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The effect of public funding on scientific performance: A comparison between China and the EU

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Abstract

Public funding is believed to play an important role in the development of science and technology. However, whether public funding actually helps to increase scientific output (i.e. publications) remains a matter of debate. By analysing a dataset of co-publications between China and the EU and a dataset of joint project collaborations in European Framework Programmes for Research and Innovation (FP7 & H2020), we investigate whether different public funding agencies have different goals in their research policy. Our results support the hypotheses that funded research output represents the intentions of funding sponsors and a high level of public funding does not necessarily lead to high scientific output. Our results show that FP7/H2020 funded projects do not have a positive contribution to the output of joint publications between China and the EU. Interestingly, cooperation in the form of jointly writing proposals to these EU programmes, especially when they are not granted by the European Commission, can contribute significantly to joint scientific publications at a later stage. This applies in particular to cases where funding from China is involved. Our findings highlight the key role that funding agencies play in influencing research performance. While the Chinese government is interested in pursuing a high number of publications, the EU cares more about the social impact and indirect effect, which is hard to measure in the short term.

Keywords: Public funding; research evaluation; scientific output; international collaboration; China; EU member states

JEL Codes: F02, H52, O20, O38, O52, O53.

1. Introduction

Scientific knowledge can be generated in two ways: it can either be driven by academic interests within one discipline (also called 'curiosity-oriented' research), or it can be driven by needs from society, created in a transdisciplinary social and economic context which is led by industry or government (also called 'strategic' research) (see more discussions in Gibbon et al. 1994; Sulter and Martin, 2001). As scientific research requires access to substantial resources that are costly (Stephan, 1996, 2010), public funding is needed in both types of research. In the former case, scientists can conduct research freely, but in the latter case there is more intervention by governments or funding agencies. The latter is seen as the prevailing model in modern society, and academic research has been moving from discipline-based to social problems (Gibbon et al. 1994; Benner and Sandstrom, 2000). For social, economic or political aims, governments can influence the scientific research carried out by research institutes via financial stimulation.

The grant-giving agencies are believed to be able to structure research performance (Benner and Sandstrom, 2000; Alberts et al. 2014; Ma et al. 2015). Thereby, "the actions taking place within the academic system are dependent on and structured by the funding" (Benner and Sandstrom, 2000, p. 293). Given the significant contribution of scientific research to industry and the economy (Nelson, 1986; Jaffe, 1989; Mansfield, 1991; Wang and Li, 2018), it is crucial to understand the relationship between public funding and its supported research output (Arora et al. 1998).

With continuous public funding support coming from various agencies, it remains a debatable issue whether public funding improves scientific productivity. One group of scholars suggests that an increase in public research funding can lead to more scientific output (i.e. publications) (Payne and Siow, 2003; Beaudry and Allaoui, 2012). It is also believed that public funding can improve research performance, but this is conditional on the capability of the researchers (Fedderke and Goldschmidt, 2015). Highly ranked researchers present a higher rate of return on funding than those with low ranking peers. Yet, another group of scholars holds a different opinion, namely that funding does not necessarily lead to high publication output. Auranen and

Nieminen (2010) show that countries with a relatively less competitive funding environment can be more efficient in generating scientific output than those with a more competitive funding environment. We contend that funded research represents the objectives of funding sponsors and high public funding does not necessarily lead to high scientific output.

Acknowledging that funded research to some extent represents the intention of policymakers to support basic research, we aim to explore how policymakers are using the funding as an instrument to steer academic research. By investigating the set of joint publications (which is regarded as high quality scientific output) between China and the EU member states and the set of joint proposal and project collaborations in The European Union's Seventh Framework Program for Research and Innovation (FP7) and Horizon 2020 (H2020), we explore whether there is a difference in funding intention between Chinese funders and EU funders.
Our results underline the differences in funding intentions between different systems. The Chinese government provides funding with the aim of increasing recognisable and measurable scientific output, while EU funding is often associated with knowledge exchange and social impact, which may not directly be transferable to scientific output. Interestingly, joint FP7/H2020 proposals that failed to receive funding, can significantly contribute to joint publications if they are later funded by Chinese funding agencies. This emphasises the crucial role that funding agencies play in influencing research performance.

The rest of the paper is organised as follows. Section two provides the background of our empirical analysis. Section 3 documents data collection and methodology. Results are provided in Section 4, and Section 5 concludes.

2. Background

2.1 Funding and scientific research

It has been acknowledged that scientific research plays a crucial role in industrial innovations (Mansfield, 1991, 1998) and brings positive economic benefits in the long-run (Salter and Martin, 2001; Pavitt, 2000; Prettner and Werner, 2016). In order to stimulate the production of scientific knowledge, science policies have been more and more committed to "planning and management" of science (Dasgupta & David 1994). Funding is often used by policymakers to steer scientific research. The funded research to some extent represents the intention of policymakers to support basic research, while in some cases it represents their intention to promote certain types of society-oriented research (Braun, 2003; Lepori, 2006). As pointed out by Geuna (1999), the goal of funding agencies is not to buy research services but to succeed in reaching "the policy goals through the tool of the research contract" (Geuna, 1999, p. 118).

Existing studies show that public funding has a positive effect on scientific productivity. For instance, Panyne and Siow (2003) find that an increase of 1 million US dollars in federal research funding to a university can lead to 10 more scientific publications. Also in relation to Canada, it is found that public research funding can help increase the number of scientific publications (Godin, 2003; Beaudry and Allaoui, 2012); the positive effect is especially strong if the funding is higher than a certain threshold (Godin, 2003). Fedderke and Goldschmidt, (2015) also stress the importance of funding amount, by suggesting that *substantial* funding is associated with raised researcher performance. In addition to the relation between public funding and the *quantity* of scientific output, studies have also shown that funded research has a higher *social impact* compared to research without funding support (Costas and van Leeuwen, 2012; Gök et al., 2015). Neufeld (2016) confirmed this for the biology field, by finding a positive impact of funding on the publication counts, the total citations, and the journal impact factor per paper.

However, there are also different opinions on the universal effect of public funding. Due to the extra resources provided by funding, and the fact that research consortia are selected on the basis of competitive tendering procedures, the quality of funded research is often expected to be high (Auranen and Nieminen, 2010). That is, superior performance in the past increases the probability of being granted. Hence it is not the funding but the past performance that influences future performance (Arora et al., 1998).

The performance of scientific research, as stated by Johnson (1972), is judged largely by "scientific standards", and such standards can be associated with "social and economic standards". Hence depending on the social and economic circumstances, the public attitude towards science, as well as financial incentives, vary greatly across countries (Johnson, 1972; Auranen and Nieminen, 2010).

Scientific research is usually governed by "institutions and social norms" and the form of knowledge produced depends on the distinct rules of the research and incentive system (Dasgupta & David, 1994). Knowledge generated by researchers can be in different forms, e.g. codified or tacit (Dasgupta & David, 1994). Literature in this stream so far is limited in theory. Our study aims to contribute to the discussions in this stream by providing empirical evidence, which hopefully can help clarify the social mechanisms that allocate resources within public science.

