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Does Chinese research hinge on US co-authors? Evidence from the China initiative

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

Keywords: Trump administration, China, US intellectual property, technologies, espionage

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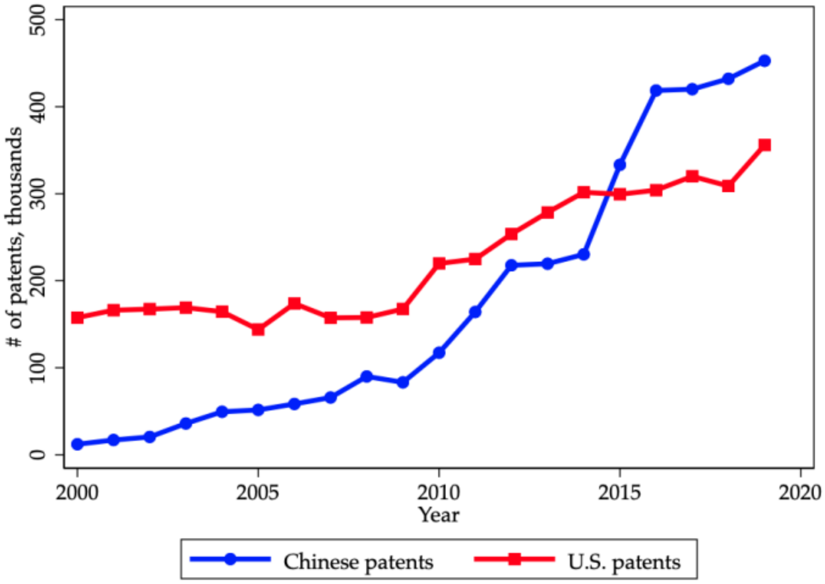
1 Introduction

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).

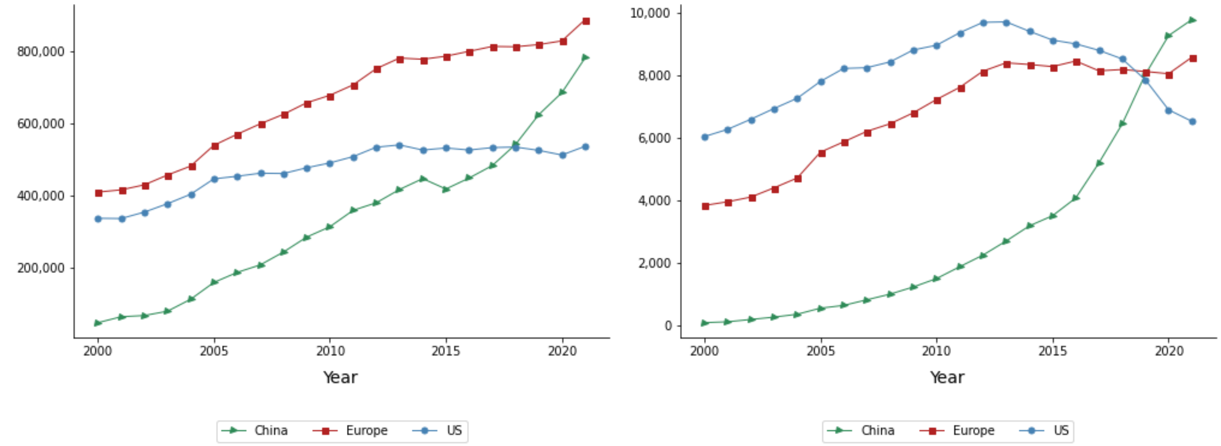
Figure 1: Number of patents granted in China and in the United States.



