

The Complexity of Funding International Research Collaboration. An Analysis of Partnership and Rivalry Between the EU and China

Journal of Studies in International Education
1–20

© 2024 European Association for
International Education

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/10283153241293797

journals.sagepub.com/home/jsi



Giulio Marini¹  and Mikkel Mouritzen²

Abstract

In recent years, increased rivalry between China and the EU has been seen as a threat to cooperation, including in the field of higher education and scientific research. We explore how cooperation in research between China and the EU has developed over time via a bibliometric analysis of international co-authorships within four different funding agencies (CAS, MOST, JRC, and ESA). Our findings suggest that EU-China cooperation has continued to strengthen, despite a new options for “rivalry to increase between these two parties”. We suggest that this is explained by the benefits that both the EU and China receive from collaboration, albeit such benefits differ in type. Possibly, our findings are also a byproduct of adjustments triggered initially by the US “China Initiative”. The dilemma of whether to collaborate or not is likely to become more pressing, as the policies of some funding agencies have implications for national defense and security.

Keywords

scientometrics, game theory, international co-authorships, funding agency, decoupling, European space agency, joint research centre, Chinese academy of science, ministry of science and technology of China

¹University of Catania, Catania, Italy

²Roskilde Universitet, Roskilde, SJ, Denmark

Corresponding Author:

Giulio Marini, University of Catania, Palazzo delle Scienze, Catania 95131, Italy.

Email: giulio.marini@unicit.it

Introduction

Recent discussions concerning contemporary China have begun to question the role of globalization. Typically, globalization was understood as a win-win dynamic. In a Francis Fukuyama “History is over” argument, allowing openness to China equals having better opportunities for all. However, more recent debates pose the idea of China surging to the role of superpower. This latter argument echoes Samuel Huntington’s idea of a “Clash of Civilizations” whereby a new Cold War order also implies increased competition and a return towards a zero-sum game. Despite these two broad ideas referring to the US and China we apply these two stances to China-EU relations: the former being the new superpower; the latter comprising the largest part of the Global West, after the US. The current policy debate in Europe is summarized in Brinza et al. (2024). In the realm of research, one of the pillars of higher education, this translates into either collaboration (being partners) or non-collaboration (being rivals).

We start by agreeing with Marginson’s (2022) process-oriented approach that points out that contemporary higher education is in flux and changing dynamically. The rapid changes in higher education have made it increasingly urgent to unpack the collaboration/competition dynamic, especially because these two opposite visions have repercussions for research and researchers alike. Full collaboration equals exploiting any possible advances in science and technology, despite where the funding is coming from, or who is receiving it. Under the “History is over” paradigm, outcomes would not influence the greater status quo. However, if one is operating from a desire for supremacy as in the “Clash of Civilizations” paradigm; or “rivalry” in EU parlance, for example, in technology and science, being open to collaboration, also includes becoming sensitive when collaborating with superpowers like China and taking care not to share too many advantages with a rival, while obtaining possibly only marginal advantages for the collaborator. For instance, EU and Chinese universities may work together to develop research about space, but at the same time the EU and China are competitors in relation to their role in space. Moreover, it is not necessarily certain that these two regions will always be partners – they might become increasingly open rivals in relation to applications stemming from such research.

Presumably the funding region establishes goals, regulations, and procedures that need to be followed. Thereby a Funding Agency (FA) also becomes an actor who binds other actors to certain goals (Geuna, 1999; for a positional paper see: Shih, 2023). For the sake of our argument, some theoretical formalization may help. From a Game Theory perspective, co-authoring scientific outputs between authors affiliated with universities and research institutions in two different regions might be considered as beneficial by both parties (on top of being beneficial to universities and authors in the first place). However, when the research is conducted by researchers from two different regions, we might assume that it is the region where the FA is based that may obtain the lion’s share of the benefits, since the FA is pursuing a greater goal for its own country/region (see Figure 1).

	Funded by national Agency (Region B)	Non-Funded by national Agency (Region B)
Funded by FA (Region A)	1. $A = B$	2. $A > B$
Non-Funded by FA (Region A)	3. $A < B$	4. $A = B$

Figure 1. A game theory application for determining the benefits of internationally co-authored scientific publications by FAs (A and B represent post-publication benefits at region level, for instance applied ones).

In Figure 1, The first scenario assumes both regions fund research co-authored by people affiliated in those countries. The fourth scenario describes a situation whereby the scientific publication does not require specific funding from either region. It is important to note that we are not investigating these two typologies. Instead, we are focusing on the second and third scenarios in which a particular region funds the research assuming that national FAs shape the otherwise freely established collaborations. Since the advantages of participating in a research project differ according to the location of the FA, authors from the non-funding region may decide to take part in (or not) in the research according to the understanding of the partnership (partnership vs. rivalry). If Region B decides to partake in collaboration along with colleague(s) in Region A under a FA from Region A, this means that researchers affiliated in Region B (and policy makers regulating this region) accept the outcomes: higher benefits for Region A than for Region B (an argument we will explore via three operative research questions).

Assuming that we are entering a new era of competition that results in retrenchments, mostly between the Global West and China, it is nevertheless difficult to imagine this affecting globalization. On the one hand, it is likely that researchers simply will not give up the reciprocal advantages gained from open science research. On the other, new institutional and national constraints may be established, which means that cooperation enters a new phase that just a few years previously would have been difficult to imagine (Cai, 2019). This phase is difficult to analyze.

In this article we aim to shed some light on the collaboration between European and Chinese science collaborators by considering internationally co-authored publications and FAs' intentions understood as a series of repeated "games" as theorized above. The way regions understand such relationships would be the aggregated, ex-post, figures in terms of frequency of collaboration (first and second research questions: *involvement* and *centrality*), and contribution given to such collaboration (third research question: *influence*).

The paper is structured as follows: after this introduction we introduce our operative research question, before engaging more actively with the literature. Then we present our data and analysis, addressing the factors of: involvement, centrality, and influence of the major players on the research questions posed. Then we discuss our findings in regard to the nature of EU and China collaborations altogether with their limitations, which will form the basis for our conclusions.

