Supporting the next generation of biomedical researchers in Europe:

The impact from ERC funding on career development for young biomedical researchers

By

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European Biomedical Research

Research systems shape the institutional environment which shapes the structure for young researchers to pursue an academic career. Before detailing the European Research Council, its strategy and impact on research careers for young biomedical researchers in Europe, we therefore first briefly sketch the landscape for biomedical research funding in Europe and the academic labour markets in Europe.

Situating Europe in Biomedical Research

The vast majority of **public funding for biomedical research** in Europe still originates from national or regional funding bodies.

Public funding for health R&D by national governments has continued to increase on a relatively stable growth path. This growth path has however been much slower than in the US, which witnessed a doubling of NIH budgets in 98-03. European public funding for health R&D has therefore not been able to catch up with the US. In 2009, the combined budgets of EU21 was still below two thirds of the US (Source: ESF/EMRC). After the financial crisis since 2009, it has remained more stable compared to the US, not witnessing the fall in federal health funding which the US has. But this overall trend masks important differences across European countries. The stronger countries, particularly Germany, has kept and even increased its federal funding for R&D, while other countries, particularly those under fiscal pressure in the South (Spain, Italy, Greece) had to reduce their budgets, thus increasing the divide in public funding for R&D within Europe (Veugelers, 2014).

Insert figure 1 and Table 1 here

Despite its lower public budgets for biomedical research compared to the US, the EU outweighs the US in terms of number of scientific **publications** in Biological and Medical Sciences. But both the EU and US have been losing their share in global biomedical publications, with especially China making strong inroads. Nevertheless, when looking at **top publications** (as measured by most cited publications), although the EU has made substantial inroads in this segment, the US remains in the lead by far, especially in the Top 1% most cited publications, while China has a longer way to catch up to the top.

Insert Figure 2 and Table 2 here

The countries with the largest public research funding in the EU are the UK, Germany and France. UK, Germany and France also represent the largest share of European biomedical publications, although they have lost a bit of their dominance, especially France. Other European countries have been catching up, but at a very slow pace. This catching up has lost momentum more recently, correlated with the increasing divide in public funding post-crisis.

Insert Figure 3 here

There are significant differences in the institutional set up of the various national biomedical research landscapes. While in the UK, the largest share of the funds went to the university sector, in France, public research organisations like Inserm (Institut national de la santé et de la recherche médicale) or CNRS (Centre National de la Recherche Scientifique) are key players in the national research landscape, next to universities. In Germany, public research institutions like Fraunhofer and the Max Planck Society, as well as the industry and university sectors were allocated roughly equal funding amounts (ESF, EMRC 2011). [1]

PhD education and the academic labour market in Europe

Biomedical research education (as well as medical education) differ within Europe and are as fragmented as is the European research landscape. Also the **academic labour market** in Europe is heterogeneous, with several models prevailing (see also EUI (2010)).

> *The Anglo-Saxon model*: This model is characterised by a relatively open and transparent merit-based recruitment procedure and is quite open to non-national researchers. The Anglo-Saxon model comprises beside fixed-term positions, tenure or tenure-track positions. Distinct career tracks coexist, beside researcher positions (with freedom from teaching tasks) there are also explicit lecturer positions. *Typical examples* are the UK, Ireland and the Netherlands.
>
> *The European Continental model*: Although the recruitment of researchers is regulated by many formal rules, it shows a tendency towards informal agreements in practice. Non-national researchers face difficulties to enter the system. Promoting along the career ladder is often regulated by seniority. In this system, researchers are formally quite strongly dependent on tenured professors and/or chair holders ("chair system") and fixed term contracts are usually only obtained after a longer period of employment. *Typical examples* are Italy, Spain, Germany and France. Over the recent decades some reforms took place, most notably in Germany, in order to attract international researchers and to foster meritocracy where individuals are assessed based on their performance; new positions were created.

[1] Note: because of this difference in institutional landscape, it is tricky to look at university rankings for biomedical publications, like the Leiden Ranking, as this misses for France and Germany the major research actors for biomedical research.

The Scandinavian model: This model presents characteristics of both the European Continental and the Anglo-Saxon model. Recruitment procedures are relatively open and competitive with a focus on merit. However, in practice, a tendency towards informal rules and agreements prevails. *Typical examples* are Denmark, Sweden and Norway.

The transitional Central-Eastern European model: Since the fall of the Socialist regime, many political, economic, administrative, and legal reforms in academic structures have taken place in Central and Eastern European States. One of the major particularities is the rise of private higher education institutions (a trend much less developed in Western Europe). *Typical examples* are Hungary and Poland.

Despite different models prevailing, the academic labour market is slowly converging within the EU. This process of convergence is one of the missions of the European Commission (EC) (the executive arm of the EU): the creation of an **integrated European Area for Research** (ERA).

As part of its ERA roadmap, the European Commission has issued a ***Code of Conduct for the Recruitment of Researchers*** which outlines principles for hiring and appointing researchers. The Code is a recommendation and has no legal implications, as the EU has no policy competence over universities or national public research organisations. Its implementation therefore rests on positive contention and peer pressure. By now, almost 900 institutions across all EU countries have signed the Code. Some excerpts from the Code of relevance for the career development of post-docs:

- *Clear rules and explicit guidelines for the recruitment and appointment of postdoctoral researchers, including the maximum duration and the objectives of such appointments, should be established by the institutions appointing postdoctoral researchers.*
- *Such guidelines should take into take into consideration that the postdoctoral status should be transitional, with the primary purpose of providing additional professional development opportunities for a research career in the context of longterm career prospects.*

Misalignment between demand and supply of biomedical PhDs in Europe

The issue of oversupply of biomedical PhDs relative to permanent (tenured) positions in academia seems less pressing in Europe as compared to the US. The number of biomedical PhDs has grown less fast in the EU compared to the US. In some countries like the UK and Sweden, it has remained fairly stable.

Insert Table 3 there

This correlates with a more stable growth path of public R&D funding for universities and for biomedical research in particular, which finances most of the permanent academic positions in Europe, compared to the boom and bust in the US. Also, fast growth in some EU countries in trained PhDs is absorbed by outward mobility to other EU countries (see eg Italy). Furthermore, EU trained PhDs move to the US for post-doc positions, while incoming flows from outside EU are much more modest than for the US. EU funded fellowships (Marie Curie Fellowships) are available for post PhD mobility to other EU countries and also, to a more limited extent to non-EU countries, where the US is the major destination.

Nevertheless, also in Europe concerns are mounting on a misalignment between the number of newly trained PhDs to grow faster than the number of open academic positions. Due to public budget constraints in many EU countries, permanent academic positions have not been growing as fast as the number of new PhDs. With tuition fees mostly state regulated and fixed, (public) European universities had to compensate the insufficient growth in their public base-funding by diversifying their financial resources. Third party financing became more important, such as acquiring research funds from national funding agencies, (sub-)national governmental agencies (e.g. ministries), the European Commission (EC) and the ERC, not to forget the foundations and the private sector (cf. for this e.g. Stephan 2012; Resnick 2014). This mismatch between supply and demand for freshly minted researchers cumulated also in Europe in a trend towards a prolongation of the postdoctoral transition phase by series of short-time contracts and decreasing job security, although probably less outspoken than in the US. (Youtie et al. 2013).

Situating EU funding in the European Biomedical Research Landscape.

Only a small share of public funding for biomedical research is handled today at the EU level: an estimated 5-10% for all public funding for R&D in Europe; an estimated 15% for biomedical research specifically (EMRC 2011). Although funding by the EU level is less important than national/regional funding, EU funds are nevertheless important, beyond their size, but, because of their unique characteristics, complementing and leveraging national/regional funding.

The *Framework Programmes* (*FPs*) are the EU's research and innovation funds that are planned and budgeted on a multiannual basis, which typically stretches a 7 year period (unlike the yearly appropriations in the US federal funding). The FPs are financed partly by the EU Member States through their regular contributions to the EU and partly by contributions from associated countries (AC) (Switzerland, Israel, Norway) in proportion to their *gross domestic product* (*GDP*).

Since their inception, the budgets of the FPs have steadily increased over time, including and particularly more recently since 2013. This is in contrast with the trend in some EU countries facing fiscal austerity (cf supra).

Framework Programme 7 (*FP7*) ran from 2007 until 2013. Defining features of the programme were its large overall budget (about € 55 billion euro) and its significant support for fundamental research via the introduction of the ***European Research Council*** **(*ERC*)** (*Ideas Programme*), which support bottom-up proposals of individual researchers (cf infra for more on ERC). The newly minted ERC was given access to significant financial resources (€ 7,5 billion for 2007-2013). However, most of FP7 resources (€ 32,4 billion) were allocated to the *Cooperation* programme which was focused on transnational research cooperation between EU countries and exchanges between the public and private sectors. The *Cooperation* programme was subdivided into several thematic areas: Health next to information and communication technologies [ICT], energy, environment, transport, and space). Finally, the *People* programme (which included the *Marie Curie Fellowships* (*MCA*)) for post-doc researchers moving cross-border,was endowed with a budget of € 4,8 billion.

Horizon 2020 (*H2020*), the successor to FP7, is currently running for a seven-year period from 2014 to 2020. The Horizon 2020 budget of more than € 80 billion is substantially bigger than that of FP7. The current programme has essentially taken over the thematic priorities of FP7, but is organised slightly differently. It is organised around three main pillars (*Excellent Science* (31,7% of the total budget) for bottom up research, *Industrial Leadership* (22,1%) supporting investment in key technologies, and *Societal Challenges* for top down targeted research in areas of societal priorities (including health, information and communication technologies [ICT], energy, environment, transport, and space). (38,5%)).

In H2020, the **ERC** takes up the bulk of the *Excellent Science* pillar's budget, with 13,1 billion euro (ie 17% of the total H2020 budget). As the ERC pillar is for bottom-up fundamental frontier research from any scientific discipline and its budget is allocated according to proposals received (to equalize success rates across scientific disciplines) (cf infra), there is no predetermined budget for biomedical research. Up till now (FP7 and midterm H2020), about 35% of the grants awarded by ERC went to Life Sciences researchers, which adds up to about 5 billion eur since its start) (cf infra) .

The **Marie Curie Fellowships** take up 6,2 billion euro. The fellowships are also for bottom-up research from any scientific discipline, but there is no information on the share of these fellowships that go the biomedical area. **Research Infrastructures** (ESFRI) takes up 2,5 billion euro in H2020. ESFRI comprises pan-European research infrastructures. Several of these are strategically important for biomedical research: BBMRI for biobanking and biomolecular resources, ECRIN for clinical research, EATRIS for translational research, Euro-bioimaging for biomedical imaging infrastructure, and ELIXIR which underpins all the biological information and data storage for biomedical research. The European Molecular Biology Laboratory (EMBL) can be regarded as a successful example of cross border research infrastructure collaboration in the biomedical area, co-funded by the EU.

The *Industrial Leadership pillar* is a top-down program, but contains no specific Health technology program.

In the *Societal Challenges pillar*, which is a top-down program, health is one of the challenges with a dedicated 7,5 billion euro budget in H2020 (the largest budgeted pillar in this area), a total budget for Health larger than distributed through ERC. In contrast with the ERC, this SC budget is distributed through regular targeted calls in the Health area and for cross-border collaborative research projects.

ERC, MC and SC, which represent the bulk of H2020 funding for biomedical research, is mostly for basic or pre-commercial biomedical research. There is little to no budget room in these programs for translational research or research that goes into development. For this, there are two other important initiatives, which the EU co-funds: The *Innovative Medicines Initiative*, in which the EU cofunds 1,6 billion in H2020 to the total 3.3 billion euro for this Initiative. [2] Another EU co-funded initiative is the *European & Developing Countries Clinical Trials Partnership* (EDCTP) where the EU through its H2020 funds 0,6 billion of its total 1,6 billion euro[3].

[2] The Innovative Medicines Initiative (IMI) is working to improve health by speeding up the development of, and patient access to, innovative medicines, particularly in areas where there is an unmet medical or social need. It does this by facilitating collaboration between the key players involved in healthcare research, including universities, the pharmaceutical and other industries, small and medium-sized enterprises (SMEs), patient organisations, and medicines regulators. IMI is a partnership between the European Union (and the European pharmaceutical industry (represented by EFPIA, the European Federation of Pharmaceutical Industries and Associations).

[3] The European and Developing Countries Clinical Trials Partnership (EDCTP) was created in 2003 as a European response to the global health crisis of poverty-related diseases. It is a public-public partnership between countries in Europe, and in sub-Saharan Africa, as well as the European Commission.

