Does Chinese Research Hinge on US Coauthors? Evidence from the China Initiative*

Philippe Aghion †, Céline Antonin ‡, Luc Paluskiewicz §,
David Strömberg ¶, Xueping Sun ‖, Raphaël Wargon **, Karolina Westin ††

This version: July 9, 2023

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Abstract

Launched in November 2018 by the Trump administration, the China Initiative was meant to "protect US intellectual property and technologies against Chinese Economic Espionage". In practice, it made administrative procedures more complicated and funding less accessible for collaborative projects between Chinese and US researchers. In this paper we use information from the Scopus database to analyze how the China Initiative shock affected the volume, quality and direction of Chinese research. We find a negative effect of the Initiative on the average quality of both the publications and the co-authors of Chinese researchers with prior US collaborations. Moreover, this negative effect has been stronger for Chinese researchers with higher research productivity and/or who worked on US-dominated fields and/or topics prior to

*We thank Pierre Azoulay, Antonin Bergeaud, Juliette Coly, Olimpia Cutinelli Rendina, Maxime Gravoueille, Florian Haissly, Ruixue Jia, Corentin Laffite, Antoine Mayerowitz, Hongbin Li, Jennifer Pan, Karolina Piechowicz, Gerard Roland, Scott Rozelle, John Van Reenen, Heidi Williams, Ron Yang and seminar participants at INSEAD, Collège de France and Stanford SCCEI for very helpful comments and suggestions. We are also grateful to Elsevier and to the ICSR Lab Team who kindly assisted us in the exploitation of the Scopus database, with special thanks to Kristy James and to Alick Bird. David Strömberg gratefully acknowledges financial support from ERC Advanced Grant No 742983.

†Collège de France, INSEAD and London School of Economics. Email: philippe.aghion@insead.edu

‡Sciences Po Paris - OFCE. Email: celine.antonin@sciencespo.fr

§Paris School of Economics. Email: luc.paluskiewicz@psemail.eu

¶Stockholm University. Email: david.stromberg@ne.su.se

‖Stanford University. Email: xpsun@stanford.edu

**Paris School of Economics. Email: raphael.wargon@psemail.eu

††Stockholm University. Email : karolina.westin@ne.su.se

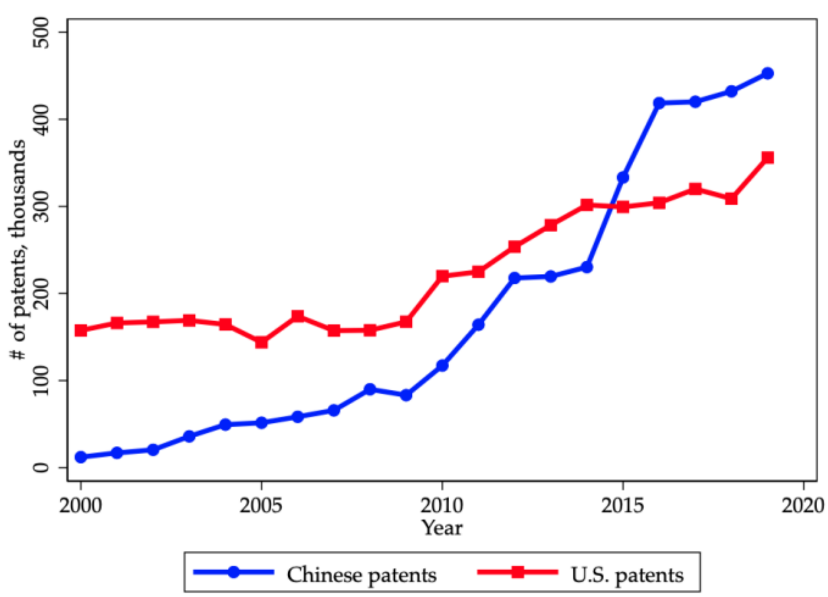
the shock. Finally, we find that Chinese researchers with prior US collaborations reallocated away from US coauthors and basic research after the shock.

1 Introduction

Since Deng Xiaoping initiated the liberalization of its economy in the early 1980s, China has experienced probably the most impressive growth takeoff in recent economic history. However, so far, the Chinese growth has largely been of a "catch-up" nature, relying primarily on very high capital investment rates and on technological imitation itself facilitated by foreign direct investment and by China's joining the World Trade Organization in 2001.

China's spectacular surge as a major economic and technological actor has raised the concern among public opinions in the West, that China could soon overtake Western advanced economies. Figure 1 indeed shows that the yearly flow of Chinese patents registered by the Chinese National Intellectual Property Administration (CNIPA) has caught up with – and even overtaken - the flow of US patents registered by the United States Patent and Trademark Office (USPTO).

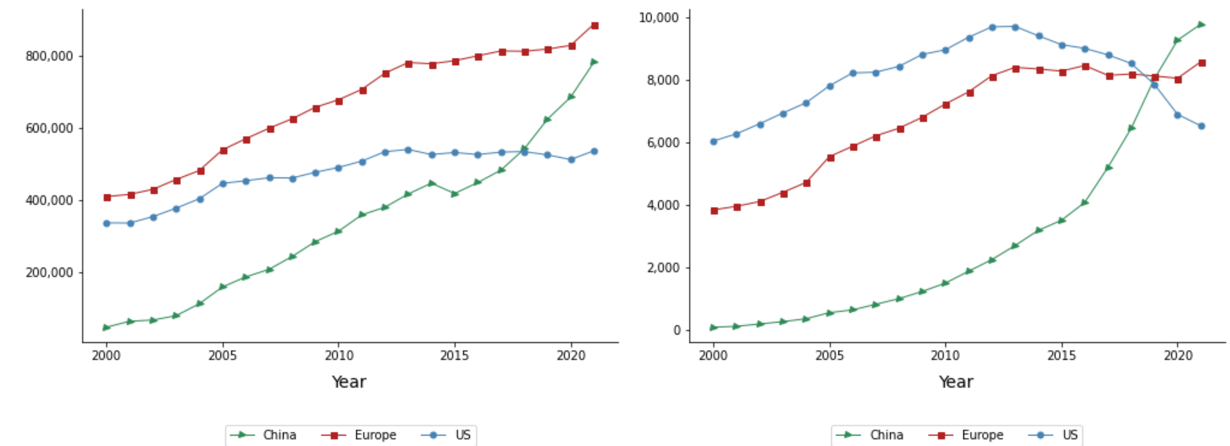
Figure 1: Number of patents granted in China and in the United States.



Notes: This graph comes from the work of Han et al. (2020). All numbers are in thousands. The number of patents in China corresponds to the number of patents registered at the Chinese National Intellectual Property Administration (CNIPA). Similarly, the number of patents in the United States is the number of patents registered at the United States Patent and Trademark Office (USPTO).

Similarly, Figure 2 provides evidence of the Chinese catch-up. The flow of Chinese scientific publications recorded in the Scopus database has exceeded the flow of US publications. The right-hand side figure shows that this statement holds when restricting attention to the top 1% most cited publications.

Figure 2: Number of total publications and top 1% cited publications by country or region of affiliation.



Notes: This figure shows evidence of the Chinese catch-up both in the total number of publication (left) and in the number of publications in the top 1% cited publications (right). Numbers are from the Scopus database on academic research that we use for our analysis (see section 2). Top 1% percentiles are computed by main domain and take into account the total number of citations of one article independently of the year when it has been cited.

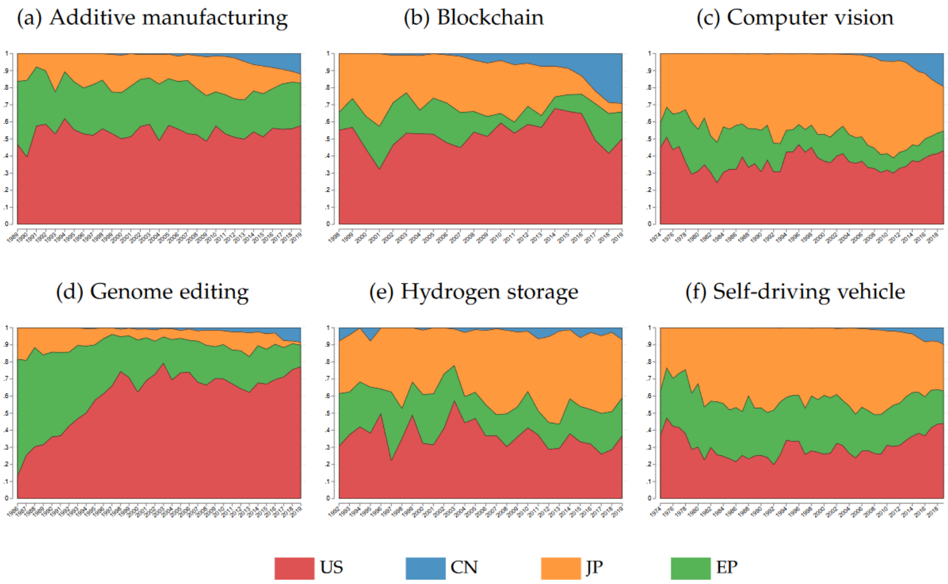
Next, Figure 3 drawn from Bergeaud and Verluise (2022) shows that China is close to becoming a leader in frontier technologies such as blockchain, computer vision, 5G, etc.

Yet, an alternative view is that absent democracy and freedom, China will not be able to fully move from imitation-based growth to growth based on frontier innovation, and may even face the possibility of falling into a "middle income trap" [1].

In this paper we argue that the Chinese research performance owes to US collaborations. Figure 4 provides suggestive evidence in this respect. It depicts the evolution of the shares of publications by Chinese researchers respectively with US and with European co-authors. We first see that the share of European partnerships has been monotonically increasing since 2005. But more interestingly, the share of US partnerships started rising more steeply – reaching 3.5% of all Chinese publications – but then declined sharply as of 2018, the year in which the so-called "China

[1] By contrast with growth based on frontier innovation, e.g. see Acemoglu and Robinson (2012) or Chapter 7 in Aghion et al. (2021).

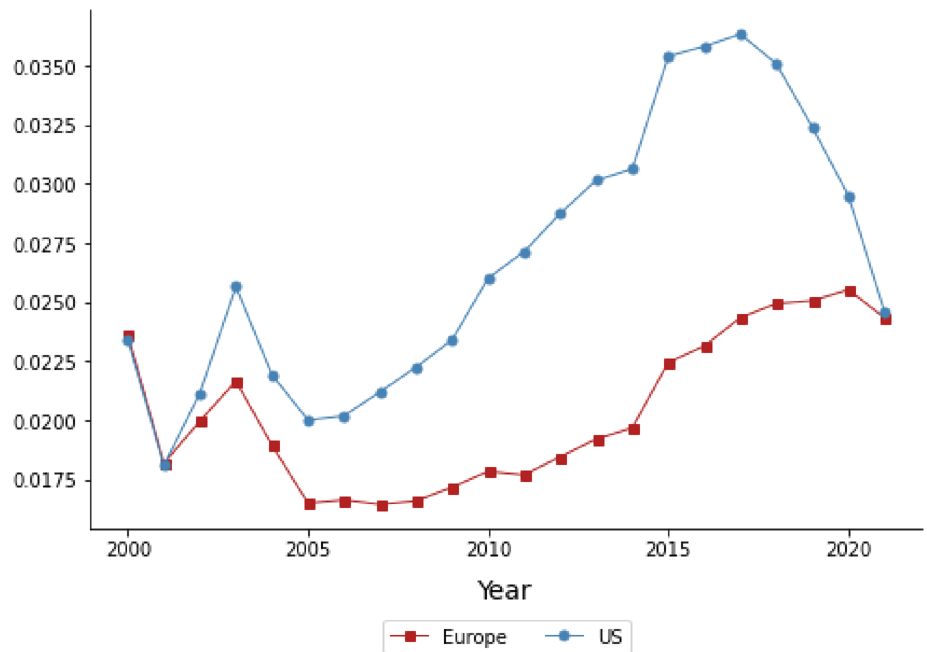
Figure 3: Relative contribution to frontier technologies (1989-2019) - restricting on international applications.



Notes: This graph comes from the work of Bergeaud and Verluise (2022). Patent counts in the four patent offices: USPTO (US), CNIPA (CN), EPO and European national patent offices (EP) and JPO (JP) as a share of the total patent count for each technology. Restriction on patent family with at least one publication in two of the main patent offices (USPTO, CNIPA, EPO and JPO). The year of publication is reported in x-axis. National European patent offices include all EU countries, UK, Norway and Switzerland.

Initiative" was implemented by the Trump administration. Since then, the decoupling between top Chinese science and US involvement has intensified: the share of US partnerships in papers published in the top 5% journals has followed a declining trend, which has starkly accelerated since 2018.

Figure 4: Share of collaborations of Chinese authors with US and European authors in all co-authored papers



Notes: This graph depicts the evolution of the shares of collaboration of Chinese authors with European and US researchers out of all publications in which there is more than one author based in China. Each curve depicts the share of co-authored publications with US-affiliated or Europe-affiliated authors over the total number of co-authored publications with at least one Chinese-affiliated author.

Launched in November 2018, the China Initiative was meant to "protect US intellectual property and technologies against Chinese Economic Espionage". In practice, the China Initiative made administrative procedures more complicated, funding less accessible for collaborative projects between Chinese and US researchers, and it also led to the exclusion of targeted researchers from US institutions[2]. In this paper we use the China Initiative as a natural experiment: namely, we analyze the effects of this exogenous shock to US collaborations on the volume, quality, and direction of Chinese research. Our main conclusion is that the China Initiative has had a negative and significant effect on the quality of Chinese research, which conveys "negative" evidence of the importance of US collaborations in frontier Chinese research.

Our source of information about Chinese publications, Chinese authors and their foreign co-authors (especially from the US and Europe) is Scopus, the Elsevier database founded in 1996. Scopus has collected data covering 43,132 academic journals, 78 million publications and 16 million

[2] See Schiavenza (2022).

authors. For each publication in this dataset, information is provided on the current and past academic affiliations of its authors, their current and past co-authors and their affiliations, and the various source(s) of funding including individual research grants.

To identify a causal effect of the China Initiative on Chinese researchers, we construct a treatment group and a control group. The treatment group comprises the Chinese researchers in the Scopus database with at least 3 publications and a sufficiently high collaboration intensity —- namely a collaboration index above the 90^{th} percentile over the period 2008-2012 — with US co-authors, as well as no European co-author. Conversely, the control group encompasses the Chinese researchers in the same database, with also at least three publications, but a sufficiently high collaboration intensity —- a collaboration index above the 90^{th} percentile over the period 2008-2012 — with European co-authors, as well as no US co-author. The control group acts as a counterfactual, i.e. it is meant to capture the situation where, *ceteris paribus*, the treated Chinese researcher would not be subject to the China Initiative.

Then we match through propensity score weighting each Chinese researcher in the treatment group to a Chinese researcher in the control group, who shares the same academic records prior to the implementation of the China Initiative in terms of the volume and quality of publications.

Our main findings can be summarized as follows. First, we find a small negative effect of the China Initiative on the number of publications by Chinese researchers in the treatment group. Second, we find a strongly negative and significant trend break in the quality of publications by treated researchers following the implementation of the China Initiative, which is reflected both in the negative trend break in the citation count to publications by treated Chinese authors, and in the negative trend break in the number of publications by treated Chinese authors in top 5% journals, compared to the citation count and top 5% publications of control Chinese authors.

This negative impact of the Initiative on the quality of Chinese publications, is further confirmed by our finding of a decline in the average H-Index of co-authors of treated Chinese researchers following the enforcement of the Initiative (the quality of co-authors is itself a good predictor for future citations, both at the article level and at the author-level).

Next, we compare the publications of treated and control Chinese authors following the implementation of the China Initiative, with regard to the regions of affiliation of their coauthors, namely the US, Europe and China. While the effect of the China Initiative on the total volume of publications is negative but limited, the number of publications by treated Chinese researchers involving a

US co-author decreases markedly compared to publications by control Chinese researchers involving an European co-author. In other words, following the implementation of the China Initiative, Chinese research reallocated away from US co-authors. This reallocation is even more striking when focusing attention on publications in top 5% journals, and it is also reflected in the fact that the number of new US co-authors for Chinese researchers in the treatment group, decreases significantly following the China Initiative compared to the number of new European co-authors for Chinese researchers in the control group.

Then, we look at the effects of the China Initiative on the direction of Chinese research, in particular its propensity to move towards more basic or more applied research. We find a significantly negative effect of the China Initiative on the basicness of publications with US co-authors by treated Chinese researchers. This, together with the absence of an overall effect of the Initiative on the flow of basic research publications, suggests that China could compensate its reduced ability to pursue basic research with US co-authors both, by an increased reliance on collaborations with co-authors from the rest of the world for basic research, and also possibly by shifting towards new — more applied — research topics.

Finally, we investigate potential sources of heterogeneity of the effect of the China Initiative. We focus on two sources, namely on Chinese researchers' pre-shock research performance and also on the extent to which Chinese researchers were working on US-dominated fields prior to the China Initiative shock. We find that the negative impact of the China Initiative is strongest for those Chinese researchers in the treatment group with the highest research performance and/or who were publishing in US-dominated fields prior to the shock.

Our paper relates to several strands of literature. First is the literature on imitation versus innovation led growth and the middle-income trap, (e.g. see Acemoglu et al. (2006); Acemoglu and Robinson (2012)) with its focus on the Chinese catch-up (e.g. see Zilibotti (2017); Acemoglu et al. (2021); Qiu et al. (2022)[3]; Bergeaud and Verluise (2022); Roland (2023)). We contribute to this literature by looking at frontier Chinese research and the extent to which it suffered from the curtailing of Chinese-US collaborations following the China Initiative.[4]

[3] Qiu et al. (2022) argue that US researchers do not build as readily on the work of Chinese researchers compared to the work of scientists from developed countries.

[4] Acemoglu et al. (2021) look at the extent to which Chinese researchers redirect their research towards the research themes of newly appointed research directors, when the latter are Communist Party members. Both their analysis and ours point to the importance of freedom in fundamental research : presumably both, political appointments of new research directors and the curtailing of US collaborations, imply a reduction in Chinese researchers' freedom. For an excellent discussion of potential institutional barriers to innovation in China, see Roland (2023).

Second, our paper relates to a recent literature on US-Chinese research collaborations. The link between the rise of China and the creation of a potent US-China network of researchers has been documented in the early stages of the catch up (Veugelers (2010)). Veugelers (2017) also stresses the impact of US connections in Chinese research and the lack of importance of European connections right before the China initiative. More recently, Han et al. (2020) provide evidence of a reduction in the scientific "decoupling" between China and the US, i.e. an increase in the extent to which US patents cite Chinese patents and vice versa. They also show that the degree of Chinese scientific dependence upon the US – namely the extent to which Chinese patents cite US patents more than US patents cite Chinese patents, - has increased and then decreased over the past two decades. We contribute to this literature by showing that despite its remarkable catching up, Chinese research still remains dependent on US collaborations[5].

A third strand of literature focuses more specifically on the China Initiative. As explained by Schiavenza (2022) and by Gilbert and Kozlov (2022), a large fraction of the US research community has fought against its implementation and then advocated its abolition. That the Initiative has made collaborations between US and Chinese researchers more difficult has already been hinted at, e.g. by Lee (2022). However no systematic attempt has been made so far, at quantifying this phenomenon and its consequences on research outcomes. One noticeable exception is Jia et al. (2022) who analyze the impact of the China Initiative shock on US-based researchers in the field of life sciences. They find that the research productivity of US-based scientists with prior co-authorship with Chinese researchers, has significantly decreased following the shock. We contribute to this literature by looking at the impact of the China Initiative shock on the productivity of Chinese researchers, with results that mirror Jia et al. (2022)'s findings regarding the impact of the shock on US-based researchers.

Fourth, our paper relates to the recent literature on innovation and networks (e.g. see Azoulay et al. (2010); Jaravel et al. (2018); Akcigit et al. (2018); and Aghion et al. (2023)). Closely related to our analysis are the Azoulay and Jaravel papers: they look at the effect of losing a star co-author on subsequent patented innovation. Similarly, we look at the effects on future research performance for Chinese researchers of the restrictions in US collaboration brought about by the China Initiative.

Our analysis also speaks to the recent literature on the role of openness and freedom in basic research (see Aghion et al. (2008) ; and Murray et al. (2016)). The access to US co-authors can be

[5]Other papers in this literature include Cao et al. (2020) who argue that research collaborations between the US and China have strengthened, and Lee (2022) who argues that these collaborations have persisted despite the American sanctions.

seen as a proxy for openness and freedom, and the China Initiative as a negative shock on it.

Finally, our research strategy and econometric analysis also build on a rich existing literature. Our empirical exercise is a difference-in-differences, making particular use of the work of Callaway and Sant'Anna (2020) on doubly robust difference-in-differences estimators. Our analysis of the impact of the China Initiative on basic versus applied research builds on the work of Hall et al. (2001) and also uses the basicness measure of Murray et al. (2016).

The remaining part of the paper is organized as follows. Section 2 presents the data sample, our main variables, and our empirical methodology. Section 3 presents the results. Finally, section 4 presents our results and section 5 concludes.