Research Questions

We focus on three observable differences analyzed by the FA and timing of the grant, frequency of collaborations (*involvement*); the centrality of co-authored science publications globally (*centrality*); and the quality of research output (*influence*).

Involvement revolves around the frequency of collaborations. Here we emphasize that a given FA can manage to involve co-authors from abroad more or less frequently across time. We assume that the more a national/regional FA can involve researchers affiliated with institutions in other regions, the more such a FA is successful in pursuing its goals. While we recognize that this assumption is inherently dangerous, as a FA may, for instance, ban specific countries from participating in their research, we do not investigate this possibility further. To the best of our knowledge such practice between China and the EU has not been currently applied by the four agencies focused on in this study. Although there are some hints that this might be changing in the future, we focus on observed collaborations as they happen, disregarding any the analyses of policies hindering collaborations. This is especially important from a European perspective, as China has recently outdone Europe in the number of collaborations with the US, potentially establishing a new duopoly (Isfandyari-Moghaddam et al., 2023). Such a duopoly is also: a rivalry of its own (Jang et al., 2022; Marini & Lombardi, 2025); highly dependent on which of the two countries takes the initiative (i.e., first author); and dependent on where the funding is coming from (Lee & Haupt, 2020).

The second part of our analysis is concerned with the centrality of a region in the web of research collaborations. This step is crucial as we develop a better understanding of the position of both the set of EU countries from one side, and Mainland China on the other, in relation to the global composition of scientific collaborations. This is useful because centrality as found within a social network analysis may vary from mere frequencies of a given phenomenon. Empirically, this is derived from an affiliation matrix, where each publication represents an event, and each entity represents a country/region that may or may not participate in the event. In general, the more central an entity is in a network, the more important it is in the global web of science. This operative research question also includes the effect of non-EU and non-Chinese countries to account for the global dimensions of science research leading to publications and other productive outcomes.

Finally, the third step assesses the quality of internationally co-authored research by FAs which we quantify through examining a series of bibliometrical publications. This dimension is included as it is often assumed that international collaborations per se boost the visibility and quality of a publication.

Literature Review

The increase in the number of international collaborations is a phenomenon that has attracted interest for more than a decade (Leydesdorff & Wagner, 2008). The spontaneousness of collaborations is reinforced by one of the few studies applying Game

Theory to co-authoring, which affirms the importance of integrity and trust amongst collaborators (Lazebnik et al., 2023). However, using Game Theory to analyze the aggregated national/regional effects enacted by FAs, is quite a novel approach in this field to the best of our knowledge.

The availability of funding is arguably one of the most important elements in being able to conduct research, especially high-end research. In this regard China is a point in case as its research and development funding has grown much more than the global average (Olechnicka et al., 2019), and considerably more than its general GDP growth. China is turning steadily into a global giant in terms of science and technology, second only to the US, if not outpacing the US in some fields. Although China in the recent past was criticized for not producing findings of the highest quality (for instance top 1% and 10% publications) and lagging behind the US and the EU (Leydesdorff et al., 2014), its capacity to produce high quality research has improved quickly. Marginson (2021) notes that several Chinese Universities are now amongst the best contributors, according to the Leiden Index.

Looking at specific sponsors, or FAs, has also become a preoccupation amongst prospective researchers (Huang & Huang, 2018). FA ready-to-use labels from repositories like Web of Science Clarivate are reliable, especially the government ones (Morillo & Álvarez-Bornstein, 2018). Internationalization pursued by FAs reveals dense but unequal distribution of funding from China attracting many countries. On the other hand, the US mostly receives collaboration from Europe (Huang & Huang, 2018). The best way to predict Sino-European co-authorships is to investigate how the proposal is developed from the design stage to win the grant (Wang et al., 2020). The same research also found that Chinese funding is more conducive to increasing productivity, whereas EU funding schemes focus on the impact of doing the research – with FAs shaping researchers' choices in terms of outcomes. Another study found that Sino-European publications are positively influenced by FA projects (Shih & Forsberg, 2023).

Membership of the EU per se is apparently conducive to higher connectedness to China (higher centrality in the network of co-authorships expressed by the concept of *betweenness*), if one uses entry into EU itself as a criterion for connectedness (Wang et al., 2017). The need to be a member of the EU helps in the success of the application. Membership to the EU, holds more weight in the application process than just being eligible to apply for grants under Associated Country status (Marini, 2023). However, Wang et al. (2017) also found that most of EU countries do not co-author publications with China to a noticeable extent, confirming that Western Europe in general, and not the EU altogether, remains the main source of partnerships for China.

Finally, some research focuses on constraints driven by geopolitical rivalries in specific applications, such as Covid-19 vaccinations (Marini, 2024), or cultural differences, for which specific funding may represent an incentive for making adjustments in China's favor (Shih & Forsberg, 2023).

Data Construction

In this article we focus on four FAs: the European Space Agency (ESA); the European Commission's Joint Research Centre (JRC); the Chinese Academy of Science (CAS); the Ministry of Science and Technology of China (MOST). Two of these agencies are funded by the EU and two by China, but apart from there being two agencies per region, all of the FAs share similar characteristics as they consider both basic and applied science, and all four are rooted in government initiatives (Bai et al., 2021; Sun & Cao, 2014). Conceivably, the two Chinese FAs are traditionally more likely to push for applied research (Huang et al., 2015). However, both the JRC and the ESA are as well rooted in facing policy issues and vested interests, the ESA having showed some sensitivity to "rivalry" (Brinza et al., 2024, p. 35).

In instances of articles that are funded by more than one of these agencies simultaneously (agglomeration), this occurs in 4.3% of the cases in this dataset. This information, apart from being a possibly useful confounding element, appreciates the importance of recognizing the possibility of multiple FAs (Wang et al., 2012). This is especially important as FAs can be part of inflating the number of citations overall (Feng, 2020; Zhou et al., 2020), although this is debatable as it is not always corroborated (Leydesdorff et al., 2019). However, we did not investigate all the other possible Chinese or EU FAs (i.e., the European Commission or the Natural National Science Foundation of China), or even beyond China and the EU, for instance the US agencies (e.g., the National Institutes of Health). This can be read as a limitation of our study, which would then need a larger scope. We have attempted to mitigate this limitation with a world-wide centrality measure, and list other major countries/regions as confounders of quality of research.