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 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 coauthors. 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

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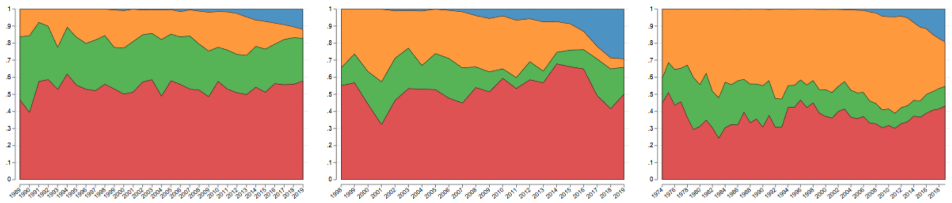
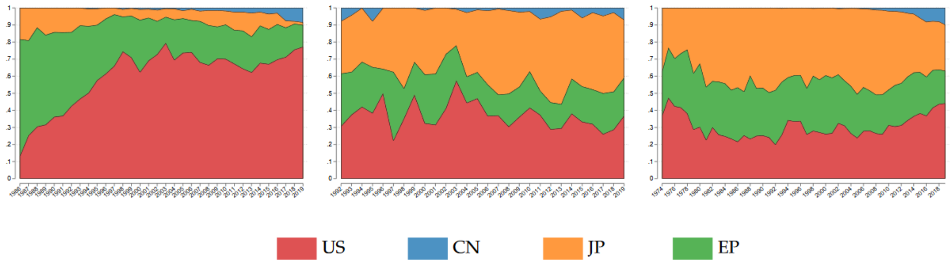
[1] By contrast with growth based on frontier innovation, e.g. see Acemoglu and Robinson (2012) or Chapter 7 in Aghion et al. (2021).

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



(a) Additive manufacturing (b) Blockchain (c) Computer vision

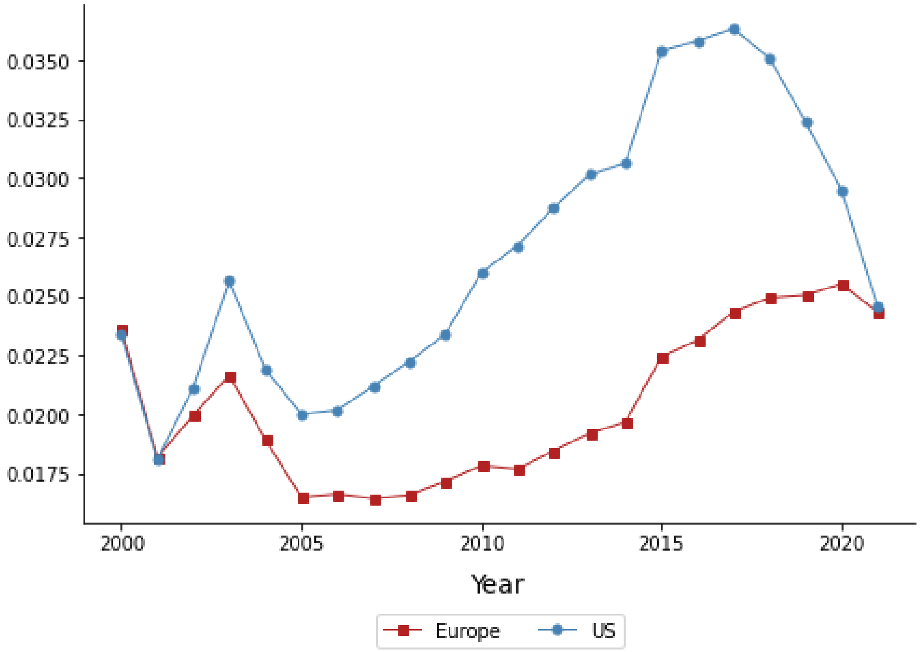


(d) Genome editing (e) Hydrogen storage (f) Self-driving vehicle

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 also 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 coauthored 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 coauthored publications with US-affiliated or Europe-affiliated authors over the total number of coauthored 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 coauthors (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 authors.

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[2] See Schiavenza (2022).

For each publication in this dataset, information is provided on the current and past academic affiliations of its authors, their current and past coauthors 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 90th percentile over the period 2008-2012 — with US coauthors, as well as no European coauthor. 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 90th percentile over the period 2008-2012 — with European coauthors, as well as no US coauthor. 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 negative trend break in the number of Chinese publications by researchers in the treatment group after the enforcement of the China Initiative. More importantly, we find a more strongly negative trend break in the quality of publications by treated researchers, which is reflected both in the negative break in their citation counts, and in the decline in their number of publications in top 5% journals.