2.2 Funding and scientific collaboration

Public funding not only spurs local basic research, but also facilitates research collaborations (Bozeman and Corley 2004). Funded projects are "collaborative in nature" (Ma et al. 2015), hence financial support makes it possible for researchers to participate in conferences or visit research institutes abroad, which in turn helps set up collaborations between researchers from different countries. Through research funding, the intensity of collaboration between partners can be greatly enhanced (Zhao et al. 2018). Facilitated by the external funding, individuals are able to work together and integrate all kinds of knowledge resources to achieve the common goal of producing new scientific knowledge.

Funding from foreign countries, an indication of increased internationally collaborated research, has become more and more important for universities, and international research groups successful in receiving external funding exhibit a higher probability of producing publishable research (Geuna, 1999). It is generally expected that researchers (teams) with larger grants would collaborate more and have more publications (Lee & Bozeman, 2005).

To understand the relationship between funded collaborations and research productivity, most studies have put efforts mainly on the structure of the collaborations without much attention to the goal of funding agencies. By focusing on the EU-funded research network, Defazio et al (2009) find that collaborations did not lead to an increase in research production in the funding period, but a positive effect was found after the funding period. We would like to challenge their conclusion that “it requires time to develop structures of collaboration that are effective in enhancing researcher productivity”. In our opinion, research output is not (or not only) influenced by the time it takes to set up effective collaboration structures, but by the intention of the funding agencies influencing the research output. In their study, it might have been the case that, after the EU-funding projects, researchers became more productive because they got involved in other funded (or unfunded) projects. We contend that collaborations subsidised by different funding agencies would vary in the productivity as well as the type of research output.

In this study, we aim to fill the abovementioned gap in the literature. Namely, by focusing on the collaborative research pairs supported by different types of funding resources, we investigate whether different public funding agencies have different goals in their research policy.

2.3 Empirical background - Collaborations between China and the EU28

China-EU collaboration has been strengthened by both China and the European Union. In 1998 both parties signed the EU-China Agreement on Cooperation in Science and Technology, which was renewed in 2004 and 2009. The document “A Long-Term Policy for China-Europe Relations”, issued in 1995, stressed the need for the European Union to develop a long-term relationship with China and introduced an action-oriented strategy to strengthen that relationship (European Commission, 1995). The Ministry of Science and Technology of China and DG Research and Innovation signed the Agreement on Implementing the Science & Technology Partnership Scheme (CESTYS) in May 2009. The National Natural Sciences Foundation of China and DG Research and Innovation signed an Administrative Arrangement in March 2010.

Efforts have been made to promote student exchange between China and the European Union. In 2012, 35,000 students from EU member states studied in China; and according to Du Yubo, viceminister of education, 30,000 scholarships would be granted to Chinese students to study in Europe in the period 2014-2019 (Tuo, 2013). There were nearly 1,000 Chinese participations in the Marie Skłodowska-Curie programme between 2007 and 2013 (European Union, 2015).

With the mobility of researchers, there are on the one hand more and more academic papers published jointly, while on the other hand more and more researchers have been involved in writing new project proposals to seek potential funding opportunities. According to reports from the European Commission (2015, 2016), in FP7, Chinese researchers were the third most allocated-to recipients of funding amongst non-European researchers. In H2020, there were 187 eligible proposals with Chinese organisations involved by 2015 (European Union, 2015).

The National Natural Science Foundation of China (NSFC) is the country's biggest research foundation, accounting for nearly half of the total public funding in China[1]. Besides the NSFC, there are also other major core-funding organisations such as the Ministry of Science and Technology of China (MOST) and the Social Science Foundation of China (SSFC). In Europe, the Framework Programmes (FPs) have been the main financial instruments via which the European Union supports Research and Innovation. Recent Framework Programmes like FP7 (2007-2013, €62.9 billion[2]) and H2020 (2014-2020, €80 billion[3]) are the biggest funding programmes covering all disciplines to foster research in the European Research Areas. Besides the Framework Programmes, there are also discipline-specific funding types. For instance, CERN[4] (known as the European Council for Nuclear Research) aims at establishing a world-class fundamental physics research organisation in Europe, EMBO (European Molecular Biology Organization) funds research in life science[5]. In addition to FP7/H2020 and discipline-specific funding, the European Research Council and the Marie-Curie programme are also well-known research funding sources in Europe.

[1] The Chinese government distributed 3.1 billion dollars (out of the total 6.6 billion) to NSFC in 2014 (24).
[2] https://ec.europa.eu/research/evaluations/pdf/archive/fp7_monitoring_reports/7th_fp7_monitoring_report.pdf
[3] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020.
[4] CERN is an abbreviation of "Conseil Européen pour la Recherche Nucléaire". See also at https://home.cern/about
[5] http://embo.org/

3. Data and Methodology

Publication count is often used as a proxy to evaluate scientific performance (Stephan, 1996). Publications resulting from funding must include an acknowledgment of grant support, including the funding agency and followed by the grant number(s). Funding acknowledgement statements are usually included in the manuscript in the form of a sentence under a separate heading entitled 'Acknowledgement' or 'Funding', if applicable. In early 2009, Web of Science released new searching functions about funding information with three new searching field tags, including FO (Funding Organization), FG (Grant Number), and FT (Funding Text), which collect and extract the funding acknowledgement statement from publications. These new funding-related search field tags make it possible to analyse the funding supported research output.

Publication data used in this study are collected from Clarivate Analytics' Science Citation Index Expanded (SCI-E) and Social Sciences Citation Index (SSCI). In our analysis, we focus on the international collaborations at national level. The affiliation address is used to identify the location of researchers. This study analyses 81,996 joint publications between China and EU member states, and about 77 per cent of these papers (62,928) acknowledged financial support from funding agencies.

There are two sets of funding data employed in this research. The first set was collected from SCI-E and SSCI. Using VantagePoint software, we extracted the field of Funding Organization from all the co-publications between China and the EU28. Based on the location of funding organizations, we classify funding resources into three types: a) China, b) European Commission (such as FP7, Horizon 2020 etc.), and c) individual European countries (such as national strategic programmes and bilateral programmes with China).