The list of publications analyzed in this study is downloaded from "InCite Web of Science", including all publications from 2010 up to the end of 2023. We consider international publications (publications whose list of affiliations is made up of multiple countries/regions) only. The only papers we have discarded from the dataset are those publications which are solely published by domestic affiliations. In the case of the EU, this means that publications are international even if only two or more countries within the EU participate. The merging of the publications of these four FAs represents the main dataset and it totals 100,000+ publications.

Data Analysis

Involvement: Time Series

As illustrated in Figure 2, we can see that the average number of countries/regions that have been involved in each publication mostly increased until 2018. The decrease is particularly evident in the two Chinese programs, whereas the JRC and the ESA seem to be more stable across time (see Figure 2). In terms of the number of included partner countries/regions, the FA with the clearest pattern of decline seems to be the

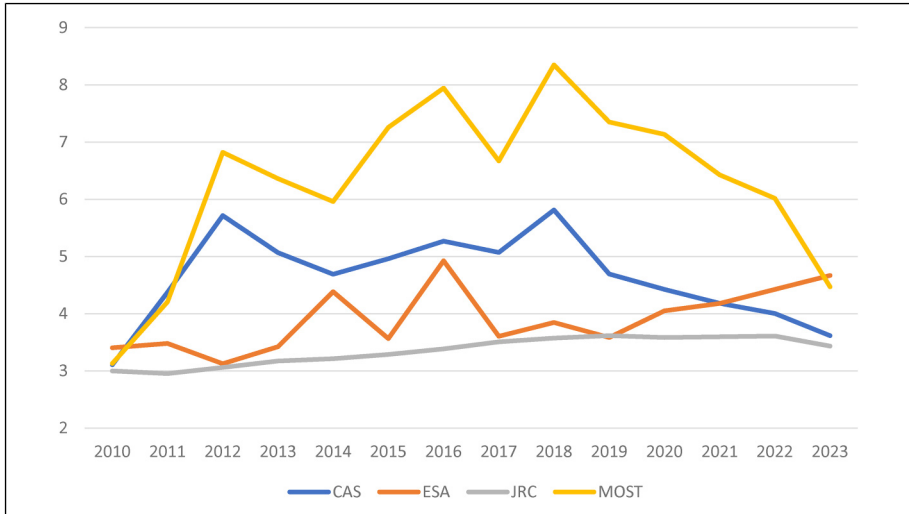


Figure 2. Average number of co-authoring countries/regions per article by FA. Time series.

MOST, which increased dramatically up to 2018 before experiencing a significant reduction in terms of partnering countries/regions. Such a reduction may be read as a disengagement from potential international partners. The CAS funding likewise seems to have experienced a similar, albeit less steep, increase and then decrease in the numbers of publications. Both of the two EU FAs have been steadier over time, and with both FAs possibly demonstrating a small but somewhat steady increase in collaborations and publications. This time series patterns are consistent with Aghion et al. (2023), especially if read by region (see further). For three out of four FAs, in 2023 (incomplete due to moment of retrieval occurred in late 2023 itself) there is a declining number of different countries/regions per article.

Table 1 illustrates the participation of the EU, Chinese, and the US in international research collaborations across time receiving CAS, ESA, JRC and MOST funding. We divide our findings by funding region and then by funding scheme.

The Chinese FAs (CAS and MOST)

Amongst the CAS funded publications, there has been a relatively large change in the participation of EU and US partners. In 2010 for instance, EU countries participated in only 37.21% of all CAS funded international publications, while authors affiliated with US universities contributed to 46.59% of the publications. Between 2010 and 2023, EU countries took part in 51.37% of all international collaborations in 2023, whereas US participation increased until 2014, and then declined to 40.62% by 2023. This means that the most recent data show a lower involvement of US affiliated researchers than when this information was first available in 2010.

Table 1. Share of Articles with Given Collaborating Country/Region (%) Among the International Ones. Time Series. China is Excluded from CAS and MOST, and EU (or any Single Country Therein) Excluded from JRC and ESA for Representing Almost 100% of International Co-authorships.

	CAS		MOST		JRC		ESA	
	EU	US	EU	US	CN	US	CN	US
2010	37,21	46,59	33,67	45,76	3,80	21,76	3,77	40,95
2011	40,73	48,09	33,69	51,19	4,30	23,12	4,46	38,85
2012	43,25	49,48	38,05	55,86	3,69	24,65	2,40	41,01
2013	40,44	51,95	39,55	56,85	4,32	25,40	4,30	38,06
2014	40,76	52,94	37,44	58,37	4,99	25,48	4,31	34,92
2015	41,61	50,60	39,48	56,99	5,22	23,64	7,62	39,26
2016	40,30	50,13	41,67	61,25	6,65	26,93	7,78	45,73
2017	42,23	50,73	38,66	61,40	6,28	28,90	10,02	40,29
2018	43,66	50,69	42,07	59,86	7,11	26,12	12,19	41,58
2019	43,63	50,55	41,58	57,13	7,77	27,35	11,78	38,22
2020	44,28	46,63	41,94	55,09	8,21	23,27	12,98	41,70
2021	46,14	43,99	41,28	47,36	7,78	24,81	9,88	41,88
2022	46,27	42,85	45,07	45,31	9,25	24,11	11,85	38,73
2023	51,37	40,62	39,20	41,53	8,68	23,49	10,02	46,30

MOST funding has shown a slightly different pattern of development. In 2010, the EU took part in 33.67% of the collaborations, while the US had 45.76% instances of engagement. The EU then increased its participation over the following years, peaking at 45.07% in 2022 and then decreasing to 39.20% the following year. This pattern is consistently different from the US pattern which peaked at 61.40% in 2017. The US co-authorship has since declined to 41.53% of all international publications funded by MOST in 2023. For both Chinese funding schemes, the EU countries have increased their presence as partners, whereas the US initially took part in a larger proportion of the publications, before later declining in its collaborations and publications. This presents us with a complex picture of decoupling between the West and China, where the EU seems to be engaging more with China, and the US seems to be returning to a less involved relationship.