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 coauthors of treated Chinese researchers following the enforcement of the Initiative (the quality of coauthors is itself a good predictor for future citations, both at the article level and at the author-level).

Next, we split our publication sample according to coauthors' region of affiliation, namely the US, Europe and China. While the negative 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 coauthor decreases markedly compared to publications by control Chinese researchers involving an European coauthor. In other words, following the implementation of the China Initiative, Chinese research reallocated away from US coauthors. 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 coauthors for Chinese researchers in the treatment group, decreases significantly following the China Initiative compared to the number of new European coauthors 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 coauthors 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 coauthors both, by an increased reliance on collaborations with coauthors 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 fields or topics close to US-dominated fields and topics 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 published in areas closest to US-dominated fields and/or topics 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. (2021)[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]

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

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[3] Qiu et al. (2021) 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).

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 coauthorship 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 coauthor 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 coauthors can be 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

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[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.

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

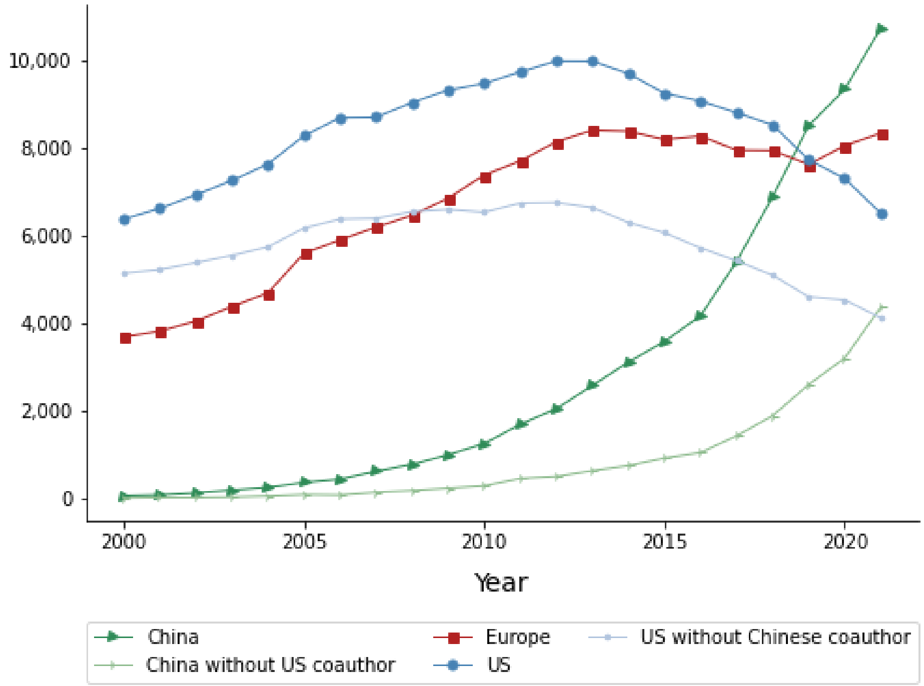
Our main source of information on the scientific production of Chinese researchers and their coauthors, is the Scopus bibliometric database. Released by Elsevier in 2004, to date, the Scopus database covers 43,132 scientific journals, 78 million publications and 16 million authors. Scopus comprises several 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 AJSC.

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. Furthermore, we distinguish between Chinese researchers with co-authors in the US and/or who have published in the US, and vice-versa, but no longer when we restrict attention to Chinese with no ties to the US. In other words, we see a surge in the share of Chinese papers among the top 1% cited papers in our database, but much less so if we remove papers with a US coauthor or with authors with experience in the US academia. This latter finding is robust to removing all China-based coauthored papers as well as papers by researchers with experience in Chinese academia from the US total.

