

Chapter 5

Self-Organisation and Steering in International Research Collaborations



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Self-organizing networks that span the globe are the most notable feature of science today. These networks constitute an invisible college of researchers who collaborate not because they are told to but because they want to, who work together not because they share a laboratory or even a discipline but because they can offer each other complementary insight, knowledge or skills. (Wagner 2008, p. 2)

5.1 Introduction

An important characteristic of the scientific community is international collaboration among its members. Some of the key works on the scientific community, such as Diane Crane's 1972 book *Invisible Colleges* and Warren O. Hagstrom's 1965 work *The Scientific Community*, demonstrate the major role that collaboration plays in advancing and diffusing knowledge in scientific communities. While collaboration, including international collaboration, has a long tradition in the scientific community since its early professionalisation in the seventeenth and eighteenth centuries (Beaver and Rosen 1978; Crawford et al. 1993), today it is intensifying, as demonstrated by an increasing share of international co-authorships from 10.14% in 1990 to 24.55% in 2011 (Wagner et al. 2015). Many factors, both internal and external to science, account for this growth, including increasing specialisation, growing costs of scientific instruments, the development of information and communication technologies, the need to address cross-border problems, and policy support for internationalisation at national and regional levels (e.g. the European Research Area initiative; see Chou and Ulnicane 2015). International collaborations lead to higher impact research (Adams 2013; Wagner and Jonkers 2017; Wagner et al. 2018).

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As the growth of international collaboration today is driven by scientific and political reasons, a better understanding of the tension between self-organisation and steering discussed in studies on international research collaboration (Engels and Ruschenburg 2008; Wagner 2008; Wagner and Leydesdorff 2005) becomes increasingly relevant. While these studies have indicated the positive role of self-organisation and the more challenging one of steering for launching productive collaborations, so far little is known about how self-organisation and steering work and interact in international collaborations.

In order to deepen the understanding of processes of self-organisation and steering, this article undertakes an explorative study to empirically identify relevant features of self-organisation and steering, their role, and interaction. To do so, two contrasting in-depth case studies of international research collaboration in nanosciences are compared. In the first case study of long-term informal international research collaboration, it can be expected that self-organisation dominates; while in the second case study of collaboration within a European project, it can be expected that steering plays the main role. While steering of research collaborations can come from diverse sources, including university governance, this contribution focuses on steering from grant-giving agencies.

Concerns about external interference in research collaboration are well known in the literature on the scientific community. In his 1965 study of the scientific community in the United States, Hagstrom analysed rapid changes in 'the traditional organisation of basic research in universities' where it was assumed that 'the scientist is essentially free to choose problems and techniques as he pleases, that he is free to accept or refuse collaboration with others' (Hagstrom 1965, p. 140). He suggested that 'a more complex form of organisation may be supplanting free collaboration' (ibid.) due to a number of changes, including dependence on grant-giving agencies, which can inhibit the flexibility of research and discourage risk-taking and long-term projects.

Since 1965, when Hagstrom's concern about dependence on grant-giving agencies was published, the share of project funding in overall science funding has increased and today accounts for a quarter to more than half of total public research funding (Steen 2012). This growing role of external funding particularly affects international collaboration because the majority of project funding is distributed nationally. Gradually increasing but still relatively limited funds for international collaborative projects are allocated, for example, within the EU Framework Programme (FP) launched in the 1980s (Ulnicane 2015). Traditionally, a lot of international collaboration has been 'informal', i.e. outside dedicated international projects, and has only shown up in international co-authorships (Georghiou 1998). Thus, the intensification of international collaboration in times when science is increasingly based on external (predominantly national) funding and is simultaneously expected to address cross-border societal challenges (Ulnicane 2016) requires better understanding of the role that self-organisation and steering plays in international collaborations.

By exploring self-organisation and steering, this article aims to contribute to studies on managing scientific collaboration (Bozeman and Youtie 2017) and theory development of research collaborations (Shrum et al. 2007).

This paper proceeds as follows. First, key claims in the existing literature on self-organisation and steering in international research collaboration are presented. Second, the methodology and data sources are explained. Third, processes of self-organisation and steering in two in-depth case studies are examined. Finally, insights on self-organisation and steering are discussed.

5.2 Self-Organisation and Steering in International Research Collaborations

Several studies on (international) research collaboration have indicated that the self-organisation of scientists plays a major role in creating productive collaborations, while the role of policy steering is limited or even counter-productive (Engels and Ruschenburg 2008; Melin 2000; Wagner 2008; Wagner and Leydesdorff 2005). In his study on collaboration, Melin (2000, p. 39) finds a high degree of self-organisation where collaborations take place ‘without other initiators than the researchers themselves, and also the forms of the ventures are the products of researchers’ own organisation’. Wagner and Leydesdorff (2005, p. 1616), in their research on international scientific networks, reach a similar conclusion on the major role played by self-organisation where international collaborations ‘are formed through the individual interests of researchers seeking resources and reputation’.

