental (C) or not having an appreciable scientific contribution (D). Limited impact on the field was often given as the main reason to classify a project as C or D. The evaluators acknowledged that, with time, some of these projects may have a bigger impact. For example, projects generating large amounts of data, such as archaeological or astronomical observations, may require longer periods for their value to come to light.

Evaluators were asked to identify the main reasons for the weaker scientific results by selecting one or more causes from a list. As shown in Figure 22, the reason identified the most often, beyond the generic *general underperformance*, was that the project was overambitious. The most common explanations provided by the evaluators for underperformance are summarised below.

Reasons for the lower level or results produced by the projects classified as C or D

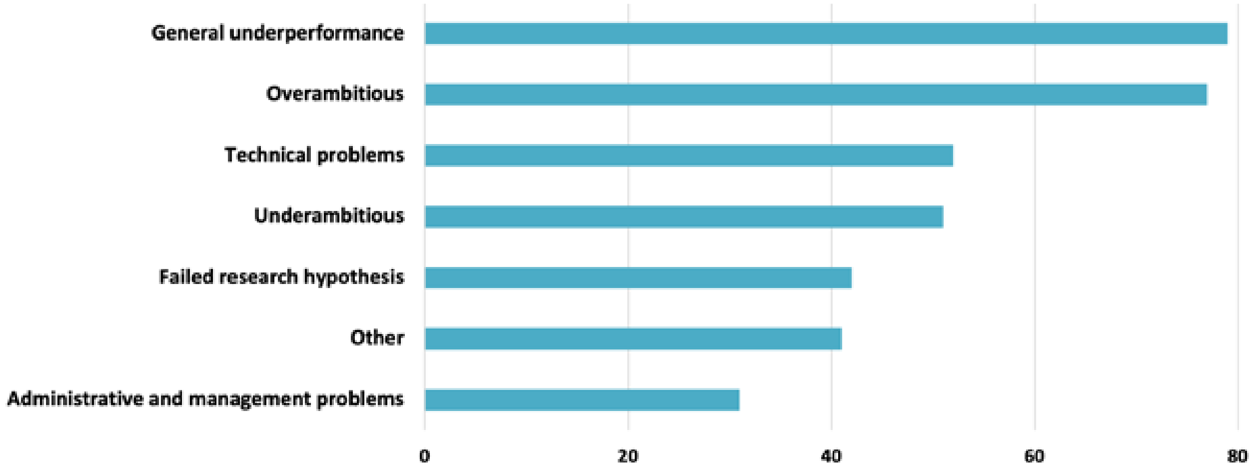


Figure 22: Reasons found for delivering weak scientific results or low impact in projects classified as C or D.

Overambition

This reason was chosen for projects that underestimated the complexity of the approach, the challenges in the construction of new instruments, the difficulties in gathering and analysing data, or the time and resources required to execute critical work packages. In some cases, the project was described by ex post evaluators as overambitious or unrealistic, even at the time of applying for the grant. Explanations for failure in achieving project goals include:

- targets were too wide, project was not focused or only some of the too many objectives were achieved;
- the research group was too small to carry out the proposed work;
- the methodology was not robust enough to address the objectives;
- the project followed conventional paths instead of testing new methods;
- the time frame was too short;
- the objectives were too challenging for a starting grantee;
- the risks greatly exceeded the gains;
- high interdisciplinarity required multiple principal investigators with complementary backgrounds;
- insufficient assessment of risks.

Underambition

Projects marked as underambitious failed to address the most challenging objectives in the proposal or applied conventional techniques instead of exploring new methodologies set out in the original work plan. Some projects were executed correctly and produced adequate results, but the groundbreaking factor was intrinsically missing in the application. Reasons for under ambition include:

- the investigator was satisfied with the partial results already obtained and did not address more interesting objectives;
- a narrow scope of outcomes and lack of generalisation;
- weak intellectual coordination;
- a focus on less risky objectives.

Failed research hypotheses

The inherent risk of frontier research increases the probability that some projects do not reach their main objectives. In C and D projects facing this difficulty, the research teams were not able to find alternative approaches to replace the original hypothesis and therefore only secondary objectives were achieved. Evaluators suggested that the work plan of high-risk projects should ideally incorporate the early pre-validation of critical methods and describe contingency measures if the main hypothesis is rejected. Some evaluators stated that the review process for ERC proposals should have detected some of the cases where the initial hypothesis was not robust enough. Additional explanations include:

- the theoretical framework was immature or not powerful enough, and either alternative approaches were not considered or reaction to failure was too slow;
- the team was unable to collect enough data to start or validate the research;
- the investigator was involved in other projects at the same time;
- although optimism was shared by other research groups, the objective was later revealed to be more difficult than expected.

Technical problems

Technical obstacles sometimes did not affect the main hypothesis but rather the execution of one or several steps in the work plan. For example, some researchers faced unexpected constraints in gathering input data due to the lack of precision in their measurement tools. Such situations could have been mitigated by using data from other research groups in the investigation. In other cases, the researchers faced excessive delays and technical challenges due to current technology constraints when building the necessary tools outlined in the proposal. Evaluators identified several issues in this context:

- the data sample collection took longer than expected;
- delays in producing technical components (such as a chip);
- difficulties in moving the lab to a new host institution;
- excessive dependence on expertise provided by collaborators or data quality provided by external labs;
- unexpected costs or challenges (risks) in the proposal;
- recent advances in the field made the project approach obsolete;
- grantees failed to find or design suitable mathematical methods;
- testing was not possible in the time frame of the project.

Administrative and management problems

Projects often experienced difficulties in recruiting or holding on to key team members. In other cases, the investigators faced:

- obstacles in moving to another host institution or to new facilities;
- problems in acquiring equipment;
- difficulties in recruiting patients for medical studies;
- collaboration with external research groups that was hindered by linguistic or cultural communication problems;
- external factors (illness, impact of COVID, war impeding field work).

General underperformance

In some cases, evaluators identified several reasons for the low performance of a project. For example, the proposed research hypothesis could not be confirmed, and the grantee faced technical challenges. In some cases, the research team lacked resources or expertise, there were important flaws in the methodology, or the interesting methods created were not explored in depth by the team. Poor decisions by the principal investigator have been frequently identified by the evaluators as the main reason for general underperformance.

Low performance projects from different angles

As Figure 23 illustrates, marginally more low-performance grants were found among the StG than the AdG. By scientific domain, a larger share of SH grant holders received a low-performance score than among PE and LS grant holders. By gender, a marginally larger share of low-performance projects was directed by females than by men.