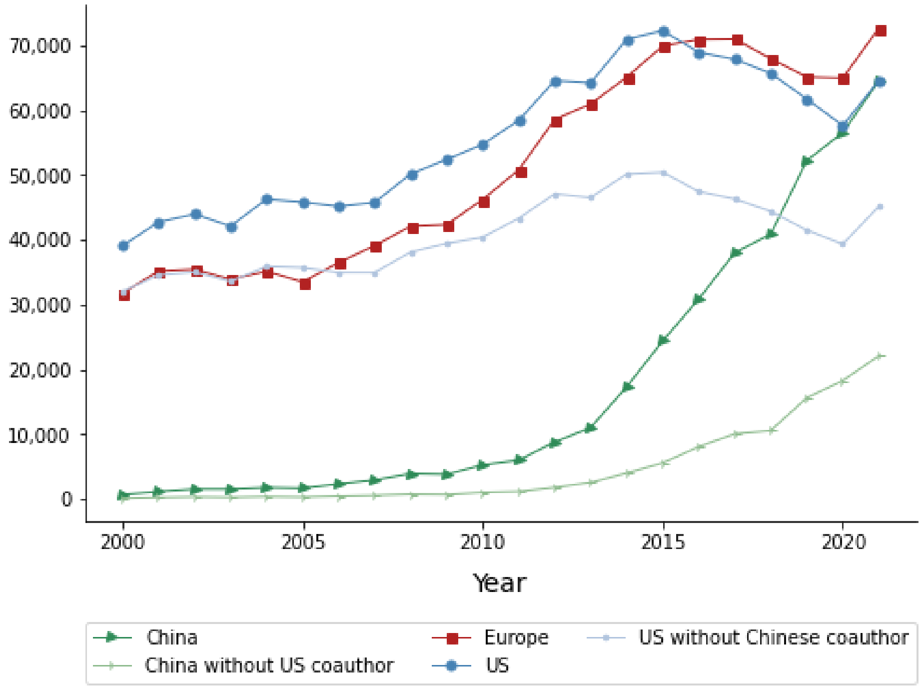
Figure 5: Number of top 1% cited publications by country of affiliation.



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 coauthor* (*resp. no Chinese coauthor*) 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.

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 computed by field, and into account the total number of citations received over a 4 y-window per paper for each source. The curve labelled with the mention *no US coauthor* (*resp. no Chinese coauthor*) 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).

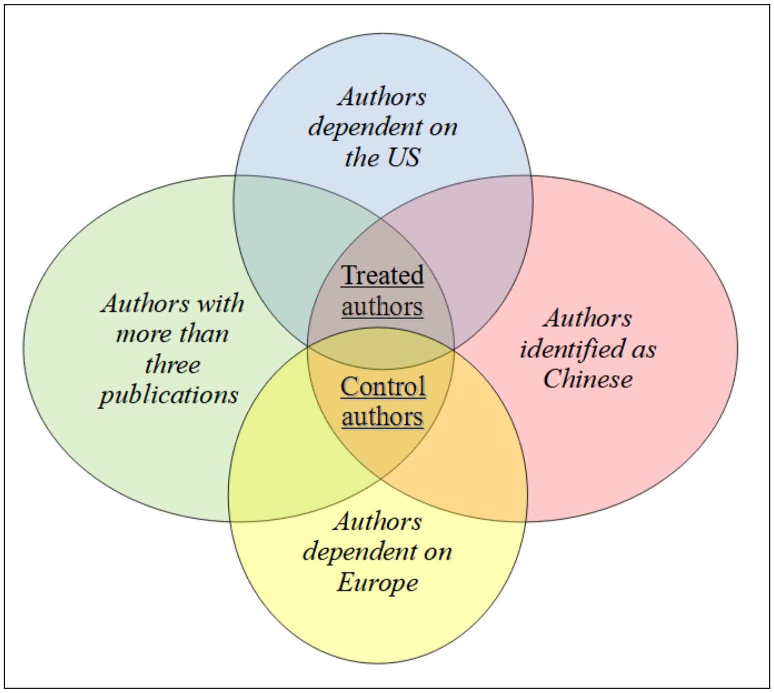
2.3 Sample selection

Within the whole set of authors in the Scopus database, in each period we focus on the subset of Chinese researchers active during the period. For each such researcher, we have access not only to 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, yet propensity scores are computed based on aggregate information over the period 2008-2012.

