Scientific research and funding networks between China and the European Union

SCIENCE, TECHNOLOGY & INNOVATION INDICATORS

Open indicators: innovation, participation and actor-based STI indicators
PARIS 2017

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ABSTRACT

Using co-publication and funding data between China and the EU28, this study examines the effect of funding on co-publication and vice versa. Our datasets include publication and funding information extracted from Thomson Reuters Web of Science as well as The European Union's Seventh Framework Program for Innovation and Research (FP7) and the currently ongoing framework program Horizon 2020 (H2020), with funding data provided by the European Commission. Our results show that scientific collaborations between China and the EU28 have been mainly financially supported by Chinese agencies. In the process of collaborating with China, there is an obvious integration phenomenon in the European Union, in particular between the new EU members and those that joined the EU earlier. We also find that earlier scientific co-publications between countries have a significant and positive effect on writing joint proposals in FP7 and H2020. Our results show that FP7 or H2020 funding proposal collaborations, although unsuccessful in directly getting the EU funding – contributed significantly to later publications.

1. INTRODUCTION

Funding plays an important role in research, as it provides financial support to scientists' research plans. 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 Agency), 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 analyze the funding supported research output (Wang et al., 2011; Wang et al., 2012). These funding related search field tags boost a lot of studies from various perspectives (Wang et al., 2011;

Wang et al., 2012; Wang & Shapira, 2011; Costas & van Leeuwen, 2012; Paul-Hus; Desrochers & Costas, 2016; Zhao et al., 2016). However, there are also coverage limitations and potential biases for the funding data provided by Web of Science (Tang, Hu, & Liu, 2017; Grassano, et al., 2017).

It has been believed that publications with funding acknowledgments present research with a higher social impact compared to publications without them (Costas & van Leeuwen, 2012; Gök et al., 2015). Neufeld (2015) 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.

Applying the funding data of the Fund for the Scientific and Technological Research in Argentina, Ubfal & Maffioli (2011) study the impact of funding on the collaborations among 768 Argentine scientists, and suggest that funding is positively and significantly related to collaboration which is measured in terms of the co-authored publication counts. Employing the funding data of the European Framework Programmes (FPs) covering a 12-year period (1995–2006), Protogerou, Caloghirou & Siokas (2013) examine the EU-funded research networks and find that the networks are rather dense, pervasive, robust, and structured around the core of large firms, prestigious universities and research institutes. Several studies have pointed at how EU FP collaboration is strongly dominated by a core set of institutions (e.g. Lepori et al., 2105; Paier & Scherngell, 2011; Piro, Scordato & Aksnes, 2016; Roediger-Schluga & Barber, 2008).

External funding also drives applicants to integrate all kinds of knowledge resources, including finding appropriate collaborators. As defined by Katz & Martin (1997), collaboration is the process through which individuals work together to achieve the common goal of producing new scientific knowledge. Public funding could promote research collaborations; however, the relationship between funding and collaboration is complicated. Funding may be an important factor to motivate collaboration. Existing studies suggest that funding has a significant positive impact on collaboration (Bozeman & Corley, 2004; Lee & Bozeman, 2005). Funding is related to the increase of collaborations, although it varies for collaboration modes and disciplines (Heffner, 1981). Employing a panel of 294 researchers in the EU over a 15-year period, Defazio, Lockett, & Wright (2009) study the effect of funded collaboration on enhancing researcher productivity and find that collaborations emerge only in the post-funding period.

During the last two decades, China has become the second most productive country in scientific publications. The collaboration between China and other countries/regions, including the European Union, is becoming more and more active in various fields (Wang & Wang, 2017). However, linking funding and collaboration and revealing the collaboration dynamics between China and EU has never been addressed in previous studies. In this study, our research questions are: what are the main funding sources of the China-EU collaborated publications? What is the relationship between joint funding and collaborative research? Does the earlier scientific collaboration drive joint funding proposals, or vice versa?

2. DATA AND METHODOLOGY

Publication data are collected from Thomson Reuters' Science Citation Index Expanded (SCI-E) and Social Sciences Citation Index (SSCI). In our analysis, we focus on the international collaborations at national level. Affiliation address is used to identify the location of researchers.

This study employs two sets of funding data. The first set was collected from SCI-E and SSCI. Using VatagePoint 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 Union (such as framework programmes, 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 FPs. Our study is based on the data for the seventh framework programme (FP7) and the early phase of Horizon2020 (H2020), covering the years 2007 until 2015. There were in total 1618 funding proposals jointly written by China and European countries, among 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 European members and China), data of funding proposals and projects have been transformed into the format of a 29 * 29 matrix. Thus we have 16 matrices for both funding proposals and granted projects in the period 2007 - 2015.