The EUROPEAN RESEARCH COUNCIL (ERC) for biomedical researchers

Because of the size of its budget and the unique characteristics of its grants, the ERC has been important for young biomedical researchers in Europe for their career enhancement. Before analyzing the impact of ERC grants on the careers of young biomedical researchers in Europe, we first detail the unique features of the ERC[4].

ERC' s Mission

ERC's mission can be summarized as supporting excellence in frontier research through a bottom-up, individual-based, pan-European competition. "Scientific excellence is the sole selection criterion. In particular, high risk/high gain pioneering proposals which go beyond the state of the art, address new and emerging fields of research, introduce unconventional, innovative approaches are encouraged".

ERC offers **independence** to grantees to work on a research topic of own choice, with a team of own choice and to move with the grant to any place in Europe if desired (**portability of grants**). The grants awarded are **long-term** (5 years), **generous** (up to 3,5 million euro) and go to **individual** PIs, i.e. do not require intra-EU collaboration (like the SC part of H2020)

The terms and conditions applying to ERC grants are specified in the Model Grant Agreement. This agreement stipulates, among others, that the beneficiary host institution shall ensure the necessary scientific autonomy to the principal investigator. It also requires the host institution to "*take all measures*" to implement the principles set out in the Charter & Code(cf supra) — in particular regarding working conditions, transparent recruitment processes based on merit and career development.

Although career advancement was never an explicit objective of the ERC, it was hoped at its launch in 2007 that its sizeable and portable grants would provide a critical and adequate support to the independent careers of young excellent researchers. In fact, one of the political motives for introducing the ERC at the time, was to support young top talent, as a reaction to counter their brain drain to the US or out of academe:

"*A widely accepted view is that Europe offers insufficient opportunities for young investigators to develop independent careers and make the transition from working under a supervisor to being independent research leaders in their own right. This structural problem leads to a dramatic waste of research talent in Europe…. It encourages highly talented researchers at an early stage of their career to seek advancement elsewhere, either in other professions or as researchers outside Europe. The ERC is well placed to develop a broad, international and consistent scheme on the much larger scale that will be necessary to make a real impact on European science and scholarship.*"

The objective is to accelerate the development of new or improved drugs, vaccines, microbicides and diagnostics against HIV/AIDS, tuberculosis and malaria as well as other poverty-related and neglected infectious diseases in sub-Saharan Africa, with a focus on phase II and III clinical trials.

[4] https://erc.europa.eu/about-erc

In the long term, the ERC hopes to substantially strengthen and shape the European research system, stimulating universities, research organisations and other funding agencies to develop better environments for young researchers to progress on their scientific careers.

ERC's Modus Operandi

With the PoC a small top-up program for , and the SyG only introduced in prototype version in 2012 &2013, almost all of the ERC budget went to its Starting Grants, Consolidator Grants and Advanced Grants between 2007 and 2017[5].

ERC's **Starting Grants** (and **Consolidator Grants**) address the perceived lack of opportunities for young researchers in Europe to become independent research leaders, and will be the focus of our attention. [6]

Starting Grants (StG) are designed to support researchers at the early stage of their careers (2-7 years of post-doctoral research experience) by enabling them to develop an independent research career and to establish their own research team or programme in Europe. The scheme provides funds of up to EUR2 million for a period of up to 5 years.

Consolidator Grants (CoG) are designed to support researchers at the stage of consolidating their independent careers in Europe and to help them strengthen their recently created research teams or programmes (7-12 years of post-doctoral research experience). This grant scheme was established in 2013 by splitting up the initial StG scheme (which originally covered all researchers with a post-doctoral research experience of 2-12 years) as a way of addressing the large disparities in research experience among the applicants for the initial StG scheme, as well as an increasing problem of oversubscription. The scheme provides funds of up to EUR2.75 million for a maximum period of 5 years.

Advanced Grants (AdG) are designed to support established and outstanding scientists (with an excellent scientific track record of at least 10 years). This scheme provides funding of up to EUR3.5 million for a maximum period of 5 years.

Synergy Grants (SyG) was a pilot scheme in 2012 and 2013 to support small teams of scientists (two to four principal investigators and their research teams), who wish to jointly address research problems at the frontiers of knowledge by bringing together complementary expertise, knowledge and resources. The scheme provides funds of up to EUR15 million for a period of up to 6 years. It will be reintroduced in 2018.

Proof of Concept (PoC) is a grant scheme launched in 2011 with the aim to explore the commercial and social potential of ideas arising from ERC grants. This scheme provides existing ERC grantees with additional funding of up to EUR150 000 for a maximum period of 18 months, which can cover activities such as establishing intellectual property rights, mapping out commercial and business opportunities, and technical validation.

[5] Since 2012 a series of "Implementing Arrangements" have been negotiated with peer funding organisations around the world. These provide opportunities for early-career scientists supported by non-European funding agencies to temporarily join a research team run by an ERC grantee in Europe. Since 2012, the ERC has such an agreement with NSF (although as yet, not much consummated by US NSF grantees) . Recently (in 2017), the ERC has also introduced together with a number of EU countries (mostly EU13) a scheme for young researchers visiting ERC funded labs with the aim to train these researchers into next generation ERC applicants.

[6] The average age of Starting Grantees is 35 years at the time of application, 40 years for Consolidator; and 52 years for Advanced grantees.

Critical for the ERC to have the intended impact on the career development of young researchers is that its selected grants have a high impact, not only because of the large sum of money provided for a long time period, but also because of their reputational value as a trusted seal of exceptional scientific excellence. To this end, it is important that the scientific governance of the ERC is done by an independent **Scientific Council**, which has full authority over allocation of funding and the selection of grantees. The Scientific Council is composed of eminent scientists and scholars. The members are appointed by the European Commission, on the recommendations of an independent Identification Committee. The President and Chair of the Scientific Council is assisted by three Vice-Presidents who represent the three ERC domains (Life Sciences (LS), Physical & Engineering Sciences (PE) Social Sciences and Humanities (SSH)). From the current 22 Scientific Council Members, 9 are from the Life Sciences. The Scientific Council is supported by the ERC Executive Agency who has about 500 employees.

The ERC Scientific Council runs the selection of ERC grant applications through a structure of peer review panels composed of renowned scientists and scholars selected worldwide by the ERC Scientific Council. The evaluation is done in 2 steps, with the second step for StG and CoG involving interviews. A total of 25 panels are used, 9 in Life Sciences (LS), 10 in Physical & Engineering Sciences (PE) and 6 in Social Sciences and Humanities (SSH). Each of the 25 panels per call consists of 1 panel chair and 12-17 panel members. About 14% of panel members are from outside Europe (some 7% from the US). External reviewers (min 3, typically 5 to 8) are solicited by panel members to assist them in the 2nd stage of the selection process. Panel members and reviewers are asked to evaluate the proposals on their groundbreaking nature, their level of ambition to go beyond the state of the art and push the frontier. Panels decide on the final ranking/who-gets-funded.

When allocating its budget to the different schemes, it has been an explicit choice of the Scientific Council to give priority to young researchers. Of the total 7154 grants that the ERC has granted from its start to the end of 2016, two third go to StG/CoG and one third to AdG. For the last 3 years (2014-2016) the share for StG/CoG was even higher, 75%.

Another explicit choice of the Scientific Council is to distribute within each call across the various panels depending on total requested budgets. Success rates are therefore more or less similar across the different domains and panels. Allocating budgets to the different calls (StG/CoG/AdG) have to be done on a yearly basis, ahead of the calls, leaving a delicate foresight exercise to have comparable success rates for StG and AdG. In the period 2007-2013, the success rate for StG was lower than for AdG (9% on average compared to 14%). But since 2014, with a growing share of a growing overall ERC budget allocated to StG calls, this has been rebalanced with an average success rate for StG of 12%, CoG of 14% and AdG of 11%.

The ERC structurally monitors, evaluates and provides information on who is being selected and why, on the impact of its funded projects on progress in science, on the career progression of grantees and their team members, its impact on local research systems. It has set up since its start a multi-methodology strategy for continuously monitoring the scientific outputs and outcomes of the projects including quantitative bibliometric and econometric analysis of publications, qualitative assessment of project outcomes, surveys of grantees, analysis of final reporting information. When assessing the scientific impact of the ERC it is important to keep in mind that both ERC grantees as well as non-ERC grantees are likely to have other national or local grants.

ERC for post-doctoral research career advancement

With the size of its budget and the characteristics of (the selection of) its grants, the ERC is an example of a funding scheme offering a considerable amount of funding for a longer time span allowing researchers to pursue their own research programme independently, with a selection that certifies exceptional excellence potential. They should thus enable selected postdoctoral researchers to further/faster progress in their career development to become an independent researcher. Whitley (2014) describes this concept as "*protected space"* characterized along three dimensions:

1. Capacities for conducting research independently in terms of time and material resources
2. Time horizon for which autonomy and freedom from hierarchical interventions is granted
3. Thematic scope within which the new idea is realised.

Working in a "protected space" may facilitate researchers to tackle challenging problems which require a considerable time span and investment in the development of new skills and competencies (Whitley 2014). This 'investment' will earn merits, first and foremost in the form of top publications. This top scientific performance will trigger the further career development of the grantee and, hence, to successfully pass into a tenured academic position.

Beyond access to funding, individual research grants serve as an indicator for scientific recognition. Receiving a grant is attributed with high prestige resulting from 'being one of the happy few' who successfully passed through a highly competitive merit-based trusted selection process. Being funded by a highly prestigious program may considerably boost the researcher's individual reputation. This, in turn, may facilitate raising further research funds – a phenomenon described by Merton (1968) as the so-called "cumulative advantage effect" or "Matthew effect" (cf. eg Stephan (2014)).

Programs in continental Europe with similar features to the ERC StG programme include the former EURYI award [7] on the European level and on the national level for example the "Emmy Noether Programme" funded by the German Research Foundation (DFG), the "Veni Vidi Vici" talent scheme funded by the Netherlands Organisation for Scientific Research (NWO), or the "Future research leaders" programmes offered by the Swedish Foundation for Strategic Research (SSF) [8]. There are also examples where the ERC has inspired others to contemplate similar schemes. Some of these examples are listed

[7] In 2003, the European Heads of Research Councils (EUROHORCs) developed the European Young Investigator Awards (EURYI) Scheme in cooperation with the European Science Foundation (ESF). EURYI awards, normally worth at least € 1 million over 5 years, may be held in any of the countries participating in the scheme, which had been designed to create a high-profile incentive for the best and brightest researchers to build up their careers in Europe. The ERC's StG funding scheme shares many characteristics with EURYI as well as a much larger scale in terms of the number of awards. For this reason EuroHORCs decided to indefinitely postpone future calls of EURYI. The EURYI award can, thus, be seen as a precursor of the StG programme). Cf: http://www.esf.org/coordinating-research/euryi.html

[8] Emmy Noether Programme Own position, staff, and material expenses for five (+1) years
Max Planck Research Groups: Own position, staff, material and travel expenses for a duration of five years

in Annex. In October 2016 the American Society for Cell Biology called for the establishment of an ERC-like system in the US to focus on funding for young scientists [9].

In several EU countries, national funding bodies have set up schemes created to integrate ERC funding, usually by supporting ERC best ranked applicants who did not obtain the funding due to ERC budget restrictions. The annex contains major examples.

Several evaluation studies provide empirical evidence on the impact of “protected space” funding programmes like the ERC, trying to address the question which role those programmes play in the career development of selected postdoctoral researchers. Overall, these studies attest a positive impact on the likelihood of successfully pursuing an academic career – i.e. to keep talented young researchers stay in academia, to increase the probability to obtain a professorship, or to receive a follow-up research grant.

- Comparing funded and rejected applicants for a 6-year 1 million Euro grant (INGVAR) to young researchers in Sweden, Melin and Danell (2006) found that one of the most important advantage of this large, 6 year research grant is that grantees can concentrate on long-term research interests and have sufficient time to develop their projects and research teams.
- Van den Besselaar and Sandström (2015) study the predictive validity of early career grant decisions (the Dutch VENI grants), using a sample of 260 early career grant applications in three social science fields including data from rejected applicants. They measure research output and impact of the applicants ten years after the application to find out whether the selected researchers perform ex post better than the non-successful ones. Their main finding is that the grant decisions seem to have no predictive validity with regard to research excellence: the successful applicants have no higher quality research output than the best performing non-successful applicants. The authors find, however, that receiving a prestigious early career grant has a strong influence on career development, as grantees are twice to three times as likely to become full professor.
- Bloch, Caversen and Pedersen (2014) analyse the career impact of grants awarded by the Danish Council for Independent Research. They find that the probability of obtaining a full professorship three years after grant application is twice as high for grant recipients than for rejected applicants (16 per cent compared to 9 per cent). Moreover, grant recipients also have a higher probability of career advancement three years after grant application in general (9 percentage points higher). Qualitative interviews with grant recipients conducted by the authors indicate that the grant heightens the status and recognition of the recipients and draws attention to their research ideas, which facilitates access to networks and collaborations with leading researchers in their field, which in turn further strengthens grant recipients’ own positions in their research community.