For each author in the Scopus database we know: the year in which the author's name appears for the first time; the author's main subject(s) as reflected by her publications; the author's past and current countries of affiliation[6].

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.

Figure 7: Selection criteria of treatment and control groups.



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[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.

We first 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]. Our main treatment group consists of Chinese researchers in that subgroup who show "high dependence" on US and have no European coauthors. The main control group consists of Chinese researchers within that same subgroup who show "high dependence" on European and have no US coauthor[8]. At the end, this selection process within the set of Chinese authors yields 23,662 treated authors and 17,858 control authors. In the next section, we describe in more details how we construct treatment and control groups.

2.4 Measurement

2.4.1 Main outcomes

Our first outcome measure is the total number of publications at the level of an individual author in any given year ; we also consider the number of publications for which at least one of the coauthors is affiliated in the US, Europe, or China[9].

Second, also at the author 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[10]. Again we can break up this number of top cited journals according to the coauthors' regions of affiliation, e.g. US, Europe or China.

Third, we consider the number of citations of an author current publications; we can break up this number according to the region of affiliation of the citing authors[11]. We can also restrict ourselves to citations received within five of ten years after publication to limit 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 coauthors of a Chinese author in any given year, which we break up by region of origin of the coauthors. Then, we decompose the

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[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] Our definition of Europe includes the 27 countries of the European Union, the United Kingdom, Switzerland, Norway and Iceland.

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

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

set of co-authors into new, short-term and long-term coauthors. A new coauthor in a given year is a coauthor with whom the Chinese researcher has never collaborated before. Short-term coauthors are coauthors during a period between 1 and 5 years. Long-term coauthors are coauthors over more than five years in a row. And once again, we break up these numbers according to the coauthors' region of origin, i.e. the US, Europe, or China.

Next, we consider two measures of coauthor quality. First, we analyze the average H-Index of coauthors of a researcher in any given year based on all information currently available[12]. Second, we compute the variable "H-Index citing", which is the H-Index of coauthors of a researcher in any given year based on information available by the end of the year[13]. In a sense, the latter can be seen as a " real-time H-Index", which measures the *observed* quality of coauthors at the time of publishing.

A third set of outcome measures pertain 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 coauthors' countries of affiliation.

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 coauthorships 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 coauthorships with European researchers but did not co-author with US researchers, during the selection period[16]. Our choice of control group is motivated by region-level descriptive statistics highlighting similar paths of research productivity for Chinese researchers with US versus European coauthors during the selection period. More

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[12] This index takes into account citations that were not yet received at the time, e.g. if a paper published in 2010 receives a citation in 2018, this citation still contributes to the coauthor's average H-Index of 2010.

[13] For instance, if a paper published in 2010 receives a citation in 2018, this citation does not contribute to "H-Index citing" 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.

[16] See Appendix.

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 coauthors 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 coauthorship reallocations by Chinese researchers with prior US coauthorship in comparison to Chinese researchers with prior European coauthorships. Namely, a Chinese researcher with prior links with US coauthors and who ventures outside the network of US coauthors to develop new collaborations with European coauthors, is different from a Chinese researcher in with prior European coauthorship who also seeks to develop new collaborations with European coauthors. Hence, simply comparing the number of publications with European coauthors between "US-linked" and "Europe-linked" Chinese researchers, is not the right thing to do, the reason being that the different types of coauthorships of these two groups of Chinese researchers during the selection period, will condition their respective coauthorships 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 coauthorship (resp. with prior European coauthorship) during the selection period to keep publishing with coauthors 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 coauthors during the analysis period by a researcher with prior US coauthorship, differently from the number of publications with European coauthors during the same analysis period by a similar Chinese researcher with prior European coauthorship.