The second set of funding data was provided by the European Commission's datawarehouse ECORDA. This dataset includes funding proposals and projects granted in the European Framework Programmes. Our study is based on data for the seventh Framework Programme (FP7) and the early phase of Horizon 2020 (H2020), covering the years 2007 until 2015. There were in total 1,618 proposals jointly written by China and EU states, of which 253 projects were granted with research funding from the European Commission (either as FP7 or H2020 projects). To examine the interaction between each pair among these 29 countries (28 EU members and China), partnership data have been transformed into the format of a 29 * 29 matrix, for both *funded projects* and *unfunded proposals*. The matrix of funded projects at year *t* is constructed as follows:

$$\begin{bmatrix} F_{1,1,t} & F_{1,2,t} & \cdots & \cdots & F_{29,29,t} \\ F_{2,1,t} & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & F_{i,j,t} & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ F_{29,1,t} & \cdots & \cdots & \cdots & F_{29,29,t} \end{bmatrix} \quad (1)$$

Where $F_{i,j,t}$ is the number of joint funded projects of country *i* and country *j* at year *t*. Similarly, we also create the matrices for unfunded proposals by year. Thus, we have 16 matrices[6] for both funding proposals and granted projects in the period 2007 – 2015. The same method is also applied to construct the matrices of joint publications for different countries in different years.

Our aim is to assess the publications and FP7/H2020 cooperation between 29 countries in the social network datasets, thus we use multiple-regression quadratic assignment procedure (MRQAP) to implement the regressions. All variables in the MRQAP regressions are in the 29*29 matrix format. For handling dyadic data where pairs are linked, the quadratic assignment procedure has been tested to be superior to ordinary least squares (OLS) in both simple and multiple regression models (Krachhardt, 1998). In conducting the MRQAP tests, we use the double semi-patriating permutation method suggested by Dekker, Krachhardt and Snijders (see more details in Dekker et al. 2007).

In measuring the intensity of international scientific collaborations, we adopt the Jaccard index (see also in Luukkonen et al., 1993).

$$CI = \frac{CO_{ij}}{P_i + P_j - CO_{ij}} \quad (2)$$

Where CO_{ij} is the number of co-authored papers between country *i* and country *j*;

[6] Eight matrices for funded projects and eight for unfunded proposals.

P_i is the total publication number by country *i*;

P_j is the total publication number by country *j*.

For the published joint research, funding resources are decomposed into three types: funded by China, funded by the EU, and funded by individual EU member states[7]. The shares of different funding resources in country *i* at year *t* are calculated as follows:

$$CNfunded\_share_{it} = \frac{CNfunded\ publications_{it}}{all\ funded\ publications_{it}} \quad (3)$$

$$EUfunded\_share_{it} = \frac{EU\ funded\ publications_{it}}{all\ funded\ publications_{it}} \quad (4)$$

$$Ownfunded\_share_{it} = \frac{Ownfunded\ publications_{it}}{all\ funded\ publications_{it}} \quad (5)$$

Control variables on the EU member state groups and languages

Based on the year of joining the European Union, EU member states are classified into three groups: before 2000, between 2001 and 2007, and after 2007 (see Table A1). This information for each country is further transformed into a relation matrix captured by the variable of EU membership time group. Countries from the same year group will be assigned the value 1, other countries will receive the value 0.

Language barriers are often assumed to be an important factor influencing collaboration communications. As EU member states are greatly heterogeneous and there are 24 official languages in the EU, our study takes into consideration the official languages that are shared between countries. There are in total 14 official languages that are shared by at least two countries (see Table A2)[8]. Countries sharing the same official languages are assumed to collaborate more easily. The information of shared official languages is also transformed into a relation matrix (29*29).

[7] The share of publications funded by individual EU member states is called 'ownfunded_share'.
[8] https://en.wikipedia.org/wiki/Languages_of_the_European_Union.

4. Results

4.1 Collaboration intensity and funding structure

China and the EU28 have jointly published in total 81,996 papers in the period between 2009 and 2014, and 76.7 per cent of these publications acknowledged funding support. In the sub-set of publications that acknowledged funding agencies from either China or European Union, there are 57,000+ records. By decomposing funding organizations into three types (funded by China, funded by the EC and funded by individual EU member states), we find that the scientific research jointly published between China and the EU28 has been mainly funded by Chinese organizations. Around 80 per cent of joint publications acknowledged funding support from Chinese organizations. Following that, funding from national level in EU member states also contributed to 48 per cent of the joint publications, and about 13 per cent of these joint publications received funding from the European Commission. It is worth noting that one scientific publication can be supported by multiple funding organizations, e.g. from both China and Europe Union.

Figure 1 plots the correlation between funding resources and international collaboration intensity. This shows that the international collaboration intensity (measured by the Jaccard index) is positively correlated with all these three types of funding (funded by China, funded by the EC and funded by individual EU member states). Located on the right side of Figure 1, funding from China has the highest share. National funding programmes from EU member states contributed at the second most. Funding from the European Commission is located on the left with a relatively lower share. For all of these three types of funding sources, there is a general positive correlation between share of funding and international collaboration intensity.

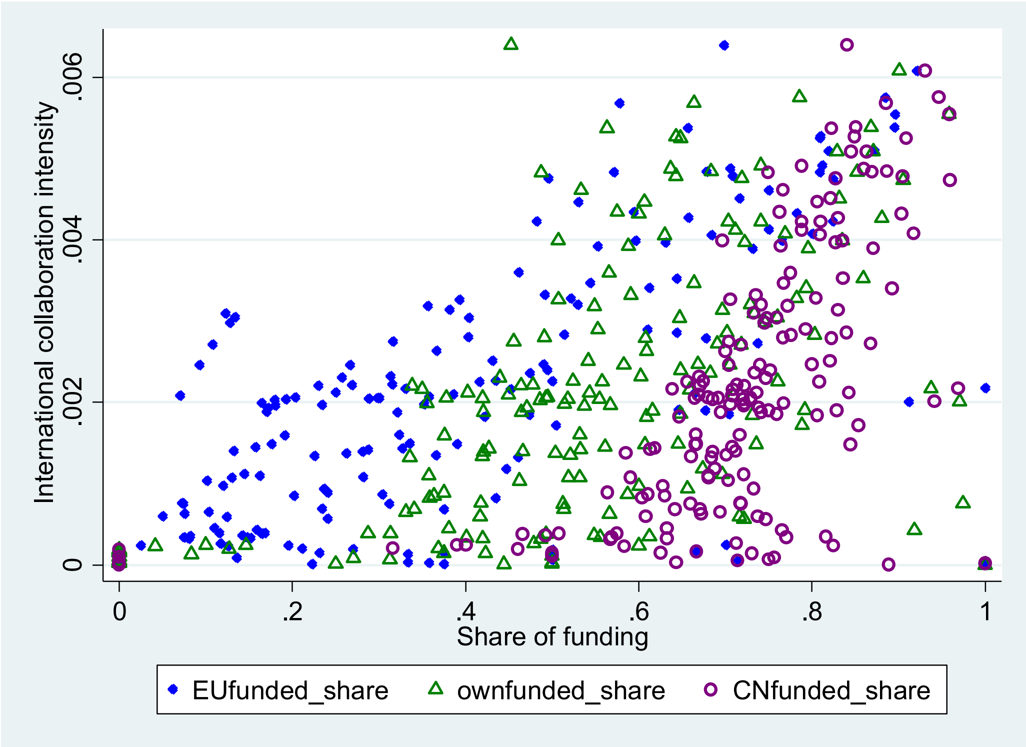

Figure 1: Scatter plot of correlation between joint publication intensity and funding share (2009-2014)

Note: 1) The calculations for the funding shares are provided in Section Materials and Methods Equations (3), (4) and (5). 2) Each point represents a country at one certain year.