Several studies of collaborations have suggested that scientists are sceptical about policy-makers’ attempts to steer and intervene in collaborations—which scientists sometimes see in the EU’s requirement that the Framework Programme projects include participants from several EU member states—that could lead to ‘artificial networks’ lacking coherence and the ability to produce high quality research (Engels and Ruschenburg 2008, p. 355). Drawing on his results, Melin (2000, p. 39) recommends that ‘the scientists themselves should choose with whom they would like to cooperate, and under which forms. Initiatives and directives from politicians and funding agencies are not welcomed by the scientific community and can lead to the establishment of contacts with people other than the scientifically most interesting ones’. Wagner (2008) suggests that science policy should seek and encourage bottom-up, self-organising global networks but mentions that ‘these networks cannot be managed; they can only be guided and influenced’ (Wagner 2008, p. 105).

Against the background of some of the key research collaboration studies reporting a strong sentiment from scientists in favour of the freedom to self-organise collaborations and against political steering, concerns raised by Hagstrom in 1965 about the impact of funding agencies on free collaboration (Hagstrom 1965) are particularly relevant because the role of funding agencies has increased. To empirically study the role of funding agencies in steering collaborations, it is of crucial

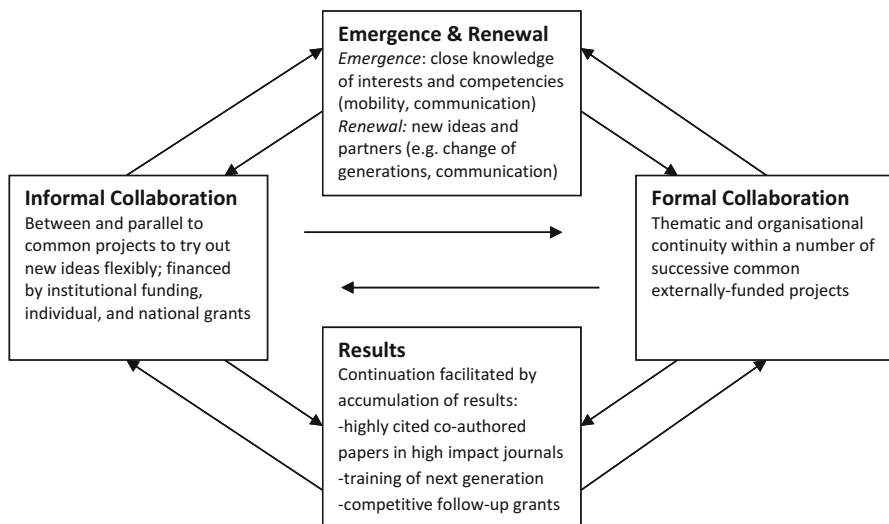


Fig. 5.1 Stylised model of long-term international collaboration process in nano S&T (Ulicane, 2015, p. 440)

importance that collaborative funding schemes differ considerably. This can also be seen in the FP, where different funding schemes for collaboration vary greatly in terms of thematic guidance (from specific topics elaborated in the calls to thematically open schemes) and other requirements (e.g. related to the type of activities and composition) with which collaborative projects must comply. Thus, externally funded collaborative projects can entail different degrees and types of self-organisation and steering that must be studied empirically.

While the above-mentioned studies do not provide precise definitions of self-organisation and steering, they indicate a number of characteristics of both. Key features of self-organisation in international collaboration include initiation in a bottom-up manner by researchers themselves based on their individual interests and free choice of collaborators and modes of interaction. In contrast, steering is associated with initiatives and directives from politicians and funding agencies and artificial collaborations based on requirements to collaborate with people from specific countries, leading to contacts that might not be the most scientifically interesting ones. This study aims to further clarify relevant characteristics of self-organisation and steering by undertaking in-depth empirical research on international collaborations.

To thoroughly study the role of self-organisation and steering, this paper uses a process model of international collaboration (see Fig. 5.1) that focuses on four elements: emergence and renewal of collaboration, informal collaboration, formal collaboration, and results (Ulicane, 2015). The emergence and renewal element explores how collaboration starts (selection of partners and topics) and how it later renews itself with new ideas and collaborators. An important ingredient of the

emergence and renewal of collaboration is the diverse scientific, institutional, and social motivations of partners to launch and continue collaboration. Collaborations can develop over a longer time, combining informal and formal interactions. Whereas informal collaboration takes place outside joint externally-funded projects, formal collaboration is organised within common externally-funded projects. Both formal and informal collaboration can lead to variety of results, including co-authorships, training of researchers, and joint follow-up projects. The collaboration process can take different paths through these four elements: it can start informally and then lead to formal projects, or it can evolve through a number of successive formal projects with some informal interactions between or parallel to projects. There can be diverse feedback loops between different elements with results from earlier collaboration leading to follow-up projects and the renewal of collaboration.