2 Data and Methodology

2.1 The Scopus database

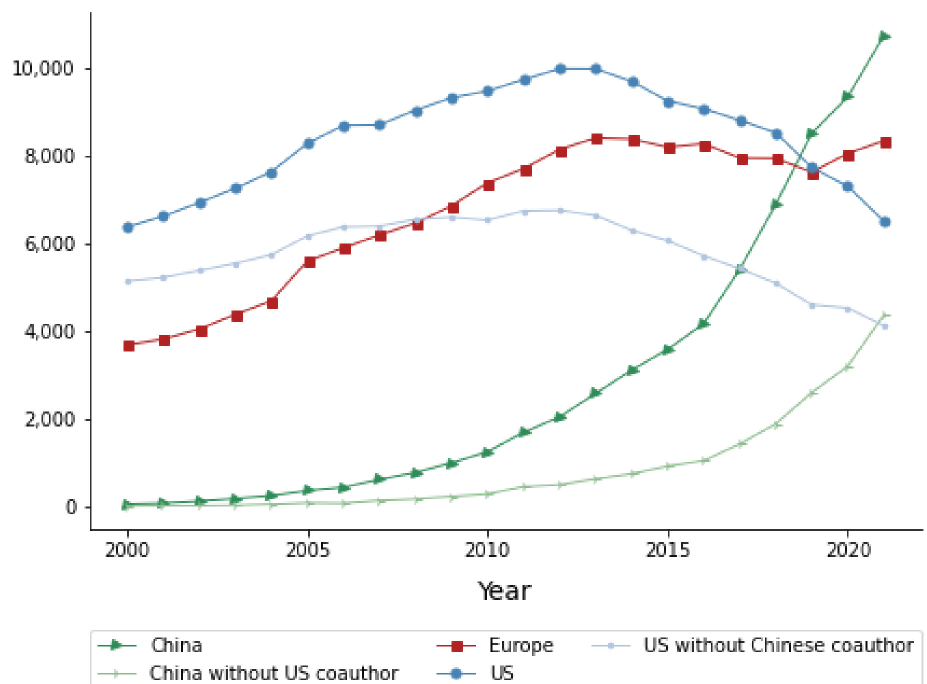
Our main source of information on the scientific production of Chinese researchers and their co-authors, is the Scopus bibliometric database. Released by Elsevier in 2004, to date, the Scopus database covers 43,132 scientific journals, 78 million publications and 16 million authors. Scopus comprises several data subsets, and the three datasets that are most directly relevant for us are : (i) the article-level dataset which includes information about the names of the authors of each article, their affiliations, the journal of publication, the article's citations, its All Science Journal Classification (ASJC) codes and its related subject areas; (ii) the author-level dataset which informs us about the authors' latest affiliation(s) and about their main research areas ; (iii) the journal-level dataset which includes their CiteScore metrics of journal quality per ASJC.

The Scopus database covers a wider range of fields and a higher number of journals than Web of Science (Mongeon and Paul-Hus (2016)), and a better coverage of Chinese scientific articles than other bibliometric data sources such as Web of Science and PubMed in most academic fields (Baas et al. (2020); Singh et al. (2021)). Although other databases such as Microsoft Academic or Dimensions may include publications that are not reported by Scopus, the Scopus database does a better job at providing citation links between publications and other types of qualitative information on articles and authors (Visser et al. (2021)).

2.2 Aggregate descriptive evidence

The following figures show interesting aggregate trends. Figure 5 depicts the evolution of the flow of top 1% cited publications in the yearly distribution of citations in Scopus, for US, European, and Chinese researchers. In addition, we plot the total number of Chinese publications among the top 1% cited papers that involve neither US coauthors nor Chinese coauthors who previously published in the US. Symmetrically, we plot the total number of US publication among the top 1% cited papers, removing those that include Chinese coauthors or US coauthor who previously published in a Chinese institution. The surge in the "no-US" Chinese top papers remains impressive, but the catching up with "no-China" US papers, is slower than when we simply look at the flows of top 1% cited Chinese versus US papers. Furthermore, the number of top "no-US" China papers currently represents about half of the total number of top Chinese publications, whereas "no-China" US top papers account for only a third of all top US papers.

Figure 5: Number of top 1% cited publications by country of affiliation.



Notes: This figure shows evidence of the Chinese catch-up in the number of top 1% cited publications. Top 1% percentiles are computed by main domain and takes into account the total number of citations of one article independently of the year when it has been cited. The curve labelled with the mention *no US co-author* (*resp. no Chinese co-author*) accounts for publications without any US-affiliated (*resp.* China-affiliated) author or an author who has ever been affiliated to the United-States (*resp.* China).

Figure 6 shows the evolution of the number of publications in the 5% best ranked journals : we still see an upward trend for Chinese publications. However, compared to all general publications such as in Figure 2, it is significantly less steep. Moreover, like above, when removing US influence from Chinese papers, the increase is much less pronounced, especially compared to US publications in top 5% of journals when removing Chinese influence.

2.3 Sample selection

Within the whole set of authors in the Scopus database, we identify the subset of Chinese researchers that were active before the shock. For any such researcher, we have access to information not only about her list of publications over the period 2008-2021, which is our sample period, but also to information about her whole publication history as reported by Scopus. Our regression analysis of the effects of the China Initiative zooms on the period 2013-2021. For each author in the Scopus database we know: (i) the year in which the author's name appears for the first time; (ii) the author's main subject(s) as reflected by her publications; (iii) the author's past and current countries of affiliation[6].

In order to precisely identify active Chinese researchers, we select researchers with at least 3 publications reported in the database. Then, within the corresponding subset, we further narrow down to researchers that have published 80% of their papers while affiliated to a Chinese institution during the period 2008-2012, have a name indicating Chinese descent, had a Chinese affiliation until 2012 for at least two years and remained affiliated in China until 2014[7]. There are 333,173 such authors in Scopus. Our main treatment group consists of Chinese researchers in that subgroup who show "high dependence" on US and have no European co-authors. The main control group consists of Chinese researchers within that same subgroup who show "high dependence" on European and have no US co-author[8]. At the end, this selection process within the set of Chinese authors yields 23,662 treated authors and 17,858 control authors[9].

[6] We use an algorithm to interpolate a researcher's country of affiliation in the years for which she did not publish between two publications.

[7] This allows us to be certain according to our definitions that they are not staying temporarily in China but are based there on a longer-term period.

[8] In the next section we shall be explicit on how we measure dependence and then set the high dependence threshold.

[9] After the first selection on the sample, we reach a sample of 26,856 treated authors and 20,408. Due to the fact that Scopus presents a lower data quality in social sciences, we only include authors who are not in these sciences. For the sake of comparability, we also remove authors entering Scopus before 1999. This explains the final number of authors in the sample.

Figure 7: Selection criteria of treatment and control groups.

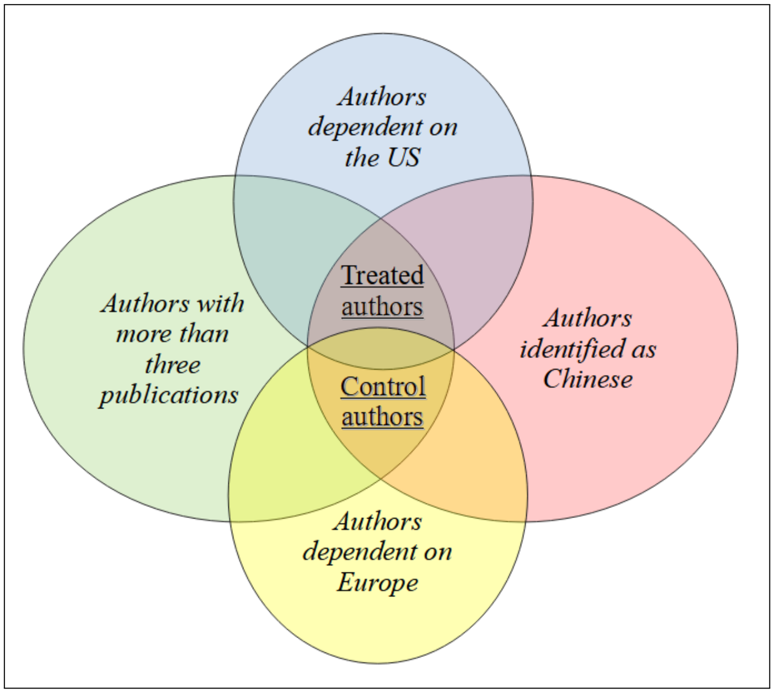


Figure 7 illustrates the various steps whereby, starting from the overall population of researchers in our Scopus database, we narrow down to Chinese researchers respectively in the treatment group and in the control group. In the next section, we describe in more details how we construct treatment and control groups.

2.4 Measurement

2.4.1 Main outcomes

We consider three sets of outcomes. The first set of outcomes reflects the productivity of Chinese researchers. The second set of outcomes speaks to the evolution of their co-authors network. The third set of outcomes captures the direction of treated Chinese researchers before and after the China Initiative shock.

Our first measure of research productivity is the total number of publications at the individual Chinese researcher's level in any given year; we also consider the number of publications for which at least one of the co-authors is affiliated in the US, Europe, or China[10]. Second, also at the author

[10]Our definition of Europe includes the 27 countries of the European Union, the United Kingdom, Switzerland,

level, we look at the number of publications in a given year that belong to the top 5% most cited journals within an academic subject (medicine, chemistry...), smoothing the number of citations per paper over a four-year window around current year t[11]. Once again, we break up the number of papers published in top cited journals according to the co-authors' regions of affiliation, e.g. US, Europe or China. Third, we consider the number of citations of an author author's current publications; we break up this number according to the region of affiliation of citing authors[12]. We can also restrict attention to citations received within five of ten years after publication to limit the scope for truncation bias.

A second set of outcome measures concerns the number and quality of co-authors of any Chinese researcher in our database. Thus, we first compute the number of co-authors of a Chinese author in any given year, which we break up by region of origin of the co-authors. Then, we decompose the set of co-authors into new, short-term and long-term co-authors. A new co-author in a given year is a co-author with whom the Chinese researcher has never collaborated before. Short-term co-authors are co-authors during a period between 1 and 5 years. Long-term co-authors are co-authors over more than five years in a row. And once again, we break up these numbers according to the co-authors' region of origin, i.e. the US, Europe, or China.

Next, we look at the quality of coauthors of treated Chinese authors before versus after the China Initiative shock. Thus, we compute coauthors' H-Indexes in any given year based on information available by the end of the year[13]. This allows us to focus on the " real-time H-Index", which measures the *observed* quality of co-authors at the time of publishing.

A third set of outcome measures pertains to the basic versus applied nature of the research carried out by the Chinese author. A first measure of the basicness of research is the total number of the author's publications in basic journals according to the CHI Research Index[14]; a variant of that measure is computed using machine learning techniques developed by Scopus researchers: namely, the mean predicted score of basicness based on the CHI-research Index[15]. We also decompose these basicness measures according to co-authors' countries of affiliation.

Norway and Iceland.

[11] We provide more information about the metrics in Appendix B and about the sensitivity of the results to the threshold in Appendix E.

[12] Citations are winsorized at the 97.5% level when looking at all articles in Scopus, prior to selecting the sample.

[13] For instance, if a paper published in 2010 receives a citation in 2018, this citation does not contribute to H-Index for the year 2010. However, it contributes to it for all years after 2018.

[14] This is the same metrics that is used in Murray et al. (2016).

[15] We use the classification developed in Boyack et al. (2014) but retrain it on more recent data.

2.4.2 *Same country* measure and reallocation

When analyzing the effects of the China Initiative on "treated" Chinese researchers, we need to find an appropriate "control group". The first selection criterion is that the control group should have characteristics as close as possible to the treatment group. Our treatment group comprises Chinese researchers that used to rely heavily on co-authorships with US researchers and did not co-author with European researchers, during the selection period. Our control group comprises Chinese researchers that used to rely heavily on co-authorships with European researchers but did not co-author with US researchers, during the selection period[16]. This choice is motivated by descriptive statistics highlighting similar paths of research productivity for Chinese researchers with US versus European co-authors during the selection period. More precisely, using propensity score weighting, we do not find significant differences in productivity between Chinese researchers in the treatment group and those in the control group[17].

Another potential issue has to do with the fact that some Chinese researchers used to have both, US and European co-authors during the selection period. To overcome this problem we exclude this subset of Chinese researchers from both, our treatment group and our control group, i.e. we restrict attention to Chinese researchers who either relied heavily on US collaborations but had no European collaborations during the selection period (the treatment group) and on Chinese researchers who relied heavily on European collaborations but had no US collaborations during the selection period (the control group).

A third issue arises when analyzing post-shock co-authorship reallocations by Chinese researchers with prior US co-authorship in comparison to Chinese researchers with prior European co-authorships. Namely, a Chinese researcher with prior links with US co-authors and who ventures outside the network of US co-authors to develop new collaborations with European co-authors, is different from a Chinese researcher with prior European co-authorship who also seeks to develop new collaborations with European co-authors. Hence, simply comparing the number of publications with European co-authors between "US-linked" and "Europe-linked" Chinese researchers, is not the right thing to do, the reason being that the different types of co-authorships of these two groups of Chinese researchers during the selection period, will condition their respective co-authorships in the future. To get around this issue, and compare the comparable, in our "*same country*" regression, we consider the propensity for Chinese researchers with prior US co-authorship (resp. with

[16]See Appendix.
[17]See Section 4.

prior European co-authorship) during the selection period to keep publishing with co-authors from the US (resp. from Europe) during the analysis period. For instance, the same country regression with regard to the number of publications looks at how the China Initiative affects the number of publications with US co-authors during the analysis period by a researcher with prior US co-authorship, differently from the number of publications with European co-authors during the same analysis period by a similar Chinese researcher with prior European co-authorship.

2.5 Descriptive statistics

In this section we provide descriptive statistics on the individual outcomes of interest for both, the control and treatment groups of Chinese researchers.

Table 1 displays descriptive statistics on research productivity, activity of the network of co-authors and research direction. On average, treated Chinese authors with prior US co-authorship outperform control Chinese authors with prior European co-authorship during the period 2013-2015, both with regard to the quality and the quantity of publications, as shown in Figure 8. It also appears that control and treated authors are equally active in updating and maintaining their respective co-author networks. Finally, control and treated authors appear to also be comparable in terms of the quality of their co-authors. Chinese researchers in the treatment group also tend to produce slightly more basic research than their counterparts in the control group.

Appendix A shows researchers characteristics in our sample during the selection period, including seniority and main field of study. Over that period, treated and control authors appear to be quite similar with regard to both seniority and the number of publications. However, treated authors show higher publication quality on average.

3 Empirical Strategy

In this section, we discuss our methodology and empirical strategy. Subsection 3.1 explains how we select our sample of authors and how we define treatment and control groups. Subsection 3.2 lays out our empirical strategy. Finally, subsection 3.3 lays out the main variables we use to compare the performance of Chinese researchers between the treatment and control groups.

Table 1: Summary Statistics - Outcome variables

	Control Group			Treatment Group			
	N	Mean	SD	N	Mean	SD	Test
Panel 1: Productivity							
Publications	40613	4.1	4.1	53700	3.8	3.8	F= 109.146***
Number of publications w/ *same country* coauthors	40613	0.54	1.6	53700	0.76	1.9	F= 376.964***
Total citations	40613	82	135	53700	90	145	F= 86.48***
Total citations from China	40613	101	229	53700	100	252	F= 0.168
Citations received within 5 years from publication	38639	15 23	51374	18	26		
Citations received within 10 years from publication	38639	23	36 51374	27	41		
Number of publications in top 5% journals	40613	0.18	0.57	53700	0.24	0.71	F= 222.367***
Number of publications in top 5% journals w/ *same country* coauthors	40613	0.045	0.33	53700	0.11	0.68	F= 344.218***
Panel 2: Coauthor activity							
Prob. of publishing w/ a new coauthor	40613	0.92	0.27	53700	0.93	0.25	F= 58.317***
Prob. of publishing w/ a new coauthor - *same country*	40613	0.17	0.37	53700	0.28	0.45	F= 1588.309***
Prob. of publishing w/ a short-term coauthor	40613	0.87	0.33	53700	0.87	0.33	F= 0.16
Prob. of publishing w/ a short-term coauthor - *same country*	40613	0.22	0.41	53700	0.31	0.46	F= 970.973***
Prob. of publishing w/ a long-term coauthor	40613	0.47	0.5	53700	0.45	0.5	F= 32.087***
Prob. of publishing w/ a long-term coauthor - *same country*	40613	0.061	0.24	53700	0.081	0.27	F= 131.431***
Panel 3: Research direction							
Nr of pubs in basic journals	6406	0.99	1.6	7313	1.2	1.7	F= 35.028***
Prob. of publishing in a basic journal	9878	0.31	0.46	10697	0.37	0.48	F= 87.986***
Score of basicness for publications	9857	2.8	0.83	10674	2.9	0.86	F= 40.528***

Statistical significance markers: * p<0.1; ** p<0.05; *** p<0.01

Notes: This table summarises the average values and standard deviations for the main outcome variables in the sample.

3.1 Empirical definition of treatment

Our treatment group consists of Chinese researchers with high dependence on US and no dependence on European co-authors. We measure this dependence by a collaboration index, based on the share of an author's citations that stem from papers with US or European co-authors. Formally, this index is defined as:

$$C_i^g = \frac{1}{\omega_i} \sum_{l \in A_{i,T}} \frac{\omega_l}{|a_l/i|} \sum_{j \in a_l/i} \mathbb{1}\{g_j = g\}, \quad g \in \{US, Europe\} \tag{1}$$

where C_i^g captures the degree of the dependence of individual i upon her co-authors from region g; ω_i is the number of citations received over the period by i; $A_{i,T}$ is the set of papers published by researcher i during time interval T. a_l is the set of authors who cosign paper l, g_j is the region of affiliation of author j and ω_l is the number of citations received by paper l. [18]

Chinese authors with a US co-author dependency index C^{US} (respectively with a Europe-dependency index C^{Europe}) above the 95$^{\text{th}}$ percentile over the period 2008-2012 belong to the treatment group (respectively to the control group). We exclude from each of these two groups individuals with co-authors in the other region.

Note that researchers are excluded from the sample both if they are not sufficiently dependent on either the US or Europe or if they are dependent on both. Authors in the latter group are on average ranked higher than the sample authors, in terms of number of publications and H-index, while those in the former group are ranked lower.

3.2 Hypotheses

The China Initiative arguably increased the cost for Chinese researchers to collaborate with US researchers, effectively reducing their set of possible co-authors. Without adaptation, it seems likely that this reduction would negatively impact the productivity of the affected researchers. However, over time, the affected researchers may adapt their collaboration networks and the topics they research to mitigate the negative effects.

It could well be that the treated authors can perfectly and immediately compensate the loss of US co-authors. China's spectacular growth in scientific output implies that there are many available co-authors domestically, and there are of course also alternative co-authors in other countries than

[18] The average value for US coauthor dependence is 0.030, to be compared with 0.017 for the average value for European coauthor dependence.

the US. In this case, their productivity would not fall and co-author quality will be constant. However, our hypothesis is that treated authors cannot perfectly compensate the loss of US co-authors, and consequently, that the China Initiative reduced the productivity of treated Chinese authors with a high level of dependence on US co-authors relative to that of control Chinese authors with a high dependence on Europe co-authors. We measure research productivity by the number of published papers, the number of citations of these papers, and the number of publications in top journals.

We also study the average co-author quality, measured by co-author H-index, to directly investigate whether Chinese authors with a high dependency on US co-authors were able to compensate the loss of these co-authors by other equally productive co-authors. In addition, the average H-index of co-authors is a strong predictor of the impact of a paper. Since we have a relatively short time horizon, the H-index of co-authors is an alternative proxy for paper quality than citations.

It is also of interest to study the dynamics of the productivity of affected researchers. Research projects take several years to complete, and for this reason, negative effects may appear with a lag. On the other hand, finding new co-authors also takes time, and for this reason, mitigation of effects may appear with a lag.

We also specifically investigate how the China Initiative affected collaborations with US co-authors for the treated authors. Our hypothesis is that the treated authors reduce their collaboration with US co-authors more than the control researchers reduce their collaboration with European co-authors. We also study co-author reallocation, whether the treated authors increase their collaboration with authors outside of the US, to compensate their lost ties, and the extent to which this compensates the productivity loss resulting from lost US collaborations.

The extent to which the treated authors can compensate the loss of US co-authors depends on the availability of alternative co-authors of similar qualities as the co-authors lost because of the China Initiative. If it is easy to find other co-authors, then the loss of US co-authors will impact the productivity of the treated authors less. The availability of alternative co-authors is likely lower for authors working in fields dominated by the US and higher in fields dominated by China. Hence, our hypothesis is that the negative effects are larger for authors researching US-dominated fields.

Finding equally good co-authors is likely also more difficult for top Chinese researchers, collaborating with top US co-authors, because top co-authors are few and in high demand. In contrast, less productive treated authors may even benefit from the resulting co-author reallocation, if the highly productive treated authors are forced to collaborate with them instead of highly productive

US co-authors. For this reason, our hypothesis is that the most productive treated authors are most negatively affected while the least productive treated authors are less affected, and may even be positively affected.

Authors can also adapt by changing their research direction. Treated authors may switch away from US-dominated topics, as collaboration with US researchers who are leading in these fields become more difficult. In addition, deglobalization may lead to more basic research outside of the US, based on the findings of Liu and Ma (2021) indicating that a country with less access to international research produces more basic research.

3.3 Empirical strategy

To test our hypotheses, we use a difference-in-differences design. Let y_{it} denote the outcome of interest for author i in year t (e.g. number of publications, citations or co-author quality). Our sample consists of our treatment and control authors for the years 2014 to 2021. Let T_i be an indicator variable for whether the author belongs to the treatment group. Let $Post_t$ be an indicator variable for the year, t, being greater than or equal to 2018 (the year the China Initiative was launched). We collect a number of pre-determined, time-invariant variables in X_i, including the author's research field and productivity. We estimate the difference-in-differences equation

$$y_{it} = \beta \cdot (T_i \times Post_t) + \gamma X_i + \delta_t + \epsilon_{it} \tag{2}$$

where δ_t are year-fixed effects. The corresponding "dynamic" event-study equation is

$$y_{it} = \sum_{t=2014}^{2021} \beta_t \cdot (T_i \times \delta_t) + \gamma X_i + \delta_t + \epsilon_{it} \tag{3}$$

Our identifying assumption is that the treated and control authors would have had parallel trends post 2018, had it not been for the China Initiative. This could be violated, for example, if the treatment and control authors are at different stages in their careers and hence are on different productivity trajectories, or if they work in different fields with different aggregate development. However, treatment and control authors are quite similar in terms of field composition and seniority, as we discuss in subsection 4.6. On the other hand, the treated authors have more productive co-authors and are themselves more productive, and may for this reason have had different trends than the control authors.