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

$$CI = \frac{CO_{ij}}{P_i + P_j - CO_{ij}} \qquad (1)$$

Where CO_{ij} is the number of co-authored papers between country i and country j;
P_i is the total publication number by country i;
P_j is the total publication number by country j.

Our aim is to assess the relationship between a number of social network datasets, thus we use a quadratic assignment procedure (QAP) to implement regressions. All variables in the QAP regression are in the 29*29 matrix format.

3. RESULTS AND DISCUSSIONS

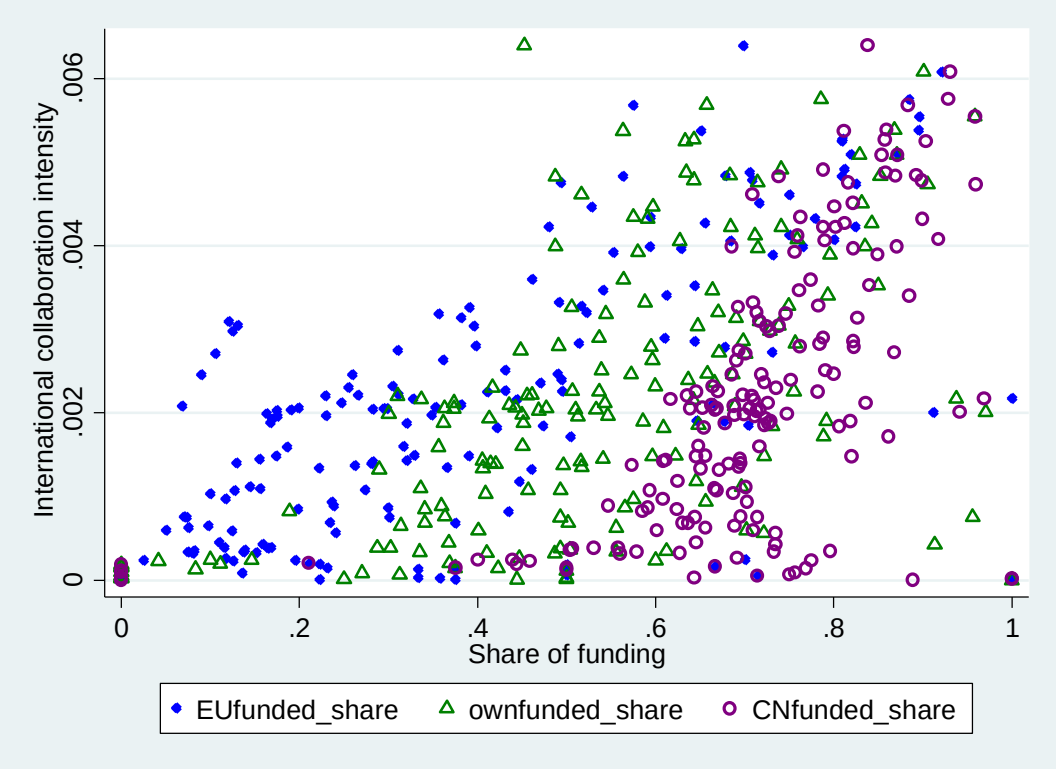
3.1 Collaboration intensity and funding structure

China and the EU 28 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 Europe, there are 55,840 records. By decomposing funding organizations into three types, we find that the scientific research jointly published between China and the EU28 has been mainly funded by Chinese organizations. Around 80% of joint publications acknowledged funding support from Chinese organizations. Following that, funding from national level in European countries also contributed to 47% of the joint publications, and about 13% 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.

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 type of funding. Located on the right side of figure 1, funding from China has the highest share. National funding programmes from

European countries contributed at the second place. Funding from the European Commission stands on the left with a relatively lower share.

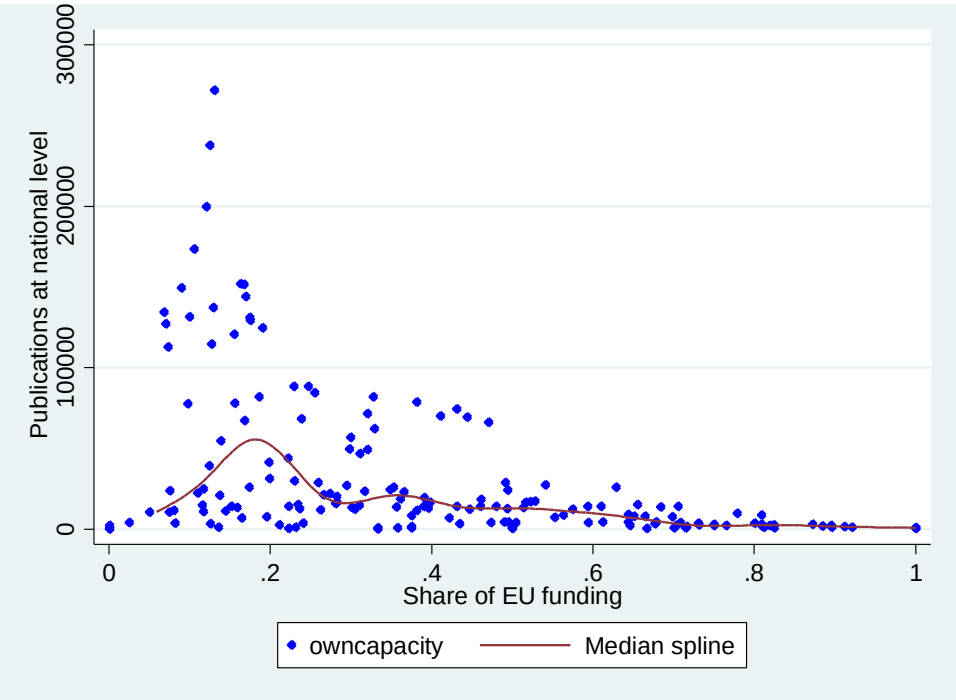
Figure 1: Correlation between joint publication intensity and funding share (2009-2014)