While many definitions are used (e.g. Chen et al. 2019; Katz and Martin 1997; Laudel 2001) in extensive literature on (international) research collaboration, the process model used for the purposes of this study understands it as a joint research activity with a common aim or shared objective among scientists based in public research institutes in different countries (Ulicane 2015, p. 434). Such joint research activity often starts because of international mobility (Jons 2009; Melkers and Kiopa 2010; Sugimoto et al. 2017; Wang et al. 2019) and afterwards can occur within a formal, common externally-funded project or be organised informally among collaborative scientists and funded from pooling together their institutional, national, individual, or industrial grants.

5.3 Research Methods and Data

To answer the research question and conduct an in-depth analysis of the role of self-organisation and steering in international collaborations, this paper combines multiple research methods and data sources. Two comparative case studies of international research collaborations are undertaken to obtain a detailed understanding of and rich insights into (George and Bennett 2005) self-organisation and steering. These collaborations were selected from the data on the main non-university research institutes in Germany (Heinze and Kuhlmann 2008) that collaborate with scientists in France, UK, and the Netherlands in the emerging field of nanosciences (Heinze 2010; Noyons et al. 2003).

According to the sociology of science studies (Crane 1972; Merton 1973), emerging sciences, also known as ‘hot fields’, are particularly relevant for studying collaborations because they are characterised by intense interaction, communication, and rivalry. Moreover, nanosciences are interdisciplinary. The two collaborations in the case studies bring together research groups with complementary expertise in chemistry, physics, and life sciences. Each research group involves scientists at different career stages, from professors and institute directors to post-doctoral

researchers and PhD candidates. Both collaborations have a strong focus on training early career researchers.

The diverse case method (Gerring 2008) was used to choose two very different collaborations: one has a long experience of informal interaction, while the other has, so far, been largely limited to a formal externally-funded project.

The within-case analysis follows the method of retrospective process tracing (George and Bennett 2005), using substantial evidence from multiple data to reconstruct the emergence and development of collaboration according to the stylised model of collaboration presented above. To undertake a careful tracing of events, the cases draw on publication, citation, organisational, project and CV data, semi-structured interviews, and site visits to the institutes of the collaborators in the four countries.

Seventeen semi-structured interviews (seven for the first case study and ten for the second) were an important source of information. Several collaborators at each institute at different career stages were interviewed. The general interview protocol focused on the emergence of collaboration; motivations; the choice of topics, partners, and forms of interaction; and the evolution of the collaboration and its results. Each interview included extensive preparation of studying interviewee's publications, CV, projects, and organisational websites.

To compare both case studies, this paper follows the approach of contextualised comparison (Locke and Thelen 1995), looking for analytical parallels in different contexts. While the two collaborations differ in terms of their topics, length, and forms of interaction, the stylised model of collaboration allows for comparing the role of self-organisation and steering in each and looking for similarities and differences.

5.4 Self-Organisation and Steering in Two International Research Collaborations

For a better understanding of the key differences between self-organisation and steering, two contrasting cases are examined. While self-organisation of scientists is expected in the first 'long informal collaboration' case study, steering from a funding agency is predicted in the second 'novel project' case.

The first 'long informal collaboration' started with a researcher doing his PhD abroad with supervisors in two countries. The international links triggered by the joint PhD led to an informal trilateral international collaboration (involving researchers based in Germany, the Netherlands, and UK) lasting over ten years, which was structured around regular research seminars. Due to the international mobility of the two main collaborators, the tradition of regular seminars ended after more than ten years. However, several of the main collaborators continue to cooperate as a core-group within two larger applied FP projects. In their joint research activities, the collaborators combine different experimental techniques. The three

Table 5.1 Key characteristics of the two case studies of international collaboration

Case study ‘Long Informal Collaboration’	Case study ‘Novel Project’
Informal international collaboration launched by a PhD candidate wanting to do his PhD in a neighbouring country and extended by an internationally mobile postdoc	An internationally mobile postdoc acquires and coordinates an FP project focusing on interdisciplinary training and fundamental research
Strong focus on training	Project has a strong focus on training PhDs and postdocs
After ten years of informal collaboration and international mobility of two key collaborators, partners acquire three joint applied FP projects	After the project, some collaborators continue informal interactions but cannot find a coordinator for a follow-up project application
Formal and informal collaboration leads to co-authored papers	Successful project leads to co-authored papers

institutes where the collaborators are based are referred to here as Institutes A, B, and C.

The second collaboration ‘novel project’ started in the form of a four-year FP-funded project. While the project involved eight institutes from six countries, this case study focuses on the four institutes constituting the core of collaboration. These four institutes based in Germany, the Netherlands, UK, and France are referred to here as Institutes A, B, C and D. In the project, they combined different experimental competencies of synthesis, characterisation techniques, and expertise from life sciences. The leading role in this collaboration was played by a researcher at Institute A who developed a novel interdisciplinary topic for a collaborative project and brought together a new network.