The EU FAs (JRC and ESA)

The two European FAs show similar patterns to those above with slightly different variations. While EU collaborators were participating more frequently in Chinese funded publications, China-based researchers have become a larger part of the EU funded research projects between 2010 and 2023. Both for the JRC and the ESA, Chinese researchers participated in close to 4% of the funded projects in 2010, and almost 10% in 2023 (an increase of around 150%). While these numbers are much

lower than those of the EU participation in Chinese research, one should keep in mind that these lower percentages might be explained by the fact that EU collaborations produce international publications, thereby inflating the number of international co-publications in the EU funding programs. Consequently, what is relevant here is that the Chinese co-authorship in the EU funded publications has more than doubled.

If we then look separately at the two programs, there seems to be a slightly smaller and less volatile increase in the JRC funded publications, while the ESA funded publications have been fluctuating slightly more, with the Chinese presence peaking in 2020. At the same time, US participation in publications funded by both EU programs have been fluctuating to some extent, but remained relatively stable at around 20–25% for the JRC funded projects, and at around 40–45% for the ESA funded publications (with a maximum of 46.30% in 2023). The stable presence of US affiliated researchers in EU funded projects suggests that the US is at a maximum level of engagement in EU programs, while China on the other hand has entered the game starting from much lower inclusion rate. The increase in the Chinese participation can be interpreted as an increase in maturity of the Chinese research system across time. The extent to which China will continue to increase its involvement (or otherwise), which is arguably within its capacity and probably still underexploited, is a matter for future analyses.

Centrality: Place in Collaborations

We suggest that coupling or decoupling (partnering or becoming rivals respectively) is not only seen in the gross number of internationally co-authored papers, but also the way these publications are connected to one another as per conventional social network analysis. Here we apply a measure of centrality in the network of collaborations out of the actor (the countries/regions) and the co-membership matrix (Faust, 1997). As is illustrated in Figure 2 and Table 1, 2018 seems to be a key year in terms of a possible turning point towards decoupling. Conveniently, we split the dataset into two halves from 2010 to 2018, and from 2019 to 2023 to examine whether the indicators of centrality change between 2010–2018 and 2019 onwards. Table 2 provides positions in the networks as a ranking. Annex S1 provides measures of centrality.

In terms of the most central actors in the international collaborations, there are some differences between publications funded by Chinese and EU agencies. In both Chinese funding schemes, the four most central countries are China, the US, Germany, and Great Britain. The position in the centrality measure did not change for any of these countries. In relation to CAS, China reduces its centrality in post-2018 years, albeit remaining the most central one. This can be interpreted as a sign of China opening to the world and seeking more partnerships in science.

As for CAS, many of the top partnering countries decreased their centrality measure after 2018, which is consistent with, though not strictly implied from, the prima facie evidence as seen in Figure 2. As a matter of empirical evidence, the US was and

Table 2. Ranking Position in the Centrality of Networks Generated by Publications and Authors Affiliated in Given Country/Region. Up to 2018 and Afterwards. Four Funding Agencies. Selection of Countries (two Digits Official Country Code) Sorted Alphabetically.

	RANKING POSITION							
	CAS		MOST		JRC		ESA	
	2010– 2018	2018– 2023	2010– 2018	2018– 2023	2010– 2018	2018– 2023	2010– 2018	2018– 2023
AU	25	11	26	13	14	11	23	16
BR	9	15	11	6	25	22	27	25
CA	34	49	37	53	18	12	9	11
CH	15	15	11	10	11	9	8	8
CN	1	1	1	1	20	17	26	13
DE	3	3	3	3	2	2	2	2
ES	9	12	11	10	6	4	7	7
FR	6	7	7	8	3	5	3	4
GB	4	4	4	4	1	1	4	3
HK	59	53	57	53	44	28	41	47
IN	24	26	34	28	29	27	20	28
IT	9	5	6	8	5	3	5	5
JP	34	42	27	48	21	19	26	19
KR	27	29	41	30	31	27	35	36
NL	30	32	26	36	7	7	6	6
NO	55	60	34	59	16	16	13	19
RU	6	6	6	11	23	24	14	22
SE	32	37	28	49	8	10	18	10
TW	15	11	20	14	41	29	21	43
US	2	2	2	2	4	6	1	1

remains the second most central nation after China, despite declining in terms of its measure of centrality. The same applies to following countries/regions, most of which are European. Interestingly, Russia – a long-standing partner of China – is 6th and remains so, surpassing France but losing a position to Italy. Over the first 20 positions, around half are EU or European (e.g., Switzerland). Australia, the 25th most central Country up to 2018, raised to 8th position in ex-aequo with Poland and Taiwan (here we assume that Taiwan can stand-alone in terms of science production). Australia is one of the few countries that finds itself becoming a more central actor in the CAS publications than it had been before 2019.

Within MOST publications, China remains the most central actor followed by the US, Germany, and Great Britain that keep their respective 2nd, 3rd and 4th positions. The centrality of Brazil and Poland increased, while Russia loses five positions moving from 6th to 11th. As for the CAS network, European countries make up

around a half of the most important partners within MOST funded co-publications. Likewise, we see a similar pattern with both CAS and MOST funded research when it comes to Australia's position that changes dramatically for the better, moving from the 26th to the 14th position. On the other hand, there are several European countries and Japan and Canada that are amongst those moving further to the periphery in terms of participating in MOST funded publications.

From these two examples of co-authorship funded by Chinese FAs, one may find a slightly different story from the overall picture presented in Figure 2. Despite MOST and CAS both showing a reduced number of different co-authoring countries after 2018, in both cases the US still remains as the most relevant partner. If the EU was considered as a unified region, it would probably challenge the US as China's main partner. Although the social network analysis shows that the US and the wider EU research partnership (i.e., EU plus other European countries) are the most important partners for China, one should not neglect some of the other countries that partner with China – Australia being a point in case. Amongst the BRICS countries, Russia and Brazil have a prominent position despite Russia being slightly on the decline.