Low performance projects by domain, call type and gender

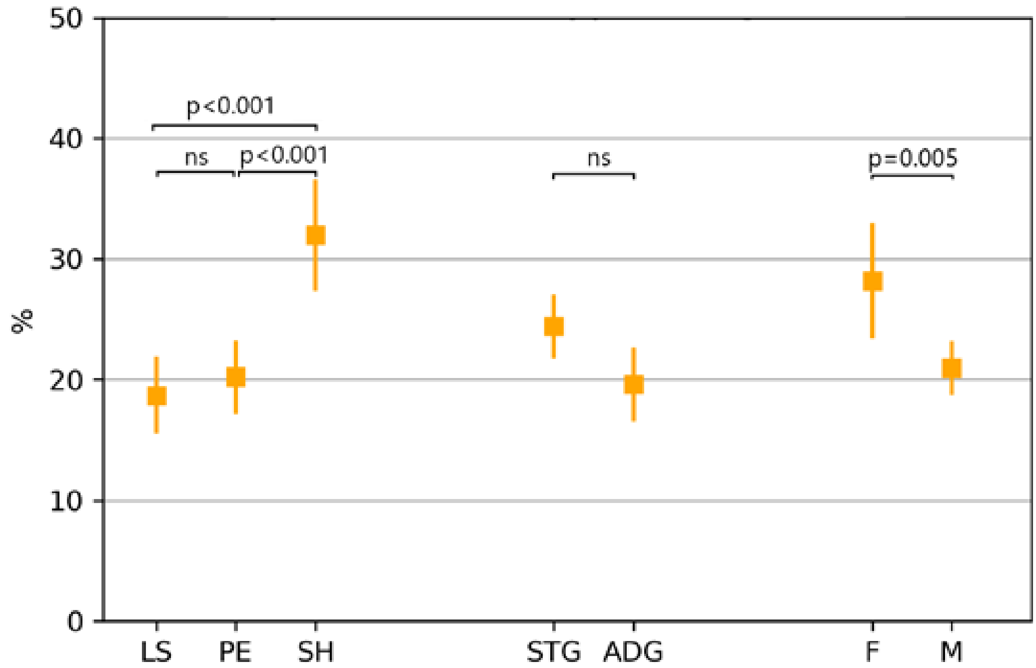


Figure 23: Low performance projects by domain, call type and gender.

Figure 24 shows that the differences across categories in the share of projects that the evaluators classified as high-risk/high-gain were generally small.

Q6 (High Risk - High Gain by domain, call type and gender

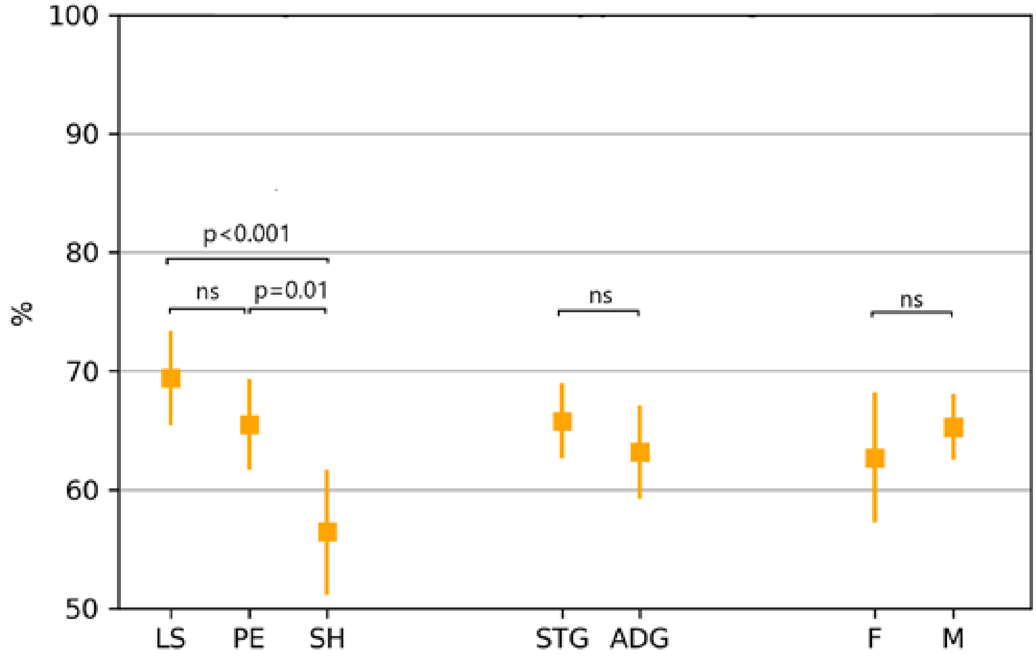
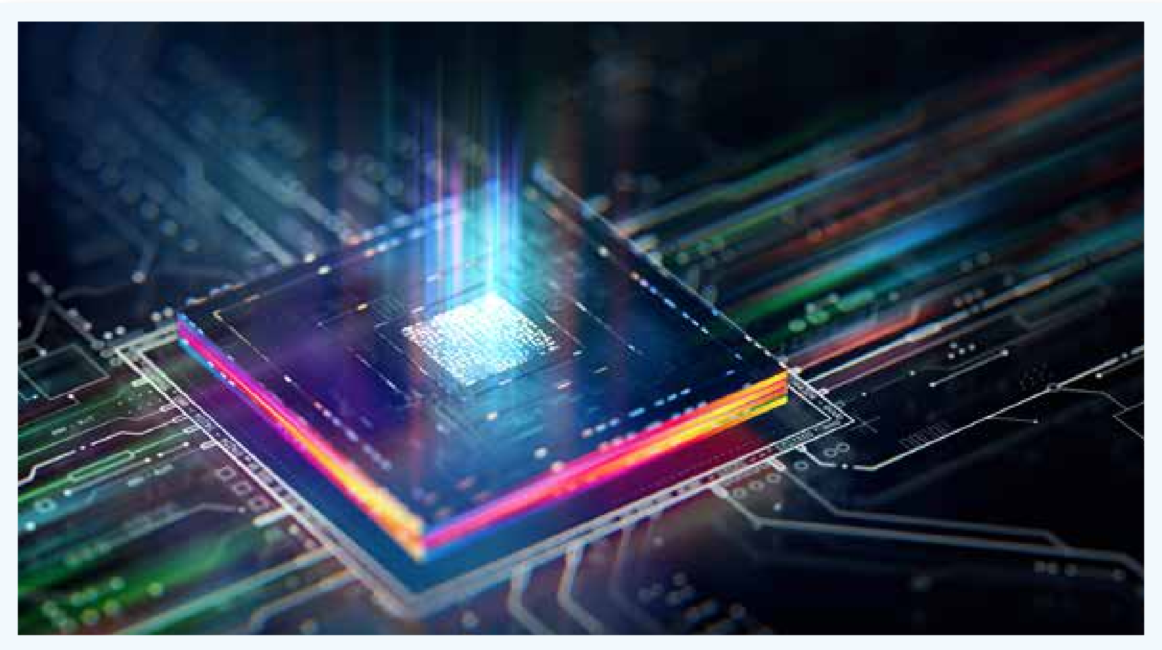


Figure 24: Percentage of high-risk/high-gain projects by domain, call type and gender.