3.2 Research capacity & funding resources

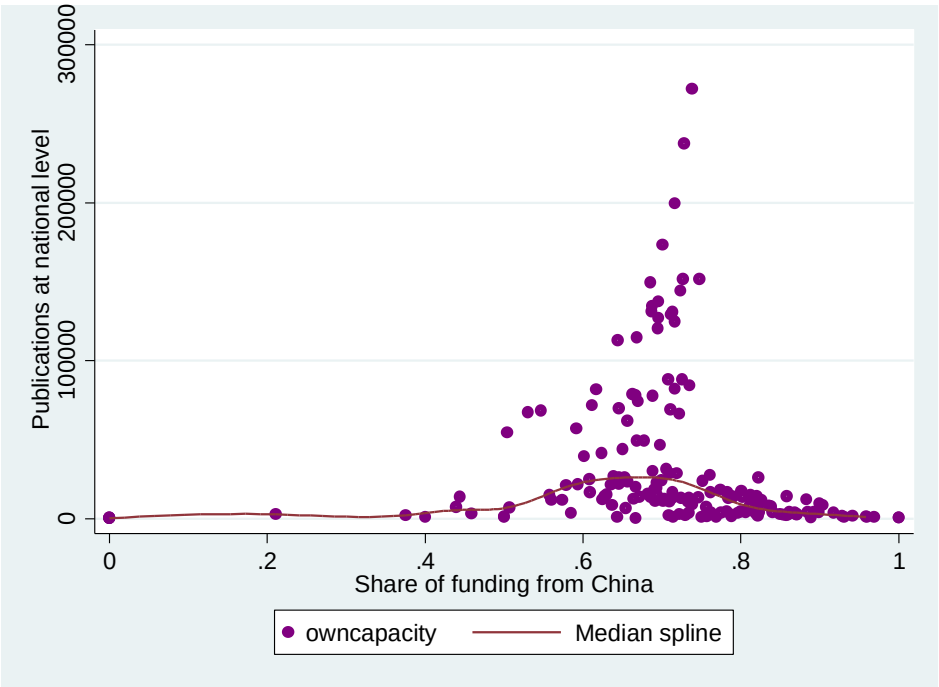
To deepen our understanding of funding schemes, we connect funding resources with research capacity of each country. Figure 2 shows that European countries with high research capacity (proxied by the number of total publications at national level) received a rather small share of funding from the European Commission. In the small European countries with low research capacity, due to the lack of national government funding, the share of EU funding is relatively higher. However, the EU-funded share is much higher for those countries with low national research capacity.

Figure 2: 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). There is generally a reversed U-shape between national capacity and funding share from China. In the countries with high research capacity, on average 75% of the joint publications co-authored with Chinese researchers were funded by Chinese organizations.

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



3. 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 improve scientific co-publications. We use multiple regression quadratic procedure (MR-QAP) to assess the impact of funding proposals (or projects) upon research output, and vice versa.

Table 1 documents the regression results. Based on the year of joining the European Union, European countries are classified into three groups: before 2000, between 2001 and 2007, and after 2007. This information for each country is further transformed into a relation matrix captured by the variable of "EU membership time group". Language barrier is often assumed to be an important factor influencing collaboration communications. As European countries 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[1]. 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).

[1] https://en.wikipedia.org/wiki/Languages_of_the_European_Union.