4.2 Research capacity & funding resources

To deepen our understanding of funding schemes, we connect funding resources with research capacity of each country. Figure 2 shows that, in the process of collaborating with China, EU member states with high research capacity (proxied by the number of total publications at national level) received a rather small share of funding from the European Commission. For instance, in the UK during the period of 2009-2014, on average 13 per cent of the publications with funding acknowledgements were funded by the European Commission. The share of EU funding[9] was also low in Germany and Sweden, which was 15 per cent and 18 per cent respectively.

[9] See Equation (4) for the calculation of the share of EU funding.

There is a long tail on the right side of the figure, mainly consisting of small European countries with low research capacity. In those countries, due to the lack of national government funding, the share of EU funding is relatively higher. Bulgaria (BG), Cyprus (CY), Estonia (EE), Lithuania (LT) and Latvia (LV) are the countries which had the highest shares of EU funding. In some cases, funded publications all acknowledged the funding from European Commission, e.g. Cyprus (CY) in 2010, and Latvia (LV) in 2010 and 2011.

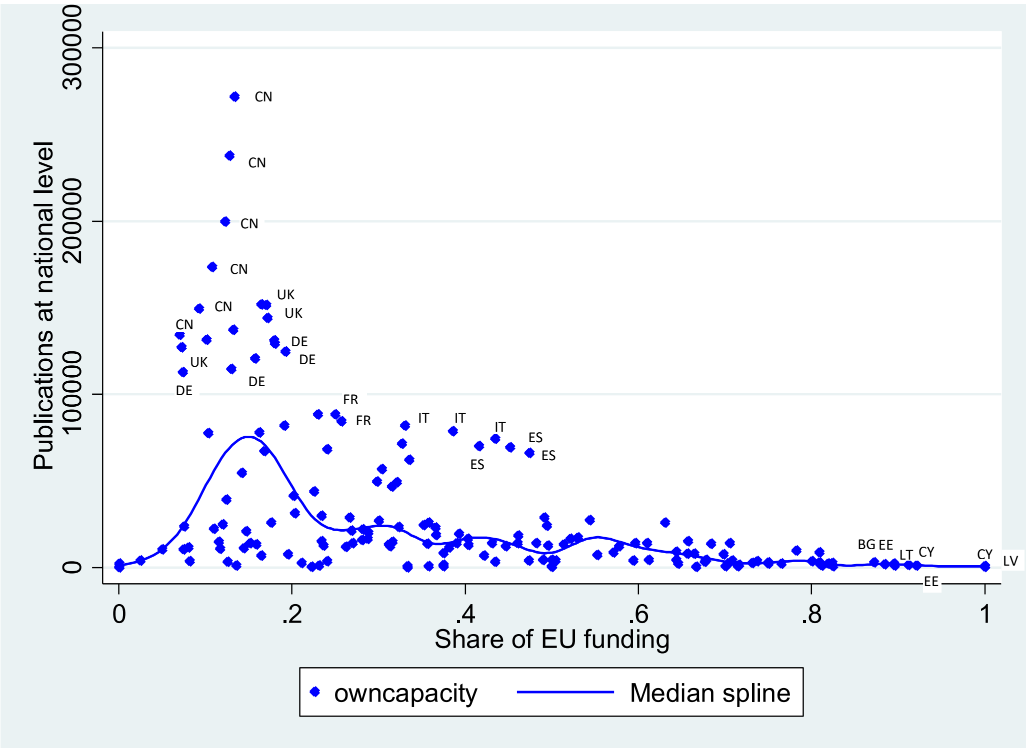

Figure 2: Scatter plot of correlation between own research capacity (i.e. total publications) and share of EU funding (2009-2014)

On the contrary, funding from China exhibits a different pattern (see Figure 3), with the long tail on the left side of the figure. In the extreme cases – such as Cyprus (CY) in 2009, Latvia (LV) in 2010 and Malta in 2010, 2011 and 2012 – there were no publications sponsored by the Chinese government. In other countries with low scientific capacity, such as Bulgaria (BG), Romania (RO), Greece (EL), Hungary (HU) and Lithuania (LT), the share of publications funded by China was low in particular in the earliest year, i.e. 2009.

However, in the countries with high research capacity (i.e. the top players in the collaboration), such as the UK and Germany (DE), on average 75 per cent of the joint publications co-authored with Chinese researchers were funded by Chinese organizations. This is in line with earlier findings that research funding goes to 'rich clubs' (Szell & Sinatra, 2015; Ma et al. 2015). This also shows that there is a 'Matthew effect' in the funding system in China, i.e. research groups with a higher profile (in terms of publication records) have a higher probability of receiving more funding.

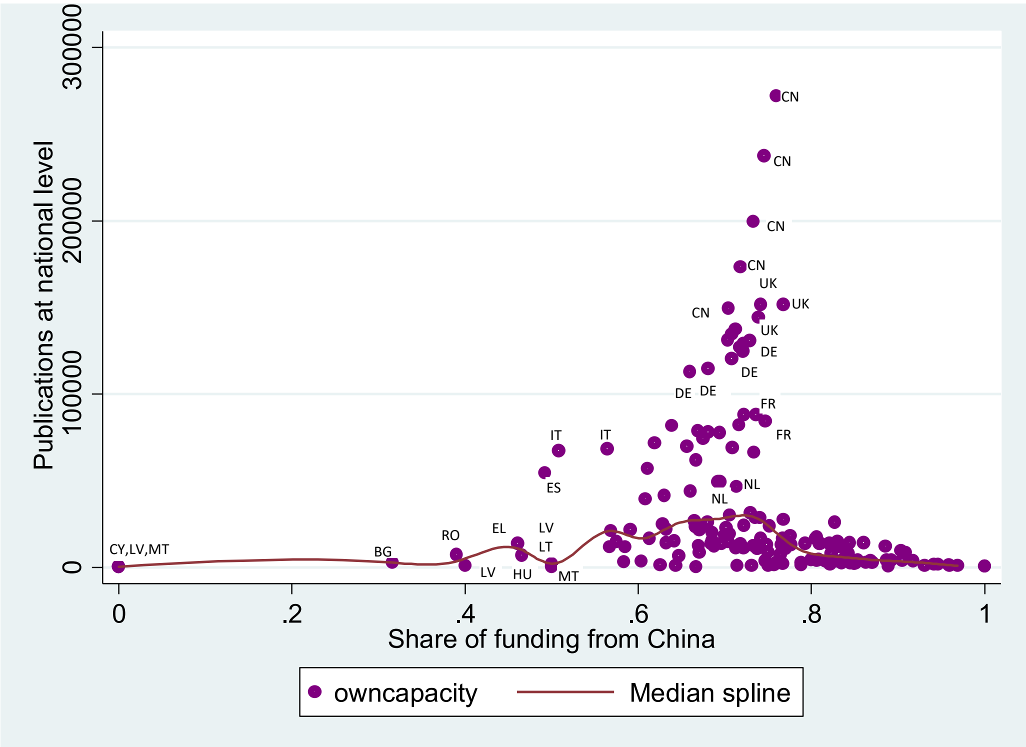

Figure 3: Scatter plot of correlation between own research capacity (i.e. total publications) and share of funding from China (2009-2014)