Chapter five

Breakthroughs by research area

Projects with breakthroughs were identified in a wide variety of scientific disciplines. The main scientific areas under which such projects were classified are described below. This is not an exhaustive and complete analysis of all the breakthroughs achieved in FP7 as it is based on the subset assessed.

5.1. Physical sciences and engineering

Mathematics

Breakthroughs spanned pure mathematics, applied mathematics, mathematical foundations of computer science, mathematical physics and statistics, creating new connections across fields.

Fundamental constituents of matter

Most breakthroughs started in the field of low-energy experimental physics, with some projects also having a strong theoretical component. These projects combined topics on quantum information science, many-body physics, quantum optics and ultra-cold gases.

Condensed matter in physics

Breakthroughs occurred predominantly in the fields of quantum technologies, nanoscience and advanced materials. Key innovations included the development of unique lasers, exploration of quantum entanglement in semiconductor dots and advancements in topological materials.

Physical and analytical chemical sciences

Breakthroughs took place in biomedical applications, molecular and chemical sciences, and advanced microscopy techniques. Significant developments were achieved in the use of metal-organic frameworks in biomedicine, advancements in simulation for energy savings, and novel methods in near-field scanning-probe optical microscopes.

Synthetic chemistry and materials

Breakthroughs ranged from the activation of inert molecules, the design of diverse catalysts and/or tools for biology to the preparation of materials with many applications.

Computer science and informatics

Breakthroughs were mostly identified in the fields of computer vision, software engineering, computer security and quantum cryptography.

Systems and communication engineering

Significant developments in new research methods and instruments were made in areas such as optoelectronics, electronics and neuromorphic architectures.

Products and process engineering

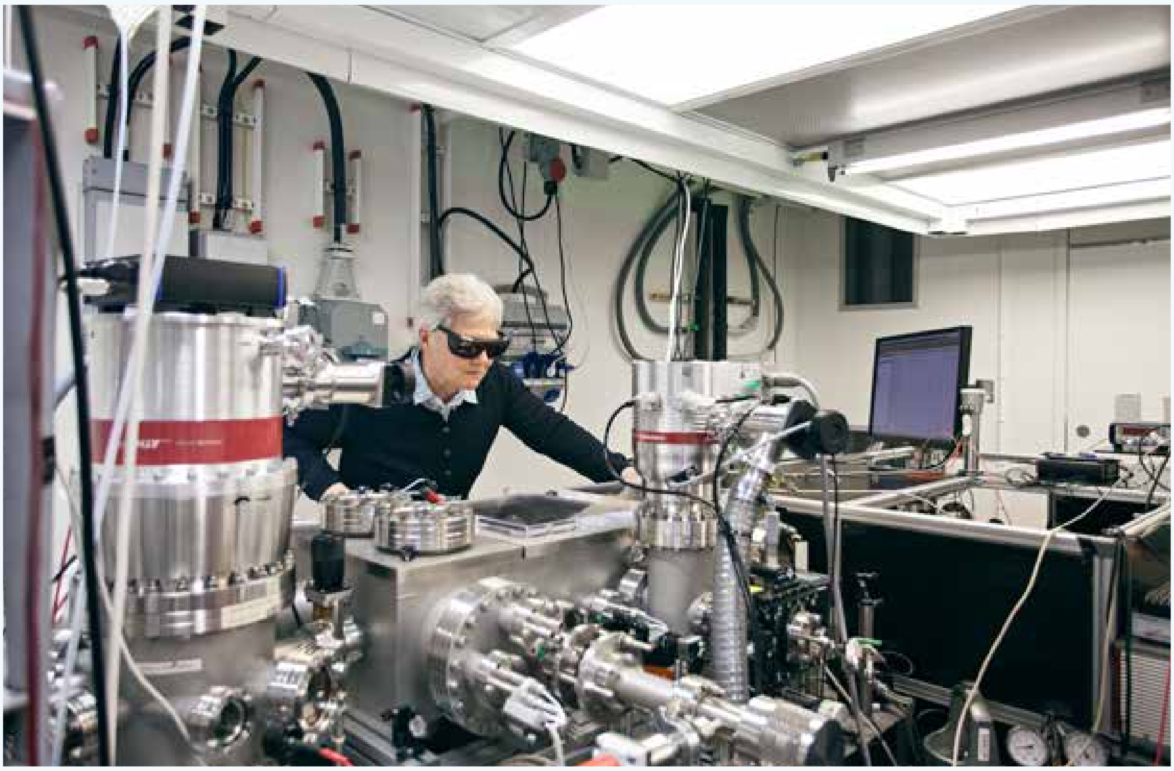
Breakthroughs occurred in physical chemistry, flow chemistry, microreactor technology, flow measurement and unsteady aerodynamics, materials science, tribology, micro-mechanics and robotics.

Universe sciences

Breakthroughs took place in various fields, including the study of galaxy evolution, time-domain astronomy, asteroseismology and high-energy astrophysics. New methods and models were developed, among other things, to discover new stars and planetary systems, better understand supernova explosions and the interior of massive stars and identify black holes.

Earth system science

Breakthroughs ranged from deep mantle geochemistry to earthquake physics, evolution of marine ecosystems and atmospheric chemistry during Anthropocene climate change.



© European Research Council

ALMA: Attosecond Control of Light and Matter

The ALMA project, led by Anne L'Huiller, has made highly significant contributions to the field of attosecond science. In 2023, she won the Nobel Prize in Physics for 'experimental methods that generate attosecond pulses of light for the study of electron dynamics in matter'.

'The European Research Council has provided great support for my research for 15 years! It has allowed me to build a research group and purchase the necessary laboratory equipment, with excellent conditions for my research in attosecond science! The possibility to explore innovative ideas and advance them towards a proof of concept has also been useful.'

Principal investigator: Anne L'Huillier
Host institution: Lund University, Sweden
Funding scheme: Advanced Grant 2008

Life sciences

5.2. Life sciences

Molecular and structural biology and biochemistry

Breakthroughs took place in the fields of molecular biology, biochemistry, structural biology and biophysics. There were also breakthroughs in the mechanistic understanding of the functioning and interactions of nucleic acids and proteins.