An important issue however that evaluation studies typically have to deal with, is the sorting of “selection effects” from “treatment effects”. A proper counterfactual group of researchers to the successful grantees need to be identified that are sufficiently similar with the exception of not being “treated” by a focal grant. Higher ex post performance for grantees (scientific performance and/or career advancement) are often due to ex ante differences, with the better researchers being selected into the grant. When evaluation studies properly compare and control, they typically find less strong difference in ex post performance and career progression for grantees compared to the control group.

[9] *http://hymanlab.mpi-cbg.de/hyman_lab/wp-content/uploads/2016/11/OCT-NL-2016PresidentsColumn.pdf*

At least part of the ex post differences in performance for grantees originate from the initial selection of "career progressable" grantees, rather than from having received the grant.

The exact attribution of the ex post performance to the focal grant received is further complicated as rejected applicants often receive other, similar funding and because successful applicants typically obtain multiple funding simultaneously.

In addition, the full realization of effects requires a long time horizon for evaluation post grant.

ERC's first results

Since 2007, some 7,000 projects have been selected for funding by the ERC from more than 65,000 applications from more than 44000 distinct PIs, which is less than 5% of EU public sector researchers. It is estimated that since 2007 the ERC has awarded grants to considerably less than 1% of the EU's public sector researchers (Source: ERCEA). The ERC is therefore a highly selective funding programme.

Over 40,000 articles acknowledge ERC support in international, peer reviewed journals to the end of 2015. But more importantly, ERC output reaches high excellence levels. About 7% of all articles acknowledging ERC funding belong to the Top1% in their field and year of publication. 20% of the Nature and Science papers that have authors based in the EU and the Associated Countries were ERC funded publications. Also, ERC grantees have won prestigious prizes, including 6 Nobel Prizes.

A peer review evaluation by independent scientific expert of an initial sample of ERC-funded papers drawn from the top 1% of highly cited papers in their respective fields showed that 21% of the papers reviewed, made a breakthrough contribution to their field, another 50% a major scientific advance.

The impact from ERC grants goes beyond the Principal Investigator. Also researchers hired on ERC projects benefit from the science being produced, offering a locus of cutting-edge research training. Of the about 1900 project for a which final reporting information was available in 2015, a total of 14000 researchers were reported to work on ERC grants. This means that on average each ERC grantee employs about 7 team members. About one third of team members are post-docs, somewhat less than one quarter are PhDs.

Around 23% of the PhDs and post-docs in ERC teams were from outside Europe, the largest number being from China, the USA and India. This shows that ERC grantees, thanks to their substantial long term funding and their seal of excellence, are able to attract talented early-stage researchers to Europe from around the world. The strong international network position of ERC grantees also shows in their publications: 64% of ERC reported publications are written in a non-ERA collaboration (75% if only top 1% papers are considered). 22% of all ERC reported publications have at least one US-based author.

ERC for the Life Sciences

Since its start in 2007 till the end of 2016, the ERC has awarded 4,73 billion euro to Life Sciences out of its total allocated budget of 12,6 billion, or 37,4%. These 4,73 billion went to 2522 LS grants, representing 35% of all ERC grants. These 2522 successful LS grantees came from more than 21000 LS applications, leaving an average success rate for LS of 11,7%, which is very close to the overall success rate at ERC. The average grant size for StG/CoG in LS is 1,6 million euro; for AdG this is 2,375 million euro.

Life Sciences has 9 panels[10]:

- LS1 Molecular and Structural Biology and Biochemistry
- LS2 Genetics, Genomics, Bioinformatics and Systems Biology
- LS3 Cellular and Developmental Biology
- LS4 Physiology, Pathophysiology and Endocrinology
- LS5 Neurosciences and Neural Disorders
- LS6 Immunity and Infection
- LS7 Diagnostics, Therapies, Applied Medical Technology and Public Health
- LS8 Evolutionary, Population and Environmental Biology
- LS9 Applied Life Sciences and Non-Medical Biotechnology

There are no big size differences among the different LS panels: LS7 (applied med technologies) and LS5 (neurosciences) are somewhat bigger with more than 14% of all LS grants. LS9 (applied LS & non-medi Biotech) is the smallest with 8%. Because of budget allocations on the basis of applications, there are no substantial differences in success rates among the 9 LS panels.

Insert Figure 4 here

The deliberate choice of the Scientific Council to favor junior researchers and support them to become independent researchers, is also reflected in LS: 65% (or 1654) of all LS grants (2007-2016) were awarded to StG/CoG for a total budget of 2,67 billion euro (in 2016 this was 75%). The following figure shows the age distribution of LS grantees, which is very similar to the age distribution for all ERC grantees. Like for all ERC grants, also in LS, the success rate of StG is somewhat lower than for AdG.

Insert Figure 5 & 6 here

Gender bias is a constant concern for the Scientific Council, who set up a dedicated working group to monitor any possible bias. While for all ERC grants, the female success rate is 10% compared to 12% for male applicants, this difference is much more pronounced in LS, where the female success rate is only 9% compared to 13% for male applicants. This difference in success rates leaves only 23% of LS grantees to be female, while 30% of LS applicants are female. This gender bias is not related to the gender composition of its panels, as 32% of LS panelists are female. Furthermore, the gender bias is strongest for the youngest applicants. Female StG in LS only have a success rate of 7% compared to 12% for their male colleagues. Once past 7 years of post-doc (CoG or AdG), the gender bias in success rates becomes smaller (12% compared to 14%).

Insert Figure 7 here

Success rates for LS vary by **country** of the Host Institution, correlating with the strength of the biomedical research in the country (cf supra). The country with the most ERC LS grants is not surprisingly the UK, with 19% of all LS ERC grants. The UK's success rate is with 14% somewhat higher than the average LS success rate of 11,7%. Germany with 17% of all LS ERC grants is the second largest country,

[10] Although not explicitly excluded, ERC typically does not fund translational research, as its selection criterion is based on pushing the scientific frontier and the size of its grants cannot exceed 3.5 million euro for 5 years.

with a success rate of 15%, similar to France. But the countries with the highest success rate are Switzerland (26%), Israel (21%) and although smaller sized, Austria (20%). Sweden (9%), but also Spain (7%) and especially Italy (4%) are below average with respect to success rates. In general, a high share of a county in LS ERC grants is correlated with the size of the research base in LS. A higher success rate for a country results typically in a share of LS ERC grants which is higher than the country's size in LS publications. This effect is strongest for Israel, thanks to its substantially higher success rate. This holds less so for Switzerland, who despite the highest success rate in LS, only has a marginally higher share of LS grants compared to its share in LS pubs. Lower Swiss application rates in LS is holding down the number of LS grants. The low application rates for Swiss LS researchers to the ERC are related to the relatively well endowed Swiss national funding system and the high concentration of top biomedical research in only few places. Italy is the country where because of its low success rate, its share in ERC LS grants is much below its share in LS pubs. In addition, many Italian LS researchers move to another EU host country for their ERC grants, especially the UK and Switzerland.

Insert Figure 8 & 9 here

Since short, the ERC also has a number of double grantees: ie researchers that held a previous ERC grant, reapplied and were again successful. About half of these double grantees involve StG holders obtaining a CoG. Double grantees are more common in LS than on average: 10% of grantees in LS are double grantees (compared to 7.4% overall). Double grantees are slightly lower among female grantees. Of those grantees that could reapply, 37% are actually reapplying (for StG as for AdG). The success rate of reapplying grantees is 40% (43% for StG), which is considerably higher than the average success rate. This higher success rate for returning StG is an important extra dimension in the ERC impact on their research careers, giving them an even longer protected space. It also further enhances their attractiveness to hosting institutes.

The European ERC case and the US NIH

Within to the US public funding landscape for Life Sciences, the NIH is probably the most relevant comparison for the ERC case. Nevertheless, the EU/ERC has some important differences, of which the major ones are summarized here:

- Unlike the NIH, the ERC does not dedicatedly fund Life Sciences. The ERC being a funding agency covering all disciplines resembles more of an "NIH-integrated-into-NSF" scenario.
- Unlike the NIH, the ERC does not operate own institutes, it is a grant distributing agency only.
- Unlike the NIH, which operates with yearly budgets, the ERC budget is fixed within a multi-annual (7 years) framework.
- The ERC only started in 2007 with a relatively small budget, but its budget has constantly expanded over time.
- In the funding landscape, the EU/ERC is only a minor part of the public funding for researchers in EU countries, the bulk coming from national funding agencies. And as most universities in continental EU are public, also block funding for universities is a major funding source for academic positions.

- Unlike the NIH, the ERC has a more limited portfolio of funding instruments, basically only grants for junior and senior researchers. It does not offer specific instruments for training, nor PhD or post-doc fellowships (for this see the EU's MSC Fellowships[11]).
- The ERC is governed by a Scientific Council, representing the Scientific Community. The Scientific Council has full autonomy on the allocation of budgets and the selection process.

Despite the differences between the US and European landscape for biomedical research and the different characteristics of ERC compared to NIH, the ERC case can provide some valuable insights for the US (NIH). Both NIH grants and ERC grants can be seen as grants offering "protective space" to the young researchers, with the potential of important career progression impact.

- Grants of the "protective space" type, with sizeable budgets during a longer term, offer more potential for career impact for the young researcher, giving grantees the thrust, the means and the time to build a unique excellent track record.
- Career impact from grants requires high quality selection; The certification and enhanced reputation effects from having passed a trusted highly competitive selection process are perhaps the most important gateway for career impact from grants, as this provides more incentives for HI-HC to accommodate grantees by giving them better career opportunities.
- For career impact, independence of PI and portability of the grant is important, improving the negotiation position of PIs.

Assessing ERC's impact on career development

The ERC is still a young agency. The large majority of all the ERC grants awarded are still running (around 5 400 are still running out of nearly 7 000 awarded). Nevertheless, some first interesting results can be reported.

The impact of ERC on career development for junior researchers runs , at least partly, through grantees being recognized by the academic labour market as being excellent researchers, having passed the high and trusted selection ERC bar. Beyond this certification and recognition of excellence, the sizeable funding should allow the selected PIs to produce top frontier research.

Hence, before looking into the ex post impact on career development, we first look at the selection of grantees and their ex ante scientific track record as well as their ex post scientific excellence performance.

Impact on scientific performance from ERC grants in LS

As already mentioned supra, the ERC regularly assesses the scientific excellence performance of its grantees. Two major questions are addressed (i) whether the ERC review process selected the best candidates as measured by their track record of publications and (ii) whether the ERC helped grantees to

[11] https://ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd(2017)221-annex-2-interim_evaluation-h2020.pdf#view=fit&pagemode=none

improve the quality of their scientific output, as measured by their publication record after the competition. Non-successful applicants in the same call serve as comparison group to ERC grantees[12]. To isolate the selection and the treatment effect, we use a "Difference-in-difference" approach. Selection is studied from comparing the successful and unsuccessful applicants prior to the treatment. For the treatment effect, we first compare the scientific output of the successful applicants before and after receiving the grant (first difference) We next do the same comparison for the unsuccessful applicants (second difference). We then compare the first difference (that of the treated group before and after) to the second difference (that of the control group before and after). This Difference-in-Difference proxies for the average treatment effect. [13] Figure 10 reports the results from all applicants for a Starting Grant in Life Sciences in the period 2007-2015 (Figure 11 for all LS applicants).

Insert Figures 10 & 11 here

The comparison of track records between the selected and the rejected applicants at the time of application, shows that the ERC does indeed select StG in LS on excellence. Compared to rejected applicants, grantees have a significantly higher track record (in a 3 year time window before application) on the ERC's key performance indicator for excellence: the share of papers in the top 1% highly cited of their field & year. The same holds for the maximum Journal-Impact-Factor among their record of publications, which is significantly higher for successful compared to unsuccessful applicants.

To measure the high-risk profile of applicants, we use two bibliometric measures which tries to capture the risk-dimension: novelty (as measured by publications making new, first-time-ever combinations of references journals, see Wang, Veugelers & Stephan (2017)) and long-distance interdisciplinary (as measured by the maximum Roa indicator). On both of these measures, the selected StG-LS applicants score significantly lower than the rejected ones. This suggests that when it comes to selecting PIs with a high-risk profile, the selection process seems to bias against high risk, at least as measured by novelty and interdisciplinarity.