In China, the core funding organization, the National Natural Science Foundation of China (NSFC), is essential in providing financial support to basic scientific research. The NSFC is responsible for almost 50 per cent of the China-EU joint publications with funding acknowledgement[10]. Special programmes from the Chinese government, such as Fundamental Research Funds for the Central Universities and the 973 Program, also played an important role

[10] Joint publications without funding acknowledgement were not considered in this sample.

in sponsoring joint publications between China and EU member states. Funding from the China Scholarship Council, which aims to support Chinese students to study abroad and foreign students to study in China, has turned out to be another important resource in promoting joint scientific publications.

In the EU, European Council for Nuclear Research, the European Regional Development Fund (ERDF) and the Marie Skłodowska-Curie Programme appear to be most important (specific) programmes in funding joint publications between China and the EU28. These programmes have turned out to be crucial in involving also the small EU member states in the joint research.

4.3 Effect of funding and co-publications

In this section, we examine whether earlier scientific collaborations drive later joint funding proposals and whether joint funding experiences increase scientific co-publications. We use multiple regression quadratic procedure (MRQAP) to assess the impact of funding projects (or proposals) upon research output, and vice versa.

Table 1 documents the regression results of the effect of FP7/H2020 funded projects (or unfunded proposals) on the output of scientific collaborations between China and the EU member states. There are in total seven different dependent variables, i.e. (a) total joint publications[11] 2011-14; (b) funded joint publications 2011-14; (c) joint publications funded by China, EU or individual EU countries; (d) joint publications funded by China; (e) joint publications funded by the EC; (F) joint publications; (g) joint publications without any financial support from any funding agencies.

Model 1a examines the contributions of FP7 and H2020 proposals and projects in the earlier years (2007-10) to the joint publications in the later years (2011-14). Interestingly, funded FP7/H2020 projects have a significantly negative effect on the number of joint publications, which indicates that partnerships working in the same funded FP7 or H2020 projects do not lead

[11] Joint publications refer to the publications jointly written by at least one researcher from China and one researcher from the EU member states.

to joint publications. One possible explanation may be that, in FP7/H2020 funded projects, much time and resources need to be spent on submitting Deliverables which are not academic publications, e.g. Deliverables relating to policy reports and stakeholder involvement.[12] Another explanation may be that some projects are related more to innovation and to an R&D intensive, yet non-publishing industry sector, and therefore less to academic research.

However, unfunded proposals significantly and positively contribute to the joint research output. This reveals that rejected applications can still lead to successful output elsewhere. One example comes from Norway, where in a survey among Norwegian researchers that had applied the Research Council of Norway for funding, a majority of the respondents agreed that even though their applications were rejected, working on the applications was seemed as useful because it was used in future applications, generated new project ideas or established new collaborations with external partners (Ramberg, 2016). Another example relates to Switzerland. Ayoubi et al. (2009) found that taking part in a Swiss research grant competition already boosted scientists' number of publications, while it also extended their knowledge base and collaboration network, regardless of whether the funding was granted. These findings are in line with the patterns observed in our study, i.e. even failed applications may be beneficial to future collaborations.

Model 1b examines such contributions in the group of joint publications with funding acknowledgement, namely funded joint publications. The results of model 1b are similar to those of model 1a. That is, funded FP7/H2020 projects had negative effect on the output of joint publications, while unfunded proposals can lead to significant positive contribution to the scientific output. To further explore this issue, we test the contribution of unfunded FP7/H2020 proposals to publications funded by different resources (Models 1c, 1d, 1e and 1f).

Models 1d, 1e and 1f show that failed FP7 (or H2020) proposal cooperation has a significant and positive effect on producing joint publications which were funded by China, the EU and individual EU member states. Among these three cases, the coefficient in the China-funded model (Model 1d) has the highest value (1.214). This means that the experience of writing joint

[12] Indirectly, some of these 'non-academic' Deliverables may still generate future academic output by researchers who are not members of the consortium.

FP7 (or H2020) proposals, though failed in getting EU funding, can contribute greatly in obtaining funding from China in the later years.

In the last column, model 1g, we test the effect of funded and unfunded FP7/H2020 projects on later joint publications without any funding acknowledgement (so called unfunded publications). The coefficients stay similar to those in the earlier models. Explanations on the results regarding EU member state groups, languages and distances are provided in the Appendix.

4.4 Results about control variables

In Table 1, the significant negative coefficient of the EU membership (time group) variable indicates that the 'new' EU member states have been actively collaborating (in term of joint publications) with the 'old' EU member states. This result can also explain the intensive collaboration network in the EU in recent years (2017). This signals that European countries have been greatly integrated.

Hoekman et al. (2013) find that scientific collaboration between different regions in the European Union has a minor effect on acquiring FP funding, and research funding significantly stimulates co-publication activities between regional pairs "that did not intensively co-publish before participation". Our results, however, suggest that in the process of collaborating with China, the scientific collaborations in *earlier* years – rather than in later years – have a stronger positive effect on joint funding proposals. In line with Hoekman et al. (2013), our study shows that EU member states have been publishing jointly in the period of 2011-2014, in particular between countries that joined the EU in different time groups.

The EU membership variable in Table 2 shows a positive effect on joint FP7 or H2020 proposals. This suggests that, different from the conducting joint scientific publications, EU member states are still fond of working on joint FP7 or H2020 projects with partners that joined the EU at a similar time (mostly this concerns cooperation between 'old' members).

The EU membership group has also a significantly positive effect on writing joint proposals in FP7 and H2020. This means that, in writing joint proposals, more collaborations are observed between EU member states that joined the EU at a similar time.

In relation to China-EU28 collaboration, language barriers and geographical distance do not seem to be important in impeding scientific collaborations. The evidence of such barriers to research collaborations have been investigated with much inconsistent findings. Some studies have concluded that language spoken by partners or their geographical proximity are not significant for research collaboration (Nokkala et al., 2008), while others, such as Guellec and Van Pottelsberghe de la Potterie (2001) argue that two countries are more likely to collaborate if they are geographically close to each other, if they have the similar technological specialisation and if they share a common language. In the case of Chinese-European collaboration in the period of 2007-2015, both the geographical distance and language differences do not seem to matter.