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 coau-

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[17] See Section 4.

thors and research direction. On average, treated Chinese authors with prior US coauthorship outperform control Chinese authors with prior European coauthorship during the period 2013-2015, both with regard to the quality and the quantity of publications. It also appears that control and treated authors are equally active in updating and maintaining their respective coauthor networks. Finally, control and treated authors appear to also be comparable in terms of the quality of their coauthors. 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.

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 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.

3.1 Empirical definition of treatment

Our treatment group consists of Chinese researchers with high dependence on US and no dependence on European coauthors. 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 coauthors. Formally, this index is defined as:

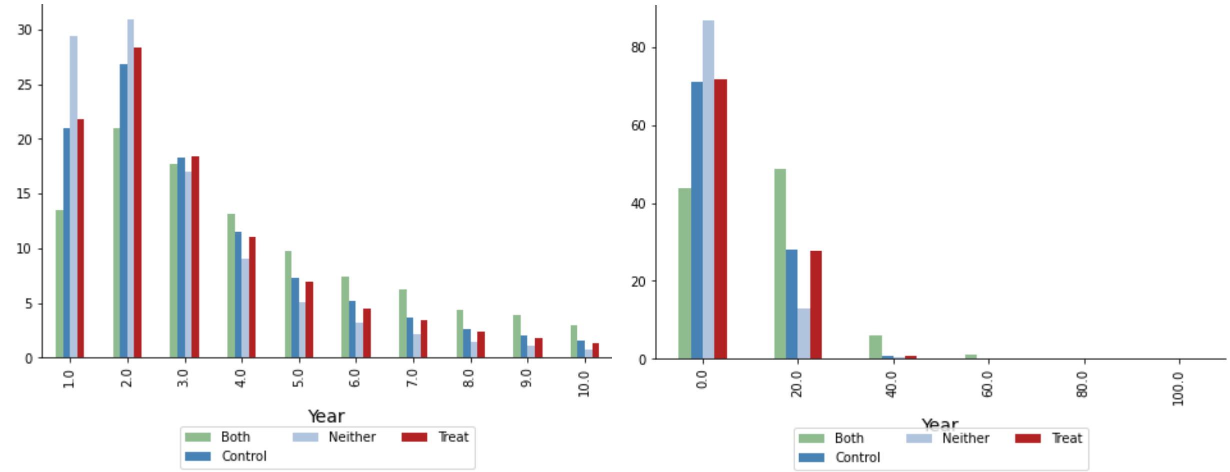
$$C_i^g = \frac{1}{\omega_i} \sum_{l \in A_{i,T}} \frac{\omega_l}{|a_l/i|} \sum_{j \in a_l/i} \mathbb{1}\{g_j = g\}, \quad g \in \{US, Europe\} \tag{1}$$

where C_i^g captures the degree of the dependence of individual i upon her coauthors 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.

Chinese authors with a US coauthor dependency index, C^{US}, (respectively C^{Europe}) above the 95^{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 coauthors in the other region. Overall, our sample contains 41,520 researchers. Among them, 17,858 belong to the control group and 23,662 belong to the treatment group.

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.

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 coauthors, while authors in the group *neither* are dependent on neither. Our dependence measure is the C index described in this subsection.

3.2 Hypotheses

The China Initiative arguably increased the cost for Chinese researchers to collaborate with US researchers, effectively reducing their set of possible coauthors. 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 coauthors. China's spectacular growth in scientific output implies that there are many available coauthors domestically, and there are of course also alternative coauthors in other countries than the US. In this case, their productivity would not fall and coauthor quality will be constant. However, our hypothesis is that treated authors cannot perfectly compensate the loss of US coauthors, and consequently, that the China Initiative reduced the productivity of Chinese authors with a high dependence on US coauthors (our treatment group), relative to those with a high dependence on Europe coauthors (control). 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 coauthor quality, measured by coauthor H-index, to directly investigate whether Chinese authors with a high dependency on US coauthors were able to compensate the loss of these coauthors by other equally productive coauthors. In addition, the average H-index of coauthors is a strong predictor of the impact of a paper. Since we have a relatively short time horizon, the H-index of coauthors 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 coauthors 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 coauthors for the treated authors. Our hypothesis is that the treated authors reduce their collaboration with US coauthors more than the control researchers reduce their collaboration with European coauthors. We also study coauthor 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 coauthors depends on the availability of alternative coauthors of similar qualities as the coauthors lost because of the China Initiative. If it is easy to find other coauthors, then the loss of US coauthors will impact the productivity of the treated authors less. The availability of alternative coauthors is likely lower for authors working on research topics dominated by the US and higher for topics dominated by China. Hence, our hypothesis is that the negative effects are larger for authors researching US-dominated topics.