Genetics, genomics, bioinformatics and systems biology

Research in this area led to breakthroughs in the fields of proteomics, single molecule transcript imaging in single cells and computational models for predicting gene expression. There were also breakthroughs in plant biology and plant genome evolution.

Cellular and developmental biology

Breakthroughs were made in classical cell biology and development, mechanobiology, regeneration, organoids development, evolutionary developmental biology, stem cells and cancer biology.

Physiology, pathophysiology and endocrinology

Breakthroughs occurred in ageing, cancer, metabolism and cardiovascular diseases.

Neurosciences and neural disorders

Breakthroughs took place in innovative imaging and computational methods, which are needed to understand the brain circuits performing computations.

Immunity and infection

Breakthroughs dealt with different steps of viral infection, the host factors involved and the use of this knowledge to prevent disease. There were also breakthroughs in the fine-tune characterisation of different immune cell types and signalling pathways in health and disease.

Diagnostic tools, therapies and public health

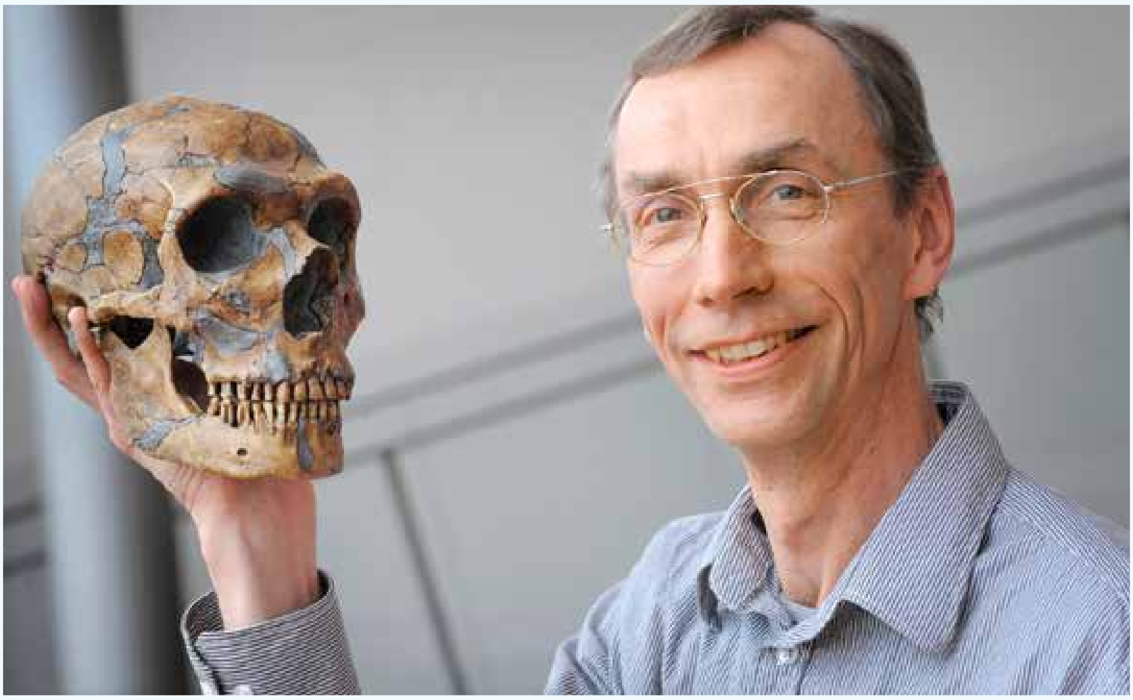
Breakthroughs were made in the fields of tissue engineering, pharmacology, imaging for basic and medical research and gene and cell therapy.

Evolutionary, population and environmental biology

There were breakthroughs in the fields of evolutionary biology, population biology, microbial ecology and evolution, theoretical ecology, life history and behavioural ecology.

Applied life sciences and non-medical biotechnology

Breakthroughs were made in fields such as synthetic biology, protein production, genetic engineering, genome editing, biocomputing, plant breeding, plant secondary metabolism, biomimetics, ecotoxicology and microbiology. Several of the breakthrough projects have implemented extended applications of the CRISPR-Cas9 genome editing technology.



© Frank Vinken/AFP

TWOPAN: Genomic and Phenotypic Evolution of Bonobos, Chimpanzees and Humans

The TWOPAN project, led by Svante Pääbo, investigated the genomic and phenotypic evolution of bonobos, chimpanzees and humans. The bonobo genome was sequenced, and complementary genomics datasets were created for comparisons with humans and chimpanzees.

Svante Pääbo won the 2022 Nobel Prize in Medicine for his 'discoveries concerning the genomes of extinct hominins and human evolution'.

'The ERC's support for curiosity-driven research is essential for the European research ecosystem that generates new insights, new products and new therapies. It has allowed our research group to pursue new projects for over a decade.'

Principal investigator: Svante Pääbo
Host institution: Max Planck Institute, Germany
Funding scheme: Advanced Grant 2008

5.3. Social sciences and humanities

Individuals, institutions and markets

Breakthroughs were made in the fields of financial economics, macroeconomics and economic growth, labour economics, consumer behaviour and economic inequality.

Institutions, values, beliefs and behaviour

Breakthroughs contributed to a better understanding of peace resolution, the welfare state, the division of labour and a new architecture of regulatory governance.

Environment, space and population

Breakthrough projects were predominantly empirical and provided new understanding on complex social phenomena, such as global migration, the link between environmental exposure and health inequalities, the role of the gene-environment interaction on fertility and fertility patterns across countries and regions.

The human mind and its complexity

Breakthroughs were mostly achieved in the fields of clinical and health psychology, cognitive basis of human development, cognitive processes and consciousness, theoretical and computational linguistics, and philosophy of mind, science and epistemology.

Cultures and cultural production

Breakthroughs took place mostly in historical and cultural studies, with perspectives ranging from visual media and architecture to literature and music. These focused on different periods such as the Middle Age, the 19th century Victorian era, and the 20th and 21st century.

The study of the human past

Breakthroughs were mainly made in archaeology, history and cultural evolution, with a special attention to human origins, the Neolithic period and the rise of urban society.