When comparing both groups post grant (in a 3 year period since the grant was acquired), the StG-LS grantees still outperform the rejected applications on scientific excellence, but as the last (DiD) column shows, not significantly more so than already before the selection, suggesting no significant treatment effect. The higher performance on scientific excellence of the ERC grantees post grant seems to be mostly related to their selection by the ERC evaluation panels, rather than from receiving the treatment of getting ERC funding. Selection, more so than access to funding, seem to matter for why StG-LS grantees deliver top scientific performance post-grant.

Nevertheless, the sizeable long-term ERC grants do seem to matter to shift the excellent research portfolio of StG-LS grantees more into risky frontier areas. Successful grantees significantly improve on

[12] Alternatively, the set of applicants that passed to step 2 but did not get funded are used as comparison group. Both ERC grantees as well as non-ERC grantees are likely to have other national or local grants.

[13] In the DiD methodology, the key "identifying" assumption is that the development of the potential for scientific output is similar for those that eventually receive funding and those who don't (common trend assumption) such that any difference in difference can be attributed to the received funding. If this would be violated (eg because the reviewers select researchers that have a higher potential for generating more scientific output in the future), the difference-in-difference would also be a "selection" effect. See Imbens & Wooldrigde (2009) for more on DiD and other techniques for program evaluation.

both novelty and distant interdisciplinarity of their publications post-grant compared to pre-grant[14]. In contrast, publications of non-successful applicants have a lower novelty score after compared to before application. The difference-in-difference is significant, suggesting a positive treatment effect for ERC grantees: ie the grant allows them to go into more novel research, more so than unsuccessful applicants. This is consistent with a "protected space" offered by the ERC grant.

In terms of scientific networks, measured bibliometrically through the nationality of co-authors, the results show that selected applicants have a stronger track record of US network connections, more so than an intra-EU network connection. This holds even stronger for StG than for other LS grantees (see Figure 11). However post-grant, this stronger US network inclination is significantly reduced to the benefit of ERA networking, suggestive of the ERC grants to be successful in stronger embedding excellent young researchers within the European research area.

In 2014, the ERCEA commissioned an external study to bibliometrically assess the results of ERC funded projects[15]. This study confirmed the higher scientific performance of ERC grantees compared to non-successful applicants, in general and for LS. It also compared ERC grantees from LS with LS researchers funded by US funding agencies NIH[16] and HHMI. With respect to highly cited publications, ERC-LS grantees perform similar to NIH grantees, although junior NIH grantees score higher than junior ERC-LS grantees. The pool of HHMI funded researchers are clearly of higher quality than both ERC-LS grantees and NIH.

Insert Table 4 here

Impact from ERC grants on careers of LS researchers

Although career development is not the primary objective of the ERC funding programme (which focuses first and foremost on supporting excellent scientific research at the frontiers of knowledge), it is nevertheless expected that researchers who achieve outstanding research results, either because of their selection and/or from the ERC funding, will as a consequence benefit in terms of career advancement. Helping young top talent in Europe to gain scientific independence and progression in their research careers remains an important indirect mission for the ERC. To this end, the ERC monitors career impact of its grants. Together with the ERCEA, it regularly tenders contracts for assessing career impacts and regularly analyses the final reports of ERC grantees which contains self-assessed career impact information. So far, these studies are still very preliminary in view of the young age of the ERC. Nevertheless, in what follows, we summarize some of the main insights from these studies, mostly as a prototype illustration on how to monitor career impact.

[14] These reported DiD descriptive results are confirmed in econometric analysis, controlling for field, year and applicant characteristics.

[15] https://erc.europa.eu/sites/default/files/document/file/ERC_Bibliometrics_report.pdf

[16] The group of NIH junior researchers is made up of 217 scientists who received at least one DP2 grant between 2007 and 2011, while the group of senior researchers comprises 183 researchers who received at least one R01 grant during the same period.

ERC funded study MERCI (Monitoring European Research Council's Implementation of Excellence): Evaluation Report on the Impact of the ERC Starting Grant Programme.[17]

The MERCI study commissioned in 2015 had as objective to study the impact of the ERC Starting Grant Programme, drawing upon on three surveyed StG cohorts (StG 2009, 2010 and 2011 cohort) resulting in about 1,700 valid cases for a first wave survey and 500 for a second wave survey. Also 40 interviews were carried out (29 with approved applicants and 11 with rejected ones of the StG 2009 cohort). What follows are excerpts from MERCI results, with a special focus on any differences for LS StG.

On motives why junior researchers applied for an ERC grant:

> *Regardless of their research field, their current host country or their funding status, the StG applications are mainly driven by the endowment which the grant offers. This on the one hand refers to the amount of funding and its duration but also to its thematic openness and freedom to set own research priorities. Contrasting the motivation to apply for a StG with the motivation to apply for other funding bodies reveals that these are also the characteristics which are perceived as outstanding*
>
> *In Life Sciences and Physical Sciences and Engineering, in contrast to Social Sciences and Humanities, an ERC grant is typically embedded in larger projects and presents an integrative part of a more diversified funding portfolio.*

As StGrantees are free to choose a host institution (in the EU or associated country) to set up or consolidate their own research group, it is interesting to understand the applicants' criteria for choosing their host institution.

> *Familiarity with the research institution and their reputation are of utmost importance for the Grantees' decisions. Overall, three out of four StGrantees deem the reputation an important or very important factor, but especially in Life Sciences reputation counts for most.*
>
> *The most important aspect negotiated between StG recipients and their host institution is the office space, followed by long-term career opportunities (such as for example a tenure track option) as well as the institutional integration of the StG research group.*

On which position they were having when applying, junior applicants from Life Sciences stand out. Only a minor share of 13 percent already obtained a professorship, compared to 20% in Natural Sciences and 29% in Engineering. Compared to other fields, roughly twice as much (36 percent) respondents from Life Sciences occupied some kind of 'intermediate position'. These stats (although on a restricted sample) are suggestive of the more difficult academic labour market position of junior researchers in Life Sciences compared to other fields, also in Europe.

Insert Figure 12 here

While 70 percent of the Starting Grantees obtained a professorship since they applied for the StG, this only holds true for 46 percent of the rejected applicants. The figures show that one third of the Grantees achieve this progress on the career ladder at the beginning of the funding period meaning that their

[17] http://cordis.europa.eu/result/rcn/177023_en.html

promotion might be a direct outcome of the successful acquisition of the Grant, rather than from strong performance thanks to the grant.

On sustainability of their position after the grant, the MERCI findings confirm the strong trend towards an extended postdoc phase in Life Sciences: the share of LS respondents who have a permanent position in sight is lowest compared to other respondents.

Insert Figure 13 here

ERCEA's final reports analysis

The final reporting template designed by the ERC contains a number of questions that allow to trace the self-reported career impact for ERC grantees at the end of their grant. Due to the young age of the ERC program, it is only recently that the first completed projects are starting to deliver their final reports.

An analysis of 196 StG2009 projects for which the final scientific reports have been received so far (of which 61 are from LS) [18] indicated that overall 71% of the ERC Starting grantees (75% for StG-LS) made progress on their career path or improved their academic status as a result of the ERC project. For 29% of the Starting grantees (25% for StG-LS) there was no important change in the academic position during the grant. In terms of career path 30% became full professors (30% for StG-LS). Considering that 16% of the PIs were already full professor or senior researcher at the beginning of the grant, this means that altogether 61% of the StG2009 grantees are now tenured academics. Over a quarter of the Starting grantees also progressed on their career path by becoming Readers and Associated professors or obtaining a permanent research position.

Insert Figure 14 here

Other elements of academic development mentioned by the Starting grantees are: becoming world leader in the field, achieving scientific independence, becoming better known worldwide in the field and entering/combining research areas that are new for the PIs.

Insert Figures 15 & 16 here

Overall, starting grant holders identified as major area of difference thanks to ERC:

> ***attract resources (more funding, better people, equipment)*** = additional funding could be obtained; other related projects were triggered; more and better scientists could be employed in the team (from all academic stages); state-of-the-art facilities were built; long-term stability was provided;
>
> ***increased visibility/recognition*** = the ERC grant made the grantee and his group more visible and brought more prestige;
>
> ***career push*** = the ERC grant helped the grantee to progress to a senior/permanent position, to make the transition to scientific independence or to improve his/her scientific network;

[18] Some of the results are reported in the mid-term H2020 evaluation for ERC, https://ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd(2017)221-annex-2-interim_evaluation-h2020.pdf#view=fit&pagemode=none. The small number of cases for the LS and especially for the Starting Grantees in LS, prohibits unfortunately any serious analysis for this focal group.

Although the numbers are still small and although this is self-reported information, they illustrate the value of using final reporting information to trace career impacts. The first preliminary results are encouraging for the impact of ERC grants on junior researchers, particularly of helping them to progress in their academic careers as independent researchers.

Some of the expressions used by the Starting grantees to describe the difference ERC made:

> *"The StG has given an enormous boost to my research career […]"*
>
> *"Obtaining an ERC Starting Grant has completely changed my research career. From considering moving to the US, I have been able to perform world-class research in my field from Europe."*
>
> *"The ERC grant was nothing short of a game-changer for us. It allowed us to conduct bigger science, on a scale that would not have been possible without it. It allowed us to conduct high-risk high-reward projects, some of which paid off well. It allowed us to spend time doing method development, which then allowed us to circumvent rate-limiting issues in the field, resulting in new discoveries and directions, but also valuable tools for us and the entire research community."*
>
> *"The ERC allowed me to "dream" science."*

Impact on research careers of team members from ERC grants

Very little research exists on the indirect effect of grants on team members of principle investigators. There is nevertheless a broader literature on the importance of peer/network effects in science, which would predict an impact from prestigious grants and the quality & reputation of the team leader on team members and their career progression. ERC grantees are typically exceptional scientists and the team members of ERC grantees are therefore exposed to a unique experience of being part of an ERC funded team. This exposure can be expected to spill over in their career development. As already mentioned, with ERC projects on average employing 7,5 team members (of which 1,6 PhDs and 2,4 Postdocs), there is possible important indirect effect on careers for young team members through ERC grants.

The final reports contain some information about the careers of the team members, as assessed by the PI. In about 34% (AdG2008) / 44% (StG2009) of the projects providing this information the team members continued in science as established scientists (this refers to researchers employed on permanent or tenure-tracked positions in research institutions). In about 37% (AdG2008) / 63% (StG2009) of the projects the team members found jobs in good academic institutions either on temporary contracts, e.g. as post-doctoral researchers, or in an unspecified type of job. In about 12% (AdG2008) / 23% (StG2009) of the projects the team members found good jobs in industry after the project.[19]

Insert Figure 17 here

In order to learn more on the career impact of ERC-PIs but also their team members, the ERC has launched a new study in 2017, which is currently still running. The core task of the study is to carry out

[19] For LS, there are as yet only 16 (StG) and 21 (AdG) final reports with information on team members' careers available, which is too low for meaningful analysis.

an in-depth analysis through surveys of the impact of ERC funding at the level of the careers of individual ERC PI's and team members, the ERC teams, and the ERC host institutions.

On a more longer term basis, tracing PIs and their team members after the grants have finished remain a challenge for the ERC. The aim is to have recurrent access to information on team members post grant. The ERC commissioned an expert report by Prof P. Stephan (GSU, US) which provided helpful suggestions on how to tackle this data challenge. The final reporting template has been recently adjusted to identify the most important team members with an author ID. Another challenge is to have recurrent access to information on career progression for a counterfactual group of researchers, such as unsuccessful applicants.

Integrating the institutional perspective

ERC funding generates a coincidence of wants between the individual recipient and the hosting institution. For institutions, hosting a grantee has become a manifestation of prestige and a competitive advantage. The ERC grant not only enables researchers to progress on their career, it also serves the interests of research organisations to host them. In order to attract junior ERC candidates, institutions will need to offer supporting environments which emphasize academic autonomy, an excellent research environment, provide resources and support for research funding, and offer tenure track positions.

Research programs like the ERC will therefore also have effects on the level of research institutions. Hosting institutions are an important mediator through which the impact of funding on careers will materialize, as they will affect not only the quality of the research environment for the individual researchers, but also how funding success will translate into career progression. To be able to monitor and evaluate the institutional level as mediator for career impact effects, requires individual level data to be complemented by organisational level data.