In general, we find that EU member states have been greatly integrated in the process of collaborating with China, in particular in terms of joint publications between 'new' EU member states and 'old' ones. One should bear in mind that the collaborations studied here do not include cooperation only between EU partners, but collaborations between the EU and China. Namely, each joint publication or funding proposal examined in this study involves China.

Table 1. Results of quadratic assignment procedure (QAP) regressions

	model 1a	model 1b	model 1c	model 1d	model 1e	model 1f	model 1g
Dependent variable	joint publications (2011-14)	joint publications _funded (2011-14)	joint publications _funded by China,EU or individual EU countries (2011-14)	joint publications _funded by China (2011-14)	joint publications _funded by the EU (2011-14)	joint publications _funded by individual EU countries (2011-14)	joint publications _unfunded (2011-14)
Intercept	0	0	0	0	0	0	0
	(15.346)	70.035	(87.323)	(190.758)	(250.230)	(198.528)	(-50.790)
FP7&H2020 funded projects (2007-10)	-0.304**	-0.300**	-0.300**	-0.414***	0.080	-0.092	-0.338**
	(-27.567)	(-21.454)	(-19.681)	(-21.373)	(1.626)	(-3.593)	(-6.543)
FP7 &H2020 unfunded proposals (2007-10)	1.138***	1.135***	1.134***	1.214***	0.813***	0.994***	1.138***
	(38.026)	(29.940)	(27.471)	(23.099)	(6.088)	(14.362)	(8.125)
EUmembership time group	-0.086**	-0.084***	-0.085***	-0.080***	-0.077*	-0.086***	-0.072**
	(-276.557)	(-215.293)	(-200.284)	(147.020)	(-55.866)	(-120.161)	(49.464)
geographical distance	0.009	-0.007	0.004	-0.008	0.089	-0.024	0.026
	(0.009)	(-0.005)	(0.003)	(-0.004)	(-0.019)	(-0.010)	(0.005)
language	-0.006	-0.009	-0.010)	-0.027	-0.009	-0.012	-0.002
	(-22.849)	(-27.388)	(-27.412)	(-57.384)	(-8.010)	(-20.314)	(-1.748)
R-sqr	0.739	0.738	0.735	0.688	0.715	0.797	0.702
N	812	812	812	812	812	812	812

Note:

1) joint publications (a) = joint publications_funded (b) + joint publications_unfunded (g) ;

joint publications_funded by China, EU or individual EU countries(c) = joint publications_funded by China(d) + joint publications_funded by the EU (e) + joint publications_funded by individual EU countries

2) Standardized coefficient in parentheses. * p<0.05; ** p<0.01; ***p<0.001

Related to the results in Table 1, one may wonder whether compared to other funding programs FP7/H2020 granted financial support to more non-academic partners, so that consequently collaborations in FP7/H2020 do not lead to joint publications. To test the funding selection bias (Arora et al., 1998)[13], in Table 2, we investigate the contributions of joint publications to the joint FP7/H2020 proposals. Joint publications are classified into two groups: the earlier years (during 2003-06) and the later years (during 2007-10). Joint FP7/H2020 proposals (model 2a) is further decomposed into funded group (model 2b) and unfunded group (model 2c). The results show that the scientific collaborations in *earlier* years (during 2003-06) – rather than in later years (during 2007-10) – have a stronger positive effect on writing joint funding proposals (model 2a). Most importantly, the results are consistent for both funded projects (model 2b) and unfunded proposals (model 2c). This indicates that joint academic cooperation in the past contributed equally to the FP7/H2020 funded projects as well as unfunded proposals. In other words, there is no evidence showing that FP7/H2020 funded projects are more connected with collaborative partners with less joint publication experience. This confirms that a different performance in publications in Table 1 is not caused by funding selection bias. (The explanations on results related to control variables are provided in the Appendix.)

[13] In the selection process, funding may more likely flow to certain types of researchers (or teams), depending on their past performance.

Table 2. Results of quadratic assignment procedure (QAP) regressions

Dependent variable	model 2a joint FP7&H2020 proposals (2007-15)	model 2b joint FP7&H2020 funded projects (2007-15)	model 2c joint FP7 &H2020 unfunded proposals (2007-15)
Intercept	0 (2.3370	0 (1.964)	0 (0.373)
Jointpub (2003-06)	1.443** (0.357)	1.443** (0.089)	1.429** (0.268)
Joint pub (2007-10)	-0.740 (-0.107)	-0.793 (-0.028)	-0.716 (-0.078)
EUmembership time group	0.227*** (54.778)	0.285*** (17.107)	0.206*** (37.671)
geographical distance	0.185* (0.013)	0.138 (0.002)	0.199* (0.011)
language	0.038 (10.677)	0.039 (2.712)	0.037 (7.965)
R-sqr	0.661	0.572	0.682
N	812	812	812

Note: Standardized coefficient in parentheses. * $p<0.05$; ** $p<0.01$; ***$p<0.001$

5. Discussion and conclusions

Using co-publication and funding data between China and the EU28, this study explores whether different public funding agencies have different goals in their research policy. Our results show that scientific research funding from China greatly supports scientific research of top performers (partner countries with high research capacity) while funding from the EU plays a crucial role in supporting European countries with a low national research capacity. This reflects the different aims of different funding organisations. Chinese funding agencies likely focus on the top players in order to achieve immediate high publication output, while EC funding agencies often set regional integration (EU internal market goals) as their priority.

In China, although the total amount of money spent by the Chinese government is unknown, funding efforts have been greatly turned into academic publications. This is related to the funding evaluation system in China which stresses the importance of immediate academic values (i.e. publications) that can be measured directly. This is also the case in many European countries where part of the national funding of higher education institutions is typically dependent on a performance-based activity measure like the number of publications in Web of Science. It is often expected that partners with larger grants would collaborate more and have more publications (Lee & Bozeman, 2005). This may be true in some countries. Large parts of the Framework Programmes in the EU are, however, different. They stress the function of the projects as means to creating knowledge which is difficult to measure in the short term. EU funding programmes often emphasise the priority of regional integration and social networks in the European Union rather than academic publications (Pavitt, 2000). This may also explain the results of Defazio et al. (2009) that funded collaborations have no contribution to scientific output during the EU-funding period, but do contribute positively after the projects are finished.

Another interesting finding was that non-funded proposals – i.e. collaborative FP7 or H2020 proposals that were rejected – contributed significantly to later publications. The experience of writing joint FP7 or H2020 proposals, when a research consortium failed in obtaining the funding it aimed for, can still lead to a successfully funded project by a different sponsor (for instance a governmental agency of an EU member state, or other European research foundations, or the Chinese government) and hence may contribute significantly to the scientific output at a later stage. Interestingly, those unfunded FP7 and H2020 proposals – if later funded by Chinese funding agencies – will have the highest chance to produce joint publications. This confirms the hypothesis that public funding is one of the means for government to implement research policy and that the performance of funded research represents the intention of funding sponsors. Although initially aiming at the EU programmes funding, such collaborations can significantly contribute to publications if they are later funded by Chinese funding agencies. This indicates that, for a certain research group with a potential amount of knowledge basis, the final product delivered can be steered by the funding contract. These findings highlight the key role that funding agencies play in influencing research performance.