European funded co-publications display a similar pattern but with slight differences. If for instance we look at the JRC, China was the 20th most central country up to 2018 in the network of international publications; the US being 4th, Australia 13th and Canada 18th. All other countries are EU members or highly embedded countries like associated countries, such as Norway. In the 2019–2023 period, the US loses two positions to the 6th most central nation, whereas China gains three positions, Canada advances by six positions and Australia advances by two. Their rise is at the behest of European countries. Notably, the US has increased its centrality as an indicator (see Annex S1), but by less of a margin than other countries.

Among the ESA publications, the US has been and remains at the main central position for both periods. China was 26th between 2010–2018, later improving its position dramatically to 13th. China has also increased its centrality to a larger extent in comparison to other countries, almost doubling its centrality measure as have Belgium and Portugal (see Annex S1). Notably, Canada has decreased its centrality, but has not altered its rank position. EU FAs, have not shown any sign of decoupling from China. Instead, EU institutions, and the free behavior enacted by scientists, shows that there has been an increase in partnership with China in recent years, more so than that developed with already more consolidated partners. This holds true especially for JRC, an agency interested in exploring many different policies, whereas ESA is more likely to have long-period infrastructural constraints along with some strategic implementations which governments cannot ignore for their own security.

Influence: Quality of Publications

The last aspect we investigate is quality. We consider two main ways to analyze and quantify this. The first is quality of journals per se, observed using the Journal Normalized Citation Index (JNCI).¹ The second aspect of quality is a post-hoc

performance based on citations. Within the list of indicators, we opt for the least time sensitive, which is also fairly normally distributed: the Percentile Subject Area indicator (PSA). In this second case, we account for JNCI as a confounding variable. This implies that the quality of the journal hosting a single article has an effect in garnering citations on top of the quality of the article per se. A paper that receives the same amount of citations as another but is published in a less prestigious journal, has performed worse as the former article benefits from the higher visibility and prestige of the higher quality journal. This second understanding of quality, despite suffering from some performance related issues, such as being relatively unreliable for very recent articles, is likely to complement actual quality along with JNCI.

Interestingly, as illustrated in Table S2, it is not possible to underline a specific turning point, nor any clear pattern or trends about averages of JNCI and PSA over the time period under analysis. As such we do not go further in depth with this part of the analysis, and now move to the results of the regression analysis, provided in Table 3. Models predict the quality of publications by each of the four FAs. Model are further split by two different dependent variables: JNCI (Models flagged “_1”); and PSA (Models flagged “_2”). In Table 3 each equation accounts for year of publication (results omitted), number of authors per publication (n_aut), number of countries/regions involved in each paper (dens), and a convenient list of countries/regions involved in the published paper represented as dummies (so that a given country/region would either be present or absent in each publication). This is relevant as, for instance, countries/regions like Taiwan, South Korea, or Pakistan are more inclined to be represented in the Chinese funded collaborations than in the EU schemes (geographical proximity argument). In this list of publications, China and the EU are not present in the equation for their respective domestic FAs because they are represented in almost 100% of their own respective cases.

CAS funded research for participation in publications by the EU, Australia, Canada, Japan and the US predicts a better target journal (JNCI, Model1), although to different extents. Brazilian affiliations on the other hand predict a journal with a lower score, along with Indian, Israeli and Russian affiliations. In terms of determining the quality of the papers scored through PSA (Model2), the EU is the third most relevant contributor, after the US, and Brazil.

From Table 3, EU co-signed publications do not predict any increase of JNCI amongst MOST funded publications. However, EU contributions do predict an increase in terms of PSA for MOST funded research. This means that under this FA, authors manage to publish in good journals irrespective of their affiliation with specific EU Countries. However, when it comes to refer to quality as per PSA indicator (at parity of the visibility and prestige conveyed by being located in a given journal), authors affiliated with any EU Country contribute positively (coefficient 4.150 meaning that MOST funded research is published in journals whose JNCI is 4 percentiles higher). A more extensive interpretation reads as follows: the MOST FA is effective in being conducive to publish in competitive journals if they are co-authored by Indian, Japanese or US affiliated scholars. Notwithstanding, when checking at parity

Table 3. OLS Prediction of Quality of Target Journal (Models “1”: Journal Normalized Citation Impact), and OLS Prediction of Quality of Single Articles (Models “2”: Percentile in Subject Area). Four Different Funding Agencies. Standard Errors in Brackets.

	CAS_1 b/t	CAS_2 b/t	MOST_1 b/t	MOST_2 b/t	JRC_1 b/t	JRC_2 b/t	ESA_1 b/t	ESA_2 b/t
<i>n_out</i>	0.002** (3.21)	0.036*** (4.92)	0.003** (3.11)	0.034*** (3.35)	0.016*** (14.16)	0.102*** (8.17)	0.025*** (6.34)	1.349*** (18.21)
<i>dens</i>	0.013*** (3.95)	-0.101* (-2.35)	-0.012* (-2.51)	-0.137* (-2.30)	0.041*** (6.67)	0.611*** (8.83)	0.121*** (3.77)	0.052* (2.13)
<i>jinci</i>		5.556*** (88.33)		5.509*** (59.45)		4.411*** (79.57)		1.127*** (5.65)
EU	0.058* (2.40)	3.246*** (10.60)	0.034 (0.88)	4.150*** (8.43)				
CN					0.290*** (6.10)	0.359 (0.67)	0.689*** (3.58)	1.203 (1.01)
AU	0.140*** (3.82)	2.793*** (6.00)	0.107 (1.90)	2.656*** (3.76)	0.101* (2.08)	1.555** (2.81)	0.874*** (3.99)	1.167 (0.86)
CA	0.185*** (4.51)	2.299*** (4.44)	0.055 (0.85)	1.306 (1.61)	-0.079 (-1.54)	1.651** (2.84)	-0.056 (-0.30)	-1.595 (-1.38)
BR	-0.244** (-2.68)	3.771** (3.28)	0.044 (0.30)	-1.920 (-1.04)	0.520*** (7.42)	-5.531*** (-6.97)	0.667 (1.86)	-4.286 (-1.93)
IN	0.072 (1.17)	-2.455** (-3.15)	0.290** (3.04)	5.411*** (4.51)	0.225** (2.99)	-3.569*** (-4.19)	1.444*** (4.94)	-7.573*** (-4.18)
IL	-0.028 (-0.34)	-2.379* (-2.29)	0.195 (1.77)	0.370 (0.27)	0.348*** (5.15)	-0.397 (-0.52)	1.108* (2.27)	3.380 (1.12)
JP	0.129*** (3.34)	0.896 (1.84)	0.258*** (4.49)	3.130*** (4.33)	0.127* (2.14)	-0.478 (-0.71)	0.241 (1.09)	0.697 (0.51)
RU	-0.010 (-0.15)	-5.498*** (-6.74)	0.200 (1.83)	-3.986** (-2.90)	0.090 (1.40)	-4.960*** (-6.80)	0.905*** (4.21)	-0.121 (-0.09)

(continued)

Table 3. Continued.