EURECIA, an ERC commissioned study, included this institutional level. [20] Restricted to only early first stage results, the study finds that ERC success is a quality label for all successful organisations across Europe with the largest impact in research organisations that are just below the top research performers. In weak organisations, the study finds that the reputation and funding related to the ERC grant is insufficient to induce change. In top performing organisations, ERC grants may enhance ongoing developments, but the real drivers of change are perceived to be global and national pressures. In general, the effect on host organisations are likely to be country specific, as the national research system shapes the degrees of freedom public host organisations have to adapt their policies. The currently running study on career impacts (cf supra) includes a dedicated survey directed to host institutions.

Identifying and tracing the relevant hosting institutions remains a challenge for the ERC. Statistics on the most successful hosting institutions are regularly published by the ERC. Table 5 lists the major host institutions for junior and senior grants in the Life Sciences.

Insert here Table 5: List of major LS Host Institutions

[20] https://erc.europa.eu/sites/default/files/document/file/eurecia_final_synthesis_report.pdf

The table of host institutions is made on the basis of who is the host institution listed on the grant. But the listed hosting institute may not always coincide with the true hosting institute. In several countries, there are cases of multiple affiliations for the PIs and, thus, overlapping occurs between different institutions. In France, the case of CNRS is well known. A number of CNRS scientists compete under different flags (like I. Pasteur, I. Curie, or others). In Flanders, a similar case exists with VIB and the KULeuven and UGent. The French CNRS and the German Max Planck cases also illustrates the problem of granularity, as the relevant research environment is often the level of the department within an organisation.

Some concluding insights from the ERC case

The young age of the program prohibits drawing already robust conclusions and insights on long term career impacts from the ERC case. The insights to be gained at this early stage come more from how to develop a monitoring and evaluation strategy to be able to trace systematically and continuously career impacts from and after the grant competition. Because the impact on careers for young researchers was a (albeit indirect) mission of the ERC from the onset, the ERC is quite unique in having put in place from the start, and continuously improving, its strategy and its supporting data & analysis infrastructure to monitor and evaluate the career impact from its grants. In what follows, we list some insights:

- Any strategy for monitoring and evaluating career impact starts with being able to identify the set of young researchers to be monitored. These are not only the PIs receiving the grant (with an ID tag (like Orchid)) but also their team members and a group of counterfactuals (eg non-successful applicants).
    - Tracing team members is important as there may be important indirect career impact effects from grants for team members benefiting from working at recognized and well financed centers of excellence.
    - Non-grantees tracking is important not only as counterfactual, but also to assess possible positive spillovers (eg from better HR policies at hosting institutions or hosting countries) or possible negative spillovers (less career progression possibilities for non-elites).
- Tracing career impact requires a multi-methodology and multi-dataset approach, combining quantitative, econometric analysis of linked information from application documents, final reports, publications & their citations, altmetrics…; qualitative analysis of significance of the results; survey evidence and interviews, case studies …
- It is important to understand the channels through which career impact materializes. Monitoring these channels will allow assessing already in the shorter term the process of career impact. Various channels can be identified:
    - Career effects from selection/certification of quality:
        - Requires monitoring the quality of the selection process
    - Career effects from ex post superior performance of the PI and his team
        - Requires monitoring the ex post performance of grantees
    - Career effects from indirect effects: recognition in the field, being able to attracting other funds, better international collaborators, expanding network…
- Career effects will depend on the (academic) labour market in which grantee is embedded; This implies that environment characteristics matter, such as the country and region of the host location. But perhaps even more importantly, the research environment and the HRM policies at the Host Institution (HI);

- The HI matters for career effects because it affects selection as well as impact
    - The HI affects selection as the quality/reputation of HI may impact the evaluation of the quality of the application and because of the quality of the research support offered to the applicant.
    - HI with attractive research environments and good career management will be able to attract and keep ERC candidates.
    - In addition, impact of an ERC grant (because it is substantial, it is portable and has reputation effects) can induce HIs to put in place accommodating career policies to attract and keep ERC grantees.

    This requires identifying the relevant HI environment and collecting information on their policies (through case studies, surveys and interviews). The ERC has only recently started to address this challenge.

- When looking at career impact, it is important to look at the portfolio of funding grants, not only the grants dedicated to juniors; Follow-on advanced grants , from the ERC or from other funding agencies, are important for grantees as prospects to be able to sustain their research agenda and their teams in the longer run. The prospects of follow-on grants will also impact the HI incentives to accommodate young ERC grantees.
- When looking at career impact, the gender dimension can not be ignored, especially in the Life Sciences;

References

Bloch, C., Graversen, E. K., & Pedersen, H. S. (2014). Competitive research grants and their impact on career performance. Minerva, 52(1), 77-96.

Melin, G.; Danell, Rickard (2006): The top eight percent: Development of approved and rejected applicants for a prestigious grant in Sweden. In *Science and Public Policy* 33 (10), pp. 702–712.

Resnick, A. (2014): Systemic addiction to research funding. In *Proceedings of the National Academy of Sciences of the United States of America* 111 (26).

Stephan, P., 2014, The economics of science, Harvard University Press.

Van den Besselaar, P. & Sandström, U. (2015). Early career grants, performance and careers; a study of predictive validity in grant decisions. Journal of Infometrics 9, 826-838.

Veugelers, R., 2016, The European Union's growing innovation divide, Bruegel Policy Contribution 2016/08.

Youtie, Jan; Rogers, Juan; Heinze, Thomas; Shapira, Philip; Tang, Li (2013): Career-based influences on scientific recognition in the United States and Europe: Longitudinal evidence from curriculum vitae data. In *Research Policy* 42 (8), pp. 1341–1355

Wang, J, Veugelers, R., Stephan, P. 2017, Bias against novelty in science: a cautionary tale for users of bibliometric indicators, *Research Policy*, 46, 1416-1436.

Whitley, Richard (2014): How do Institutional Changes Affect Scientific Innovations? The Effects of Shifts in Authority Relationships, Protected Space, and Flexibility. In Richard Whitley, Jochen Gläser (Eds.): Organisational Transformation and Scientific Change. The Impact of Institutional Restructuring on Universities and Intellectual Innovation. Bingley: Emerald Group Publishing Limited, (42), pp. 367–406.

Figures & Tables

Figure 1:

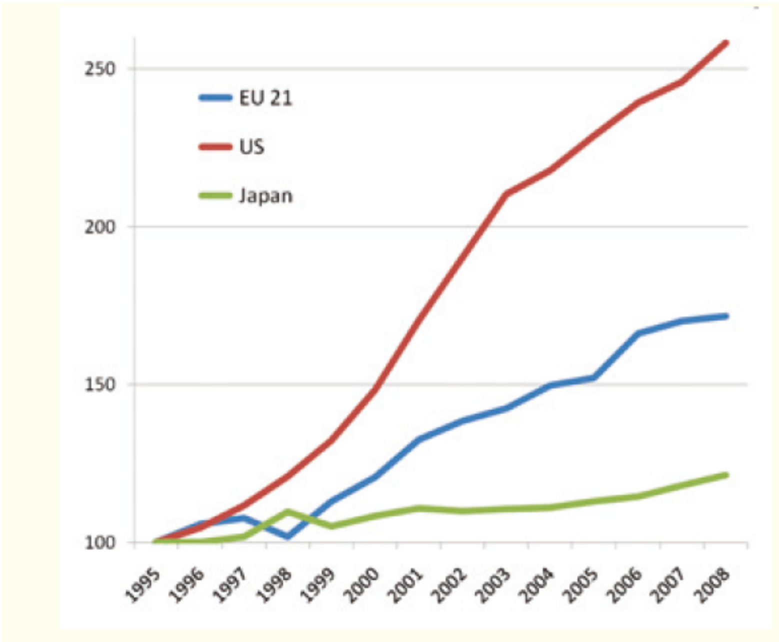


Figure 2.d.2.
Expenditure growth – time trends for nominal medical research expenditures performed in the non-market sectors relative to 1995 levels (=100) in national currencies (euro for all European countries)

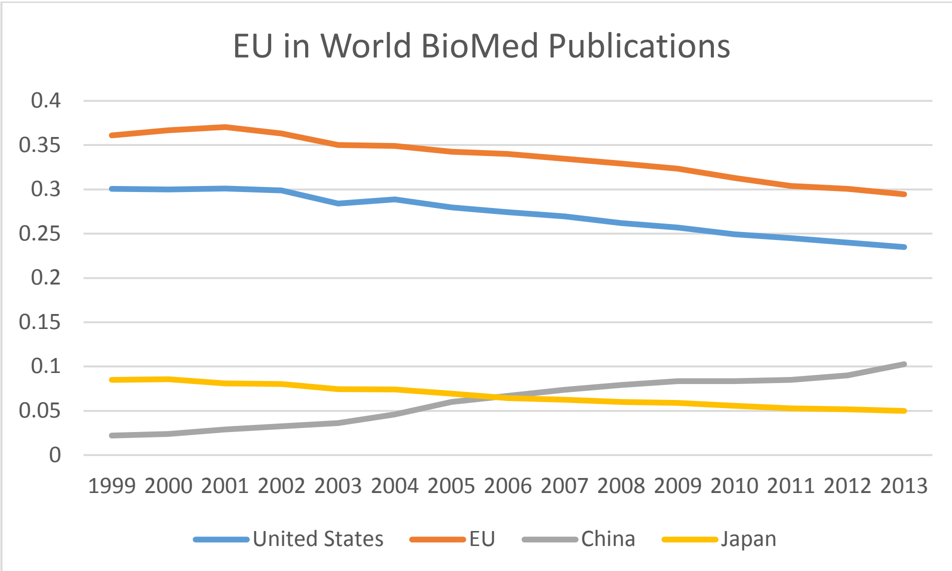
Source: ESF-EMRC (2011)

Table 1

Region/country	**Year**	**GBAORD (current PPP US$millions)**	**Health and environment**	**General university funds**
United States	2000	83 612,5	49,9	na
	2010	148 962,0	56,1	na
	2013	132 477,0	54,7	na
EU	2000	77 028,5	11,8	34,9
	2010	117 886,5	14,1	33,2
	2013	117 621,6	14,2	35,1

Source: On basis of SEI 2016

Figure 2



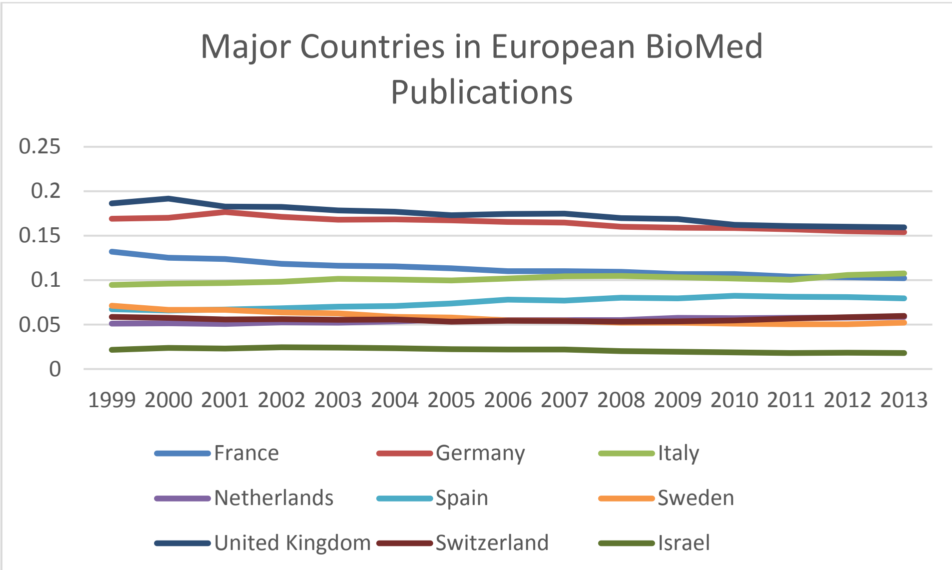
Source: on basis of NSF, SEI 2016

Table 2

Share of S&E articles, by field, citation percentile, and country/economy of institutional author: 2002 and 2012								
	United States		EU		China		Japan	
Field and percentile	2002	2012	2002	2012	2002	2012	2002	2012
Biological sciences								
99th (top 1%)	1,65	1,96	0,95	1,45	0,18	0,53	0,61	0,98
90th (top 10%)	14,27	16,22	10,37	13,19	2,66	6,92	7,68	9,91
Medical sciences								
99th (top 1%)	1,91	2,05	0,88	1,37	0,30	0,55	0,42	0,71
90th (top 10%)	16,16	16,31	9,28	12,07	4,12	7,24	5,45	6,95

Source: On basis of NSF-SEI 2016

Figure 3



Source: own calculations on basis of NSF, SEI (2016)