To deal with this issue, we use the doubly-robust estimation method, as implemented by Callaway and Sant'Anna (2020). This combines inverse probability weighting with the inclusion of control variables in the difference-in-differences specification. The propensity scores are computed based on aggregated characteristics over the period 2000-2010, which predates our sample period 2014-2021. We do not consider the years 2016 and 2017 due to Donald Trump's election possibly allowing researchers to anticipate such kind of political change.

4 Results

4.1 The aggregate productivity effects of the China Initiative

We start by analyzing effects on the number of publications, citations and publications in top journals. Figure 9 shows a small negative effect of the China initiative on the number of Chinese publications by treated authors compared to control authors, only significant at the 10% level. In contrast, Figure 10 shows a strong decline in the citation count to Chinese publications by treated authors compared to those of control authors. This effect does not appear to reflect a mechanical decrease that would be caused by a lower reach on US authors following the China Initiative shock, which in turn would have caused the observed decline in citations from the US. Indeed, citations to treated Chinese researchers by other Chinese authors are shown to decline as well in Figure 12. Figure 11 also shows that the number of papers by treated authors which are among the top 1% most cited papers in a given year also drops starkly. Further evidence of a decline in the quality of publications by treated Chinese researchers following the China Initiative shock, is provided by Figure 13, which shows a decline in the number of publications by treated Chinese researchers compared to control Chinese researchers in top 5% journals. If anything, the effect is increasing over time, indicating that the loss is not temporary.

Next, we analyze the impact of the China Initiative on the average quality of co-authors. Figure 14 shows a decline in the average quality of co-authors, measured by their average H-index, for treated Chinese researchers following the enforcement of the China Initiative. This is direct evidence that the treated authors were not able to compensate the lost US collaborations with other co-authors of equal quality. It may take more time to find new co-authors, but there is no evidence of their closing of the gap during our sample period. Note that the quality of co-authors is a good predictor for future citations, both at article level and at author level. In Table 2 we regress citations within five years and citations within ten years on the current quality of co-authors measured by their average H-Index, and we indeed see positive and significant correlations between the average quality of co-authors and future citations.

Table 2: Predictions of the number of citations (5 and 10 years windows) using the average H-Index of coauthors (paper level)

Dependent Variables:	Citations (5 years post. publication)	Citations (10 years post. publication)
Model:	(1)	(2)
Variables		
Average H-index of coauthors	1.088***	1.508***
	(0.0808)	(0.1150)
Fit statistics		
Observations	1,391,945	1,391,945
R^2	0.04256	0.04849
Adjusted R^2	0.04250	0.04843

Clustered (year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: The table above reports estimates for a fixed-effects regression of the citations received in the next 5 and 10 years by a paper based on the average H-index of its authors. The fixed effects include time and main domain of study (life, health, physical sciences).

4.2 The reallocation effects of the China Initiative

We next investigate how the China initiative affected the reallocation of co-authorship across regions or "country groups" (US, Europe, China) and the resulting effect of that reallocation on research output. More specifically, we investigate the extent to which researchers with a high dependence on coauthors from one particular region during the pre-shock period continued to co-author with researchers from the "*same*" region or country group in the post-shock period. In particular, we compare the evolution of the US co-authorships of treated Chinese authors with that of European co-authorships for control Chinese authors.

Figure 15 shows that treated authors write markedly fewer articles with US co-authors after the shock, compared to the evolution of the European co-authorship of control Chinese researchers. Since the total number of publications by treated Chinese authors is only moderately affected by the China Initiative, this effect is mainly driven by a reallocation away from US co-authors.

We see evidence of the impact of the reallocation away from US co-authors when looking at top 5% journals. In Figure 13, we showed that the China Initiative reduced the treated authors' number of publications in these journals. Looking at co-authors' affiliations helps understand better what underlies this aggregate dynamic pattern. Figure 16 shows that most of this fall can be attributed to a corresponding fall in top publications with US co-authors. The number of publications by treated authors in top journals with US co-authors declines sharply after the shock compared to the number of publications in top 5% journals by Chinese control authors with European co-authors. The comparison with the aggregate fall in Figure 13 shows that there is no increase in top 5% journal publications with Europe, China or the rest of the world that would — even partly — offset the decline in the number of top 5% publications by treated Chinese researchers with US co-authors. We provide more evidence on this in Appendix subsection D.

Finally, we look at whether the China Initiative had a larger impact on new and short-term relationships than on long-term co-author relationships. Figure 17 shows that there is a decline in the number of new US co-authors for treated authors right before and at the time of the shock, compared to the evolution of new European co-authorships for control authors. At the same time, there is no change in the total number of new co-authors of treated Chinese authors compared to control Chinese authors after the shock. Hence the decline in new US co-authors for Chinese researchers in the treatment group is compensated by a rise in new co-authorships for those same Chinese researchers outside of the US.

Consistent with the view that there should be a negative effect of the China Initiative shock on treated authors' new partnerships with US researchers, Figure 18 shows a significant decline in short-term co-authorship of treated authors with US co-authors. However, as shown in Figure 19, we do not see a decline in long-term co-authorship of treated Chinese authors with US co-authors. This indicates that Chinese researchers have managed to maintain their research collaborations with long-term US co-authors.

Taken together the results in this section point to a reallocation of coauthorship for treated Chinese researchers following the China Initiative away from US co-authors. This in turn at least partly explains the observed reduced research quality of treated Chinese authors, reflected both in the reduced number of publications in top journals, and in the fall in co-author quality. Yet, the fact that so far Chinese researchers have managed to maintain their research collaborations with long-term US co-authors, might have contributed to limit the magnitude of the quality decline following the China Initiative shock.

4.3 The China Initiative and the choice between basic and applied research

The China Initiative did not only affect the amount and quality of publications by Chinese researchers with prior US co-authorship, but also the direction of Chinese research. In the introduction we mentioned recent work by Liu and Ma (2021) pointing at a positive effect of deglobalization on the basicness of innovation. It might also be the case that, following the China Initiative, treated Chinese researchers decide to rely more on local research inputs which in turn should encourage more basic research in China. But it may also be the case that, facing a restricted access to high-quality US co-authors, treated Chinese researchers focus primarily on replicating or adapting existing ideas and findings, thereby producing more applied research.

Here we look at the extent to which the China Initiative shock would affect the basicness of research by treated Chinese authors. Our primary measure of research basicness is the CHI Index, developed by CHI Research and used by Lim (2004) and Murray et al. (2016). This index assigns to each journal a value of basicness of research, from 1 to 4, in which 1 corresponds to the highest degree of applied science and 4 to the highest degree of fundamental research. We match the journals that are assigned a value in the CHI index scale to their identifier in Scopus. Then, we count the number of times an author published an article in a given year in a journal identified by CHI as being fundamental, and we also consider a dummy equal to one whenever she published any such article at all during the year.

Figure 20 looks at the effect of the China Initiative on the basicness of Chinese publications using our primary CHI Index measure of basicness. There is no change in the overall number of basic publications by treated Chinese authors compared to control Chinese authors after the shock.

However, we see a decline in the probability to publish in a basic journal by treated Chinese authors *with US co-authors* after the shock, compared to the evolution of the number of basic publications by control Chinese authors with European co-authors. This, together with the absence of an overall effect of the China Initiative on the flow of basic research publications, suggests that China might have tried to make up for its reduced ability to pursue basic research with US co-authors by increasing its reliance on collaborations with non-US co-authors for basic research.

In the Appendix subsection B, we also perform a topic-level analysis, using information about funding sources for each of the 1495 topic clusters. This information in turn is derived from Scopus based on the proximity of research articles by keywords[19].More specifically, we construct a variable equal to one if over 50% of articles involve US funding, or Chinese funding, or NIH funding and zero otherwise. Among topics that are heavily funded by the US, we further zoom on topics in which articles are heavily funded by the US military and/or are deemed to be "sensitive" topics funded by the military and the government. We find that the China Initiative shock has no significant effect on the probability for a treated Chinese researcher to write an article in a topic heavily funded by the US on average, yet there is a positive and significant effect of the China Initiative shock on the probability for a treated Chinese researcher to produce a paper on a topic heavily funded by

[19]More information on Topic Clusters is provided by Scopus on the Scival page about Topics of Prominence.

the US military. This effect remains significant when restricting attention to new publications by treated Chinese authors with Chinese co-authors. One interpretation is that such topics are also of national Chinese interest and that consequently the Chinese government's answer to the China Initiative is to redirect scientists that used to work with US researchers towards topics of military interest.

4.4 Magnitude of the Average Treatment Effects on the Treated (ATT)

Table 3 computes the Average Treatment Effects of the China Initiative on the amount and quality of publications by Chinese researchers on average over the whole analysis period. The table shows significantly negative effects of the China Initiative on : (i) publications by Chinese researchers (first column), although only at the 10% level overall, but at a level below 1% with US co-authors compared to publications by control Chinese authors with European co-authors (eleventh column), both stronger conditional on publishing (second and twelfth columns); (ii) citation counts for Chinese researchers, both overall and conditional on publishing (fourth and fifth columns) ; (iii) publications by Chinese researchers in top five percent journals (fifth column), also conditional on publishing (sixth column), all the more for publications of Chinese researchers with US co-authors (thirteenth column) ; (iv) citations received from publications with at least one Chinese author, unconditional and conditional on publishing (seventh and eighth columns); (v) number of papers published that fall into the top 1% of most cited papers of the year (ninth and tenth columns). Together, these ATT results confirm our findings in the event studies depicted in Figures 4 to 7, of a negative effect of the China Initiative on the volume and more importantly quality of subsequent research by treated Chinese authors.

This table also informs us about the magnitudes of the effects of the China Initiative shock. The effect on publications is of moderate size; it represents around 1% of the mean and 2% of the median for the number of publications (3). However, on average, there is a decline in citations of the order of 5 citations on all publications in a given year for the treated authors; this corresponds to about 13% of the median number of citations (39) for the years before the shock. Furthermore, given that the average number of publications during that period published in the top 5% journals is 0.28, the -0.034 coefficient corresponds to a decline of around 12% of the pre-shock mean value of the number of such publications.

Table 4 computes the Average Treatment Effects (ATT) of the China Initiative on the reallocation and quality of Chinese researchers' co-authors. The table shows : (i) no significant effect on

Table 3: Average Treatment on the Treated (ATT) for publications-related performances of researchers.

											with co-authors 'same country'		
	publications		citations		pub. top 5% journals		citations China		nr is hit paper		publications		pub. top 5% journals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
ATT	-0.053*	-0.148***	-5.269***	-7.207***	-0.034***	-0.034***	-5.511***	-10.130***	-0.008**	-0.015***	-0.037***	-0.092***	-0.011***
	(0.032)	(0.053)	(1.175)	(1.573)	(0.013)	(0.013)	(1.444)	(2.579)	(0.003)	(0.005)	(0.010)	(0.028)	(0.003)
Mean.Dep.Var.Pre	3.117	3.117	98.809	98.809	0.279	0.279	119.885	119.885	0.069	0.069	0.481	0.481	0.099
Pvalue.PreTrend	0.990	0.862	0.063	0.092	0.318	0.318	0.714	0.475	0.300	0.785	0.571	0.974	0.384
N.authors	39858	39799	39799	39799	39799	39799	39799	39799	39799	39799	39858	39799	39799
N.obs	358722	255653	255653	255653	255653	255653	255653	255653	255653	255653	358722	255653	255653
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing		Yes		Yes		Yes		Yes		Yes		Yes	

Note:results are from DRDID regression, for each outcome for the whole sample and conditioning on having published during the year of observation. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the number of publications (columns (1)-(2)),number of citations for publications from that year (columns (3)-(4)), rate of publications on top 5 % journals (within subject) from that year (columns (5)-(6)), citations received from papers with at least of Chinese author (columns (7)-(8)), number of "hit papers" (papers that are among the top 1% cited papers in a given year) (columns (9)-(10)) number of publications with US-based coauthors for the treated and Europe-based coauthors for the control (columns (11)-(12)), rate of publications on top 5 % journals (within subject) with US-based coauthors for the treated and Europe-based coauthors for the control from that year (columns (13)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

the probability of publishing with a new, short-term or long-term co-author for the treated (first to third columns); (ii) a significantly negative effect on real-time H-Index of co-authors for the treated (fourth column); (iii) a significantly negative effect of the China Initiative on publishing with new US co-authors for the treated compared to the probability of publishing with a new European coauthor for the control (fifth column) ; (iv) a significantly negative effect of the China Initiative on publishing with short-term US co-authors for the treated compared to the probability of publishing with a short-term European coauthor for the control (sixth column) ; (v) a significantly positive effect on long term co-authorship for treated Chinese researchers with a US co-author compared to long-term co-authorship for control Chinese researchers with European co-authors (seventh column); (vi) a non-significant effect on real-time H-Index of US co-authors for the treated compared to that of European coauthors for the control (eighth column). Together these confirm and extend our findings from the event studies depicted in the above Figures 15 to 19.

On average, the negative effect of the China Initiative shock on the probability for a treated Chinese researcher of publishing with a new co-author in the US drops by 1.8 points compared to the probability for a control Chinese researcher of publishing with a new co-author in Europe; this corresponds to a 7% drop compared to the pre-shock mean (0.2285). The effect on the (real-time) average H-index of co-authors is smaller, reaching 3% of the median of the pre-period level (13.4).

Table 5 computes the Average Treatment Effects on the Treated (ATT) of the China Initiative on the basicness of publications by Chinese researchers. We see a significantly negative effect of the China Initiative on the basicness of publications by Chinese researchers with a US co-author. The average probability to publish a basic article (conditional on publishing) with a US co-author

Table 4: Average Treatment on the Treated (ATT) on coauthor' activity-related outcomes

					with co-authors 'same country'			
	any new co-authors	any co-authors (ST)	any co-authors (LT)	avg H index co-authors	any new co-authors	any co-authors (ST)	any co-authors (LT)	avg H index co-authors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ATT	0.003	-0.001	0.003	-0.386**	-0.018***	-0.018***	0.015***	-0.978
	(0.004)	(0.006)	(0.007)	(0.174)	(0.007)	(0.006)	(0.005)	(0.928)
Mean.Dep.Var.Pre	0.944	0.887	0.578	14.928	0.245	0.251	0.104	16.926
Pvalue.PreTrend	0.437	0.906	0.849	0.161	0.142	0.813	0.020	0.096
N.authors	39799	39799	39799	39623	39799	39799	39799	26200
N.obs	255653	255653	255653	251553	255653	255653	255653	89689
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing				Yes				Yes

Note:results are from DRDID regression, for each outcome relating to any type of coauthor or only US coauthors for the treated and European coauthors for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the probability of having a new coauthor (columns (1)-(4)), the probability of having a new short-term coauthor, i.e. 1 and 5 years, (columns (2)-(5)), the probability of having a new long-term coauthor, i.e. ¿5 years (columns (3)-(6)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Average Treatment on the Treated (ATT) on research direction-related outcomes

			with co-authors 'same country'	
	any basic	nr basic	any basic	nr basic
	(1)	(2)	(3)	(4)
ATT	-0.009	-0.004	-0.022**	-0.012
	(0.006)	(0.018)	(0.011)	(0.009)
Mean.Dep.Var.Pre	0.237	0.750	0.143	0.159
Pvalue.PreTrend	0.559	0.971	0.423	0.781
N.authors	39799	32966	26414	21669
N.obs	255653	151095	90846	65411
Controls	Yes	Yes	Yes	Yes
Cond. on publishing	Yes	Yes	Yes	Yes

Notes : Results are from DRDID regression, for each outcome relating to any type of coauthor or only US coauthors for the treated and European coauthors for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the probability of publishing in a journal classified as basic by CHI research (columns (1) and (3)), the number of publications in such journals (columns (2) and (4)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

(*resp.* a European co-author) for a treated (*resp.* control) Chinese researcher is 0.143, meaning that the -0.022 effect represents a 14% decrease in the corresponding outcome variable.

4.5 Heterogeneous effects across Chinese authors

In this subsection we look at the extent to which Chinese researchers are impacted differently by the China initiative depending upon their research performance prior to the shock and their exposure to US scientific dominance in their field.

4.5.1 Heterogeneity across productivity levels

In order to factor in heterogeneity based on performance, we run the same regressions as in Section 4.1,but separately for different categories of Chinese researchers. We break up the population of Chinese researchers into subsamples, where each subsample corresponds to a different tercile in the distribution of citations per author during the selection (pre-sample) period, 2008-2012. When we first look at the effect of the China Initiative on the number of publications by treated Chinese researchers broken up by terciles, we see no significantly negative effect on the volume of publications by lower tercile Chinese researchers in the treatment group compared to those in the control group, whereas the publications of the middle and top tercile Chinese researchers in the treatment group appear to drop significantly compared to those of middle and top tercile Chinese researchers in the control group (Figure 21). Furthermore, the effect of the China Initiative on the number of publications in top 5% journals by top and middle tercile Chinese researchers in the treatment group compared to the control group, is significantly negative and of larger magnitude than its overall effect on the number of publications in top 5% journals by the overall population of treated Chinese researchers (Figure 22).

4.5.2 Heterogeneity across fields

Here we look at how the effects of the China Initiative on the performance of Chinese researchers in the treatment group, vary with the researchers' main fields of publication. More specifically, we compute the average aggregate ATT coefficients on the number of publications (Figure 23) and on the number of publications in the top 5% of journals (Figure 24) for treated Chinese researchers in each field separately, to identify which fields have been most notably affected by the China Initiative shock.

Figure 23 shows that treated Chinese researchers whose number of publications has been significantly negatively affected by the China Initiative shock are those whose main publication fields are physics, in particular materials science and energy, and chemistry, particularly in pharmacology and chemical engineering. Figure 24 shows that when it comes to publications in top journals, researchers in most fields have been negatively affected by the China Initiative shock, but the effect is stronger for researchers whose main area of publication is physics, chemistry, and life sciences (especially in pharmaceuticals and in biochemistry). Interestingly, Figure 25 shows a monotonic relationship between the magnitude of the negative effect of the China Initiative shock on treated

Chinese researchers' publications overall (left-hand panel) and in top journals (right-hand panel) and the degree of US dominance in the corresponding main field of publication: namely, it is in those fields in which US authors claim a higher share of total citations to papers in top 5% journals, that treated Chinese researchers' citations are more negatively affected by the shock.

Finally, Figure 26 and Figure 27 show that, whenever significant, the effects of the China Initiative shock respectively on the publications and on the publications in top journals of treated Chinese researchers in each field are driven by researchers in the top half of the distribution of citations in the selection period.

4.6 Discussion

First, we can make the case that our results are not driven by intrinsic differences between Chinese researchers in the treatment versus the control group. First, Figure 28 shows that there are very few significant absolute mean differences between the treatment and control groups after weighting observations by propensity scores, and moreover the remaining differences are no longer significant when using Kolmogorov-Smirnov statistics. Second, treated and control Chinese researchers do not display systematic differences in seniority or in fields of study, two potential reasons for differential trends in publications and citations between the two groups.

Second, we check that our results are robust to using simpler selection methods solely based on any co-authorship. As before, we keep authors who have at least 3 publications over the selection period, 80% of their affiliation in China during this same period and are last observed publishing in China. We now include in the treatment group all Chinese researchers with at least one US co-author and no European co-author. Similarly, our alternative control group comprises all Chinese researchers with at least one European co-author and no US co-author. Table E.1 in the Appendix shows no major change in the results when using this selection process, aside from the loss of significance on the effect of small magnitude on publications.

Third, we check that our main findings are robust to considering alternative measures of quality for both, publications and coauthors of Chinese researchers. More precisely, to identify top publications we replace the 5% threshold by a 10% threshold (see Figure E.2) and we also consider variants of our citations metrics[20] All of the resulting alternatives yield significant results, aside from citations in the first year after publication, probably due to noise. Table E.2 in the Appendix summarizes the corresponding ATT results for the various outcome variables on average over the period. Next, when looking at coauthor quality, we show that using a seniority-normalized H-Index for co-authors to avoid lifecycle effects on their H-Index as provided in Figure E.3 does not change our results.

Finally, we perform a placebo test where we take 2010 instead of 2018 as the alternative time dummy. As shown in Figure 29 for the volume of publications, and in Figure 30 for our two main measures of publication quality, no trend breaks are observed this time in these outcome variables

[20] In particular in Appendix subsection B we consider the Scopus CiteScore metrics, which contains more US-based journals than ours.