	CAS_1 b/t	CAS_2 b/t	MOST_1 b/t	MOST_2 b/t	JRC_1 b/t	JRC_2 b/t	ESA_1 b/t	ESA_2 b/t
US	0.059* (2.50)	5.172*** (17.18)	0.078* (2.10)	4.640*** (9.94)	0.079** (3.01)	5.087*** (17.12)	-0.1115 (-0.98)	3.753*** (5.18)
_cons	1.141*** (22.96)	54.463*** (85.90)	1.185*** (17.70)	54.048*** (63.64)	0.890*** (24.92)	58.180*** (142.97)	0.242 (1.06)	54.412*** (38.46)
Year	YES	YES	YES	YES	YES	YES	YES	YES
N	40.606	40.606	18.452	18.452	41.704	41.704	6.989	6.989
adj R2	0.0114	0.2313	0.0138	0.2274	0.0336	0.2213	0.0897	0.1581

of quality of journals, under a MOST FA an article is more likely to be better off as per PSA metric if it is co-authored by countries such as those in the EU, Australia, India, Japan, or the US. In the case of Russian affiliations, articles are less likely to be performing well, to the extent that they are losing four percentiles. The interpretation of the CAS funded publications is similar to the MOST, although with less prominent results. Broadly speaking, in relation to Chinese FAs, western countries are more conducive to receiving higher quality ratings with more citations at parity of time and disciplinary area, keeping the quality of the journal constant. The EU countries are the second strongest partner within this pattern, second only to the US.

Table 3 also provides specular results for EU FAs. Interestingly, this effect seems to be reversed for Chinese-affiliated researchers, who help to increase the quality of target journals, but to a much lesser extent. This appears to be in line with the most recent findings on the topic (Gómez-Espés et al., 2024). Looking more closely at China-EU relationships under EU FAs, such partnerships seem to have different nuances. For instance, when China (meaning any scholar affiliated on the Mainland) co-authors publications under ESA or JRC funded projects, these FAs seem to have a stronger influence in terms of positioning papers in the best journals. However, this beneficial effect does not appear on the average quality of the single paper, as coefficients do not have respective statistical significance. One may note that a similar pattern is present for Israeli and Japanese collaborations under European schemes. For countries like India and Brazil, the prediction is reversed: researchers affiliated with the latter countries secure higher quality target journals when participating in the EU funded programs. At the same time however, despite this trend of securing higher quality target journals, articles are *less* likely to result in a higher percentile distribution in their respective disciplinary area. From a European FA point of view, those countries that predict a higher quality (PSA) are Australia and Canada (JRC), and above all the US for both JRC and ESA funded publications.

Overall Perspective

Based on our analysis, China-based researchers have increasingly accessed EU funding, at least when it comes to JRC and ESA FAs, having more than doubled their participation in the past 14 years. China-based researchers have also gained a more central role in the web of collaborations. These participations and the role they play are, however, still relatively under-exploited if one compares them with that represented by the US or other developed countries. It is difficult to assess whether this is because the EU-China partnership has increased up to a point of saturation, or if it is still a relatively an underused collaborative opportunity that will expand further in the years to come. It could be the case that this collaborative opportunity is underused because the parties/countries involved are in a process of decoupling. Another interpretation could point to China aiming at replacing opportunities to co-author with American colleagues, something consistent with Aghion et al. (2023). Whilst only a few years ago the two Chinese FAs had more collaborations with mid and minor science producing countries (and the US), in recent years the Chinese FAs seem to facilitate more collaborations with

researchers based in countries/regions that are traditionally considered to be science-producing strongholds. From the perspective of European FAs, China has positioned itself as an increasingly relevant collaborating partner, although not as relevant as the US is (especially for its centrality).

Part of the explanation for not identifying a decoupling or rivalry occurring between China and the EU might simply be that the Chinese contribution is now more important and that tangible advantages in collaborating between the two regions overshadow disadvantages that might be considered just marginal. Another interpretation is that respective collaborations might be considered necessary by researchers even if it is politically more challenging now than it used to be only a few years ago. Finally, a third interpretation is that the political challenge to the partnership has yet to manifest itself in the empirical material as collaborations and projects are long-term commitments. For instance, the European Commission has developed “an outbound investment screening mechanism, focused on a narrow set of technologies (for instance quantum, AI and advanced semiconductors) that could enhance military and intelligence-gathering capabilities” (Brinza et al., 2024, p. 62) only just recently in December 2023. With this in mind, the future of the EU-China relationship is very likely to change in the way that the US-China relationship has changed.

In terms of the researchers’ capacity to target journals, country/region affiliation (and presumably also institutional affiliations, here not observed) play a major difference in terms of quality, if we understand quality as capacity to attract citations (in this paper we have understood citations as per conventional understanding of quality in Kuhnian standard stage of scientific development). Under this interpretation, Chinese FAs seem to facilitate publication in better target journals, whereas EU ones receive a higher number of citations at parity of quality in their target journal.

Limitations

There are a series of limitations to list, which may serve also for paving the way for future research. First, also non-FA acknowledged research would allow a better understand of FAs, representing a counter-factual. Second, positioning of authors (first/corresponding, last author) would inform researchers more precisely about leadership and responsibility. The study could benefit from a better breakdown by discipline, by topics that are more sensitive to government issues such as security, and disentangling between frontier and non-frontier research and this in turn will help with mapping selectivity and partnership/rivalry. The mobility of researchers, has been overlooked and is also relevant, as researchers may move according to grant acquisition and overall opportunities.