© World Inequality Lab

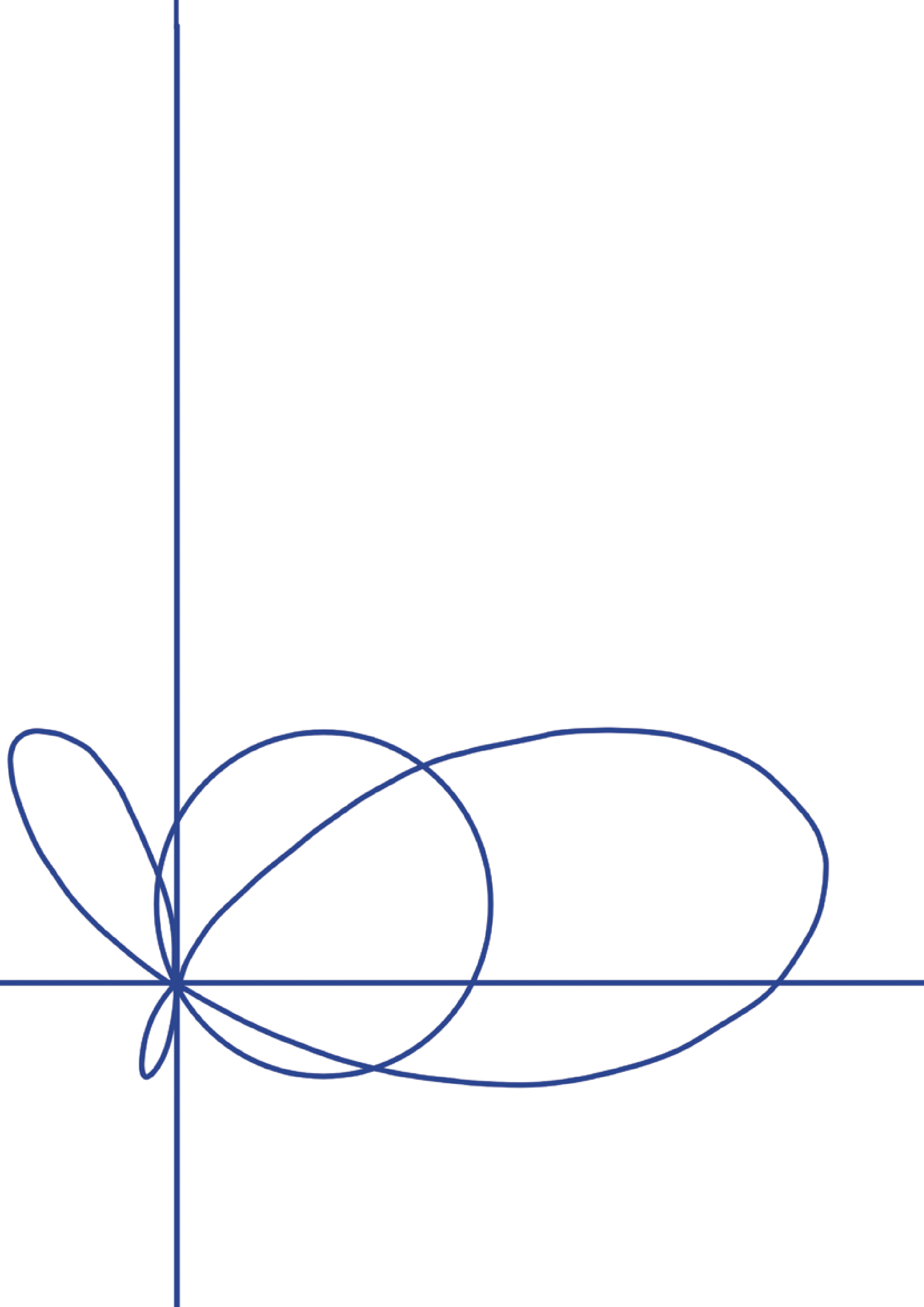
DRIWGHP: The Distribution and Redistribution of Income and Wealth: A Global and Historical Perspective

The DRIWGHP project, led by Thomas Piketty, created the World Inequality Database (WID), a publicly available database on the historical evolution of the world's income and wealth distribution. This has expanded previous data collections by including data on wealth distribution in addition to income distribution and greatly expanding country coverage.

The WID has become an essential resource for researchers, policymakers, institutions and anyone interested in inequality trends. It has also made a major contribution to the reports of international organisations, such as the OECD and the UN.

'This ERC grant played an enormous role in […] my academic research. Most importantly, it paved the way for the development of the World Inequality Lab and the World Inequality Database, … offering the largest available database on the historical evolution of the distribution of income and wealth, both within and between countries.'

Principal investigator: Thomas Piketty
Host institution: Paris School of Economics, France
Funding scheme: Advanced Grant 2013



Chapter six

Conclusions

The ERC scientific assessment of completed projects (SAP) was developed in the early years of the ERC and has screened 40% of all grants funded under FP7 through a unique ex post evaluation system, running from 2015 to 2022. Annually, and starting 2 years after the completion of the scientific project in the sample, peer-review evaluation panels assessed the scientific quality and impact of the projects. The panels gave insights into the effectiveness of the ERC proposal evaluation, the success of individual grants and the methodology for ex post evaluation of frontier research.

The overall conclusion supports the claim that the ERC has been funding scientific and scholar excellence and that the programme has used the significantly increased budget over the years without any evidence of reduced quality of the projects funded (see conclusions 1 and 2 below). The assessment also highlights some areas of attention for the current and future ERC research funding programmes.

The main conclusions of this report are summarised below.

1 Almost 80% of ERC projects assessed achieved scientific excellence

The evaluators reported that 20% of the projects made scientific breakthroughs, and 58% produced major scientific advances. Only 20% were found to have produced only incremental or no appreciable scientific advances.

2 Excellent frontier research funded by the ERC is only limited by the available budget

The number of projects delivering breakthrough results grew proportionally to the increase in the ERC funding budget. There are therefore no signs of saturation in the amount of excellent science that can be funded by the ERC programmes.

3 A majority of ERC projects are interdisciplinary

The projects funded by the ERC are of a strong interdisciplinary nature. About 60% either produced results that were applicable in other areas (beyond the project main goals) or brought together research fields that had previously seen little interaction.

4 Interdisciplinarity and scientific breakthroughs are correlated

The generous ERC funding made the creation of interdisciplinary research teams possible, and interdisciplinary projects were more likely to lead to major scientific advances and breakthroughs.

5 Excellence is widespread across European research organisations

Institutions with a low number of ERC grants make a significant contribution to excellent scientific results, only slightly below that of well-established research institutions. This finding supports strengthening existing ERC programmes that promote grant applications from regions with low levels of participation (the visiting fellowship programme and the mentoring initiative).

6 Frontier research must take risks

High-risk/high-gain projects are more likely to produce scientific breakthroughs. About 65% of the projects were identified by evaluators as high-risk/high-gain research.