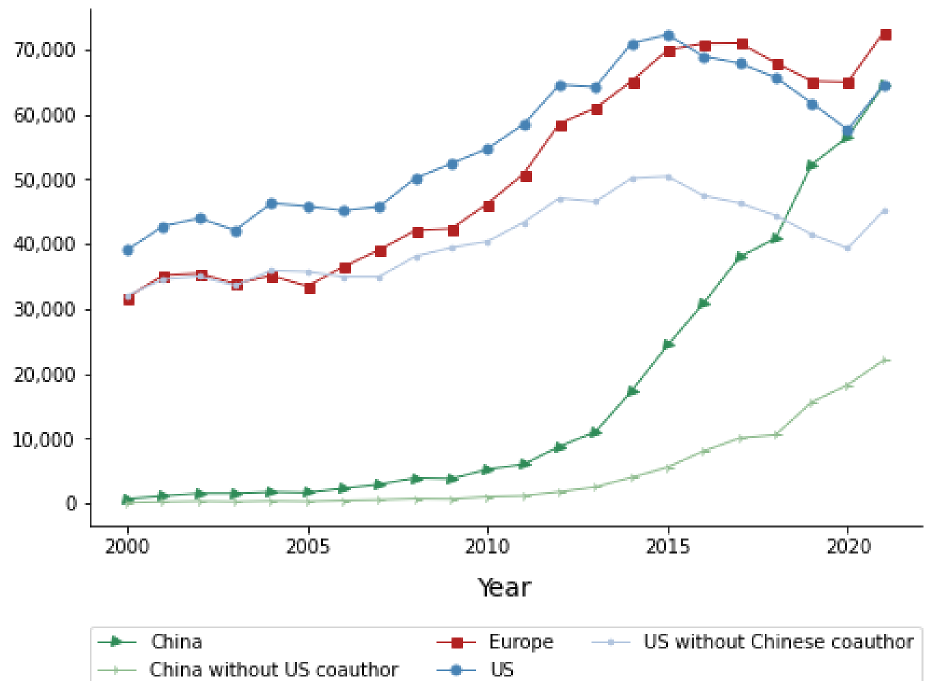
for treated Chinese researchers. In Table E.3 in the Appendix we show the results of the ATT values for the main outcome variables, estimated on a sample selected in the period 2001-2005 of a placebo shock happening in 2010. Although there is a positive effect on the number of publications in the top 5% of journals, this does not appear to be due to a trend break in 2010 based on the propensity score weighting, as can be seen in Figure 30. If anything, we find that treated authors in the placebo sample tend to deepen their links with the US compared to control authors after 2010, especially when looking at high-ranked publications.

5 Conclusion

In this paper we used information from the Scopus database to analyze how the China Initiative shock affected the volume, quality and direction of Chinese research. We found a negative effect of the Initiative on the average quality of both the publications and the co-authors of Chinese researchers with prior US collaborations. Moreover, we saw that this negative effect was stronger for Chinese researchers with higher research productivity and/or who worked on US-dominated fields and/or topics prior to the shock. Finally, we found that Chinese researchers with prior US collaborations reallocated away from US researchers after the shock, in particular those specialized in basic research. The lack of reallocation towards China or the rest of the world suggests that the main beneficiary of the policy might have been Europe.

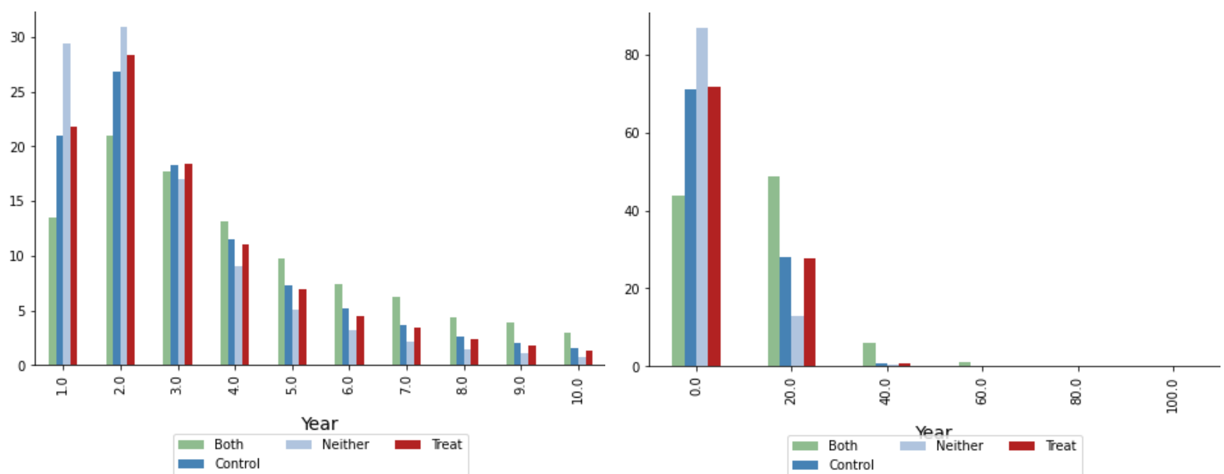
Our analysis can be extended in several interesting directions. One direction would be to consider other dimensions of heterogeneity among Chinese researchers, for example the extent to which they work on research topics that meet the strategic priority of the Chinese government : our conjecture is that the negative effect of the China Initiative on the quality of subsequent publications, should be less pronounced for Chinese researchers who work on topics that are considered as priorities by the Chinese government, e.g. digital and face recognition, biotechnologies, and energy transition. A second avenue for future research would be to investigate further the role of freedom and the mobility of Chinese researchers as determinants of the quality, nature, and direction of Chinese research : in particular, can Chinese research lead to Kuhnian discoveries and become truly frontier in the absence of both freedom at home and the ability to initiate collaborations with researchers abroad? A third avenue is to bridge the gap between the Scopus information on publications and the existing patenting information (see Bergeaud and Verluise (2022)) to better predict the technological fields where China is more likely to achieve frontier. These and other extensions of the analysis in this paper are left for future research.

Figure 6: Number of publications in the top 5 % best ranked journals (2000-2020).



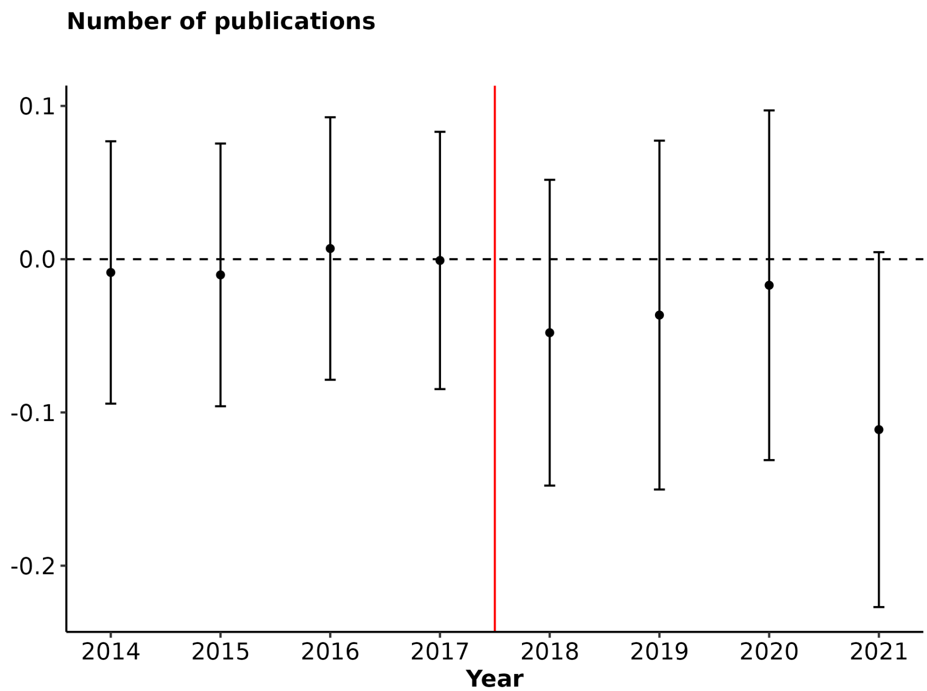
Notes: This figure shows evidence of the Chinese catch-up in the number of publications in the top 5% cited journals. Top 5% journals are classified by field, over the total number of citations received over a 4 y-window per paper for each source. The curve labelled with the mention *no US co-author* (*resp. no Chinese co-author*) accounts for publications without any US-affiliated (*resp.* China-affiliated) author or an author who has ever been affiliated to the United-States (*resp.* China).

Figure 8: Comparison of the distribution of publications in the pre-shock period and H-indices per group



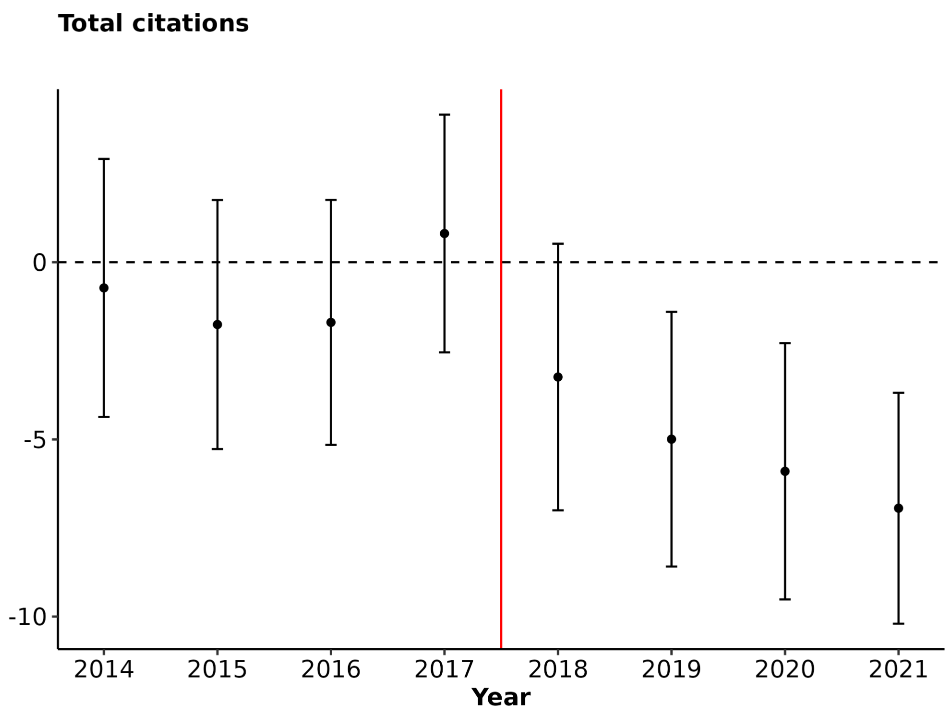
Notes: This graph represents the distribution of publications (left) and of H-indexes (right) during the pre-shock period per groups. Treat and control individuals are identify according the method we detail in section 3. Authors in the group *both* are dependent on US and European co-authors, while authors in the group *neither* are dependent on neither. Our dependence measure is the C index described in this subsection.

Figure 9: Effect of the China Initiative on the number of publications



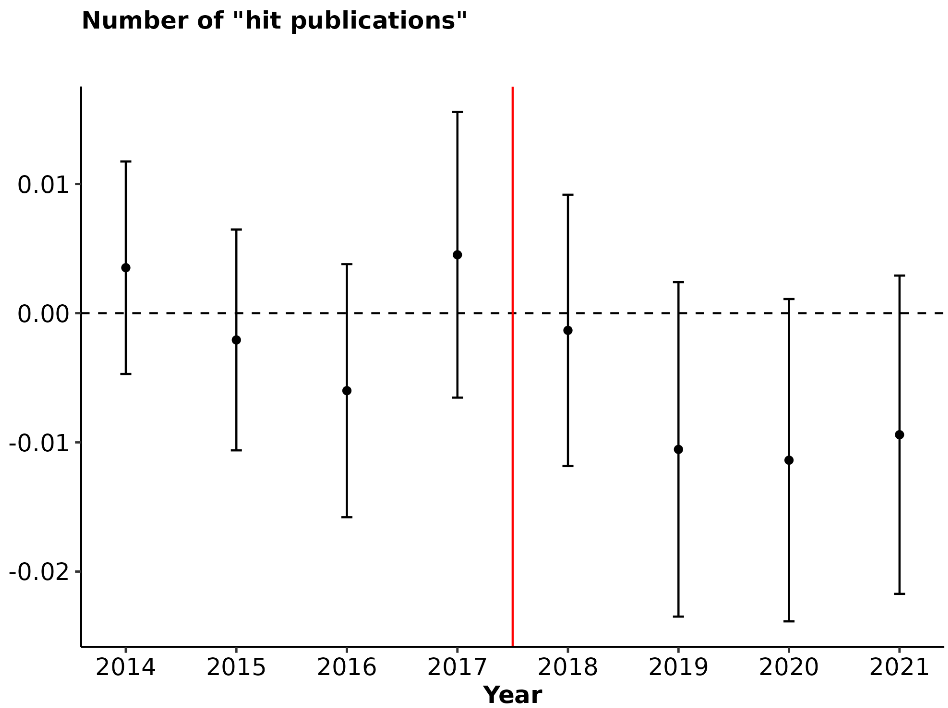
Notes: The graph above reports regression estimates for the difference in number of total publications between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 10: Effect of the China Initiative on the number of citations (normalized yearly)



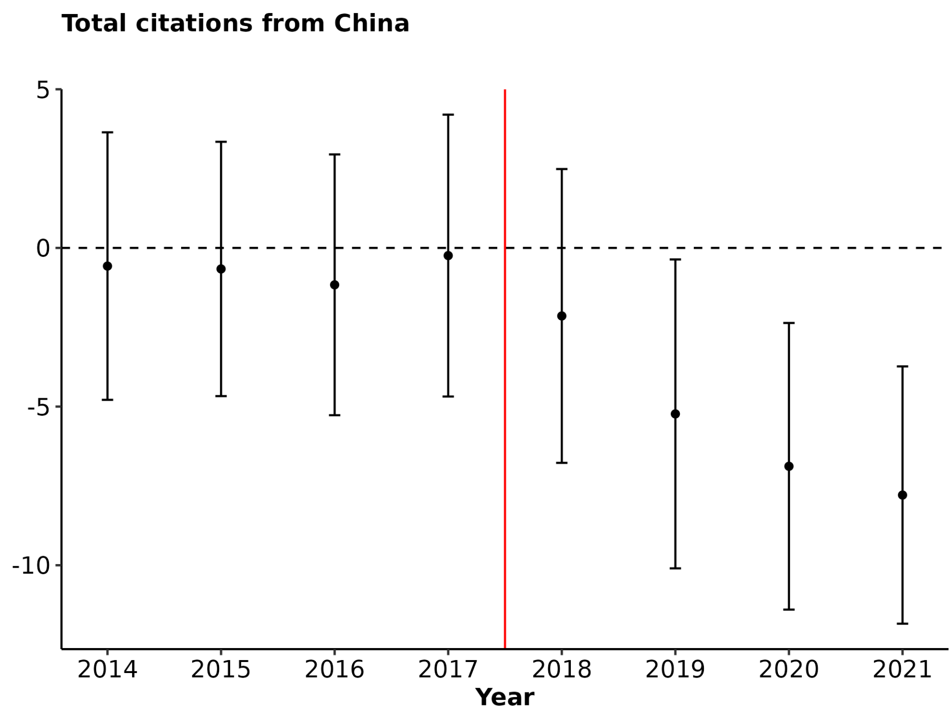
Notes: The graph above reports regression estimates for the difference in number of total citations received until today for an article published in a given year between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 11: Effect of the China Initiative on the number of papers in the top 1% cited papers



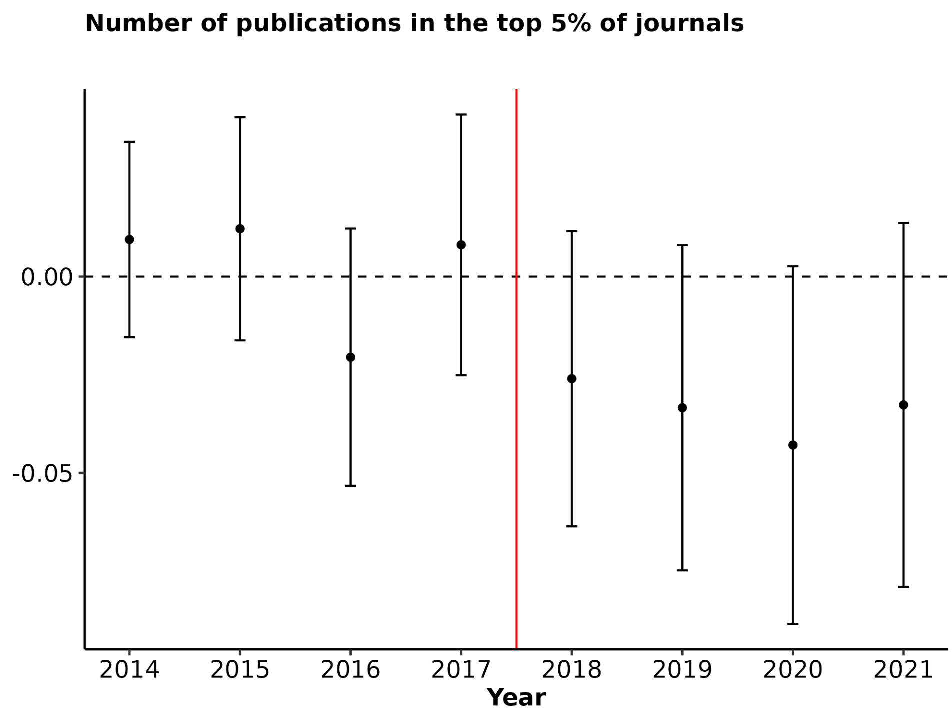
Notes: The graph above reports regression estimates for the difference in number of papers in the top 1% most cited papers of the year between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 12: Effect on number of total citations from Chinese papers



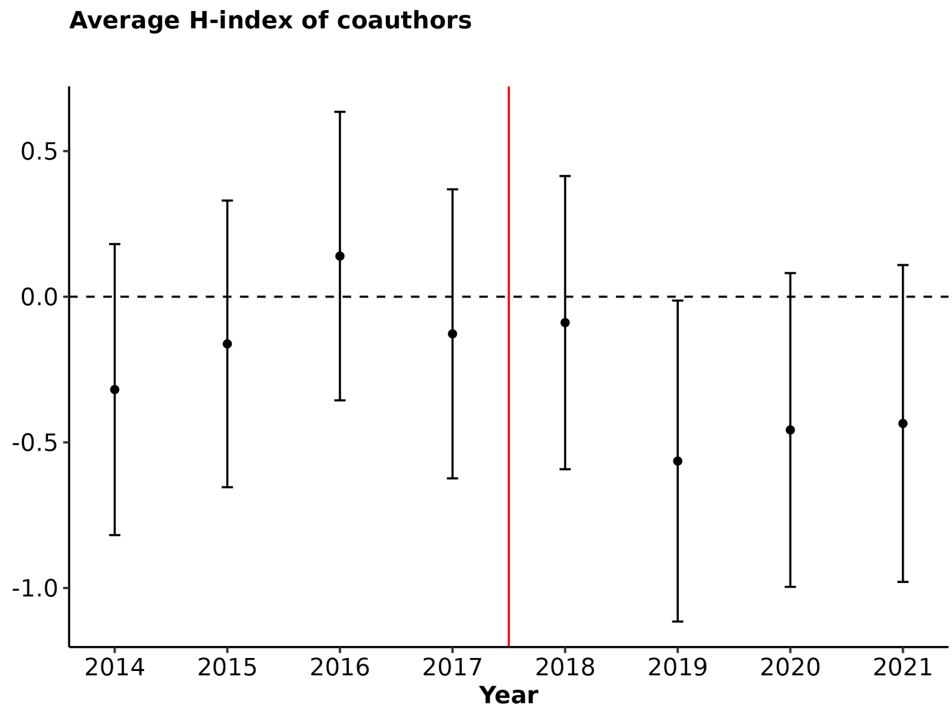
Notes: The graph above reports regression estimates for the difference in number of citations received from papers published by authors with a Chinese affiliation between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 13: Effect on number of publications in top 5% of journals



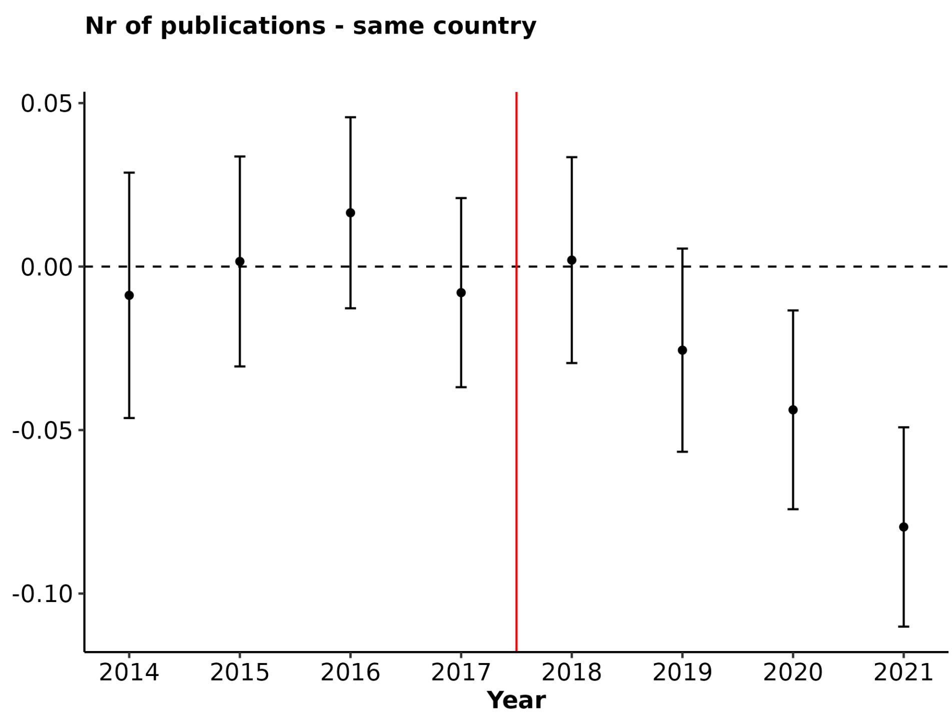
Notes: The graph above reports regression estimates for the difference in number of publications in the 5% most cited journals within a discipline between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 14: Effect on average real-time H-Index of co-authors