We agree with the literature (Arora et al. 1998; Stephan, 1996) that funding agencies are likely to choose best performers to implement their tasks. However, what we would like to add is that, the final form of output is crucially dependent on the types of funding agencies.

One limitation of this study is that the publication dataset and FP7/H2020 proposal dataset are limited to China and EU collaborations. Although it sufficiently shows the difference between China and EU research policy, it does not cover the complete picture of the funding systems in China or the EU. Further research covering more funding types is encouraged.

References:

Alberts, B., Kirschner, M., Tilghman, S. & Varmus, H. (2014). Rescuing US biomedical research from its systemic flaws. *Proceedings of the National Academy of Sciences*, 111(16): 5773-5777.

Arora, A., David, P. A., & Gambardella, A. (1998). Reputation and competence in publicly funded science: Estimating the effects on research group productivity. *Annales d'Économie et de Statistique*, No.49/50: 163–198.

Auranen, O., & Nieminen, M. (2010). University research funding and publication performance - An international comparison. *Research Policy*, 39(6): 822–834.

Ayoubi, C., Pezzoni, M., & Visentin, F. (2019), The important thing is not to win, it is to take part: What if scientists benefit from participating in research grant competitions?, *Research Policy*, Vol. 48, 84-97.

Barajas, A. & Huergo, E. (2007). International R&D Cooperation within the EU Framework Programme: The Case of Spanish Firms. Contributed Paper for the *2007 Conference on Corporate R&D (CONCORD)*. Madrid: CDTI and GRIPICO-Universidad Complutense de Madrid.

Beaudry, C., & Allaoui, S. (2012). Impact of public and private research funding on scientific production: The case of nanotechnology. *Research Policy*, 41(9): 1589–1606.

Benner, M., & Sandstrom, U. (2000). Institutionalizing the triple helix : research funding and norms in the academic system. *Research Policy*, 29: 291–301.

Bozeman, B., & Corley, E. (2004). Scientists' collaboration strategies: implications for scientific and technical human capital. *Research policy*, *33*(4): 599-616.

Braun, D. (2003). Lasting tensions in research policy-making — a delegation problem. *Science and Public Policy,* 30(5): 309–321.

Costas, R., & Leeuwen, T. N. (2012). Approaching the "reward triangle": General analysis of the presence of funding acknowledgments and "peer interactive communication" in scientific publications. *Journal of the American Society for Information Science and Technology*, *63*(8): 1647-1661.

Dasgupta, P., & David, P. A. (1994). Toward a new economics of science, *Research Policy*, 23: 487–521.

Defazio, D., Lockett, A., & Wright, M. (2009). Funding incentives, collaborative dynamics and scientific productivity: Evidence from the EU framework program. *Research policy*, *38*(2): 293-305.

Dekker, D., Krackhardt, D., & Snijders, T. A. B. (2007). Sensitivity of MRQAP tests to collinearity and autocorrelation conditions. *Psychometrika*, 72(4): 563–581.

European Commission. (2000). Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions: Towards a European Research Area. *COM(2000)6*.

European Commission. (2015). *Seventh FP7 monitoring Report*. Directorate-General for Research and Innovation.

European Commission. (2016). *Roadmap for EU-China S&T cooperation*, Brussels, October 2016.

European Council. (2000). Presidency conclusions. http://www.europarl.europa.eu/summits/lis1_en.htm (26/12/2015).

European Union. (2015). EU-China Research & Innovation Relations.

Fedderke, J. W., & Goldschmidt, M. (2015). Does massive funding support of researchers work ?: Evaluating the impact of the South African research chair funding initiative. *Research Policy*, 44(2): 467–482.

Grassano, N., Rotolo, D., Hutton, J., Lang, F., & Hopkins, M. M. (2017). Funding Data from Publication Acknowledgments: Coverage, Uses, and Limitations. *Journal of the Association for Information Science and Technology*, *68*(4): 999-1017.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London-Thousand Oaks-New Delhi: Saga Publications.

Geuna, A., & Martin, B. (2003). University research evaluation and funding: An international comparison. *Minerva*, 41: 277–304.

Godin, B. (2003). The Impact of Research Grants on the Productivity and Quality of Scientific Research, *NRS Working Paper*, National Sciences and Engineering Research Council of Canada (NSERC).

Gök, A., Rigby, J., & Shapira, P. (2016). The Impact of Research Funding on Scientific Outputs: Evidence from Six Smaller European Countries. *Journal of the Association for Information Science and Technology*, 67(3): 715–730.

Guellec, D. & Van Pottelsberghe de la Potterie, B. (2001). The internationalisation of technology analysed with patent data. *Research Policy* 30(8): 1253-1266.

Geuna, A. (1999). *The Economics of Knowledge Production*. Cheltenham, UK • Northampton, MA, USA: Edward Elgar

Heffner, A. (1981). Funded research, multiple authorship, and subauthorship collaboration in four disciplines. *Scientometrics*, *3*(1): 5-12.

Hoekman, J., Scherngell, T., Frenken, K., & Tijssen, R. (2013). Acquisition of European research funds and its effect on international scientific collaboration. Journal of Economic Geography, 13(1): 23–52.

Jaffe, A. B. (1989). Real Effects of Academic Research. *The American Economic Review*, 79(5): 957–970.

Johnson, H. (1972). Some Economic Aspects of Science, *Minerva*, 10: 10–8.

Katz, J. S., & Martin, B. R. (1997). What is research collaboration? *Research policy*, *26*(1): 1-18.

Krackhardt, D. (1988). Predicting with networks: Nonparametric multiple regression analysis of dyadic data. *Social Networks*, 10, 359–381.

Lee, S., & Bozeman, B. (2005). The impact of research collaboration on scientific productivity. *Social studies of science*, *35*(5): 673-702.

Lepori, B. (2006). Public research funding and research policy: a long-term analysis for the Swiss case. *Science and Public Policy*, 33(3): 205–216.

Lepori, B., V. Veglio, B. Heller-Schuh, T. Scherngell & M. Barber (2015). Participations to European Framework Programs of higher education institutions and their association with organizational characteristics. *Scientometrics* 105(3): 2149-2178.

Luukkonen, T., Tijssen, R.J.W., Persson, O., & Sivertsen, G. (1993). The measurement of international scientific collaboration. *Scientometrics*, 28: 15-36.

Ma, A., Mondragón, R. J., & Latora, V. (2015). Anatomy of funded research in science. *Proceedings of the National Academy of Sciences*, 112(48): 14760–14765.

Mansfield, E. (1991). Academic Research and Industrial Innovation. *Research Policy*, 20(1): 1–12.

Mansfield, E. (1998). Academic research and industrial innovation: An update of empirical findings. *Research Policy*, 26(7–8): 773–776.