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

	model 1	model 1a	model 1b	model 1c	model 2	model 2a	model 2b
DV	joint publications (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 FP7&H2020 proposals (2007-15)	joint FP7&H2020 funded projects (2007-15)	joint FP7 &H2020 unfunded proposals (2007-15)
Intercept	0	0	0	0	0	0	0
	15.346	90.712	256.760	183.840	2.337	1.964	0.373
FP7&H2020 funded projects (2007-10)	-0.304**	-0.368**	0.079	-0.078			
	-27.567	-24.283	1.778	-3.724			
FP7 &H2020 unfunded proposals (2007-10)	1.138***	1.177***	0.831***	0.974***			
	38.026	28.671	6.934	17.145			
Jointpub (2003-06)					1.443**	1.443**	1.429**
					0.357	0.089	0.268
Jointpub (2007-10)					-0.740	-0.793	-0.716
					-0.107	-0.028	-0.078
Eumembership time group	-0.086***	-0.094***	-0.083**	-0.094***	0.227***	0.285***	0.206***
	-276.557	-220.403	-67.245	-160.530	54.778	17.107	37.671
geographical distance	0.009	-0.001	-0.083	-0.011	0.185*	0.138	0.199*
	0.009	-0.001	-0.020	-0.006	0.013	0.002	0.011
language	-0.006	-0.010	-0.005	-0.007	0.038	0.039	0.037
	-22.849	-28.574	-4.355	-14.400	10.677	2.712	7.965
R-sqr	0.739	0.701	0.748	0.794	0.661	0.572	0.682
N	812	812	812	812	812	812	812

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

Model 1 examines the contributions of FP7 and H2020 proposals and projects in the earlier years (2007-10) to the joint publications in later years (2011-14). Unfunded proposals significantly and positively contribute to the joint research output. This reveals that rejected applications can still lead to successful output elsewhere. In a survey among Norwegian researchers that have 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). These findings are in line with the patterns observed in our study, i.e. even failed applications may be beneficial to future collaborations. To further explore this issue, we test the contribution of unfunded FP7& H2020 proposals to publications funded by different resources (Models 1a, 1b and 1c).

Models 1a, 1b and 1c show that failed FP7 (or H2020) proposal cooperation has a significant and positive effect on obtaining funded research opportunities from China, the EU and individual European countries. Among these three cases, the coefficient in the China-funded model (Model 1a) has the highest value (1.177). This means that the experience of writing joint FP7 (or H2020) proposals, though failed in getting EU funding, can contribute greatly in obtaining funding from China in the later years. Interestingly, the coefficient of "FP7&H2020 funded projects" is negatively significant. This indicates that successful FP7 or H2020 projects can make partners busy enough and there would be less research time put in pursuing scientific collaborations funded by China.

Model 2 investigates the contributions of joint publications in the earlier years to the joint FP7&H2020 proposals in the later years. The results show that earlier scientific collaborations (during 2003-06) have a positive and significant contribution to joint funding proposals in later years (2007-2015). European 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 similar time. One should bear in mind that the collaborations studied here are not pure cooperation within Europe, but collaborations with China. Namely, each joint publication or funding proposal examined in this study involves China.

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". However, our results show that in the process of collaborating with China, the scientific collaborations in earlier years – rather than in later years – have positively stronger effect on joint funding proposals. Secondly, the European membership variable shows a positive effect on joint FP7 or H2020 proposals, but negative effect on joint publications. This shows that EU member states are still fond of working on joint FP7 or H2020 projects with partners that joined the EU at similar time (mostly between the "old" members), but in the wider range – i.e. conducting joint scientific publications, it is obvious that European countries have been greatly integrated, in particular between countries with "old" European Union members and "new" members. This can to some extent explain the results from Hoekman et al. (2013). The "new" EU countries have been actively collaborating with the "old" EU members, cf. Scherngell & Lata (2012) who documented that while geographical distance between two regions still exerts a negative effect on the collaboration probability in the FPs, the effect significantly decreased between 1999 and 2006. Thus, they concluded that the FPs had helped to increase the probability for large

distance collaborations in Europe, and contributed to geographically integrated European research systems.

In relation to Chinese-EU 28 collaboration, language barrier 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 & 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.

4. CONCLUSIONS

Using co-publication and funding data between China and the EU28, this study examines the effect of funding on co-publications and vice versa. Our results show that joint publications between China and the EU28 have been financially supported mainly by Chinese agencies. This also explains why Chinese researchers are the main corresponding authors in China-EU joint publications (Wang and Wang, 2017). We find that funding received from the European Commission contributed greatly to the integration of the European Union in the process of collaborating with China, in particular between the new EU members and those that joined the EU earlier. In the European countries with low national research capacity, in the process of collaborating with China, a large share of scientific research funding is from the European Commission. We also find that scientific co-publications in the earlier years have a positively strong effect on joint funding proposals in FP7 or H2020 between China and the EU28. FP7 or H2020 funding proposal collaborations – in particular those unsuccessful in getting EU funding – contributed significantly to later publications. This indicates that, after failing in FP7 or H2020, cooperative partners were more likely to be successful in achieving funding elsewhere.

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