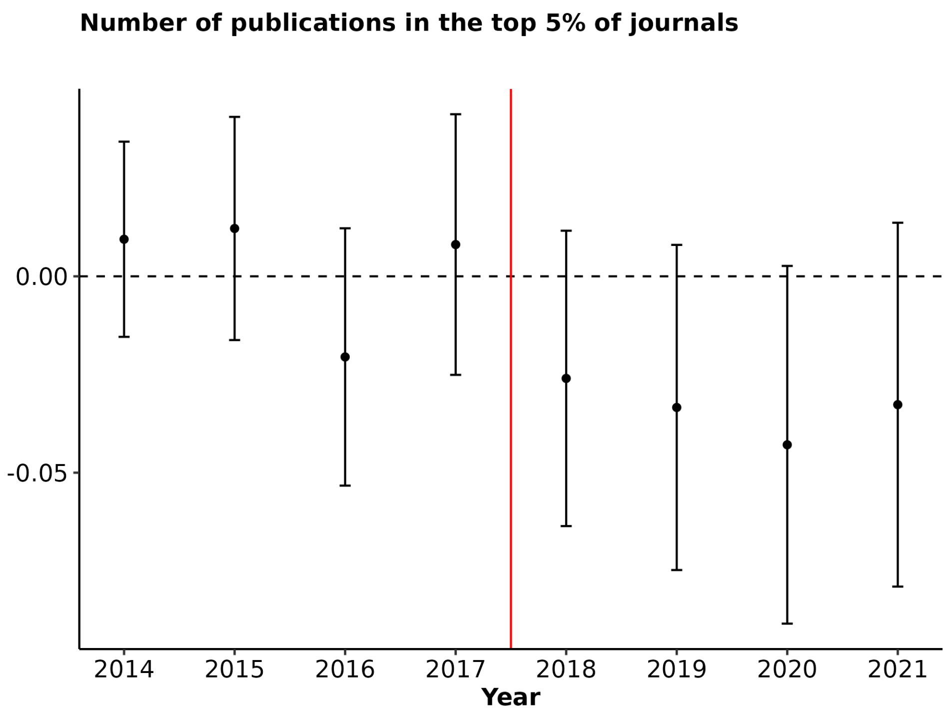
Notes: The graph above reports regression estimates for the difference in average H-Index of co-authors between the treated and control group for each year between 2013 and 2021, based on information available at the year this measure is calculated. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 15: Effect of the China Initiative on the number of publications by the treated group with US co-authors compared to the number of publications of the control group with European co-authors



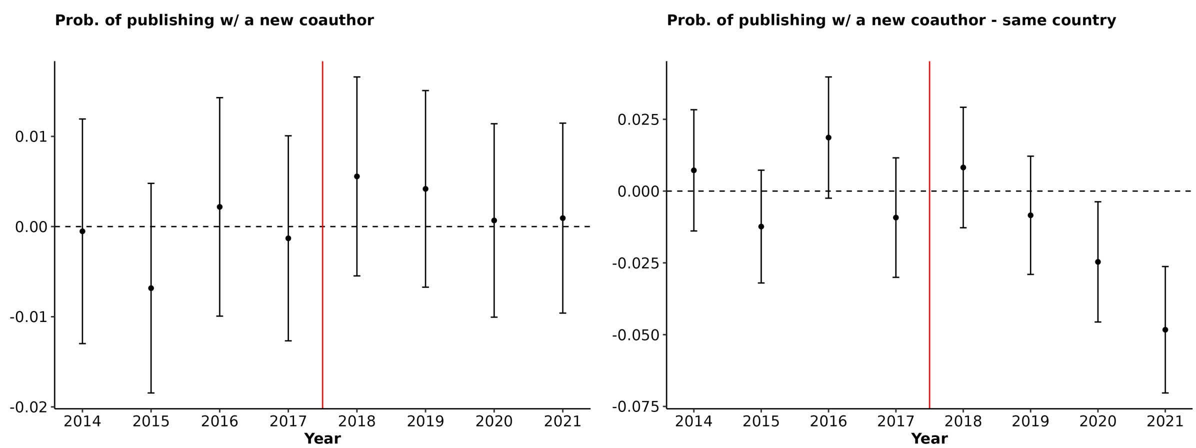
Notes: The graph above reports regression estimates for the difference in number of publications by the treated with US co-authors and number of publications by the control with European co-authors for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 16: Effect of the China Initiative on the number of publications in top journals by the treated group with US co-authors compared to the number of publications of the control group with European co-authors



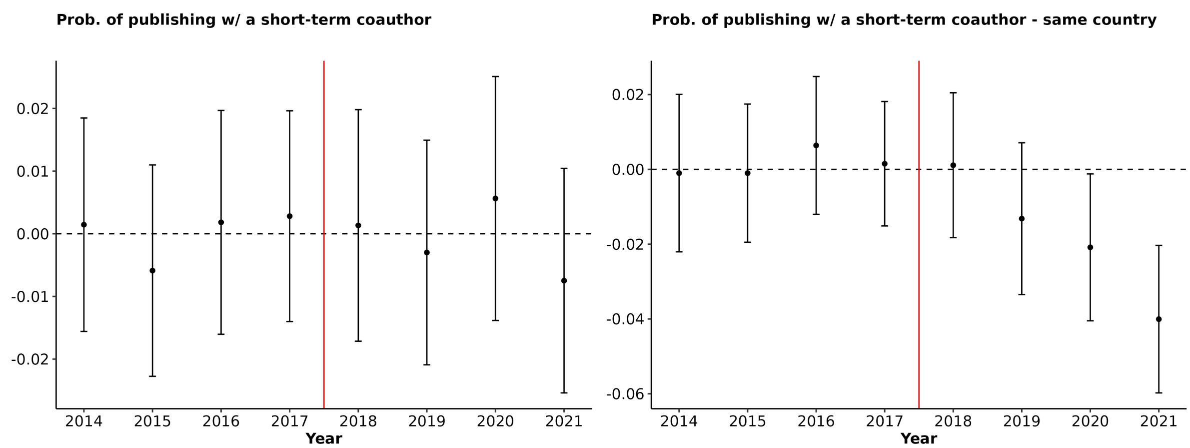
Notes: The graph above reports regression estimates for the difference in number of publications in the top 5% most cited journals within discipline by the treated with US co-authors and number of publications in the top 5% most cited journals within discipline by the control with European co-authors for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 17: Effect on having a new co-author: global and US compared to control with Europe



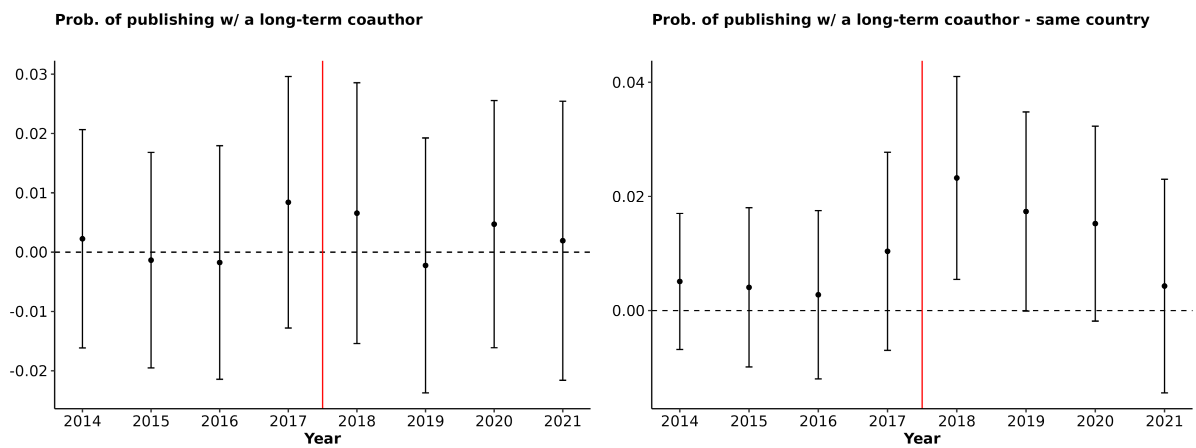
Notes: The graphs above report regression estimates both for the difference in the probability of publishing with a new co-author (left) and publishing with a new US co-author for the treated and a new European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 18: Effect on having a short-term co-author: global and US compared to control with Europe



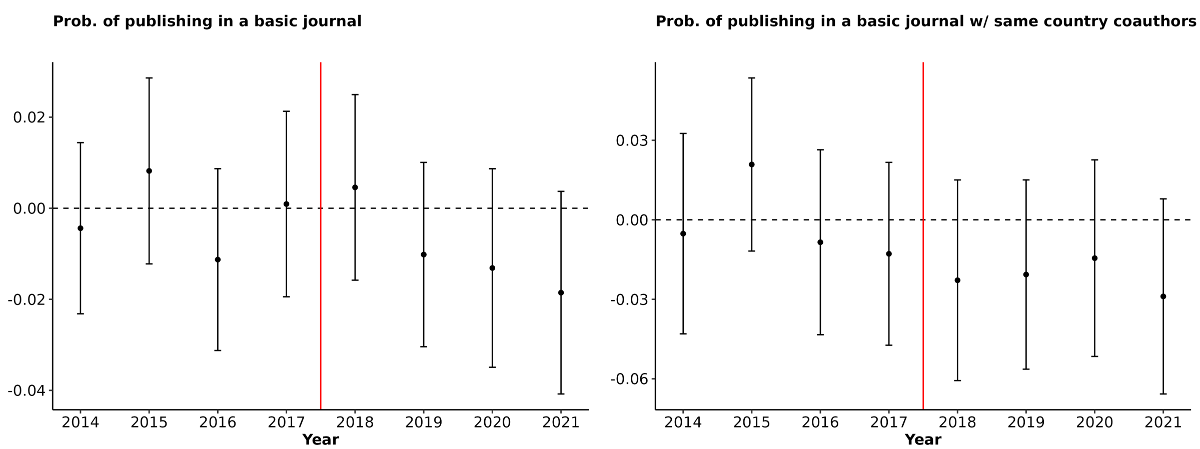
Notes: The graphs above report regression estimates both for the difference in the probability of publishing with a short-term co-author (left) and publishing with a short-term US co-author for the treated and a short-term European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021 (short-term meaning a co-author that the author had for between 1 and 5 years). Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 19: Effect on having a long-term co-author: global and US compared to control with Europe



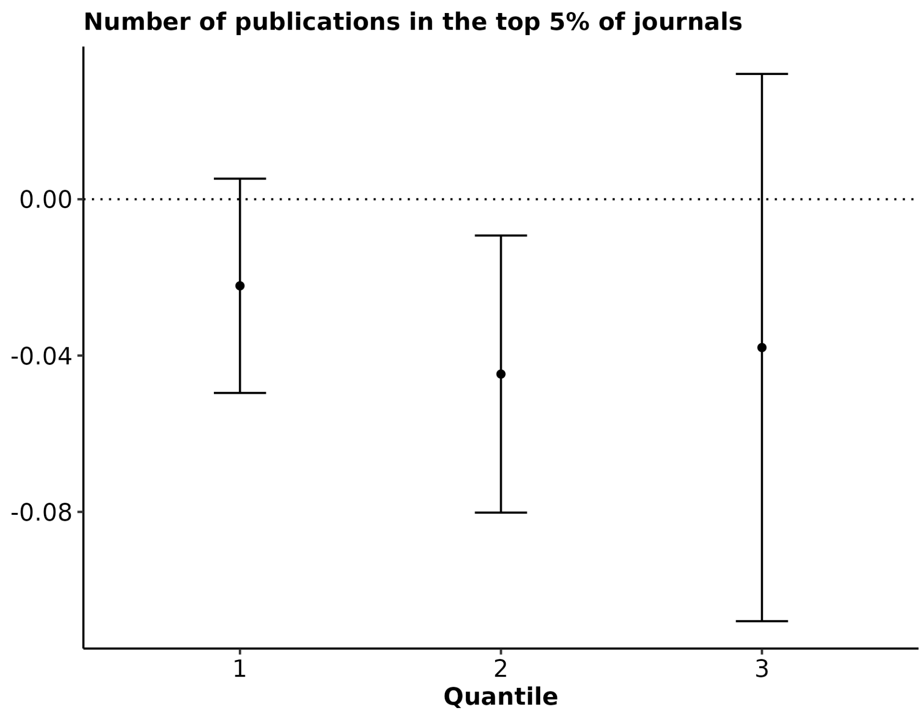
Notes: The graphs above report regression estimates both for the difference in the probability of publishing with a long-term co-author (left) and publishing with a long-term US co-author for the treated and a long-term European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021 (long-term meaning a co-author that the author had for over 5 years). Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 20: Effect on probability of publishing in a basic journal: global and US compared to control with Europe



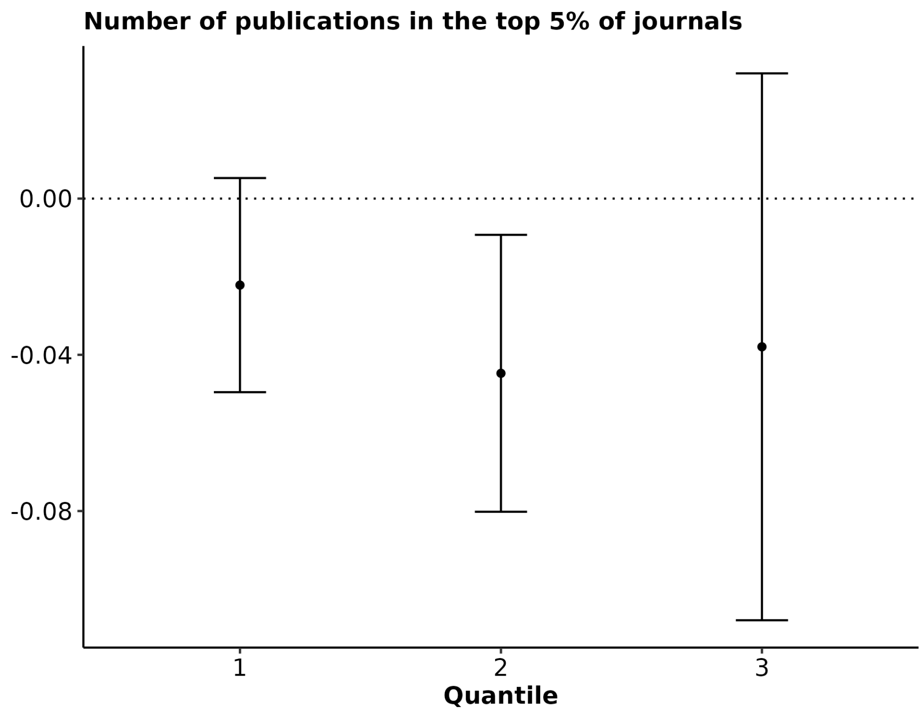
Notes: The graphs above report regression estimates both for the difference in the probability of publishing in a journal flagged as basic by CHI research (left) and of doing so with a US co-author for the treated and a European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 21: Effect of the China Initiative on publications: effect by terciles.



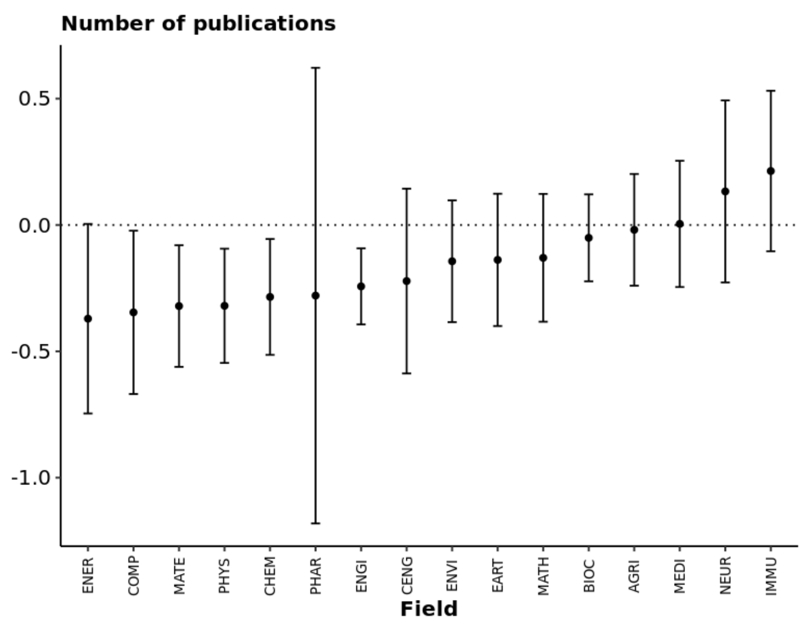
Notes: The graph above reports regression estimates for the difference in the total number of publications between each tercile of the distribution of citations of the treated and its counterpart in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 22: Effect of the China Initiative on publication in top 5% of journals: effect by terciles.



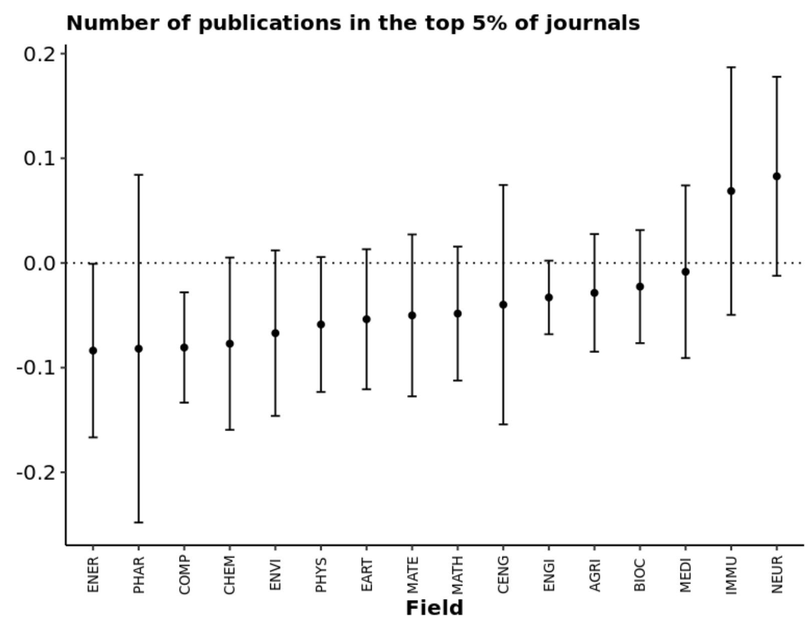
Notes: The graph above reports regression estimates for the difference in the number of publications in top 5% cited journals between each tercile of the distribution of citations of the treated and its counterpart in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 23: Effect of the China Initiative on publications: effect by field.



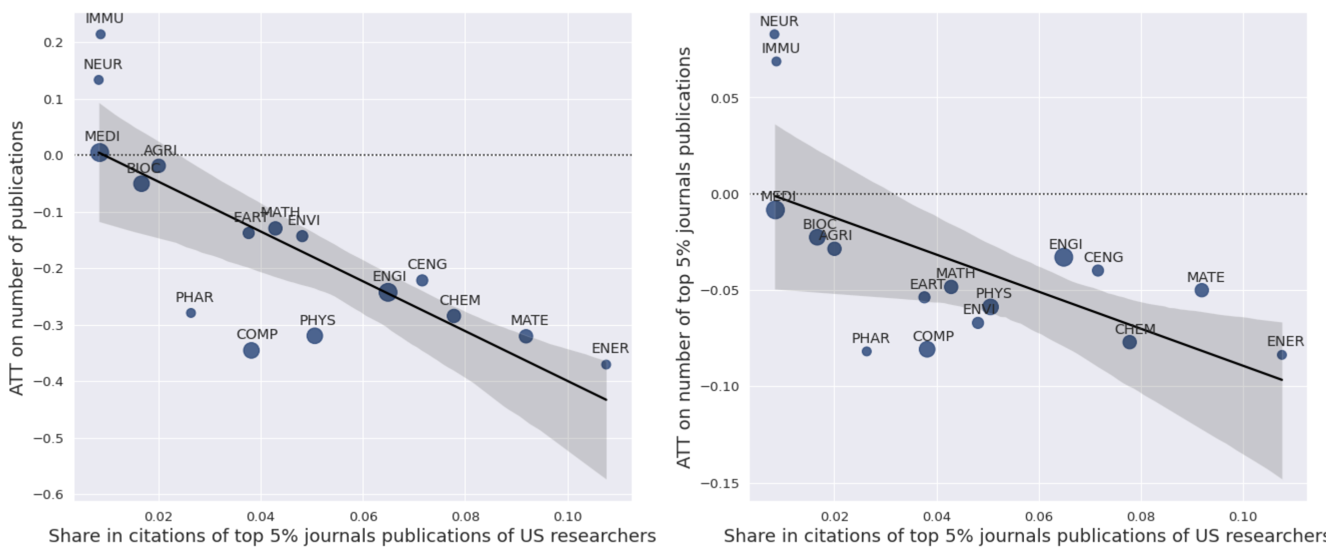
Notes: The graph above reports regression estimates for the difference in the total number of publications for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 24: Effect of the China Initiative on publications in top journals: effect by field.