While the two cases summarised in Table 5.1 have major differences regarding the focus on either predominantly formal or informal collaboration, they also have some important similarities. Both collaborations were launched by internationally mobile early career researchers—PhD and postdoc—and have a strong focus on training PhDs and postdocs who play an important role in laboratory sciences such as nanosciences. Over time, an interesting change happens in both cases—informal collaboration leads to formal projects, while the formal project is followed by a number of informal interactions.

To establish what role self-organisation and steering play, the emergence and evolution of both collaborations will be compared.

5.4.1 *Emergence*

‘**Long informal collaboration**’ was initiated when a student wanted to do his PhD in a neighbouring country at Institute A. As a researcher recounts, this collaboration started ‘when a young man walked through the doors of [our institute] and said “I

want to do a PhD”. And we thought it was so cool that we said “Wow, we have to take this guy”.’

However, Institute A is a non-university institute and cannot award a PhD degree. The engineering degree the researcher had from his home country was not seen as sufficient to enrol him as a PhD at the local university near Institute A. Thus, in order to do his PhD at Institute A, he had to register as a PhD student in his home country. Institute B was chosen for that purpose. He was jointly supervised by the professors at Institutes A and B and did his PhD research in both institutes. This joint PhD initiated collaboration between Institutes A and B. His supervisor at Institute B explains that the joint PhD:

Brought us together—professor [in the Institute A] and me and we started talking and said ‘o, Jesus, very interesting because we can do here more engineering as a technical university’. At [the Institute A] they are more up-stream, a lot of fundamental things. So we can combine our strengths and this guy [common PhD] could be a glue between the two groups.

While this collaboration was initially bilateral, very soon it became trilateral when a former postdoc from Institute A, who had also previously visited and co-authored a highly cited paper with researchers at Institute B, got a permanent position at Institute C in his home country and joined the collaboration.

A leading role in initiating ‘**novel project**’ was played by Institute A, which sees participation in and coordination of international projects as a sign of scientific quality and a way to be internationally recognised in its research field and integrated into international networks. Scientific leadership in preparing and coordinating the project was provided by a postdoc at Institute A. He developed an idea for this project while he was abroad. He states that the scientific idea for the network was based on an idea from local research which needed additional expertise and resources in order to be developed further:

That is based on some ideas in in-house research and also patents which we did and also based on a local cooperation . . . Then it turned out that we need some more complementary research and we were trying to get some funding . . . [A]t that time I was postdoc [abroad] and I met one [scientist] there and so I decided to set up such a network.

He states that for a novel interdisciplinary topic he looked for potential international partners in a number of ways: using links from individual international mobility, looking for scientists with relevant competences and equipment on the internet, searching via publications and projects on their websites, and asking for advice within the scientific community:

I did relatively naïve approach. I was sitting at my desk at [laboratory abroad] and trying to think or to make a plan what I would be interested in. So and then I checked what is needed and I made a plan and then I checked the internet for possible partners. So I knew what I wanted to have all those techniques and then I checked out and called people, introduced myself, trying to find others who knew people working in that respective field.

The relevant competences and equipment of researchers at University B were identified via an internet search of websites and previous projects. Other collaborators were found via individual international mobility and local links at the respective sites. The researchers involved emphasise that, compared to their other

collaborations, the origin of this project was rather unusual as the partners had not collaborated before. Nevertheless, they state that this approach worked out well. One of the researchers involved explains that:

[The core initiators of the project] approached a large group of people via e-mail and internet. And that is very curious because that would be a recipe for disaster, having non-motivated people in the project. An interesting thing is that it turned out to be an incredibly productive network. So this e-mail and internet procedure worked out well, and I think one of the reasons for that is that they did not ask friends, but they started looking for who is the best in this type of field, and they simply approached them. And if you start with the group of friends, you want to be friendly to everybody, and maybe you don't make the best choices in all cases. And in this case they were pretty lucky in the choices that they made, and they found very interesting consortium of really interested multidisciplinary people and research groups. From the beginning I was surprised how good the atmosphere in this network was.

However, the coordinator says that the choice of partners was based not only on scientific needs but also on his perception of EU rules. He explains that:

The real problem is: you have to obey the European rules. You have to find people, let's say from good regions; you have to include women, and, irrespectively of their scientific quality, you have to obey these rules in order to get chances. And obeying the rules means decreasing the scientific quality. It is not only the science anymore which plays a major role. That is a price you have to pay.

He adds that in order to fulfil the EU requirements for partners from different countries, he invited collaborators who performed tasks that are also done at his own institute. He explains: 'we could also do the chemistry; therefore we, in some sense, would have needed much smaller network—we could have done much more ourselves. But this obviously contradicts the idea of such networks, and you get of course also new things if you go to other partners'.