Nelson, B. R. R. (1986). Institutions supporting technical advance in industry. *The American Economic Review Proceedings*, 76(2): 186–189.

Neufeld, J. (2016). Determining effects of individual research grants on publication output and impact: The case of the Emmy Noether Programme (German Research Foundation). *Research Evaluation*, 25 (1): 50-61.

Nokkala, T., Heller-Schuh, B., Paier, M. & Wagner-Luptacik, P. (2008). Internal integration and collaboration in European R&D project. *NEMO Working Paper no. 13*.

Paier, M. & Scherngell, T. (2011). Determinants of Collaboration in European R & D Networks: Empirical Evidence from a Discrete Choice Model. *Industry and Innovation*, 18(1): 89-104.

Paul-Hus, A., Desrochers, N., & Costas, R. (2016). Characterization, description, and considerations for the use of funding acknowledgement data in Web of Science. *Scientometrics*, 108(1): 167–182.

Pavitt, K. (2000). European funding academic research should be increased : a radical proposal. *Science and Public Policy*, 27(6): 455–460.

Payne, A. & Siow, A. (2003). Does federal research funding increase university research output? *Advances in Economic Analysis & Policy*, 3: 1–22

Piro, F.N., Scordato, L., & Aksnes, D. (2016). Choosing the right partners. Norwegian participation in European Framework Programmes. *NIFU report 41/2016*. Oslo: NIFU.

Piro, F.N., Scordato, L. & Aksnes, D. (2017). The changing behaviour of European universities in Horizon 2020. *EU-SPRI* Conference, Vienna, Austria, June 2017.

Prettner, K., & Werner, K. (2016). Why it pays off to pay us well: The impact of basic research on economic growth and welfare. *Research Policy*, 45(5): 1075–1090.

Protogerou, A., Caloghirou, Y., & Siokas, E. (2013). Research networking and technology fusion through EU-funded collaborative projects. *Science & Public Policy*, 40(5): 576-590.

Qiu, J. (2014). China goes back to basics on research funding. *Nature*, 507: 148–149.

Ramberg, I. (2016). Tids- og ressursbruk for søkning til Norges forskningsråd i 2016 (English: Time- and resources spent on applications to the Research Council of Norway in 2016). *NIFU report 2016:43*. Oslo: NIFU.

Roediger-Schluga, T. & Barber, M. (2008). R&D collaboration networks in the European Framework Programmes: data processing, network construction and selected results. *International Journal of Foresight and Innovation Policy*, 4(3-4): 321-347.

Salter, A. J., & Martin, B. R. (2001). The economic benefits of publicly funded basic research: a critical review. *Research Policy*, 30: 509–532.

Scherngell, T. & Lata, R. (2013). Towards an integrated European Research Area? Findings from Eigenvector spatially filtered spatial interaction models using European Framework Programme data. *Papers in Regional Science* 92(3): 555-577.

Stephan, P. (1996). The Economics of Science, *Journal of Economic Literature*, 34/3: 1199–235.

Szell, M. & Sinatra, R. (2015). Research funding goes to rich clubs. Proceedings of the National Academy of Sciences, 112(48): 14749-14750. Stephan, P. (2010). The Economics of Science-Funding for Research, International Center for Economic Research. *SSRN Working Paper No.12/2010*. doi:10.2139/ssrn.1634772

Tang, L., Hu, G., & Liu, W. (2017). Funding acknowledgment analysis: Queries and Caveats. *Journal of the Association for Information Science and Technology*, *68*(3): 790-794.

Tuo, Y. (2013). Chinese govt to support international students, *China Daily*, 2013-05-01.
Ubfal, D., & Maffioli, A. (2011). The impact of funding on research collaboration: Evidence from a developing country. *Research Policy*, *40*(9): 1269-1279.
Wang, J., & Shapira, P. (2011). Funding acknowledgement analysis: an enhanced tool to investigate research sponsorship impacts: the case of nanotechnology. *Scientometrics*, *87*(3): 563-586.
Wang, X., Liu, D., Ding, K., & Wang, X. (2012). Science funding and research output: a study on 10 countries. *Scientometrics*, 91(2): 591-599.
Wang, L., & Li, Z. (2018). Knowledge Transfer from Science to Technology — The Case of Nano Medical Device Technologies. *Frontiers in Research Metrics and Analytics*, 3(11): 1–8.
Wang, L., & Wang, X. (2017). Who sets up the bridge? Tracking scientific collaborations between China and the European Union. *Research Evaluation*, 26(2): 124–131.
Wang, L., Wang, X., & Philipsen, N. J. (2017). Network structure of scientific collaborations between China and the EU member states. *Scientometrics*, 113(2): 765–781.
Zhao, S. X., Tan, A. M., Yu, S., & Xu, X. (2018). Analyzing the research funding in physics: The perspective of production and collaboration at institution level, *Physica A*, 508: 662–74.
Zhao, S. X., Yu, S., Tan, A. M., Xu, X., & Yu, H. (2016). Global pattern of science funding in economics. *Scientometrics*, *109*(1): 463-479.

Appendix:

Table A1: Time groups of joining the European Union

EU 28	Country_code	Before 2000	Between 2001 and 2006	Between 2007 and 2014
Austria	AT	1		
Belgium	BE	1		
Bulgaria	BG			1
Croatia	HR			1
Cyprus	CY		1	
Czech Republic	CZ		1	
Denmark	DK	1		
Estonia	EE		1	
Finland	FI	1		
France	FR	1		
Germany	DE	1		
Greece	EL	1		
Hungary	HU		1	
Ireland	IE	1		
Italy	IT	1		
Latvia	LV		1	
Lithuania	LT		1	
Luxembourg	LU	1		
Malta	MT		1	
Netherlands	NL	1		
Poland	PL		1	
Portugal	PT	1		
Romania	RO			1
Slovakia	SK		1	
Slovenia	SI		1	
Spain	ES	1		
Sweden	SE	1		
UK	UK	1		

Table A2: Shared Official languages in EU member states

	Croatian	Czech	Danish	Dutch	English	French	German	Greek	Hungarian	Irish	Italian	Slovak	Slovenian	Sweden
Austria	1						1		1				1	
Belgium				1		1	1							
Bulgaria														
Croatia	1										1			
Cyprus								1						
Czech Republic		1										1		
Denmark			1				1							
Estonia														
Finland														1
France						1								
Germany			1				1							
Greece								1						
Hungary									1			1	1	
Ireland					1					1				
Italy						1	1				1		1	
Latvia														
Lithuania														
Luxembourg						1	1							
Malta					1									
Netherlands				1										
Poland														
Portugal														
Romania									1					
Slovakia		1							1			1		
Slovenia									1		1		1	
Spain														
Sweden														1
UK					1					1				
sum	2	2	2	2	3	4	6	2	5	2	3	3	4	2

Source: https://en.wikipedia.org/wiki/Languages_of_the_European_Union

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