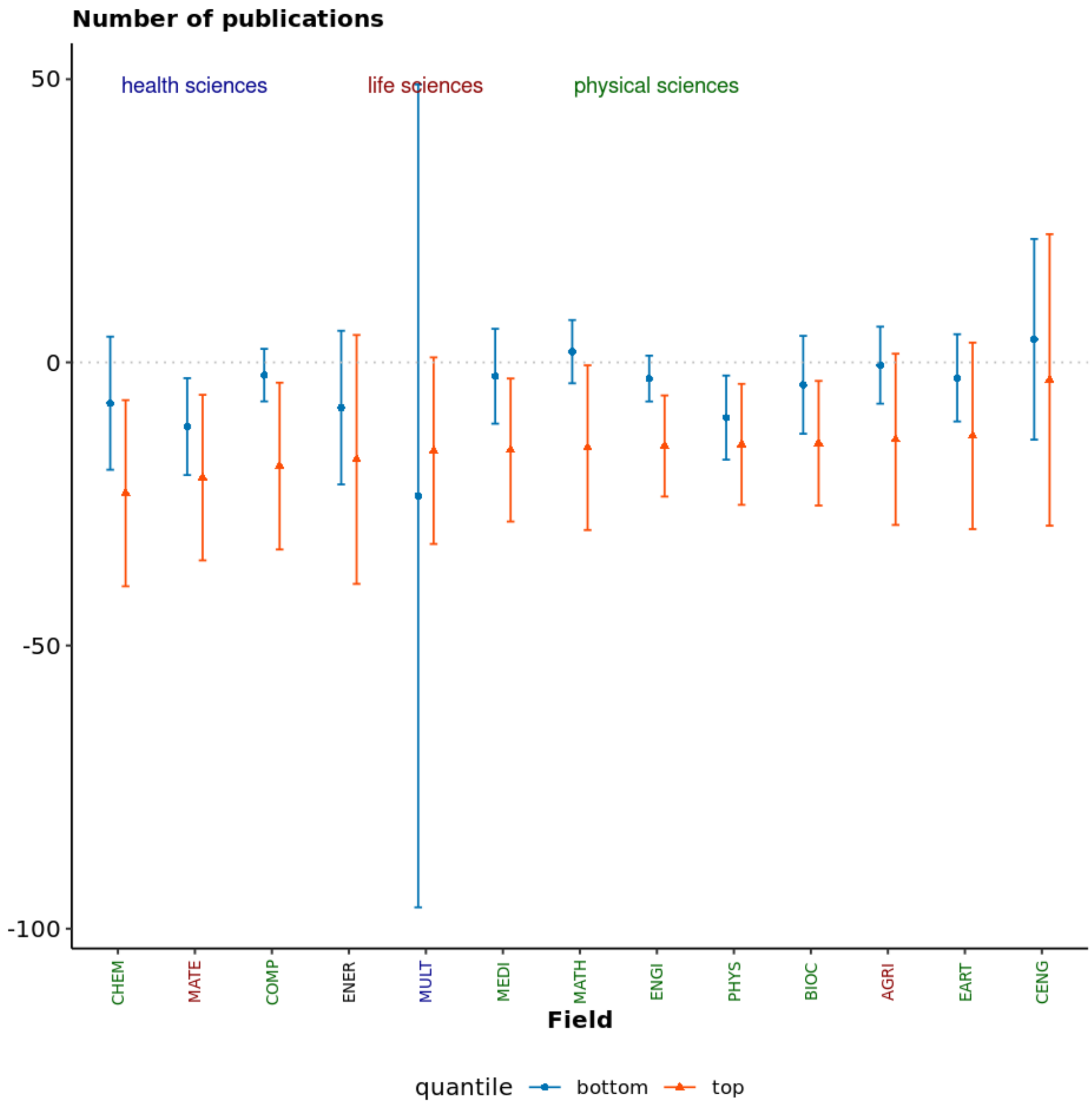
Notes: The graph above reports regression estimates for the difference in the total number of publications in the 5% most cited journals for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 25: Effect of the China Initiative by field compared to US dominance by field



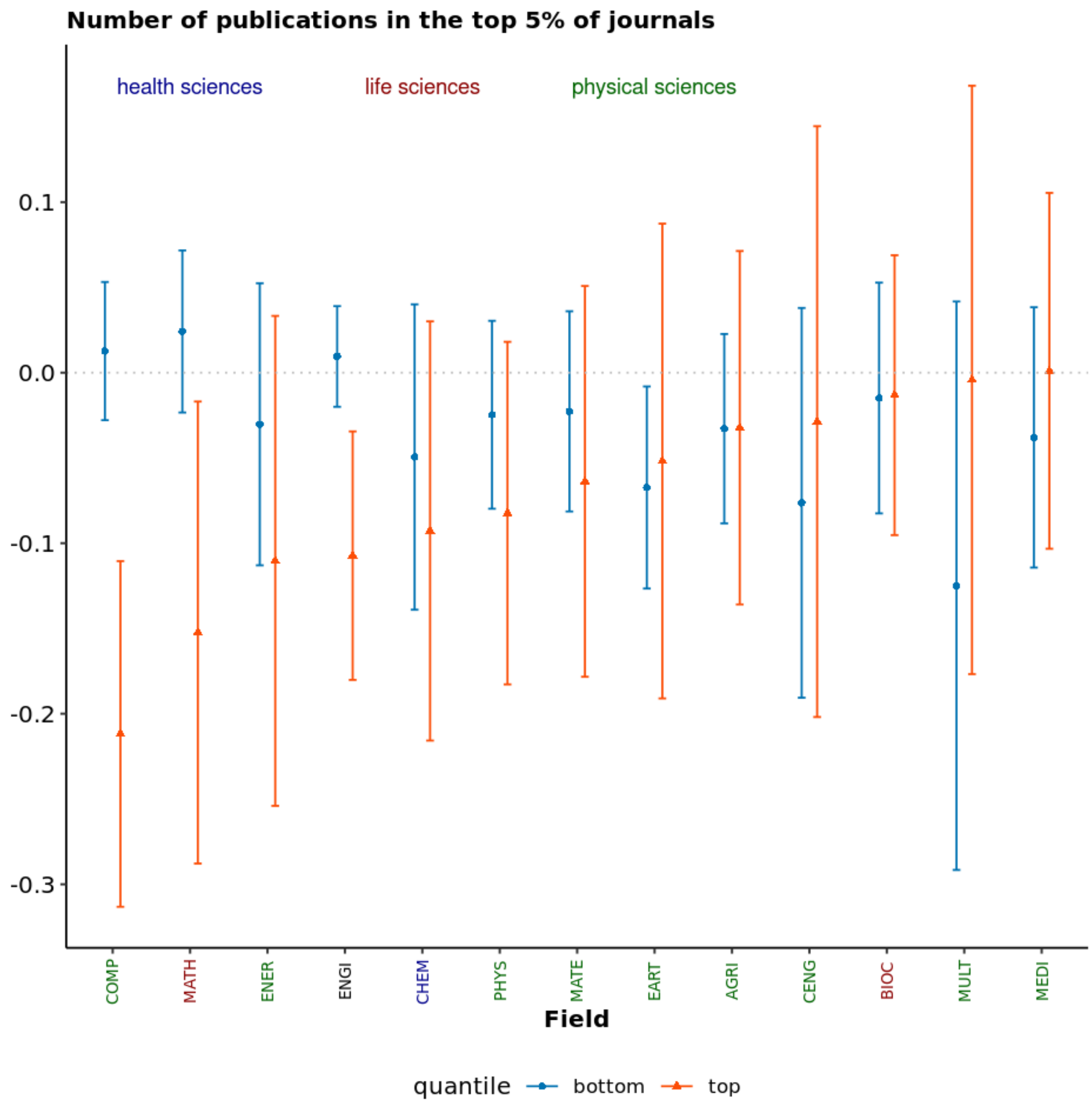
Notes: The graphs above report regression estimates both for the difference in publications (left) and publications in the 5% most cited journals (right) in 2018-2021 compared to 2013-2015 between the control and treated group inside each field (obtained with Callaway and Sant'Anna (2020) propensity scores based on publications (total and with US and European co-authors respectively for treated and control groups), total citations, and first year of publication in Scopus). These estimates are plotted against the share of all citations to publications released between 2000 and 2012 in top 5% journals in that field that accrue to papers with at least one US author.

Figure 26: Effect of the China Initiative on publications: effect by field and quantile



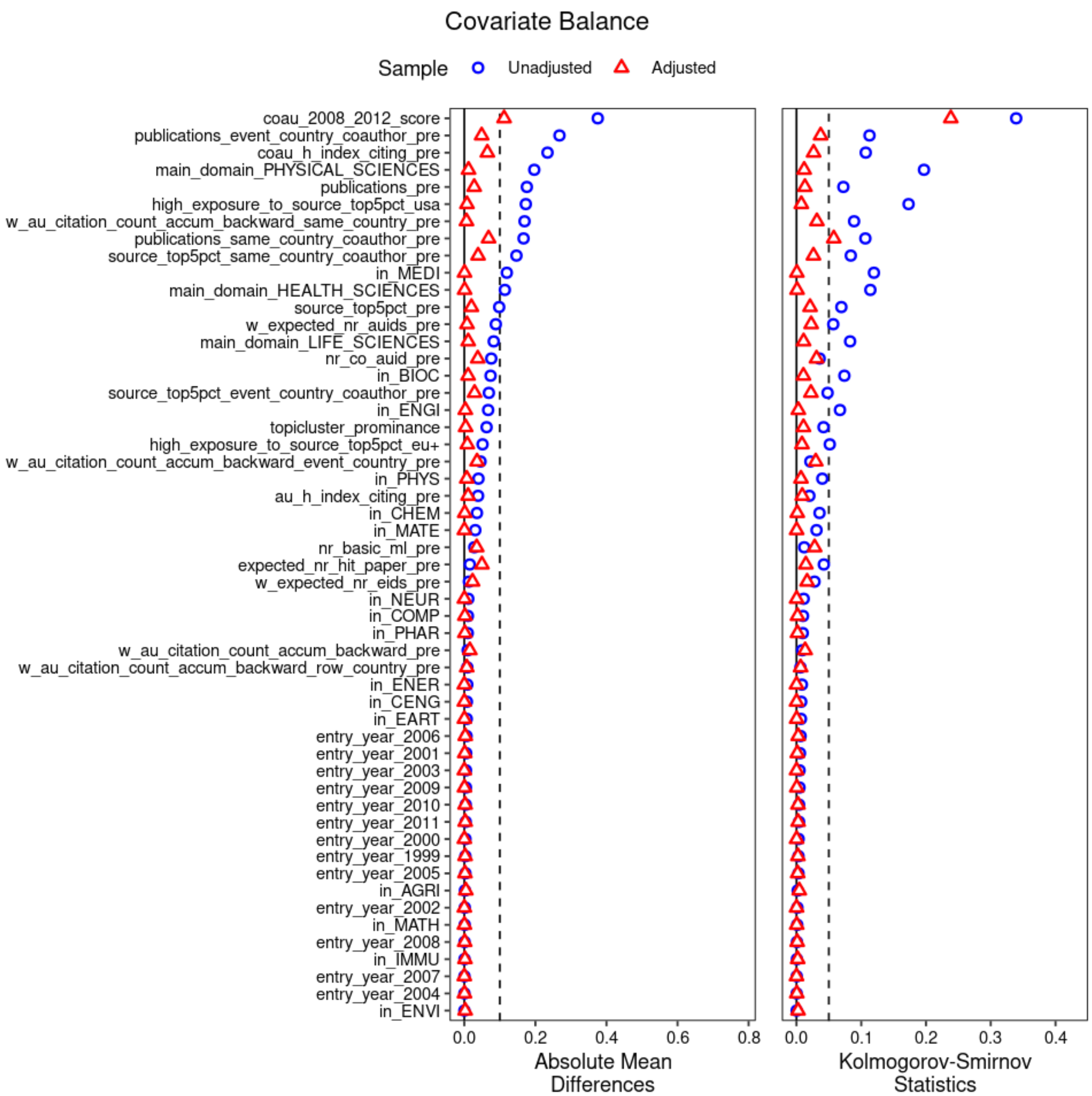
Notes: The graph above reports regression estimates for the difference in the total number of publications for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 27: Effect of the China Initiative on publications in top journals: effect by field and quantile



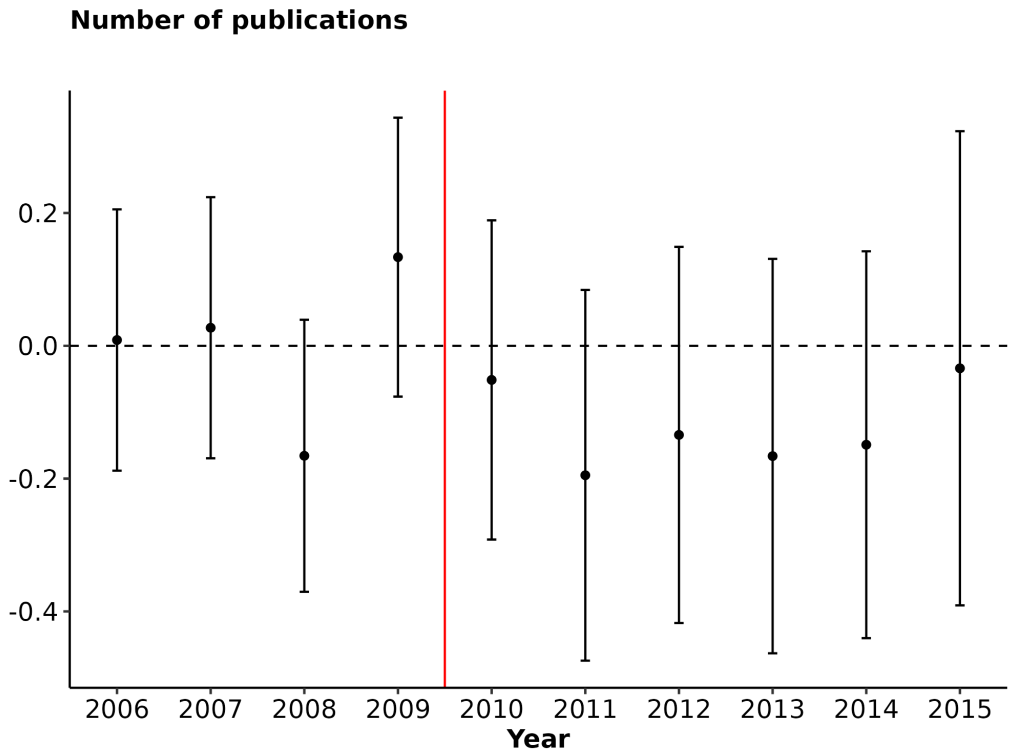
Notes: The graph above reports regression estimates for the difference in the total number of publications in the top 5% of journals for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 28: Differences based on observables between the treated and the control, after and before weighting: absolute mean differences and Kolmogorov-Smirnov statistics



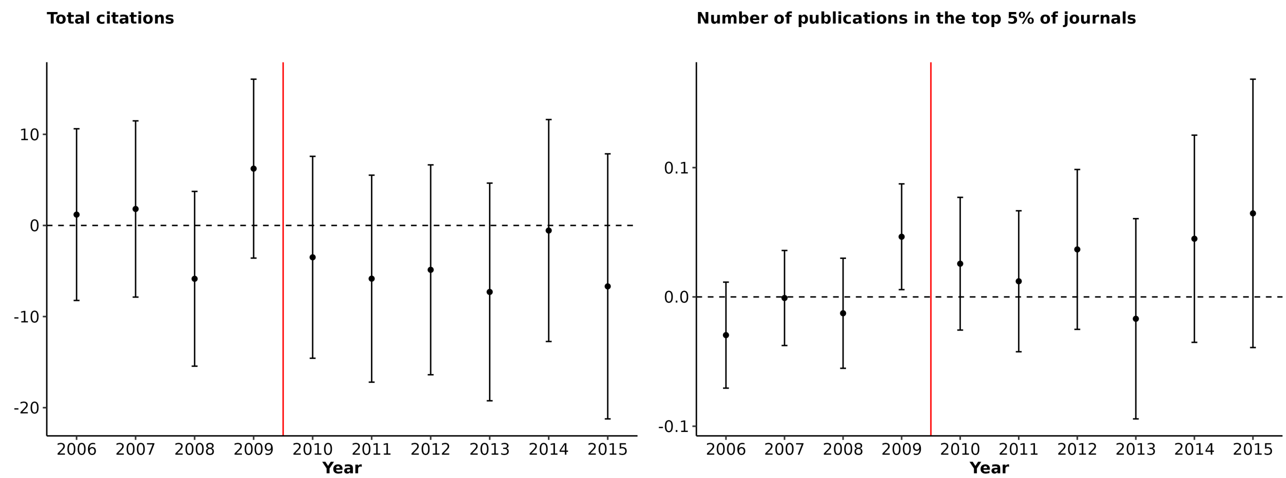
Notes: The graph above depicts absolute mean differences (left) and Kolmogorov-Smirnov statistics (right) for the differences between the unweighted sample (red) and the weighted sample (blue). The variables included are publications, publications with the US and Europe respectively for the treated and the control, and citations in the pre period (respectively *publications_pre*, *publications_same_country_pre* and *citations_pre*), as well as the interaction of seniority represented by the year of first publication on Scopus and main domain of study (variables *y_x_dom*). We can see that the weighted sample features almost no differences in the latter.

Figure 29: ATT on number of total publications for a placebo shock in 2010



Notes: The graph above reports regression estimates for the difference in number of total publications between the placebo treated and control group for each year between 2001 and 2015, for a placebo shock happening in 2010. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers.

Figure 30: ATT on total number of citations (left) and publications in top 5% of journals (right) for a placebo shock in 2010



Notes: The graph above reports regression estimates for the difference in number of total citations (left) and in number of publications in the top 5% most cited journals (right) between the placebo treated and control group for each year between 2001 and 2015, for a placebo shock happening in 2010. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received in the selection period (total and with US co-authors for the treated and European for the control), h-index of researchers and their co-authors in the selection period, first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and the Scopus metrics of prominence of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

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Appendix

A More descriptive statistics

In this section, we provide additional information on sample balance and the methodology we use to build the datasets. Table A.1 shows the distribution of authors in the sample across years of first publication in Scopus and the various scientific fields identified by Scopus. Table A.2 shows descriptive statistics for selection-period characteristics.

Table A.1: Summary Statistics - Individual level

	Control Group		Treated Group		
Variable	N	Percent	N	Percent	Test
First year of publication in Scopus:	17818		23632		X2= 27.08***
... 1999	453	3%	536	2%	
... 2000	527	3%	622	3%	
... 2001	759	4%	883	4%	
... 2002	892	5%	1151	5%	
... 2003	1073	6%	1527	6%	
... 2004	1308	7%	1752	7%	
... 2005	1606	9%	2215	9%	
... 2006	1775	10%	2206	9%	
... 2007	1781	10%	2361	10%	
... 2008	2152	12%	2845	12%	
... 2009	2185	12%	2992	13%	
... 2010	2008	11%	2737	12%	
... 2011	1299	7%	1805	8%	
Main domain of study:	17818		23632		X2= 1584.543***
... Health sciences	2442	14%	5904	25%	
... Life sciences	3022	17%	5888	25%	
... Physical sciences	12354	69%	11840	50%	

Statistical significance markers: * p<0.1; ** p<0.05; *** p<0.01

Notes: This table summarises the distribution of our sample in their main discrete individual characteristics accounting for sample attrition.

Figure A.1 complements Figure 5 and Figure 6. The trend in total publications is similar to the trend for top publications. Chinese publications still surpass US publications when removing articles co-authored with the other country as well as authors who published in the other country. However, the catch-up process takes longer, and the ratio of "no US" Chinese publications to total Chinese publications is much lower than the ratio of "no China" US publications to total

Table A.2: Summary Statistics - Individual level - Controls

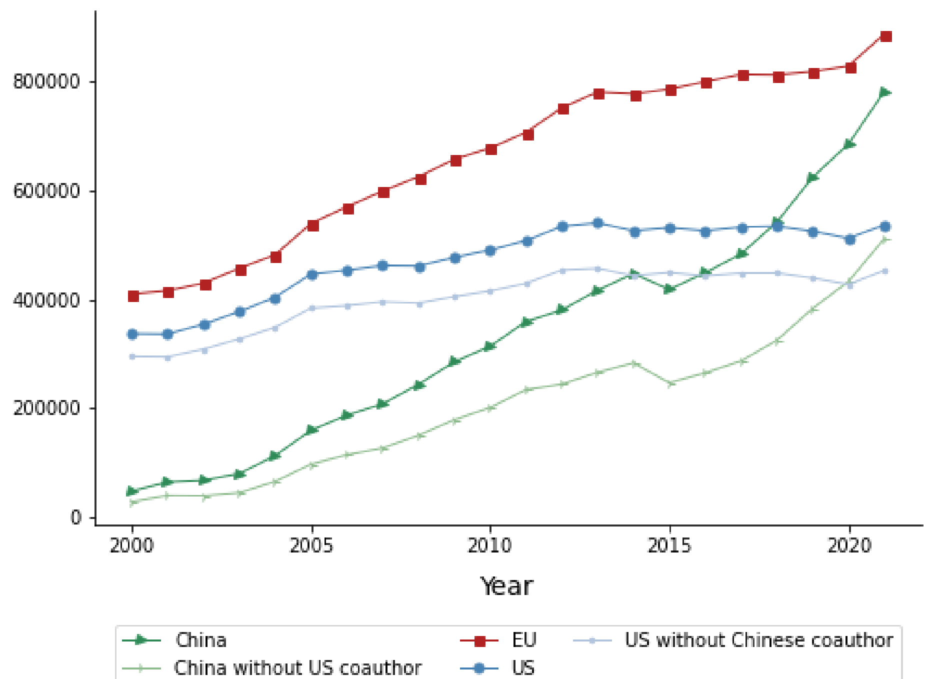
	Control Group			Treated Group			
Variable	N	Mean	SD	N	Mean	SD	Test
Publications (2008-2012)	17818	12	10	23632	10	9.1	F= 266.527***
Total citations (2008-2012)	17818	242	357	23632	257	360	F= 16.375***
Share of publications in top 5% cited journals (2008-2012)	17818	0.5	1.6	23632	0.76	2.1	F= 200.536***

Statistical significance markers: * p<0.1; ** p<0.05; *** p<0.01

Notes: This table summarises the values of the main controls used for pre-period characteristics in the regressions.

publications.