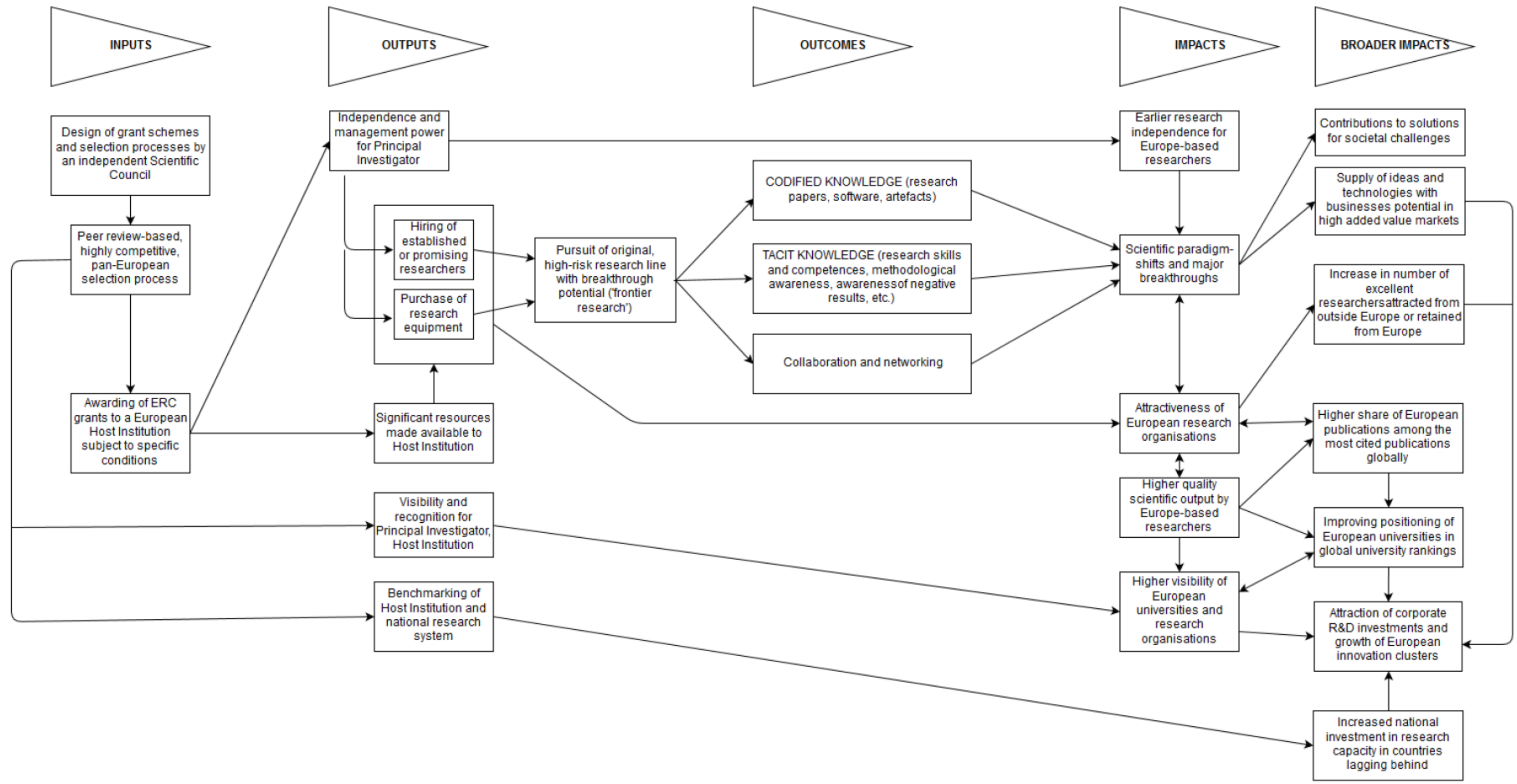
Table 3: Doctoral Degrees in Physical/Biological Sciences

	Total Number 2012	AAGR (12-02)
US	13143	4.4%
EU-7	22752	2.4%

	Total Number 2012	Share of EU-7	AAGR (12-02)
FRANCE	5048	22%	1.9%
GERMANY	6844	24%	3.0%
ITALY	2277	10%	9.4%
SPAIN	2740	12%	0.5%
SWEDEN	624	3%	0%
SWITZERLAND	903	4%	2.9%
UK	4316	19%	0%

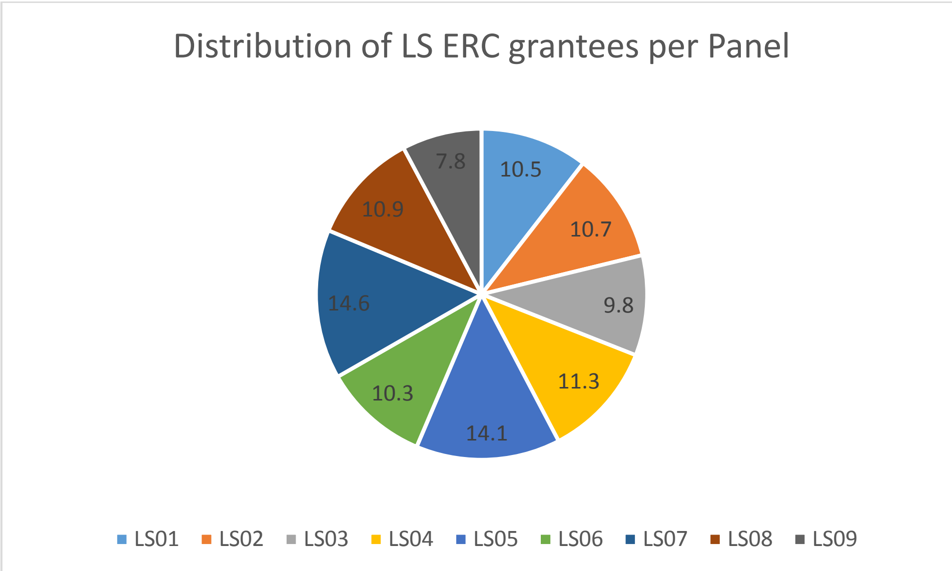
Source: Own calculations on basis of NSF, SEI (2016)

Figure 1 - Schematic intervention logic of the European Research Council



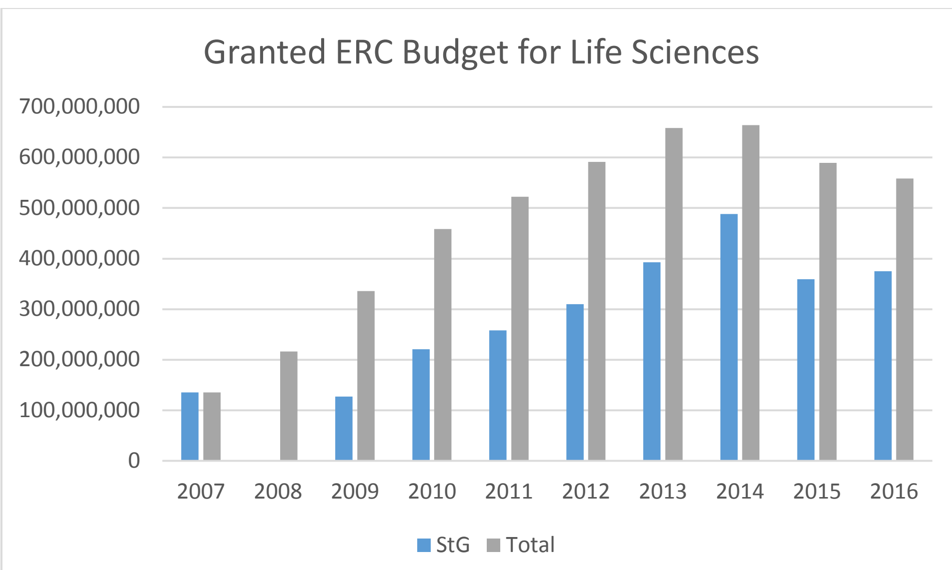
Source: ERCEA.