7 Strategies to mitigate risks and maximise gains have been identified

The evaluators recommended that applicants mitigate the risk components in their proposals by adopting strategies such as validating the critical hypothesis early on, including contingency plans for potential weaknesses identified in the methodology, and designing robust back-up plans where there are high dependencies between work packages.

8 ERC-funded frontier research has a big impact beyond science

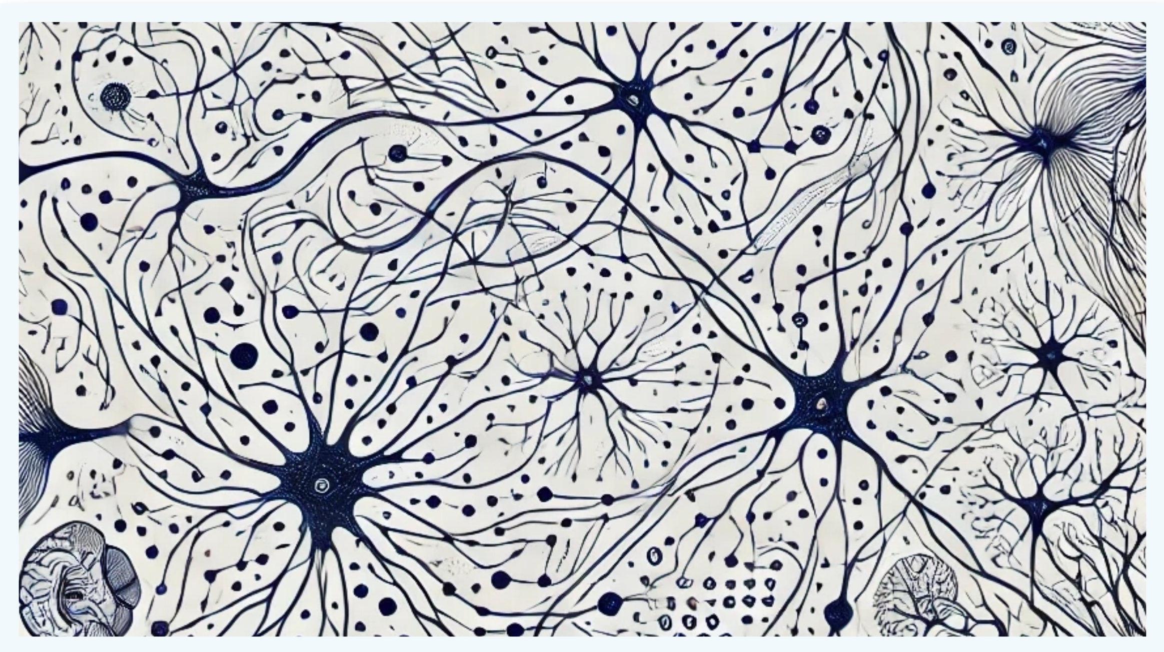
Almost half of the evaluated projects had already (at the time they ended) had an impact beyond new scientific knowledge by influencing industry, the economy, society and policymaking.

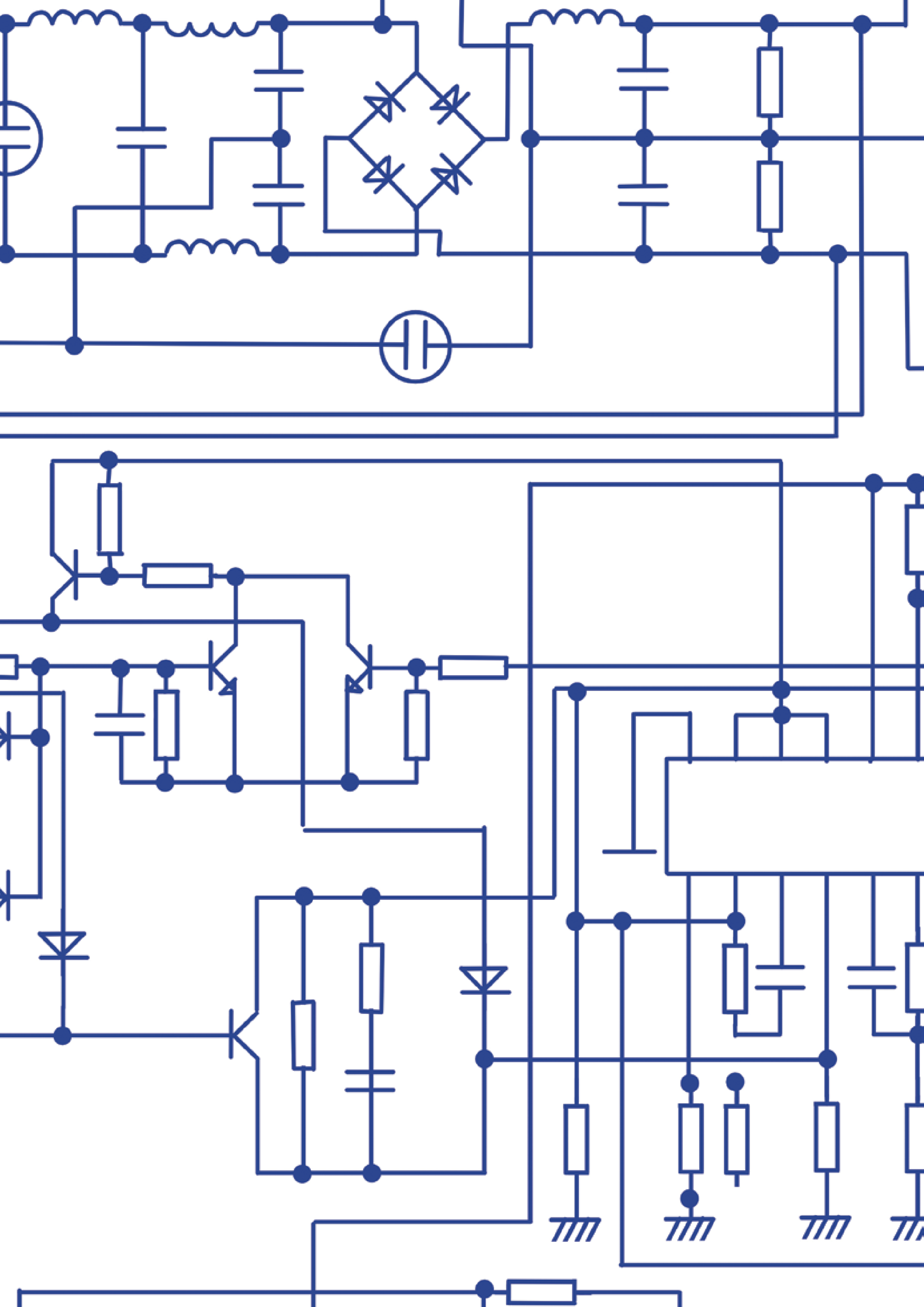
9 The ERC also funds applied research with industrial and commercial value

Commercial products created by ERC-funded projects include medical devices, innovative technologies to generate sustainable energy or food, and models for the early detection of natural disasters. Such products came to light through industrial collaboration or the creation of start-ups, often supported by ERC Proof of Concept grants.