The initiator of the collaboration chose to prepare an application within a thematically open FP funding scheme dedicated to research training through fundamental research. He explains his choice as follows:

If you are waiting for a call in the normal European funding scheme then it never fits very well. If you really want to do fundamental research, so Framework Programmes are meant for industrial support, and what we are doing is really basic research. And in this sense it does not fit to usual schemes, and, in addition, in the calls topics are old in some sense. At least two, three years before people set them up, and then the call rises, and then you have to write something about that. If you are working on that it is five years behind more or less. And therefore that is always the problem if you really want to do state of the art stuff. And in this sense [a thematically open scheme] was the obvious choice.

The application was granted in this highly competitive scheme. The coordinator assumes that the main reasons for it succeeding were the application's interdisciplinarity, its thematic coherence, and the quality of involved groups.

The emergence of two collaborations confirms some expected contrasts of self-organisation and steering. The 'long informal collaboration' started as a result of the initiative of a young researcher who wanted to do PhD at a top institute abroad and was supported not only by that institute but also by a professor in his home country. The 'novel project' started on the initiative of a postdoc to apply for an

externally-funded project to get the necessary resources to develop further findings from in-house research. The development of the project demonstrates a mix of self-organisation and steering. Self-organisation includes carefully selecting external funding scheme that allows work on a topic of one's own interest and also the initial selection of collaborators. However, the selection of collaborators is also partly based on the researcher's perceptions of EU rules preferring geographical and gender diversity. That led to including international collaborators for tasks that could be done in-house; however, international partners brought new knowledge about these tasks. Informal collaboration is smaller and includes three partners, while the project is bigger with eight partners, which is at least partly due to EU rules.

5.4.2 Formal and Informal Collaboration

The main elements of the **'long informal collaboration'** over ten years were regular seminars, short visits and joint experiments, and at least five common PhD students. The focal point of the informal collaboration among the three groups was regular seminars that took place at least once a year, lasted for two to three days, and were hosted by the collaborating institutes on a rotating basis. The aim of these seminars was to give PhD researchers an opportunity to present their work, learn from the presentations of others, and find opportunities for collaboration.

These seminars led to short visits (e.g. three days or a few weeks) by PhDs to collaborating institutes, where they learned complementary techniques and did joint experiments which led to chapters in their PhD theses and co-authored papers. This informal collaboration also involved a researcher from Institute C receiving a fellowship to do a postdoc in Institute A, after encouragement from the group leader who had previously done the same.

There have been at least five common PhDs. The collaboration was initiated by a common PhD between Institutes A and B and there have since been at least four joint PhDs between Institutes A and C. The reason for these joint PhDs was the same as for the initial joint PhD: Institute A, as a non-university institute, cannot award PhD degrees, and it is difficult to enrol researchers with an engineering degree as PhDs at the local university near Institute A. Thus, a number of PhD students at Institute A were registered as PhDs at Institute C. They did their PhD research at Institute A, fulfilled the requirements for a PhD degree at Institute C, regularly discussed their results with the co-supervisor at Institute C, and, finally, were awarded their PhD degree at Institute C. Afterwards, some of them did their postdoc at Institute C.

An important characteristic of this collaboration was communication and collaboration across all levels of hierarchy: senior professors and group leaders as well as PhDs and postdocs. Collaboration was largely possible due to the support from the department leaders in Institutes A and B. As explained by a researcher, a crucial precondition for this long-term informal collaboration has been 'support by the people who make decisions, support by the directors; they wanted it'. At the same time, one of the directors emphasise the importance of communication among PhDs

for successful collaboration in experimental research, where laboratory work is done by PhDs: ‘eventually the job gets done by PhD students. If the PhD students don’t talk, we [professors] can talk, but if they [PhDs] don’t talk and they don’t know each other, then it is a dead end’.

The informal collaboration was financed either by institutional funds (Institute A) or income from contract research (Institute B). One of the collaborators explains that ‘it was funded by internal money. We never had any specific funding to pay for this seminar programme and we did it as cheaply as possible’. The collaborators outline a number of benefits from such informal collaboration: the ability to be responsive to new research ideas, no need to write reports, the ‘beauties of excluding and ruling out bureaucrats from such collaborations’, and the ability to have ‘the least possible administration’. One senior collaborator summarises informal collaboration as follows: ‘We had a joint work; a lot of joint work but there was no reporting, no funding agencies, no administrations, no bureaucracy. Great thing. As long as we can afford it’.

To summarise, this long-term informal collaboration had a number of advantages and disadvantages. Among the advantages mentioned were intellectual independence, flexibility, low administrative burdens, and no requirement to comply with external rules. At the same time, it had disadvantages, such as limited funding and no room for expansion. In order to expand, external funding is important. The long-term informal collaboration allowed the collaborators to develop mutual knowledge that helps in common formal projects.

The main renewal of collaboration took place when, after the two main collaborators were no longer internationally mobile, the tradition of joint seminars stopped. At the same time, a new generation of research leaders formed a core-group within three FP projects with more applied research topics and additional partners.