Figure 4



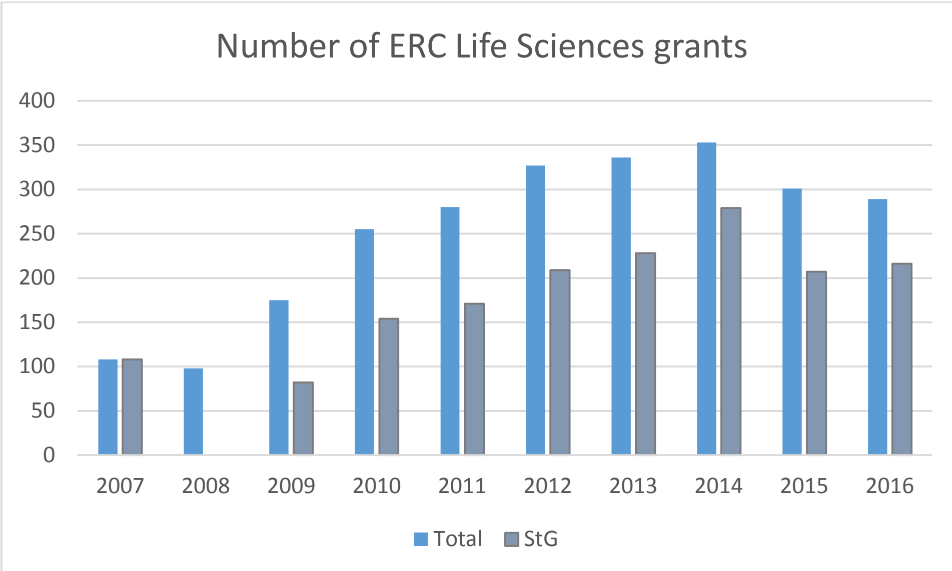
Source: ERCEA

Figure 5-I



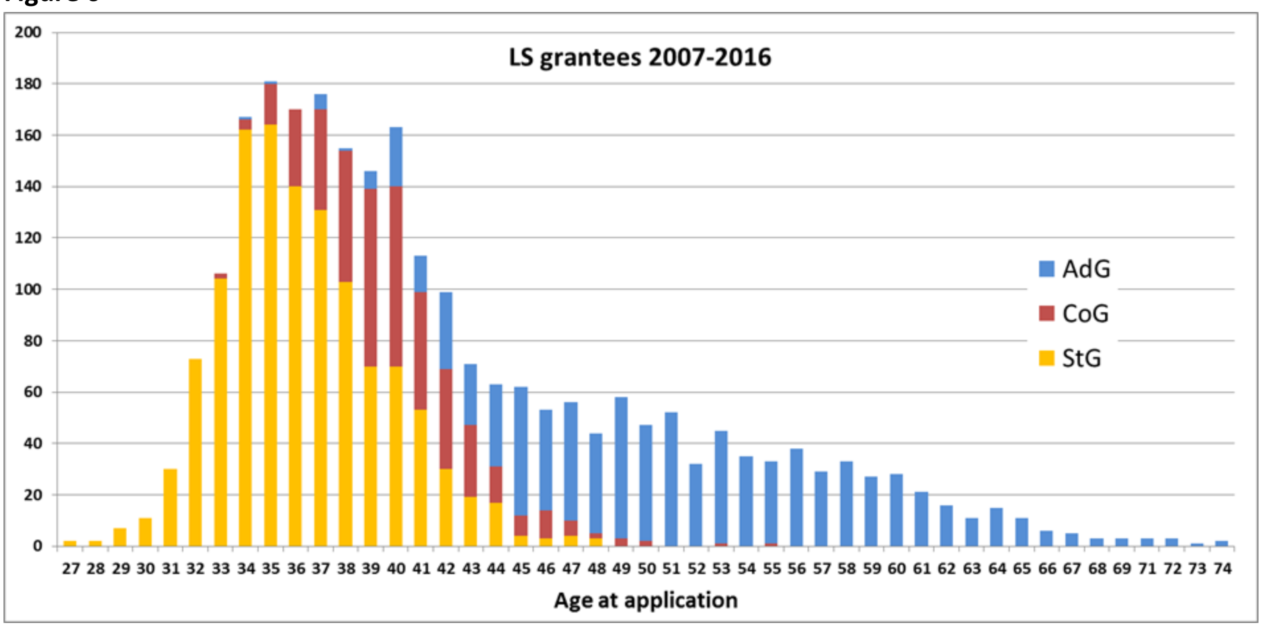
Source: ERCEA

Figure 5-II



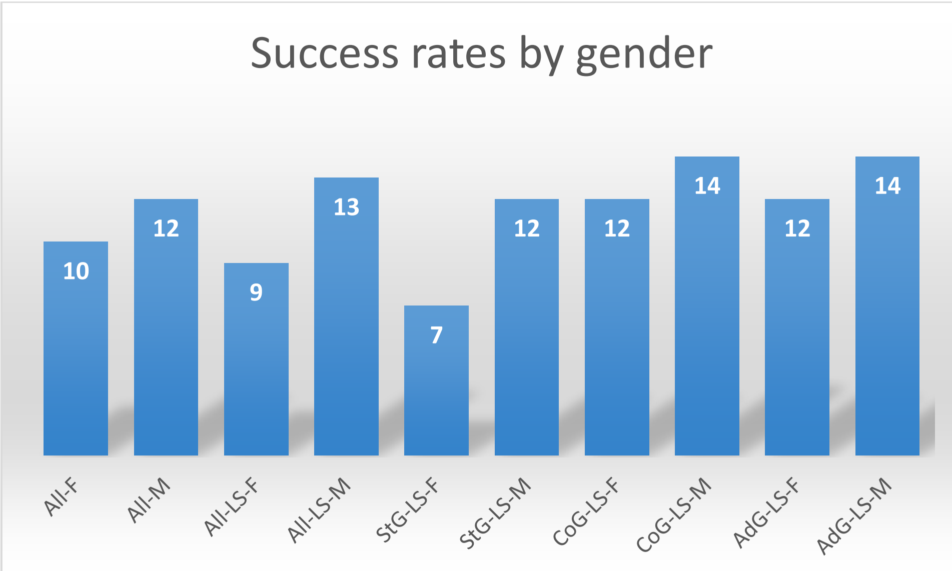
Source: ERCEA

Figure 6



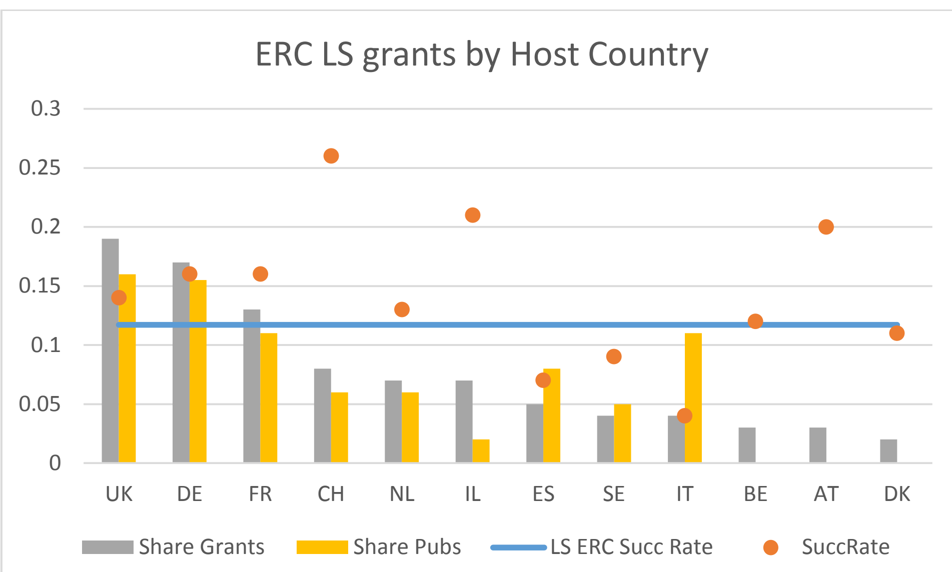
Source: ERCEA

Figure 7



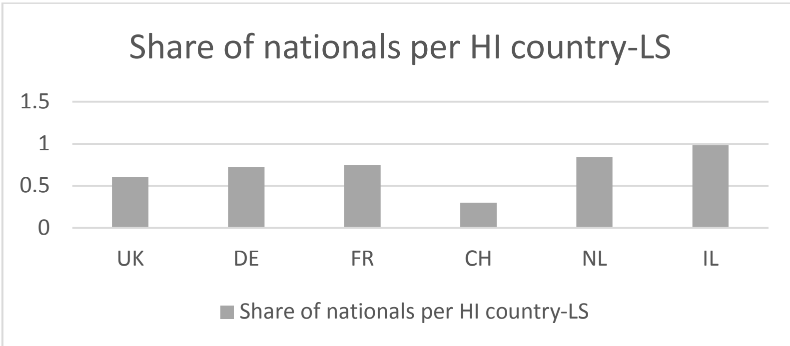
Source: ERCEA

Figure 8



Source: own calculations on basis of NSF-SEI and ERCEA

Figure 9



Source: Lagat-ERCEA study

Figure 10: Publication profile from ERC grants: Starting Grants in Life Sciences

Starting Grants in Life Sciences		Pre-Selection				Post-Selection				Impact	
Dimension	Proxy	Rejected	Granted	Diff (Selection)		Rejected	Granted	Diff (Post-Selection)		Diff-in-Diff	
Quality: Highest IF pub	JIF_MAX	10.18	17.86	7.68	***	10.09	16.65	6.56	***	-1.13	
Quality: Share of pubs in Top1%	RATIO_C3TOP01	0.04	0.08	0.04	***	0.02	0.06	0.03	***	-0.01	
Risk: Novelty	DUM_HIGH_NOV	0.26	0.13	-0.13	***	0.17	0.17	0.00		0.13	***
Risk: Interdisciplinarity	rao stirling_MAX	0.31	0.28	-0.02	***	0.31	0.30	-0.01	***	0.01	*
International EU Network	ratio international pubs, within ERA	0.19	0.16	-0.03		0.20	0.23	0.03		0.06	**
International US Network	ratio international pubs, with US	0.29	0.42	0.13	***	0.20	0.28	0.09	***	-0.05	

Source: Own calculations on basis of ERCEA; Unit of analysis: project. Measures based on 3 years publication profile before/after call year (excl.).

Figure 11: Publication profile from ERC grants: All Grants in Life Sciences

All Grants in Life Sciences		Pre-Selection				Post-Selection				Impact	
Dimension	Proxy	Rejected	Granted	Diff (Selection)		Rejected	Granted	Diff (Post-Selection)		Diff-in-Diff	
Quality: Highest IF pub	JIF_MAX	11.96	18.69	6.73	***	12.13	18.83	6.69	***	-0.03	
Quality: Share of pubs in Top1%	RATIO_C3TOP01	0.04	0.07	0.03	***	0.03	0.06	0.03	***	0.00	
Risk: Novelty	DUM_HIGH_NOV	0.28	0.20	-0.08	***	0.20	0.22	0.02		0.11	***
Risk: Interdisciplinarity	rao stirling_MAX	0.31	0.30	-0.02	***	0.32	0.31	-0.01	***	0.01	*
International EU Network	ratio international pubs, within ERA	0.21	0.18	-0.03	**	0.22	0.23	0.01		0.04	**
International US Network	ratio international pubs, with US	0.25	0.35	0.10	***	0.21	0.27	0.06	***	-0.04	*

Source: Own calculations on basis of ERCEA

Table 4

International Benchmarking ERC LS funded researchers

	n	Share 1%-All	Share 1%-Junior	ARC-all	ARC-Ack-All	ARC-Junior
ERC	913	5.2%	4.6%	2.7	3.0	2.6
NIH	400	4.7%	6.2%	2.7	2.8	3.1
HHMI	100	7.1%	8.9%	3.4	3.6	3.7

Source: Scientometrics ERCEA study

Figure 12

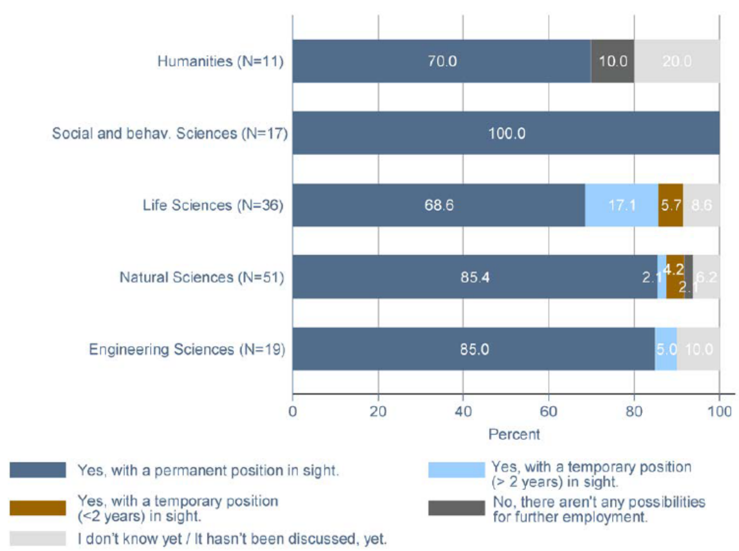
Table 48 Position before StG application by research field

Position before StG application		HUM	SOC	LS	NS	ENG	Total
Full/associate professor	N	29	57	69	95	70	320
	in % (row)	20.86	32.95	12.95	19.71	28.57	20.36
Assistant professor/ group leader	N	21	27	192	84	47	371
	in % (row)	15.11	15.61	36.02	17.43	19.18	23.60
(Senior) Researcher	N	66	83	237	272	118	776
	in % (row)	47.48	47.98	44.47	56.43	48.16	49.36
Other	N	23	6	35	31	10	105
	in % (row)	16.55	3.47	6.57	6.43	4.08	6.68
Total	N	139	173	533	482	245	1,572
	in % (row)	100.00	100.00	100.00	100.00	100.00	100.00

Source: MERCI online survey (1st wave), approved and rejected applicants pooled

Figure 13

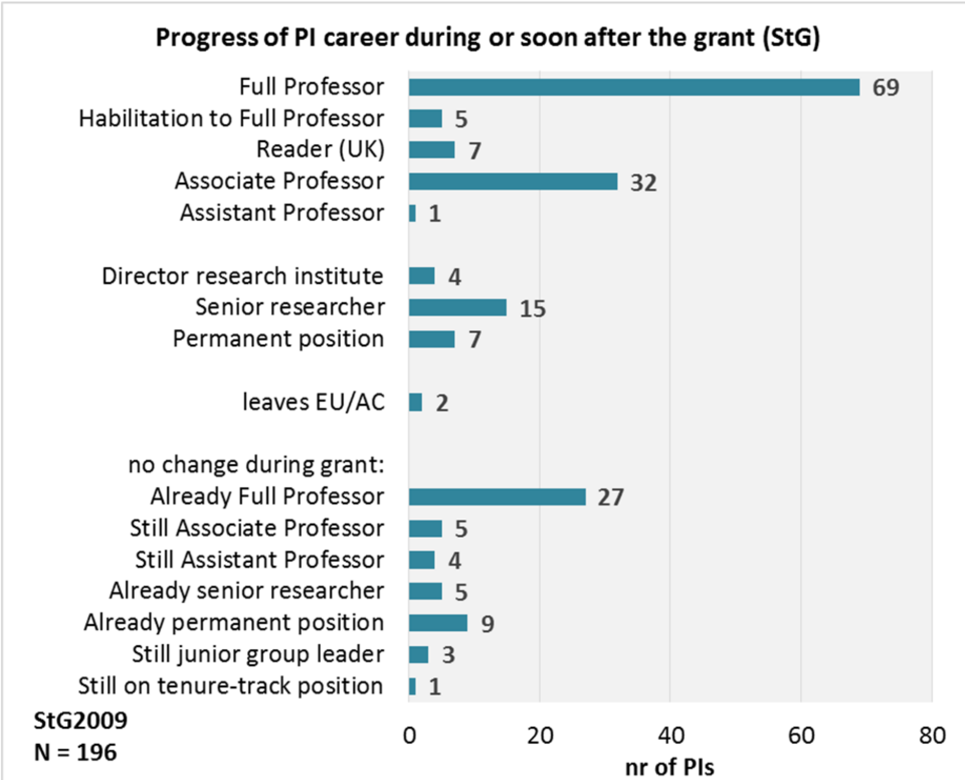
Figure 39 Position in prospect at the StG host institution after the ERC funding will expire across research fields