10 Results from frontier research are informing policies

ERC-funded projects have influenced international debates on social and economic inequality, immigration's impact on job markets, food poverty, fertility trends and climate change. They have also had an impact on major policymaking institutions by creating knowledge on topics such as the financial crises, economic bubbles, regulation policies, payment cards and the social impact of economic depression.





Chapter seven

Annexes

Annex I: Evaluation questionnaire

1. To what extent has the project resulted in new important scientific advances of knowledge?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent

2. Have the project findings opened a promising new research agenda (i.e. a set of new research questions, new hypotheses to be tested) or a possible paradigm shift?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent

Q1 and Q2 focus on the scientific impact of the project of which two aspects are assessed. In Q1, evaluators express their opinion on the advances made in the field of research due to the results obtained in the project. In Q2, evaluators assess if the research results have opened up a new research agenda or a paradigm shift that others are taking up. These can be important new research questions or hypotheses that have led to entirely new ways to work in the field. In these two questions, the field can be well established, emerging or interdisciplinary.

3. Has the project developed new research methods or instruments?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent

Q3 focuses on the generation or development of new research methods or instruments in the project. In some projects, creating research methods or instruments can be either an intended goal of the project or a valuable by-product of the work carried out.

4. Has the research performed found recognition or applicability outside its main field?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent | Not applicable

5. Are the results of the research bringing together areas that previously did not have much interaction?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent | Not applicable

Q4 and Q5 focus on interdisciplinarity. The level of interdisciplinarity of the research carried out is looked at from two different angles. In Q4, evaluators assess whether the research carried out has been recognised or applied outside its main field. This should take into account the level of impact on the other fields and how far they are from the project's core field. If the project had the potential to have an impact on other fields but did not, the evaluators can choose 'Not at all'. If the research is purely mono-disciplinary with no expected visibility in other fields, they can choose 'Not applicable'. In Q5, evaluators are asked to assess whether the research brought together areas that had not previously seen much interaction. The question aims to identify novel forms of interdisciplinarity.

6. Taking into account the state of the field at the time of funding, would you agree that this is a high-risk/high-gain project?

Strongly disagree | Disagree | Neutral

Agree | Strongly agree

7. Do you consider that the risk component influenced the overall project results?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent | Not applicable

Q6 and Q7 focus on the high-risk/high-gain nature of the project. A project is considered high-risk when, at the time of funding, it was not clear if the project could achieve its goals despite the best efforts of the principal investigator. The project is considered high-risk/high-gain if, in addition to being high-risk, it has the potential of creating research outcomes with a significant impact.

In Q6, evaluators give their opinion on whether the project, when it was evaluated for funding, was a high-risk/high-gain project. Low-risk/high-gain projects are marked as 'neutral' and low-gain proposals as '(strongly) disagree'. 'Agree' is selected when the high-risk/high-gain nature is present in some objectives of the proposed research but not for the main one or most of them. As in the previous questions, an explanation for the chosen option has to be provided.

In Q7, evaluators assess how the risk component of the project has influenced positively or negatively the overall project results. If the project is considered to be lacking risk, this question does not apply and the option 'Not applicable' is selected. Otherwise, it is very important to explain the reasons behind the response: e.g. whether the project has been successful because of its high-risk nature that led to unexpected results or whether the low performance is just due to the fact that the risks materialised and the principal investigator could not mitigate them. The answer to this question is particularly important for those projects that have been identified as high-risk/high-gain projects in Q6.

8. In addition to its scientific impact, to what extent has the project had other types of impact (e.g. on the economy, on society, on policymaking, on industry)?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent

9. In addition to its scientific impact, in your opinion, could the project have other types of impact (e.g. on the economy, on society, on policymaking, on industry) in the future?

Not at all | Slightly | Moderately

Significantly | To an exceptional extent

Q8 and Q9 focus on other types of impact beyond scientific impact (e.g. on the economy, society, policymaking or industry). Evaluators are asked in Q8 whether the research carried out in the project has already had this type of impact. In Q9, the same question is asked but on the likelihood of such an impact happening in the medium and long-term. In the comments, the evaluators should explain the kind of impact that might be currently occurring or is expected to occur in the future. Note that ERC projects are not required to have any type of impact beyond a scientific one, and therefore, the absence of any other type of impact should not influence the overall project evaluation.

10. Based on the scientific results, please give the project an overall grade according to the following scale:

A - Scientific breakthrough | B - Major scientific advance

C - Incremental scientific contribution | D - No appreciable scientific contribution

11. If the project is graded as 'C - Incremental scientific contribution' or 'D - No appreciable scientific contribution', please select one or more categories from the list below as the primary reason(s) for the limited scientific output:

- ☐ Overambitious
- ☐ Underambitious
- ☐ Failed research hypothesis
- ☐ Technical problems
- ☐ Administrative and management problems
- ☐ General underperformance
- ☐ Other

Annex II: Eligibility and conflict of interest (CoI) rules for evaluators

Eligibility rules

Panels will be composed of three to four experts according to the following guidelines:

- Two to three experts with previous or current participation in ERC evaluation panels (i.e. StG, CoG, AdG or SyG) as panel member (PM).
- One expert without previous or current participation in an ERC evaluation panel as PM (i.e. StG, CoG, AdG or SyG). However, they could have participated as a remote referee in any ERC call. These 'non-experienced' experts should also not have been a grantee at any time or an applicant in the last **5 years**[7]**.**

Experts cannot participate more than four times as a panel member in this qualitative evaluation. If they become ineligible for this reason, they will be eligible again after three additional exercises.

Panels can recruit up to one **external expert**[8] per project, and they are appointed by the panels. The previous eligibility restrictions do not apply to external experts.