After ten years of informal collaboration, the major collaborators decided, according to one researcher, that they ‘should really try to get some serious money to do some work together’. Thus, acquiring funding for common FP projects was seen as a way to expand their research. All three FP projects have been coordinated by the project leader at Institute A, where the acquisition and coordination of such projects helps strengthen a scientist’s position. The two main projects are the so-called small- and medium-sized research projects; each has funding of around 3,000,000 euros and involves around ten partners, including research institutes, small and medium-sized companies, and hospitals. The third project is a smaller one with funding of around 100,000 euros; it supports the international exchange of researchers.

The two bigger projects emerged as a response to specific calls with predefined topics. The topics of these projects fitted well with the collaborative work previously published in co-authored papers and with new interdisciplinary expertise developed at Institute C. Moreover, there are thematic links between the two projects, as one builds on the other. Thus, there is a lot of thematic continuity between the informal and formal collaboration as well as between the two formal projects. Both projects are of a more applied character than the research done during the informal collaboration, but the main collaborators are also interested in applied research. For them,

these applied research projects involve some very fundamental questions and allow doing some ‘crazy things for the future’. Key collaborators see positive effects of acquiring FP projects not only as a source of additional funding but also for enhancing their institution’s visibility.

While the core collaborators have known each other for a long time, the formal projects involve a number of new partners who were found via the web and publications or through suggestions from their colleagues. Within these projects, particularly within the first, the core collaborators have experienced the problem of ‘unreliable partners’. According to the core collaborators, it turned out that some new partners had gotten involved in the projects ‘simply because they supply quite a lot of money’. The main strategy for dealing with unreliable partners has been to replace them in a follow-up project and to design the tasks for the successive project in such a way that the core-group can, if necessary, deliver the main project outputs independently. As explained by one of the core collaborators, in the second project, his group ‘wanted to be able to proceed as fast as possible without having to be dependent’ and has ‘found it more efficient to be a bit more autonomous where collaboration gives a lot of value added but is not absolutely essential to the successful outcome of the project’.

The training of young researchers was a major element in the informal collaboration, and it is also important for the common projects, which provide funding to hire PhDs and postdocs who carry out the laboratory work. Within the projects, training seminars have been organised and carried out by PhDs and postdocs to teach each other specific techniques and conduct joint experiments. Moreover, PhDs and postdocs in the projects have had to present their research results in project meetings every six months. A PhD student in one of the projects explains that presentations in the project meetings provide strong additional incentives to work well. According to her:

It helps being a part of the big project . . . when you are working in a bigger group you feel more responsible for doing your own work and standing out within the group and trying to get results. It is a big motivator . . . because we have to do these six-monthly meetings and progress reports. You have to have worked to present and to show that you are getting the work done.

To summarise, the decision to acquire European projects has been important in renewing and expanding the collaboration while simultaneously building on common topics and key collaborative links developed in previous informal collaboration.

The ‘**novel project**’ received FP funding of around 3,000,000 euros. The key FP rules that affected the project focused on recruitment, regular meetings, training, and interdisciplinarity. According to the rules, PhDs and postdocs had to be recruited from abroad, and gender balance was desired. While some partners had a lot of experience in recruiting high quality international researchers, others took a long time to find suitable candidates, and some joint activities were delayed due to some late recruitments.

The project was funded by the research training network scheme, which supported short-term exchanges of PhDs and postdocs as well as training

workshops. The thematic coherence of the project was facilitated by the regular network meetings every six months and by close interaction between junior researchers. The coordinator explains the role of exchanges of PhDs in ensuring coherence:

[PhD] students which we have are extremely smart, they are really extremely good. They are doing research, and in a lot of groups they are also giving the direction which we also search. And, if they are meeting . . . they are very proud of hosting their partners, and that provides coherence.

The interaction among PhDs doing experimental research ensured active communication and facilitated joint research activities. A researcher explains: ‘my PhD students . . . send an e-mail to [a] production person, also a PhD [student] or postdoc, and then they have to produce that material, and in general they come to an agreement and things are being sent’.

Within the regular network meetings, PhDs initiated collaborations themselves which later resulted in internationally co-authored papers. A researcher states that, for him, it is safer to hire a PhD within an international network that provides a lot of support for PhD research on a novel topic. A former PhD who prepared material explains how she started to collaborate with another PhD doing physical characterisation:

It was my own initiative. I think, basically, I had something that she wanted, and she had something that I wanted, so we started talking at the meetings. She wanted me to supply her with material . . . so she would not have to do the chemistry. And I asked—can you analyse them for me? And we found it to work very well.

She adds that ‘at the beginning I did [the characterisation] myself, and then I found it is quicker and nicer if I send [material to the partner abroad]’. Both PhDs also visited each other for two to four weeks, which helped them to do ‘a lot of analysis together’. This collaboration between the two PhDs led to a number of internationally co-authored articles.

As the project according to the project requirements was interdisciplinary, the collaborators initially experienced typical challenges in communicating across disciplines. Researchers state that it took time to understand each other’s language and that presentations at the regular project meetings helped with this. A researcher explains that:

[at] the first, the second network meeting we were all new to each other; we are still very polite of course, you do not want to question what everybody else is doing, saying, but then the third and the fourth meeting people start to ask ‘but what do you really mean when you talk about milligrams’ or ‘what do you really mean when you talk about moles or number of molecules’. And it was very eye opening to get to that point.