Conclusion

Our analysis has contributed to the current discussion of decoupling in science and technology (Aghion et al., 2023; d’Hooghe & Lammertink, 2020), focusing on four relevant FAs from the EU and China and drawing from an emerging body of empirical

literature considered in the literature review. Despite this topic being at an emerging stage of analysis, our findings reveal some of the complexities in international research collaboration, particularly as related to the current discussion of decoupling which in the European debate is still uncertain. This novel perspective is relevant if some of the most important countries/regions in science perceive each other as rivals, for instance in the Space Race which has implications for defense and national security. Whilst we deliver some solid and new evidence of reciprocal advantages that both the EU and China obtain through collaboration, perhaps the best contribution of this present study is that of posing emerging dilemmas.

Researchers based in specific countries may purposively avoid collaborations with, say, a colleague based in China. This decision may or may not be influenced by national regulations, inserted also as part of funding regulations – this is one of our main assumptions. Another scenario is to make FA grants unattainable, to researchers in rival nations where specific technology-enabling research is taking place. If one, for instance, assumes that China would gain more than another collaborating country/region; would this be a situation of rivalry. We use a novel Game Theory application to analyze this scenario which can be seen also as a typical case of possible suboptimal Pareto efficiency.

Scientific production is shaped by FAs, despite this topic being still at a nascent stage of analysis. This is even more novel if one considers not only the possible different research findings countries/regions may generate as a result of their own national/domestic/regional FAs, but also for the possible different advantages countries/regions may gain when choosing to collaborate with a specific foreign FA (or, from a FA country/region point of view, getting input from a foreign brainpower). We sketched this theoretical framework in the introduction, and considered evidence as an aggregate of multiple (potentially infinite) games, treating each event as a case of an outcome of possible publication; whether there is a decision to work together across countries/regions or not. Whatever the decision, different outcomes may occur.

In other words, China appears to be open to international collaborations to facilitate its own growth in science also via opening its FA opportunities to the world. However, whilst the US seems to follow a rivalry principle (“I avoid a win-win dynamic if the other wins more than I do”), and the EU, up until now seems to be still engaging with a partnership principle. Our analyses appear consistent with Mervis (2019). We confirm some hints of *selective* decoupling pursued by the US toward China. The EU has had a different reaction to China surging to superpower in science.

Overall, we don’t find clear evidence of a decoupling between the EU and China. There is no evidence to date to indicate that the EU has started to consider China a rival in science. Rather, the two regions seem to be collaborating more, and with tangible, albeit different, reciprocal advantages. One may appreciate also that the US signaled it would be disengaging some years ago. When the EU echoed this disengagement, it was done years later, and with similar, though milder, words (see Ursula von der Leyen’s speech on March 30th 2023² and following implementations already discussed). Part of the reason we might not identify rivalry between the EU and China is that scientific funding and collaboration typically lasts for several years, and

consequently the time-lag might be significant. It would be necessary to replicate similar analyses in the years to come as any decoupling in science research between the EU and China, if any, is likely to become more visible.

However, our analysis of these four funding programs contributes to the contemporary discussion of partnership/rivalry (also narrated as decoupling) in research between the West and China. Whilst we draw from a particular domain of the wider cooperations in higher education between China and Europe (Cai, 2019), we shed original light on the situation. We do so by entering empirically the “zone of multiple objects” that is represented by the intersection of global/universal and national/particular interests (Marginson, 2022), advancing first insights of this kind. This exercise answers timely questions facing European institutions implementing a fresh new approach in their relations with China and paves the way for further studies that will deepen knowledge about this topic, and also trace the outcomes of new policies that are likely to be processed via funding agencies.


Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Giulio Marini  <https://orcid.org/0000-0002-3259-2309>

Supplemental Material

Supplemental material for this article is available online.

Notes

1. For more details about indicators, see: <https://incites.help.clarivate.com/Content/Indicators-Handbook/ih-normalized-indicators.htm#Journal>
2. https://www.eeas.europa.eu/delegations/japan/speech-president-von-der-leyen-eu-china-relations-mercator-institute-china-studies-and-european_en?s=169.

References

- Aghion, P., Antonin, C., Paluskiewicz, L., Stromberg, D., Wargon, R., Westin, K., & Sun, X. (2023). Does Chinese research hinge on US co-authors? Evidence from the China initiative. <https://cep.lse.ac.uk/pubs/download/dp1936.pdf>
- Bai, A., Wu, C., & Yang, K. (2021). Evolution and features of China's central government funding system for basic research. *Frontiers Research Metrics Analytics*, 6, 751497. <https://doi.org/10.3389/frma.2021.751497>