Conflict of interest rules

In addition to the CoI rules set out in the ERC code of conduct, the following CoI rules apply:

- Panel members cannot participate in the evaluation if:
    - they were the principal investigator or co-principal investigator of any project assessed in the evaluation.
- Panel members can participate in a specific panel but cannot review[9] a specific project if:
    - they reviewed the project at the funding stage as a remote reviewer, panel member, panel evaluator or cross-panel evaluator;
    - they were members of a panel that reviewed the project at the time of funding; or
    - they have an institutional CoI with the project.
- External experts cannot review a project if:
    - they reviewed the project at the time of funding as a remote reviewer, panel member, panel evaluator or cross-panel evaluator;
    - they were members of a panel that reviewed the project at the time of funding;
    - they have an institutional CoI with the project; or
    - they were the principal investigator or co-principal investigator of the project.

If the host institution (HI) was changed one or several times during the lifetime of the project, the last HI will be the one taken into account for the institutional conflict of interest.

Current members of the ERC Scientific Council cannot participate in the evaluation.

[7] A grantee is eligible if sending an application in CoG or AdG the same year.
[8] Two external experts can be recruited in exceptional cases.
[9] When the panel members discuss a project during the panel meeting, those experts who have a CoI with this project are requested to leave the meeting room.

Annex III: List of panel members

PHYSICAL SCIENCES AND ENGINEERING

MATHEMATICS

Yuri F. Bilu
Martin R. Bridson
Luigi Chierchia
Maria Chudnovsky
László Erdős
Daniel S. Freed
Helge Holden
Gitta Kutyniok
François Loeser
Per Lötstedt
Gábor Lugosi
Angus MacIntyre
Tony Pantev
Luigi Preziosi
Alfio Maria Quarteroni
Tudor Ratiu
Michael Röckner
Dirk Roose
Marta Sanz-Solé
Wil Schilders
Mariya Shcherbina
Herbert Spohn
Andras Szenes

FUNDAMENTAL CONSTITUENTS OF MATTER

Charalampos Anastasiou
Laura Baudis
Jens Biegert
Jean-Sébastien Caux
Francisco del Águila Giménez
Johannes Hecker Denschlag
David DiVincenzo
Tilman Esslinger
Wojciech Gawlik
Yolanda Lozano
John Martin
Piet Mulders
Peter Norreys
Markus Kurt Oberthaler
Christophe Salomon
Ferdinand Schmidt-Kaler
Concettina Sfienti
Andrew Shields

CONDENSED MATTER IN PHYSICS

Jouni Ahopelto
Alberta Bonanni
Luis Brey Abalo
Jeff T. M. De Hosson
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Annex IV: Ex-post evaluations of research programmes across the world

Research Funding Organisation	Name of Exercise (link)	Subject/Type	Periodicity
Agence National de la Recherche (France)	Les maladies neurodégénératives: le défi des neurosciences projets financés sur la période 2010–2018 (2020)	Thematic Report with project descriptions and emphasis on impact by funded projects	Regularly (changing topics)
Deutsche Forschungsgemeinschaft (Germany)	Evaluation der Klinischen Forschungsgruppen (2022), Evaluierung "Fachinformationsdienste für die Wissenschaft" (2019)	Research Group or Programme	Commissioned (once)
European Research Council	Scientific Assessment of completed Projects	Technical Report for the ERC Scientific Council	Annual
FWF (Austria)	Ex-Post Evaluation and Performance of FWF Funded Research Projects (2005)	Programmes	Commissioned (once)
Human Frontier Science Program	Review of the Human Frontier Science Program (2009-2017) 2018	Process and impact evaluation	Commissioned (once)
Max-Planck-Society (Germany)	The procedures of the Max Planck Society (p.13)	Institutes (monitoring)	Regularly (no exact data available)
National Science Foundation (US)	Committee of Visitors (COV) Reports	Program operations, process and management	Regularly (ca. every 2 years)
Novo Nordisk Foundation (Denmark)	Annual Impact Report	Programmes	Annual
NWO (Netherlands)	Evaluatie van portfolio van onderzoeksinstituten van NWO en KNAW (2019)	Overall institutional evaluation	Commissioned (once)
Swedish Research Council	Quality and impact of research in Physics in Sweden 2023	Discipline (scientific quality and societal impact of physics)	Regular reports according to disciplines (second of its kind)
Swiss National Science Foundation	Evaluation of the Swiss National Science Foundation (2022)	Overall institutional evaluation	Commissioned (once)
UKRI	Driving the electric revolution challenge Phase 3 (of 4)	Process evaluation and interim impact evaluation	Commissioned (once)

*Only within the context of the mentioned report.

Other RFOs websites that have been consulted, with no document found relevant to this inquiry, including: CSIC (Spain), Wellcome Trust, National Science Centre (Poland), Norwegian Research Council, CNRS (France), Consiglio Nazionale della Ricerche (Italy), Luxembourg FNR, CONICYT (Chile), Volkswagenstiftung (Germany), Estonian Research Council. Purely statistical reports on the budget, number of projects, principal investigators funded according to discipline, etc. were not considered.

Instance (for finished projects)	*Peer-review with external committee or panel	*Peer review with individual external experts	Number or share of total	Author
1 year after finishing	NO	NO	278 selected projects	ANR
1- 2 years after commissioning	not applicable (programme)	not applicable (programme)	not applicable (programme)	inspire research (ext.), Prognos AG (ext.)
2 years after finishing	YES	YES	40%	ERCEA
Different instances (for data analysis)	NO	NO	503 projects for data analysis	Joanneum Research (ext.)
1 year after	YES	NO	Depending on either Surveys or Bibliometric analysis	Independent Scientific Review Committee, Science-Metrix Inc. (ext., from Canada)
not applicable (institutes)	YES	n/a	not applicable (institutes)	Max-Planck-Society (830 Scientific Advisory Board member)
n/a (current operations)	YES	n/a	n/a	Committee of Visitors (a Federal advisory committee)
not applicable (partially ongoing)	NO	NO	4 630 people on grants in 2020	Researchfish (ext.), NovoNordisk
not applicable (institution)	YES	n/a	n/a	Independent Committee (NWO, KNAW)
1 year after (publications)	YES	NO	400, or 2 per cent of all Swedish physics publications	Evaluation Panel of 14 international experts set up by the SRC, composed of 8 subject experts with a focus on assessing scientific quality and 5 experts for the assessment of societal impact
not applicable (institution)	not applicable (institution)	not applicable (institution)	not applicable (institution)	Swiss Science Council (Federal advisory committee)
During project lifetime	NO	NO	not applicable	Frontiers Economics (ext.)

Luxembourg: Publications Office of the European Union, 2024

PDF: ISBN 978-92-9215-129-4 • ISSN 2363-2593 • doi: 10.2828/3025176 • JZ-01-24-000-EN-N
Print: ISBN 978-92-9215-130-0 • ISSN 1831-239X • doi:10.2828/0841016 • JZ-01-24-000-EN-C

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