A PhD student mentions that it might have taken as many as seven presentations at the network meetings combined with visits to each other’s labs for partners to understand each other’s research: ‘at the beginning may be there was a little bit like—woo, don’t understand that, but after a while, like a seventh time, they finally knew what you were doing, and also when they visited your lab or you visited theirs

it became more clear.’ A senior researcher explains the need to understand a collaborator’s research:

You got to be able to communicate with the collaborators. I don’t think collaboration will work very well if you have no idea about the other aspects of the work. You may have less expertise in it, you may have less capability in it, but you must at least have some idea about how it works, what its capabilities are. All collaboration requires a little bit of knowledge on both sides of both sides.

This fits with the notions of ‘contributory’ and ‘interactional’ expertise developed by Harry Collins and Robert Evans (2002). For them, contributory expertise means enough expertise to contribute to the specific science field, while interactional expertise implies sufficient expertise to interact with representatives from that field. Thus, each collaborator has contributory expertise in their own area and interactional expertise in partner’s area.

During the last two years of the project, the collaborators actively discussed the possibility of preparing an application for a joint follow-up project. The major stumbling block in preparing a follow-up project turned out to be difficulties in finding a coordinator as, due to their workload or lack of institutional support, none of the partners could commit themselves to a very time-consuming coordination task for the next four years. However, a number of project partners continue to interact informally.

To summarise, while both collaborations evolved quite differently, there were also some important similarities. The focal point for both was interaction and short exchange visits among junior researchers as well as regular meetings, which occurred more often during the project than in informal collaboration. While informal collaboration provides more freedom to choose topics and forms of collaboration, external funding is needed for expansion. Many rules that come with external funding reinforce activities that researchers already do—for example, meet regularly, provide training, and collaborate across disciplines. The most negative aspect of EU-funded projects, as seen by all researchers, is heavy administrative tasks.

5.5 Results

To sum up, ‘long informal collaboration’ has resulted in co-authored publications, common PhDs, and, recently, joint projects. For an overview of this collaboration, see Fig. 5.2 with full lines depicting actual directions and dotted ones indicating potential future developments. The scientists involved deem that collaboration has given ‘PhD students much broader perspective and appreciation of science going on in other institutions’ and contributed to the ‘quality of the students you educate in the long run’.

The ‘novel project’ was seen as successful by collaborators and the funder, which mentioned it among its success stories. It resulted in co-authored publications, training, and new contacts (see Fig. 5.3).

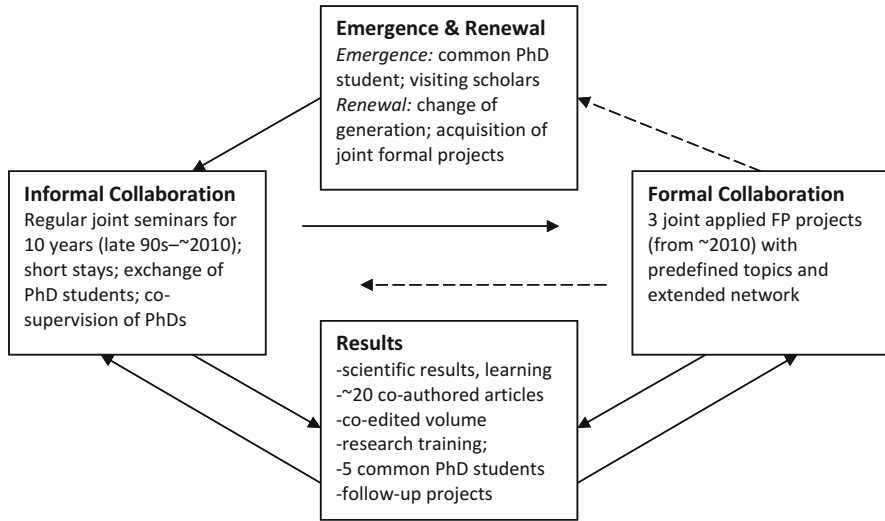


Fig. 5.2 Stylised model of ‘long informal collaboration’