- Brinza, A., Bērziņa-Čerenkova-Čerenkova, U. A., Corre, P. L., Seaman, J., Turcsányi, R., & Vladislavljev, S. (2024). *EU-China relations: De-risking or de-coupling: the future of the EU strategy towards China: in-depth analysis*. European Parliament.
- Cai, Y. (2019). China-Europe higher education cooperation: Opportunities and challenges. *Frontiers of Education in China*, 14, 167–179. <https://doi.org/10.1007/s11516-019-0009-5>
- d'Hooghe, I., & Lammertink, J. (2020). Towards sustainable Europe-China collaboration in higher education in research. *Leiden Asia Center*.
- Faust, K. (1997). Centrality in affiliation networks. *Social Networks*, 19(2), 157–191. [https://doi.org/10.1016/S0378-8733\(96\)00300-0](https://doi.org/10.1016/S0378-8733(96)00300-0)
- Feng, G. C. (2020). Research performance evaluation in China: A big data analysis. *SAGE Open*, 10(1), <https://doi.org/10.1177/2158244019901257>
- Geuna, A. (1999). *The economics of knowledge production*. Edward Elgar.
- Gómez-Espés, A., Färber, M., & Jatowt, A. (2024). Benefits of international collaboration in computer science: A case study of China, the European union, and the United States. *Scientometrics*, 129(2), 1155–1171.
- Huang, M. H., & Huang, M. J. (2018). An analysis of global research funding from subject field and funding agencies perspectives in the G9 countries. *Scientometrics*, 115(2), 833–847. <https://doi.org/10.1007/s11192-018-2677-y>
- Huang, C., Su, J., Xie, X., Ye, X., Li, Z., Porter, A., & Li, J. (2015). A Bibliometric Study of China's science and technology policies: 1949-2010. *Scientometrics*, 102(2), 1521–1539. <https://doi.org/10.1007/s11192-014-1406-4>
- Isfandyari-Moghaddam, A., Saberi, M. K., Tahmasebi-Limoni, S., Mohammadian, S., & Naderbeigi, F. (2023). Global scientific collaboration: A social network analysis and data mining of the co-authorship networks. *Journal of Information Science*, 49(4), 1126–1141. <https://doi.org/10.1177/01655515211040655>
- Jang, B., Choung, J. Y., & Kang, I. (2022). Knowledge production patterns of China and the US: Quantum technology. *Scientometrics*, 127, 5691–5719. <https://doi.org/10.1007/s11192-022-04478-4>
- Lazebnik, T., Beck, S., & Shami, L. (2023). Academic co-authorship is a risky game. *Scientometrics*, 128(12), 6495–6507. <https://doi.org/10.1007/s11192-023-04843-x>
- Lee, J., & Haupt, J. (2020). Winners and losers in US-China scientific research collaborations. *Higher Education*, 80, 57–74. <https://doi.org/10.1007/s10734-019-00464-7>
- Leydesdorff, L., Bornmann, L., & Wagner, C. S. (2019). The relative influences of government funding and international collaboration on citation impact. *Journal of the Association for Information Science and Technology*, 70(2), 198–201. <https://doi.org/10.1002/asi.24109>
- Leydesdorff, L., & Wagner, C. (2008). International collaboration in science and the formation of a core group. *Journal of Informetrics*, 2, 317–325. <https://doi.org/10.1016/j.joi.2008.07.003>
- Leydesdorff, L., Wagner, C., & Bornmann, L. (2014). The European union, China, and the United States in the top-1% and top-10% layers of most-frequently cited publications: Competition and collaborations. *Journal of Informetrics*, 8, 606–617. <https://doi.org/10.1016/j.joi.2014.05.002>
- Marginson, S. (2021). What drives global science? The four competing narratives. *Studies in Higher Education*, 119, <https://doi.org/10.1080/03075079.2021.1942822>
- Marginson, S. (2022). 'All things are in flux': China in global science. *Higher Education*, 83, 881–910. <https://doi.org/10.1007/s10734-021-00712-9>

- Marini, G. (2023). International co-authored publications: The effect of joining the European union or being part of the European research area. *Hungarian Educational Research Journal*, 13(2), 276–297. <https://doi.org/10.1556/063.2022.00192>
- Marini, G. (2024). The megaproject race to fight COVID-19. A scientometric assessment of the national institute of allergy and infectious diseases (NIAID) international funding. In F. Cantoni, L. Corazza, E. De Nito, P. Di Nauta, & E. Favari (Eds.), *Complexity and sustainability in megaprojects. MERIT 2023. Lecture notes in civil engineering*, 493. Springer. https://doi.org/10.1007/978-3-031-59703-9_16.
- Marini, G., & Lombardi, S. (2025). Mega science and re-nationalization in the field of semiconductors. An evidence-based exploration of Decoupling triggered by the China initiative. In F. Cantoni, E. Favari, F. Borghetti, V. De Nito, P. Di Nauta, & M. Allena (Eds.), *Sustaining the future: Addressing grand challenges through megaprojects. MERIT 2024. Lecture notes in civil engineering*. Springer (in press).
- Mervis, J. (2019). Chinese Ties don't faze European funders. *Science*, 365, 1068–1069. <https://doi.org/10.1126/science.365.6458.1068>
- Morillo, F., & Álvarez-Bornstein, B. (2018). How to automatically identify major research sponsors selecting keywords from the WoS funding agency field. *Scientometrics*, 117, 1755–1770. <https://doi.org/10.1007/s11192-018-2947-8>
- Olechnicka, A., Ploszaj, A., & Celinska-Janowicz, D. (2019). *The geography of scientific collaboration*. Routledge.
- Shih, T. (2023). Research integrity and security: Exploring funding agency roles in supporting responsible internationalization and reciprocity-Insight paper. Pre-print.
- Shih, T., & Forsberg, E. (2023). Origins, motives and challenges in Western–Chinese research collaborations amid recent geopolitical tensions – findings from Swedish–Chinese research collaborations. *Higher Education*, 85, 651–667. <https://doi.org/10.1007/s10734-022-00859-z>
- Sun, Y., & Cao, C. (2014). Demystifying central government R&D spending in China. *Science*, 345, 1006–1008. <https://doi.org/10.1126/science.1253479>
- Wang, X., Liu, D., Ding, K., & Wang, X. (2012). Science funding and research output: A study on 10 countries. *Scientometrics*, 91, 591–599. <https://doi.org/10.1007/s11192-011-0576-6>
- Wang, L., Wang, X., & Philipsen, N. J. (2017). Network structure of scientific collaborations between China and the EU member states. *Scientometrics*, 113, 765–781. <https://doi.org/10.1007/s11192-017-2488-6>
- Wang, L., Wang, X., Piro, F. N., & Philipsen, N. J. (2020). The effect of competitive public funding on scientific output: A comparison between China and the EU. *Research Evaluation*, 29(4), 418–429. <https://doi.org/10.1093/reseval/rvaa023>
- Zhou, P., Cai, X., & Lyu, X. (2020). An in-depth analysis of government funding and international collaboration in scientific research. *Scientometrics*, 125, 1331–1347. <https://doi.org/10.1007/s11192-020-03595-2>

Author Biographies

Giulio Marini is assistant professor of Organization Science. His area of research is higher education as a research field focusing on careers, HRM, productivity.

Mikkel Rønnow Mouritzen is PhD investigating transnational talent mobility between Europe (DK) and China, and vice versa.