Figure A.1: Number of total publications by country group/region of affiliation and by type of collaborations



Notes: This figure shows evidence of the Chinese catch-up in the total number of publication. The curve labelled with the mention *no US co-author* (*resp.* *no Chinese co-author*) accounts for publications without any US-affiliated (*resp.* China-affiliated) author or an author who have ever been affiliated to the United-States (*resp.* China).

B Discussion of our variables

B.1 Number of publications

Research projects, especially those that are most impactful, can take years before completion. Thus, one may reasonably wonder how a recent shock like the China Initiative shock could have an have an impact on the quality and direction of Chinese research which one could already detect. However, the following considerations help address this timing concern. First, the China Initiative is likely to have interrupted research projects with US coauthors that were close to completion, thereby affecting the volume and quality of Chinese publications[21].Second, the vast majority of Chinese authors in our sample, produce at least one publication per year on average.

Table B.1 provides statistics on the research productivity of Chinese authors in our sample. On average, the time an author takes before publishing again after a year in which she has published, amounts to 1.3 years, with a median of 1 year. These metrics get closer to 2 when looking at publications by Chinese researchers with a US co-author for the treated group, and publications by Chinese researchers with a European co-author for the control group, and also when looking at publications by the two groups in the top 1% cited papers or top 5% of journals. Overall, the frequency of publications by Chinese researchers is sufficiently high that the China Initiative shock could have an impact after only one year. This observed frequency of publications is consistent with the view that researchers in our sample have many ongoing projects at the same time. Each project may take more than one year to be completed, yet it is quite believable that the China Initiative shock did affect the flow of (high-quality) publications with US coauthors.

We also show that treated Chinese authors have fewer new and short-term coauthors from the US compared to control Chinese authors and their European coauthors following the shock, and furthermore they are more likely to publish with a long-term US coauthor in the years right before the shock. This in turn might be explained by the fact that treated Chinese researchers anticipated the shock and therefore decided to give priority to completing their long-term projects with their existing US coauthors, at the expense of projects with more recent co-authors. Due to the China Initiative, they are also unable to find new co-authors of the same quality outside of the US, which explains why coauthor quality remains low instead of reverting to the pre-shock level.

Finally, note that peer review times widely differ across disciplines and can be quite short in

[21] In Aghion et al. (2019) we show that more earmarks to US states from the Senate's Appropriation committee, has a positive effect of university patents after only one year, presumably for the same reason: the resulting additional funding to research and development, helps complete innovative projects already started.

Table B.1: Descriptive statistics - Average years between two years of publication, per author in the sample - 1999-2017

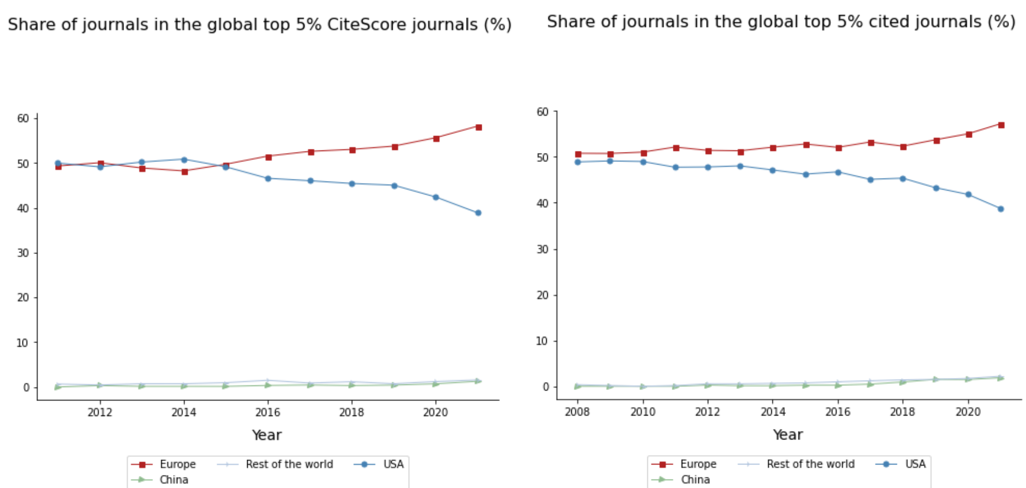
Statistic	Min	Median	Mean	St. Dev.	Max
Average time between publications	1.000	1.200	1.332	0.446	9.000
Average time between publications with same country coauthor	1.000	1.571	2.030	1.328	12.000
Average time between publications with Chinese coauthor	1.000	1.214	1.373	0.517	12.000
Average time between publications in top 5% papers	1.000	2.000	2.387	1.785	17.000
Average time between top 1% cited publications	1.000	2.000	2.559	1.954	15.000

some fields. Thus, surveying 3500 scientists of different fields, Huisman and Smits (2017) find that the average review duration for accepted papers across all fields is 17 weeks, ranging from a minimum of 12 weeks in medicine to a maximum of 25 weeks in economics and business. Excluding social sciences, the average duration is of 22 weeks and aside from Psychology, around 80% of all papers are published within six months after submission.

B.2 Home journals

To the extent that the vast majority of journals in the top 5% of the distribution of citations per paper in the database for a given year and field, are published in the US, one could argue that the observed effects of the China Initiative shock on treated Chinese researchers, are mechanical.

Figure B.1: Share of all journals in the top 5% of journals by publication region (%)



Notes: The graph above represents the share of all sources of publications per region of publication that are in the top 5% of the distribution of citations received over a rolling window of 4 years, within their academic field.

However, according to CiteScore, as shown in the left-hand panel of Figure B.1, US-based journals are only dominant during the first third of the period of analysis. European publications account for more than half of all top 5% sources, and become dominant after 2015. Our metrics perform the transformation at a higher level (field rather than ASJC code) than CiteScore. The trend that we find is similar to CiteScore in terms of country of publication of journals, as shown in the right-hand panel of Figure B.1. European journals are more numerous even at the start of the period. US journals' share in top journals decreases faster in our metrics than in CiteScore. If we expect treated researchers to keep seeking publication in top ranked sources, then these researchers would choose to submit to European journals.

B.3 Citation analysis

Dealing with frequent issues in measuring citations: Figure 10 shows that the raw number of citations per year decreases for the treated authors in comparison to the control authors. However, this estimate could be biased due to the shape of the distribution of citations received over time per paper. Because the number of citations accumulated over time typically increases non-linearly, the difference in citations for papers of different qualities increases over time. Unfortunately, controlling for the year does not allow us to take this non-linear shape into account as we are estimating the effect of the China Initiative parametrically as a constant per year. As a consequence, there could be a bias in the estimated effect.

For instance, let us compare a treated author and a control author. Before the shock, the two publish papers of the same quality. After the shock, the control author publishes a paper of the same quality and the treated author publishes a paper of a lower quality. If we compare the citations received by the new papers of two authors early after the shock, we will observe a *smaller* difference compared to the situation in which we would observe citations received for the same papers later in time. In other words, the difference in citations between the two papers increases over time. If it is measured later, for the same quality and the same shock, the observed effect is larger. Given that over the years, we see less and less of the actual distribution of citations for papers of the treated and the control, we could expect to underestimate the shock in absolute value as we move further away from 2018.

This issue is addressed by different strands of literature. Hall et al. (2001) and Hall et al. (2005) provide explanations about this truncation issue in the context of patents. Addressing this skewness in the distribution of citations received over time[22] is not only standard in economics but

[22] Redner (1998) approximates the tail of the distribution with a power law, Lehmann et al. (2003) find that either a power-law or stretched exponential fit the data, Vieira and Gomes (2010) find that a double exponential-Poisson law fits best the empirical distribution.

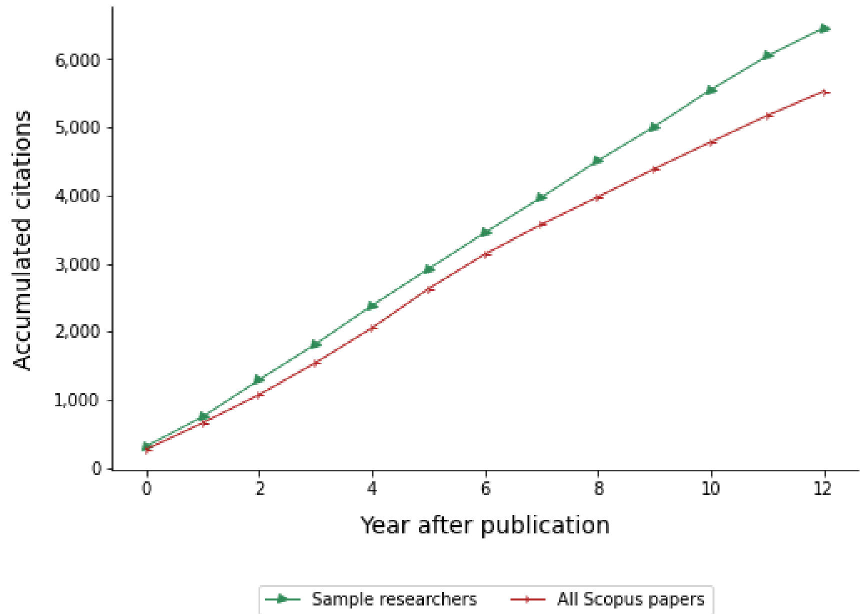


Figure B.2: Average citations received per year after citation for articles published between 2000 and 2010

Notes: The graph above reports the number of citations received for papers published between 2000 and 2010, respectively for all papers in Scopus and papers published by authors of the sample. Our calculation includes zeros for years in which a paper has received no citations.

also in scientometrics[23].

Figure B.2 shows that at the paper-level, the linear approximation is not unrealistic for citations received in the first 10 years upon publication of the paper for papers published between 2000 and 2010. However, our authors receive more citations on average than the majority of Scopus authors. We can see that after 6 years, the difference between these better-cited authors and the majority starts to increase. Therefore, the aforementioned bias could be at play in our regressions. In accordance to the literature, and in order to remove this bias, we perform several transformations to our measure of citations which we summarize in table Table B.2.

The first transformation that we apply is truncation. We only consider citations received during a given period. This will eliminate part of the bias, even though recent papers' citations record will be "more truncated" than the rest (for instance, we will only observe citations in 2021 and 2022 for a paper published in 2021, while we will observe citations from 2017 to 2022 for a 2017 paper). However, this counteracts a part of the bias. We select citations received within 10, 5 and 1 year(s) of publication. The only one that yields no significant negative result (of a magnitude of around

[23] Hassan et al. (2017) use the hit rate of papers, Kaur et al. (2013) cite a variety of field/year normalizations.

Table B.2: ATT on different metrics of citations

	citation_count		citations_10yf	citations_5yf	citations_1yf	citation_count_norm		citation_count_ratio_to_mean
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ATT	-5.269***	-7.207***	-1.113***	-0.753***	-0.052	-0.128***	-0.203***	-0.294***
	(1.174)	(1.393)	(0.271)	(0.217)	(0.056)	(0.048)	(0.065)	(0.097)
Mean.Dep.Var.Pre	98.809	98.809	24.764	18.867	3.484	1.010	1.010	6.359
Pvalue.PreTrend	0.063	0.092	0.014	0.135	0.007	0.419	0.311	0.672
N.authors	39799	39799	39230	39230	39230	39799	39799	39799
N.obs	255653	255653	243776	243776	243776	255653	255653	255653
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing		Yes					Yes	

Notes : Results are from DRDID regression, for each outcome relating to any type of coauthor or only US coauthors for the treated and European coauthors for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the total number of citations ((1)-(2)), citations received within 10, 5 and 1 years after publication ((3)-(5)), citations demeaned and divided by the standard error of the distribution of citations to publications from the same year ((6)-(7)) and citations divided by the average number of citations to papers published the same year ((8)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

4% of the average value in the pre-shock period) is the 1 year metrics. We surmise that this is due to noise and to the monthly timing of publication (a paper will not receive the same amount of citations if it was published in January or December of the same year).

The second type of transformation we apply to the metrics is normalizations at the level of all papers (not only those of sample authors) for a given year. We consider two normalizations: subtracting the mean and dividing the difference by the standard error of the yearly distribution, or simply dividing by the mean. Both devices allow us to compare how papers rank within their publication cohort, which in turn helps us deal with the truncation issue. Both results are also in line with the results on unprocessed citations in terms of sign. The result for the first normalization has a far larger magnitude. This could be due to the underestimation issue mentioned above.

The local component of citations: Citations are associated with research published by researchers who are affiliated in institutions with an address. There is therefore a local component to citations. There are two possible concerns for the integrity of this metrics in measuring quality, in light of the main findings of Qiu et al. (2022). First, they show that Chinese papers are under-cited in the US and that the probable explanation is a lack of ability to spread the information about their research through a research network. Therefore, the decline in collaboration with the US could lead to a mechanical decrease in citations, the more so because the US is a unified country with a single language, whereas the research network in Europe is probably less connected. This would further render difficult replacing US citations by European citations. Secondly, Chinese research

Table B.3: ATT on citations by region of affiliation of authors of the citing papers

	citations	citations w/o China	citations (China)	citations (US)	citations (Europe)	citations (RoW)
	(1)	(2)	(3)	(4)	(5)	(6)
ATT	-5.269***	-2.496***	-5.511***	-2.298***	-0.020	-2.356***
	(1.161)	(0.609)	(1.523)	(0.279)	(0.404)	(0.647)
Mean.Dep.Var.Pre	98.809	44.536	119.885	18.483	26.296	50.992
Pvalue.PreTrend	0.063	0.007	0.714	0.000	0.997	0.102
N.authors	39799	39799	39799	39799	39799	39799
N.obs	255653	255653	255653	255653	255653	255653
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing	Yes	Yes	Yes	Yes	Yes	Yes

Notes : Results are from DRDID regression, for each outcome relating to any type of coauthor. The unit of observation is author by year and the sample period is from 2013-2021. The ouctome variable is the total number of citations received from this region, for respectively the whole world (1), the whole world excluding China (2), China (3), the US (4), Europe (5), and the rest of the world (6). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

has the largest home bias of all the countries they analyse. Indeed, the authors prove that the share of home citations by Chinese researchers largely surpasses the real weight of Chinese research in Chemistry. Therefore, a drop in US citations of Chinese research after the China Initiative could be compensated by Chinese home citations. This home bias could come into play to lower the expected effect on citations of the China Initiative.

In order to address these concerns, we computed estimates of the effect of the China Initiative on citations, splitting them by affiliation country of authors of the citing paper. Table B.3 shows that the citations are decreasing for all regions aside from Europe. In order to subtract the home bias from the estimate, we use citations from all countries but China. These citations decline by 2.5, about 5% of the mean. The pre-trend from this regression is however very significant. When we focus on citations from the USA, we find a very strong effect of -12%. This figure probably captures — at least partly — the mechanical decrease stemming from the mechanism described by Qiu et al. (2022). Due to the high pre-trend for this metrics, it is hard to quantify how much. Nevertheless, the decline also appears in China in spite of the home bias and in the rest of the world, in which we do not expect preferential treatment. These effects represent around 4% of the mean per year on average, about the same as the effect on total citations. Furthermore, the pre-trend completely disappears. This implies that the decrease that we observe in citations does not only reflect the decrease in awareness of Chinese research in the US but also a decrease in quality or, at least, in influence of research by treated authors, in China and the rest of the world.

Table B.4: ATT on probability of writing in topics highly funded by type of funder

		w. " same country" co-authors	w. Chinese co-authors		w. " same country" co-authors	w. Chinese co-authors		w. " same country" co-authors	w. Chinese co-authors		w. " same country" co-authors	w. Chinese co-authors
	Sensitive US funder			US military			Chinese government			US funder		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ATT	0.005	-0.004	0.006	0.010***	-0.004	0.012***	-0.004	-0.013*	-0.003	-0.007	0.008	-0.004
	(0.004)	(0.007)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)	(0.007)	(0.005)	(0.006)	(0.011)	(0.006)
Mean.Dep.Var.Pre	0.245	0.132	0.239	0.224	0.111	0.218	0.288	0.135	0.284	0.272	0.162	0.265
Pvalue.PreTrend	0.295	0.393	0.294	0.768	0.865	0.485	0.707	0.694	0.645	0.933	0.152	0.881
N.authors	39799	26414	39577	39799	26414	39577	39799	26414	39577	39799	26414	39577
N.obs	255653	90846	249952	255653	90846	249952	255653	90846	249952	255653	90846	249952
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes : Results are from DRDID regression, for each outcome relating to publications with any type of coauthor or only US coauthors for the treated and European coauthors for the control, or only Chinese coauthors. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the probability of publishing a paper in a topic with papers often funded by sensitive US funders such as nuclear power, etc. (columns (1)-(3)), in a topic in the top 50% funded by the US military (columns (4)-(6)), in a topic highly funded by China (columns (7)-(9)), or the US (columns (10)-(12)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p$¡$0.01, ** p$¡$0.05, * p$¡$0.1.

B.4 US-funded topics

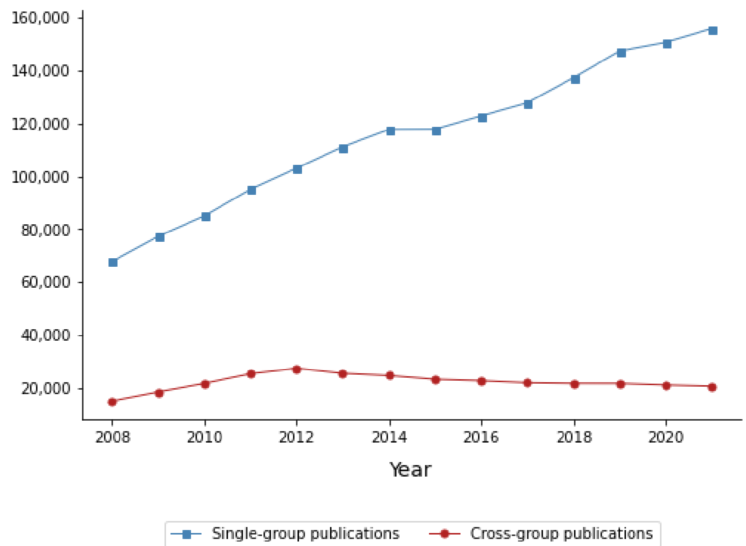
In this section, we report the heterogeneous effect of the China Initiative according to the funding associated to topics of research. Table B.4 reports the probability of publishing on a given topic depending on characteristics of its funders. We observe there is no increase or decrease on the probability of publishing in topics that are more funded by the US, the NIH or by Chinese agencies (except for the latter with a US co-author). There is also no effect on the probability of publishing in a topic funded by US agencies that are deemed as "sensitive", such as energy or military. However, treated researchers have an increased probability of publishing, especially with other Chinese coauthors, on topics which are more funded by the US military after the shock.

A possible interpretation would be that the topics that were of interest to the US military during the selection period are still of national interest to China. In this case, treated authors may have a national incentive to research such topics with other Chinese co-authors, as they can no longer research these topics with the US, the more so as Chinese research is partly steered by central planning.

C Cross-group spillovers and co-author-stealing: researching the impact of the China Initiative on the control group

A consequence of the China Initiative could be that authors in our sample reallocate away from US co-authors and towards each other, given that they are comparable authors working with international researchers. This would not be detected by our strategy because any increase in co-authorship with Chinese co-authors from one group would be mirrored on the other side. However, Figure C.1 shows that while the number of papers published separately by authors of both groups is rising, this is not the case for papers authored by at least one author from each group. This category of papers is on a slow decline after the selection period, the trend of which does not seem to be changed by the China Initiative.

Figure C.1: Single- and cross-group publications between 2008 and 2021



Notes: The graph above report represents the share of publications by researchers of the sample that are co-authored respectively by at least one co-author of each group (blue) and by no authors of the same group (red).

Furthermore, we find no evidence that authors of the treated group are stealing existing co-authors of the control group. Selecting US co-authors of the treated and European co-authors of the control during the pre-selection period[24], we compute how many of them carry one writing only with treated authors, only with control authors and with both. Figure C.2 shows the evolution of the number of co-authors in each category. If treated authors were co-authoring more with long-term co-authors of the control, we would observe a trend break at the moment of the China Initiative in the "Both" and the "Control-only co-author" lines; this does not appear to be the case.

D Reallocation away from the US, but where to?

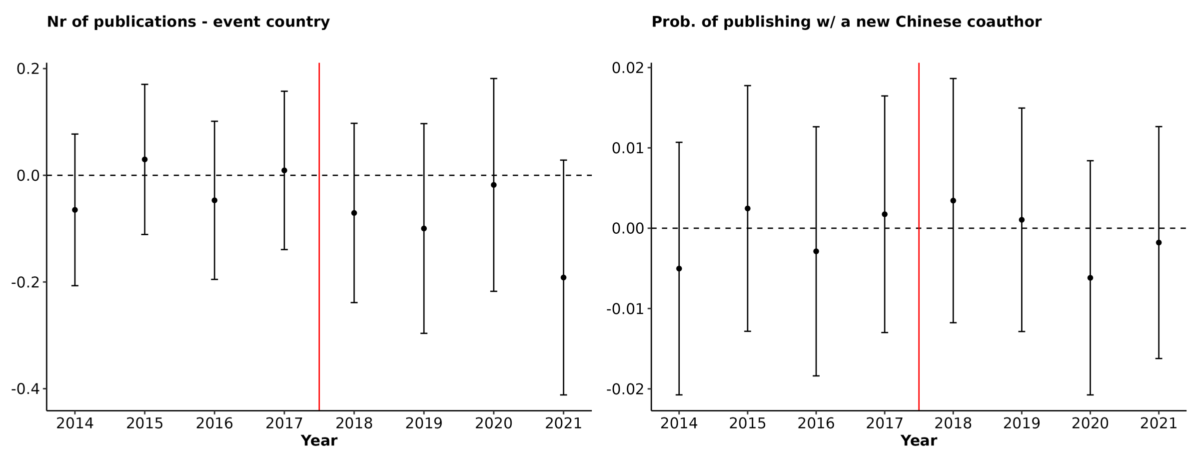
Although we show that treated authors publish less with US coauthors following the China Initiative shock than control Chinese authors publish with European coauthors, we cannot directly show that treated authors publish more with European researchers than they did before the shock. Moreover, control Chinese authors are also hindered in their ability to collaborate with US researchers following

[24]Due to attrition of the sample of co-authors, if we condition on being a co-author before 2018, the change in trend that we want to check for is going to be partly absorbed by a mechanical drop in the number of co-authors.

the shock, which introduces is a bias in the comparison in of reallocation from US to European co-authorship between treated and control Chinese researchers.