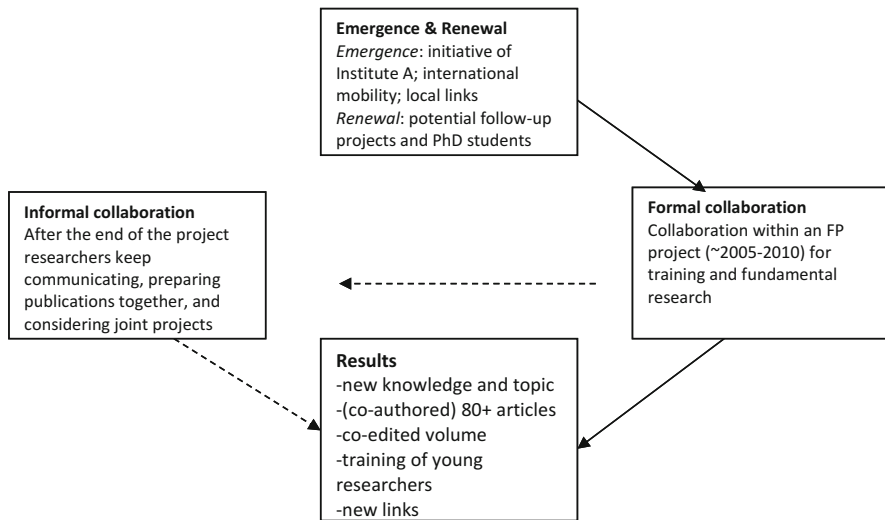


Fig. 5.3 Stylised model of ‘novel project’

Thus, while the main types of outputs—co-authorships and training—are quite similar in both cases, resources provided by the externally-funded project can facilitate more productivity.

5.6 Conclusions

The important starting points of this article were two concerns raised in the literature. First, the suggestion from Hagstrom's 1965 work on the scientific community that, due to the increasing dependence on grant-giving agencies, free collaboration might be replaced by a more complex form of collaboration (Hagstrom 1965). Second, indications in studies of international research collaboration that self-organisation is the best way towards productive collaborations, while steering from funders can lead to 'artificial collaborations'.

Against this background, in-depth case studies of two collaborations demonstrate that when collaborating both within or outside externally-funded projects, scientists still have various degrees of freedom to choose their collaborators, common topics, and interactions. When applying for external funding, scientists carefully consider which funding scheme will best fit their research interests.

Rather than being purely self-organised or steered, the examples of successful and productive collaborations illustrated here present a mix of both. The elements of self-organisation and steering that were identified as relevant relate to choice of the topic, type of research (basic-applied, interdisciplinary, etc.), collaborators, recruitment of researchers, modes of interaction, and results. Interestingly, in the case of highly competitive EU funding schemes, not only formal rules but also perceptions of preconditions for success (e.g. geographic diversity) steer the design of collaborations. In contrast to literature that depicts self-organisation as supportive for productive collaborations and steering as problematic, insights presented in this article suggest that both can facilitate and limit collaborations (see Table 5.2).

One interesting result from comparing formal and informal collaboration is the many similarities between the two, including a focus on training, joint publications, and interdisciplinarity. Thus, project rules and requirements can largely reinforce the type of collaboration that scientists are interested in anyway. Moreover, all studied researchers and institutes are simultaneously involved in a number of diverse collaborations. Each specific collaboration—formal or informal—is a result of a number of factors, including research and resource needs, institutional strategies, and career stage of researchers. Thus, in the case of 'long informal collaboration', involved institutes had resources (institutional and business) and support from established professors to collaborate informally for ten years on a small scale. Externally-funded projects were sought later in order to expand the collaboration and advance the careers of the next generation of research leaders. In the second case, project funding was necessary in order to expand research. It was supported by institutional strategy and fit with the career development of project leaders.

Characteristics of self-organisation and steering identified in this study would benefit from testing on a larger sample of diverse cases from different disciplines (Heidler 2017), countries, and funding schemes. While both collaborations here were relatively small-scale and focused largely on interactions among scientists, in future, large-scale collaborations (Ulnicane 2020) involving society, stakeholders, industry, and policy-makers—which are increasingly relevant in the context of the

Table 5.2 Summary of elements and effects of self-organisation and steering

	Self-Organisation	Steering
<i>Elements</i> in international research collaborations	Freedom to choose topic and type of research (e.g. basic, interdisciplinary);	Support for certain topics and types of research;
	Freedom to choose collaborators;	Rules on specific types of collaborators (geographic, gender);
	Freedom to recruit any researchers;	Rules on recruitment of researchers (e.g. from abroad)
	Freedom to choose modes of interaction and results;	Requires certain modes of interaction (regular meetings, training events, short exchange visits etc.) and results;
<i>Effects</i> on international research collaboration	<i>Positive</i>	<i>Positive</i>
	Scientists collaborate on topics and types of research they are most interested in;	Provides resources to expand collaborations;
	Freedom to choose collaborators;	Facilitate inclusion of diverse collaborators;
	Limited administration;	Learning from additional collaborators;
	Trusted collaborators;	
	<i>Potentially problematic</i>	<i>Potentially problematic</i>
	No resources to expand collaborations;	In order to acquire funding, scientists adjust topics and types of research;
	Excludes collaborators from less developed regions and underrepresented groups;	Compromise on collaborators;
Less opportunities to learn due to limited number of partners;	Heavy administration; Unreliable collaborators;	

recent focus on supporting digital data infrastructures (Aicardi et al. 2018) as well as challenge- and mission-oriented research (Ulnicane 2016)—should be studied in the future as well.

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