Source: MERCI online survey (2nd wave survey), only approved applicants included

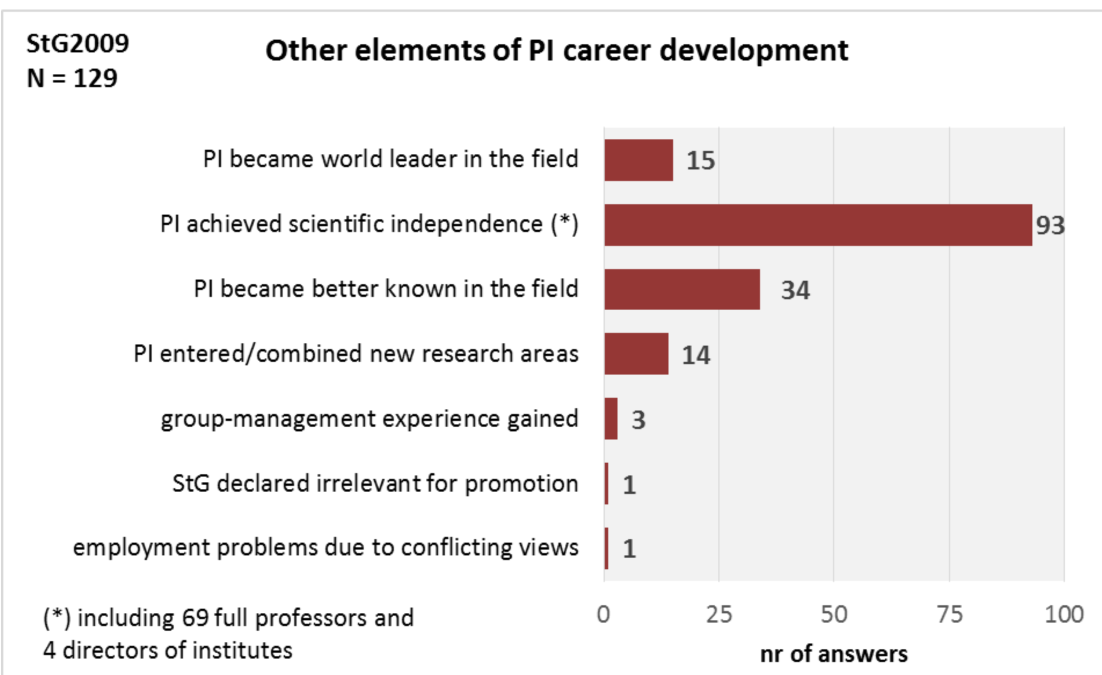
Note: Original question reads as following "Looking at your current job situation: Are there already any agreements to continue your employment at your current StG host institution (e.g. tenure track, contract extension)?"

Figure 14



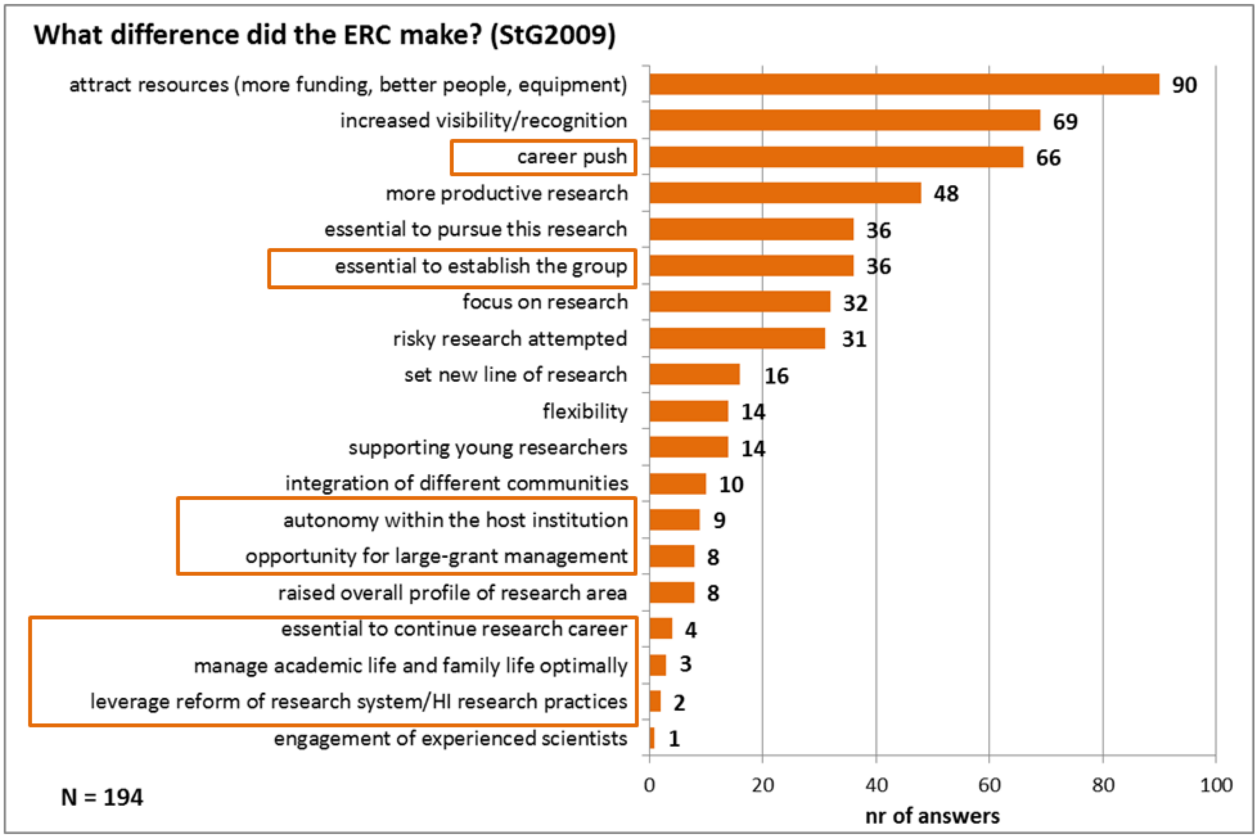
Source: ERCEA

Figure 15



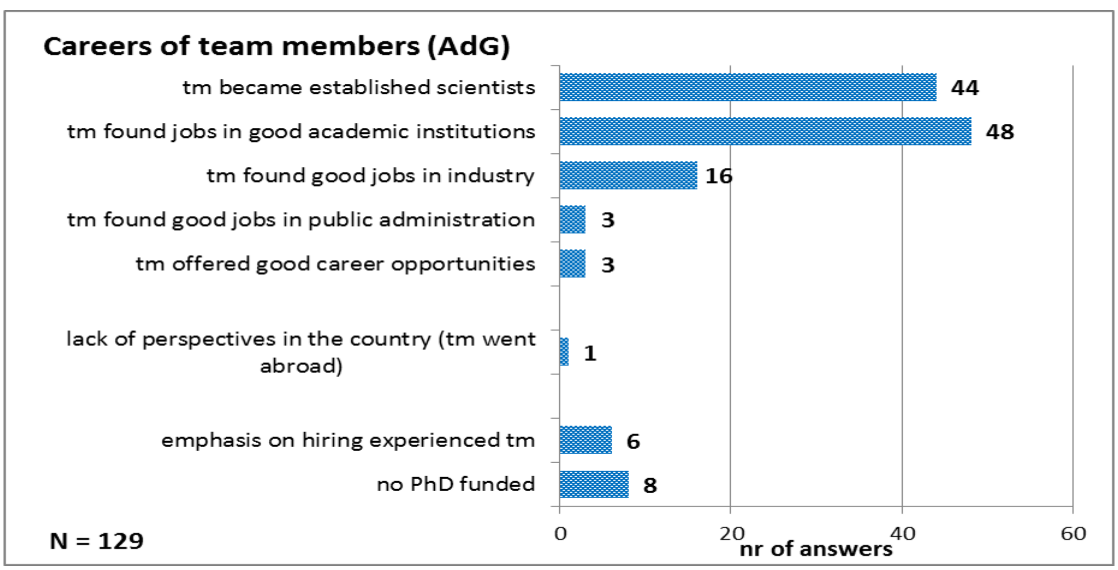
Source: ERCEA

Figure 16



Source: ERCEA; Note: boxed items are specifically asked for StG only.

Figure 17



Source: ERCEA

Table 5

Major LS Host Institution	**Country**	**StG-LS**	**AdG-LS**	**Total-LS**	Succ Rate – Total LS
CNRS	FR	79	26	105	13.7
Max Planck Society	DE	55	43	98	26.3
INSERM	FR	60	23	83	15.4
University of Cambridge	UK	39	29	68	22.5
Weizmann Institute	IL	50	16	66	34.6
Helmholtz Association	DE	44	20	64	18.2
University College London	UK	37	19	56	17.4
University of Oxford	UK	29	26	55	14.8
Hebrew University of Jerusalem	IL	32	13	45	20.6
Karolinska Institute	SE	26	19	45	10.3
KULeuven/VIB	BE	28	11	39	26.7
ETH Zurich	CH	17	18	35	28.9
Pasteur Institute	FR	22	13	35	30.6

As of April 2017

Source: ERCEA

ERC-like or ERC complementing schemes at national funding level

A first list includes examples of national research bodies that have been established/reformed partly or entirely inspired by the ERC approach. The selection is based either on specific references to ERC in basic law creating or reforming the respective organisations, or on account by national contact points or other national experts .

- in **Poland** an entirely new funding organisation (the National Science Centre) was set up based on the ERC model with a decisional scientific council (2010)

- in **Greece** the Hellenic Foundation for Research and Innovation (ELIDEK) was established (2016), led by Scientific Council that will be established in accordance with best practices from across Europe and around the world.

- in **France** the National Research Agency was created to fund research projects on a competitive basis (2005).

- in **Romania** the National Council for Scientific Research was created to coordinate scientifically the national programmes "Ideas", "Human Resources" and "Capacities", replacing the former National Council for Scientific Research in Higher-Education Sector (announced 2007, operational 2011)

- in **Ireland** the two research councils for the Humanities and Social Sciences and Science, Engineering and Technology, were merged into a single body, the Irish Research Council (2012)

- in **Estonia** the Estonian Research Council (ETAg) took over the functions of the Estonian Science Foundation (2012)

A second list includes examples of national schemes created to integrate ERC funding, usually by supporting ERC best ranked applicants who did not obtain the funding due to budget restrictions. The information has been gathered from websites of the funding organisations or provided by national experts.

Flanders (FWO) offers each year to the best ranked Principal Investigators on the ERC Starting Grant reserve list with a host institution in Flanders, the possibility to start a research project financed by the FWO. (about 5 every year)

FWO supports up to 5 applicants with a Flemish university as HI who reached the end of step 2 of the evaluation process of the ERC Starting Grants 2016 call and received an 'A' score, but did not receive European funding due to budgetary constraints. FWO offers a research project, including 1 scientific staff member for 4 years and 10.000 EUR consumables per year (70.000 EUR in total). The research project must be carried out at a Flemish university as HI.

Czech Republic: National funds (600 million CZK for the years 2012-2019). Addressed to Czech researchers at Czech HI that have obtained in A in evaluation. The proposal is funded entirely as submitted to ERC. (Budget can be cut in justified cases).

Finland: Invitation call: open to finalists in the reserve list. Proportion of a research grant is a maximum of 50 per cent of the average annual amount of funding in an application that has been addressed to the ERC.

France: Agence National de la Recherche launched an initiative to support researchers with a French host institution who passed the ERC quality threshold but who did not get ERC funding (For 2017 a budget of 10 mil euro)

Ireland: ***SFI ERC Resubmission Incentivisation and Development Programme*** funds researchers that applied with a HI in Ireland whose proposals scored "A" at Step 2 in ERC calls. Funding is also available for reserve list candidates based outside IE, committed to reapplying from Irish HIs, in order to attract more talent to IE. The grants will be 50% of the original ERC proposal, or €500,000, whichever is lower, for a maximum of 24 months. The programme aims to encourage such researchers to resubmit to future ERC calls. The only review criterion is "How well will the proposed research improve an ERC resubmission". Since 2012 SFI also has an ERC support programme for the Irish host institutions of ERC grantees. Top-up awards were available as incentives for the first Starting Grant.

Norway: The Norwegian Research Council (RCN) has established a funding scheme which aims to back unfunded ERC candidates with a Norwegian host institution who passed the ERC quality threshold after step 2 (for calls in WP2012 and later: scoring an A).The amount made available by the RCN for a proposal is maximum 75 % of the amount requested from the ERC. Norway's research council has launched a call aiming to help researchers who are narrowly rejected for European Research Council funding to apply again.

Slovenia: Slovenian Research Agency published a national complementary scheme for applicants (Starting and Advanced) with Slovenian host institutions who made it to step 2 but were not successful in ERC calls. The level of funding depends on the result achieved in ERC evaluation, but in principle the project budget is diminished (as well as the duration).

Sweden: The Swedish Research Council supports candidates that obtained an A, were on the reserve list and were not funded by ERC.In 2016 a group of Swedish Foundations launched the Swedish Foundation's Starting Grant for ERC applicants that got an A but were not on the reserve list. The amount applied for from the ERC is granted for five years, given that a new application to the ERC is submitted, if possible.