However, publications of Chinese researchers with coauthors from countries or regions outside the US and Europe are not subject to this bias. Figure D.1 shows evidence that there is no reallocation towards Chinese co-authors, be it in number of publications or in the probability of adding a new Chinese co-author. Moreover, Figure D.2 shows that there is a significant negative effect of the China Initiative shock on the reallocation towards the rest of the world.

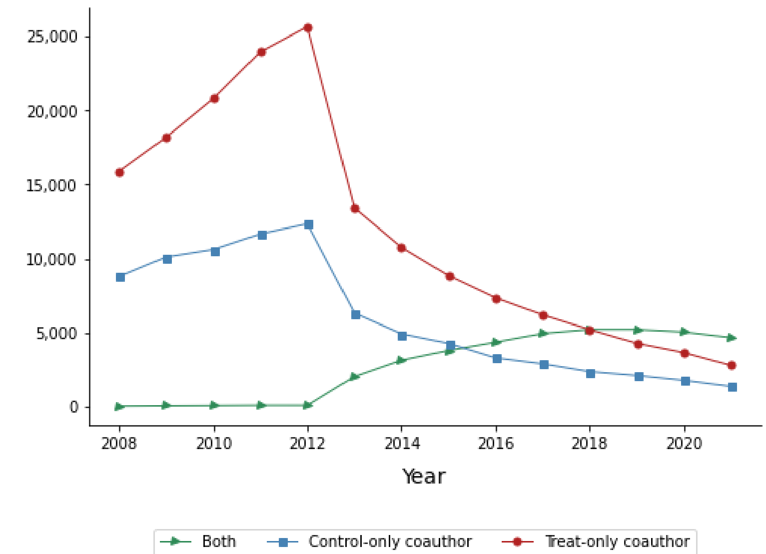
Figure D.1: Effect on reallocation to Chinese co-authors: number of publications and having a new Chinese co-author



Notes: The graphs above report regression estimates both for the difference in the number of publications with a Chinese co-author (left) and in the probability of publishing with a new Chinese co-author (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the number of publications.

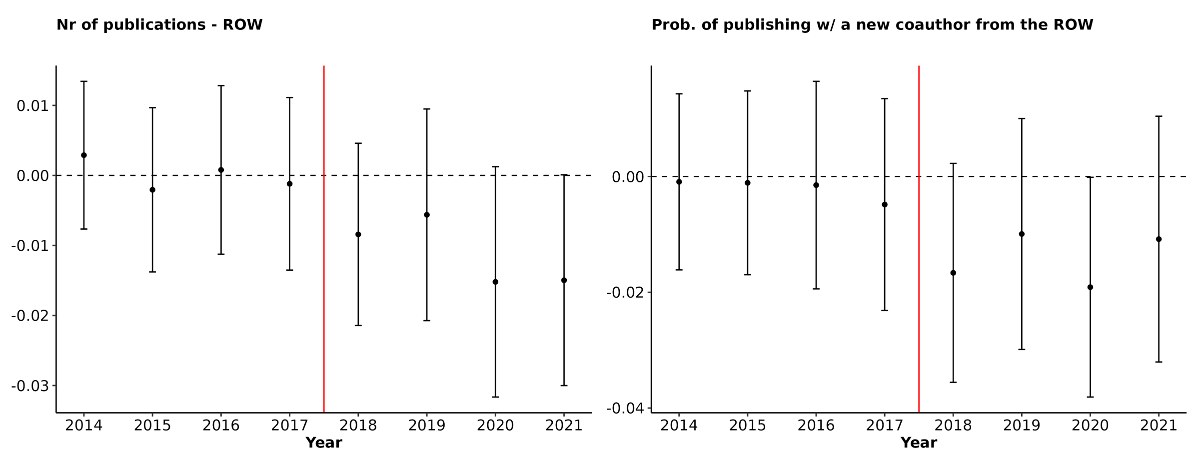
This, together with our findings in Section 4.2, these results tell us the following: first, that reallocation does not go towards China, which reinforces our conclusion that top Chinese research remains dependent on international collaboration with regions at the frontier rather than becoming self-reliant. Second, we can rule out reallocation towards regions that are not the US or Europe. Indeed, Figure D.2 shows whether that treated Chinese authors do not alter their coauthorships with the rest of the world but that control authors increase their collaborations with the rest of the world; or that both, treated and control Chinese authors, although not at the same pace (or only the treated), are moving away from co-authors in the rest of the world to compensate for the loss

Figure C.2: Number of US and European coauthors from the selection period, who continue to collaborate with treated/control/both groups



Notes: The graph represents the number of active US and European co-authors of the sample during the selection period (2008-2012) each year by each of the following categories: has only published with treated authors (red), has only published with control authors (blue), has published with both (green).

Figure D.2: Effect on reallocation to ROW co-authors: number of publications and having a new ROW co-author



Notes: The graphs above report regression estimates both for the difference in the number of publications with a co-author from the rest of the world(left) and in the probability of publishing with a new co-author from the rest of the world(right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the number of publications.

Table D.1: ATT on publications and top publications by place of affiliation of coauthor

	with coau from China	with coau from ROW	with coau from China	with coau from ROW
	publications	publications	nr_source_top5pct	nr_source_top5pct
	(1)	(2)	(3)	(4)
ATT	-0.095	-0.011**	-0.006	-0.001*
	(0.060)	(0.005)	(0.014)	(0.001)
Mean.Dep.Var.Pre	5.067	0.146	0.389	0.030
Pvalue.PreTrend	0.678	0.966	0.033	0.921
N.authors	39858	39858	39799	39799
N.obs	358722	358722	255653	255653
Controls	Yes	Yes	Yes	Yes
Cond. on publishing	No	No	No	No

Notes : Results are from DRDID regression, for each outcome relating to any type of coauthor or only US coauthors for the treated and European coauthors for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variables are respectively the number of publications with Chinese coauthors (1), with coauthors from the rest of the world, i.e. not the US, Europe or China (2), and publications in top 5% cited journals with Chinese coauthors (3) and rest of the world coauthors (4). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

of quality. Although by construction this is not a hypothesis that we can test, both of explanations are consistent with a reallocation of treated Chinese authors towards European coauthors.

Note that this reallocation does not compensate for the loss in quality due to the loss of US co-authors. Indeed, the overall estimate for publications in top 5% cited journals is negative. Table D.1 reports the estimate for the ATT on such publications with co-authors from China and the rest of the world. The estimates are negative, and the effect is significant for the rest of the world.

Table E.1: ATT for main outcomes - Alternative sample (simple selection)

				with coau from same country			with coau from same country	
	publications	citation_count	nr_source_top5pct	publications	nr_source_top5pct	any_coau_new		avg_coau_h_index_citing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ATT	-0.053	-3.741***	-0.036***	-0.015**	-0.004**	0.004	-0.014***	-0.386**
	(0.032)	(1.035)	(0.011)	(0.006)	(0.002)	(0.003)	(0.005)	(0.175)
Mean.Dep.Var.Pre	3.007	91.136	0.237	0.358	0.072	0.945	0.214	14.928
Pvalue.PreTrend	0.112	0.209	0.045	0.095	0.002	0.043	0.246	0.161
N.authors	47242	47186	47186	47242	47186	47186	47186	39623
N.obs	425178	300196	300196	425178	300196	300196	300196	251553
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing								Yes

Notes : Results are from DRDID regression, for each outcome relating to any type of coauthor or only US coauthors for the treated and European coauthors for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the total number of publications (1), citations (2), publications in top 5% journals (3), publications (4) and publications in top 5% journals (5) with US coauthors for the treated and European coauthors for the controls, probability of publishing with a new coauthor (6) and with a new US coauthor for the treated and new European coauthor for the control (7), and average H-index of coauthors (8). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.

E Discussion and Robustness

E.1 ATT in alternative sample

Table E.1 reproduces our estimations on a sample which no longer uses our Cindex measure to select the treated and control groups. We start from the same population of Chinese researchers as before. We consider as treated authors the ones who have published with a US coauthor at least once during the selection period and never with a European co-author during the selection period. Conversely, control authors have published at least once with a European co-author and never with a US co-author during the selection period. This allows us to keep more lower-quality authors who are also less dependent on the US or Europe and therefore less affected by the China Initiative. However, most of our results hold. In particular, the drop in the quality of publications of treated authors compared to control authors remains. Treated Chinese authors also publish fewer papers both overall and in top journals with US co-authors compared to what control Chinese authors publish with European co-authors.

E.2 Alternative variables

Here, we extend our event study analysis to using alternative specifications of the number of publications in top 5% journals, namely using the CiteScore metrics instead of our own in Figure E.1 and using a threshold of 10% rather than 5% in Figure E.2.

We also show that using a seniority-adjusted H-Index (dividing the value by seniority in Scopus) for co-authors to avoid lifecycle effects on their H-Index as provided in Figure E.3 does not change our result. Figure E.4 further shows that the effect on the H-index does not come from the reallocation to less senior co-authors as there is no aggregate effect of the China Initiative on seniority of co-authors.

Table E.2 summarises the ATT for these variables on average over the period.

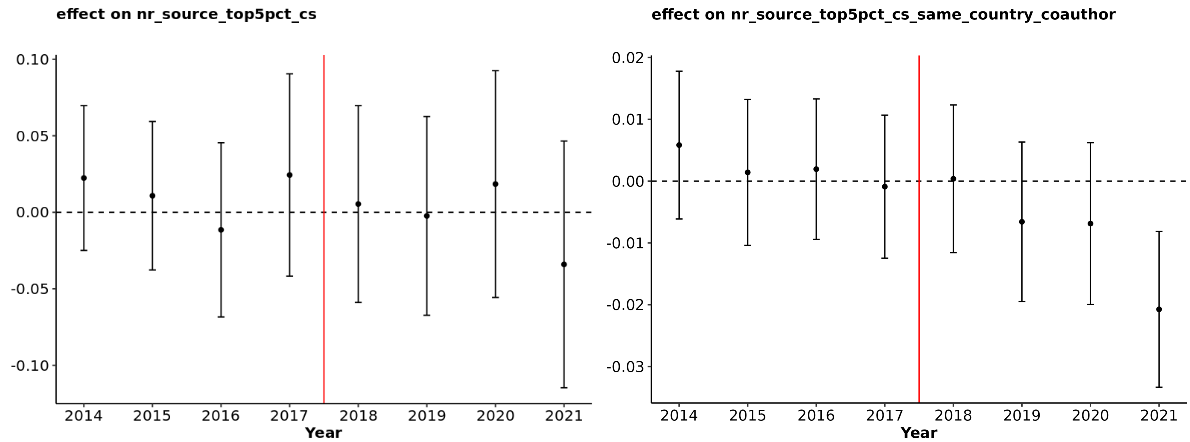


Figure E.1: Effect on publishing in the top 5% of journals based on CiteScore: global and treated with US compared to control with Europe

Notes: The graphs above report regression estimates both for the difference in the number of publications in top 5% journals according to CiteScore (left) and in the number of publications in top 5% journals according to CiteScore with a US co-author for the treated and a European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

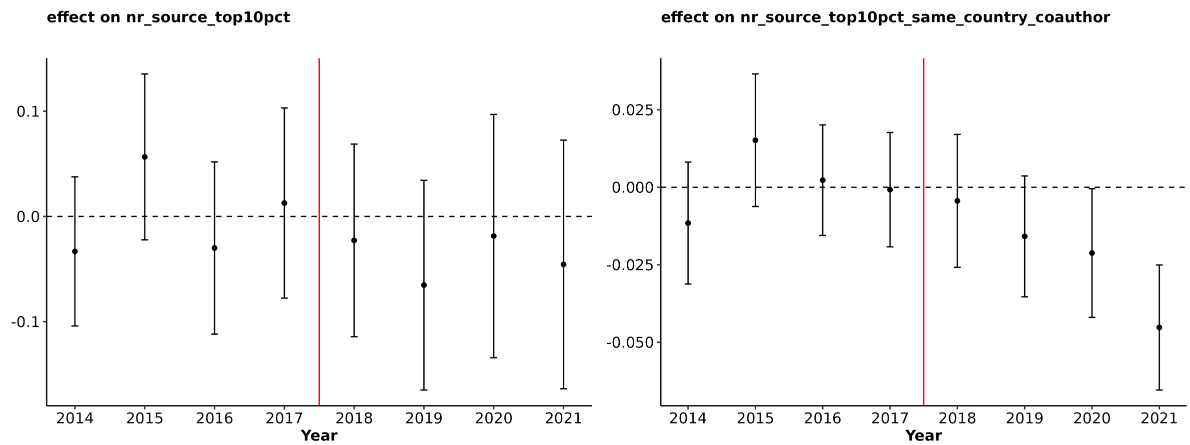


Figure E.2: Effect on publishing in the top 10% of journals: global and treated with US compared to control with Europe

Notes: The graphs above report regression estimates both for the difference in the number of publications in top 10% journals (left) and in the number of publications in top 10% journals with a US co-author for the treated and a European co-author for the control (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publication on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Table E.2: ATT for alternative outcome variables

		with coau from same country		with coau from same country		with coau from same country
	nr_source_top5pct_cs		nr_source_top10pct		avg_coau_h_index_citing_agenorm	
	(1)	(2)	(3)	(4)	(5)	(6)
ATT	-0.003	-0.003	-0.008**	-0.038	-0.010*	-0.021***
	(0.021)	(0.021)	(0.004)	(0.031)	(0.005)	(0.007)
Mean.Dep.Var.Pre	0.708	0.708	0.119	0.201	1.055	
Pvalue.PreTrend	0.422	0.422	0.442	0.247	0.788	0.295
N.authors	39799	39799	39799	39799	39799	39623
N.obs	255653	255653	255653	255653	255653	255653
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing		Yes			Yes	Yes

Note:results are from DRDID regression, for each outcome for the whole sample and conditioning on having published during the year of observation with a US coauthor for the treated and European coauthor for the control. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the number of publications on top 5 % journals according to citescore, (columns (1)-(2)), number of publications on top 10 % journals (columns (3)-(4)), and age-normalized H index of coauthors ((5)-(6)). Control variables account for author's publication characteristics overall and by category of coauthor during 2008-2012, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p$¡$0.01, ** p$¡$0.05, * p$¡$0.1.

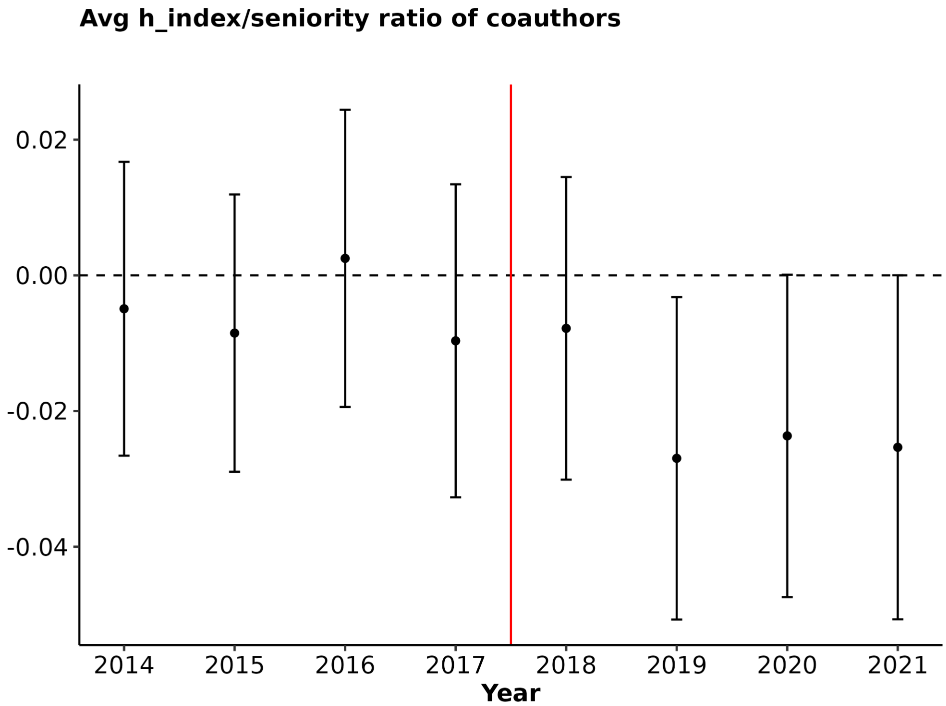


Figure E.3: Effect on H index of co-authors normalized by seniority

Notes: The graph above reports regression estimates for the difference in average H-Index of co-authors divided by their years of activity as registered in Scopus between the treated and control group for each year between 2013 and 2021, based on information available at the year this measure is calculated. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publica tion on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers.

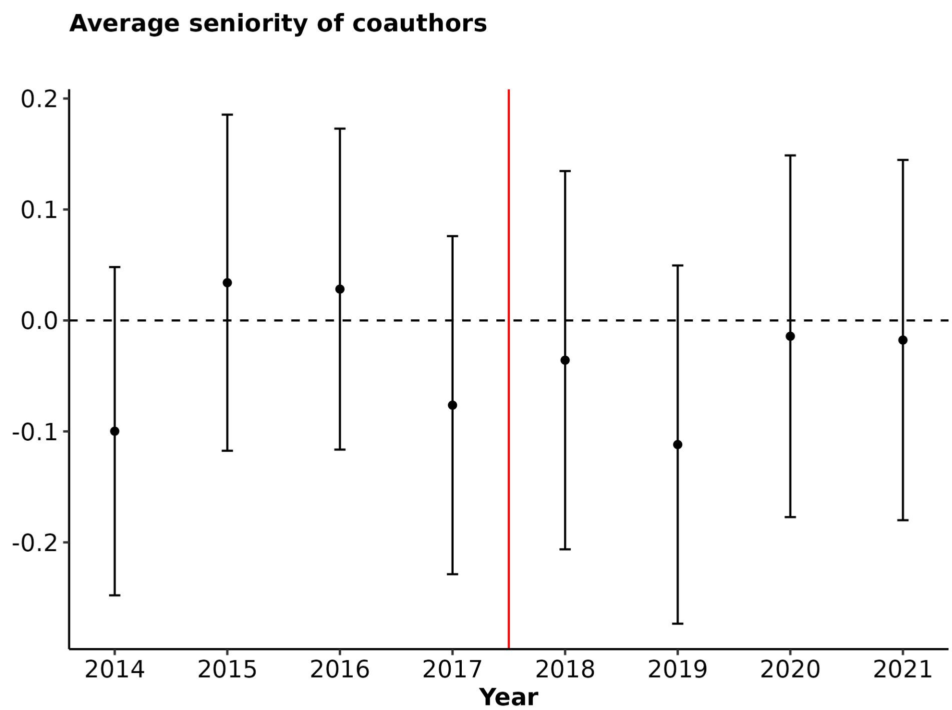


Figure E.4: Effect on seniority of co-authors

Notes: The graph above reports regression estimates for the difference in average years of activity of co-authors as registered in Scopus between the treated and control group for each year between 2013 and 2021, based on information available at the year this measure is calculated. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications, publications in the top journals, citations received and h-index of researchers and their co-authors in the selection period (total, with US co-authors for the treated and European for the control, with Chinese and rest of the world co-authors), first year of publica tion on Scopus, dependency on co-authors, number of co-authors in the selection period, main fields of activity, exposure to US or European dominance and expected progression of topics of interest of researchers.

E.3 Placebo test

Table E.3 presents results from using the years 2001-2005 as the placebo pre-shock period, and 2010 as the placebo shock year, otherwise using the same methodology as in our core analysis. We see no significant effect of the placebo shock on the volume and quality of publications by "treated" Chinese researchers.

Table E.3: ATT for main outcomes - Placebo sample

	publications		citation_count		nr_source_top5pct		citation_chn	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ATT	-0.066	-0.127	-3.411	-6.483	0.026	0.026	1.546	-3.652
	(0.091)	(0.140)	(3.981)	(4.915)	(0.022)	(0.022)	(4.447)	(8.348)
Mean.Dep.Var.Pre	4.115	4.115	119.601	119.601	0.136	0.136	117.750	117.750
Pvalue.PreTrend	0.094	0.217	0.284	0.118	0.036	0.036	0.702	0.992
N.authors	8589	8573	8573	8573	8573	8573	8573	8573
N.obs	94479	79636	79636	79636	79636	79636	79636	79636
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cond. on publishing		Yes		Yes		Yes		Yes

Note:results are from DRDID regression, using year 2010 as the year of a placebo shock, for each outcome for the whole sample and conditioning on having published during the year of observation. The unit of observation is author by year and the sample period is from 2013-2021. The dependent variable is the number of publications (columns (1)-(2)),number of citations for publications from that year (columns (3)-(4)), rate of publications on top 5 % journals (within subject) from that year (columns (5)-(6)), citations received from papers with at least of Chinese author (columns (7)-(8)). Control variables account for author's publication characteristics overall and by category of coauthor during 2001-2005, including number of publications, number of accumulated citations, number of top publications, coauthor dependency, as well as number of coauthors, characteristics of the fields and topics of interest of the author. Standard errors (SE) are clustered by author. In parentheses: *** p<0.01, ** p<0.05, * p<0.1.