Finding equally good coauthors is likely also more difficult for top Chinese researchers, collaborating with top US coauthors, because top coauthors are few and in high demand. In contrast, less productive treated authors may even benefit from the resulting coauthor reallocation, if the highly productive treated authors are forced to collaborate with them instead of highly productive US coauthors. 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 (DID) design. Let y_{it} denote the outcome of interest for author i in year t (e.g. number of publications, citations or coauthor 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 coauthors 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.

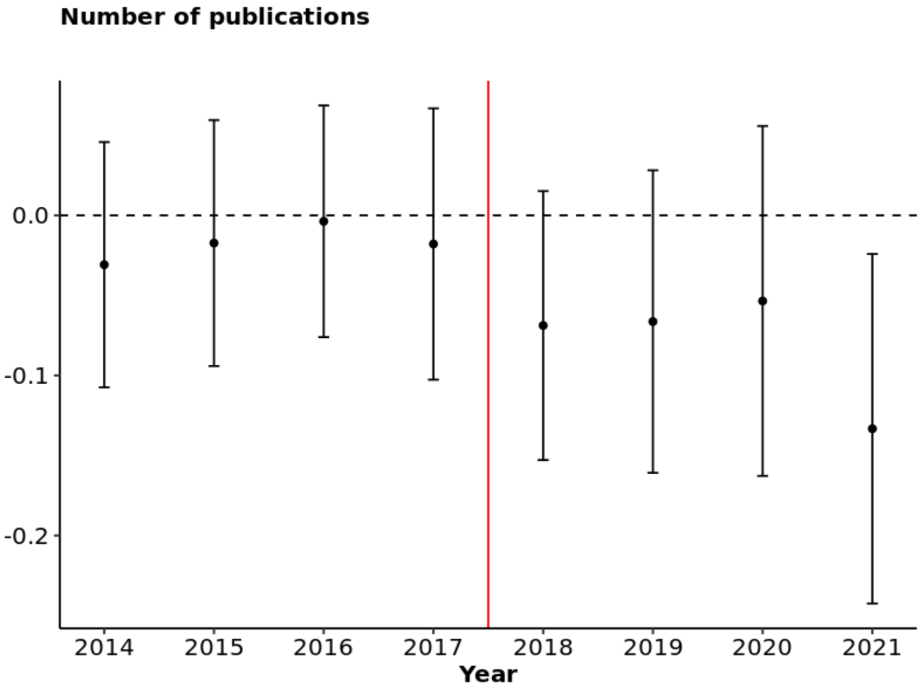
4 Results

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 significant but small negative effect of the China initiative on the number of Chinese publications by treated authors compared to control authors. 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 be a mechanical decrease that would be caused by a lower reach on citing US authors following the China Initiative shock. Indeed citations to treated Chinese researchers by other Chinese authors are shown to decline as well in Figure 11. Further evidence of a decline in the quality of publications by treated Chinese researchers following the China Initiative shock, is provided by Figure 12, 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 analyse the impact of the China Initiative on the average quality of coauthors. Figure 13 shows a decline in the average quality of coauthors, measured by their average H-index, of 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 coauthors of equal quality. It may take more time to find new coauthors, but there is no evidence of a closing of the gap during our sample period. Note that the quality of coauthors 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 coauthors measured by their average H-Index, and we indeed see positive and significant correlations between the average quality of coauthors and future citations.

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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

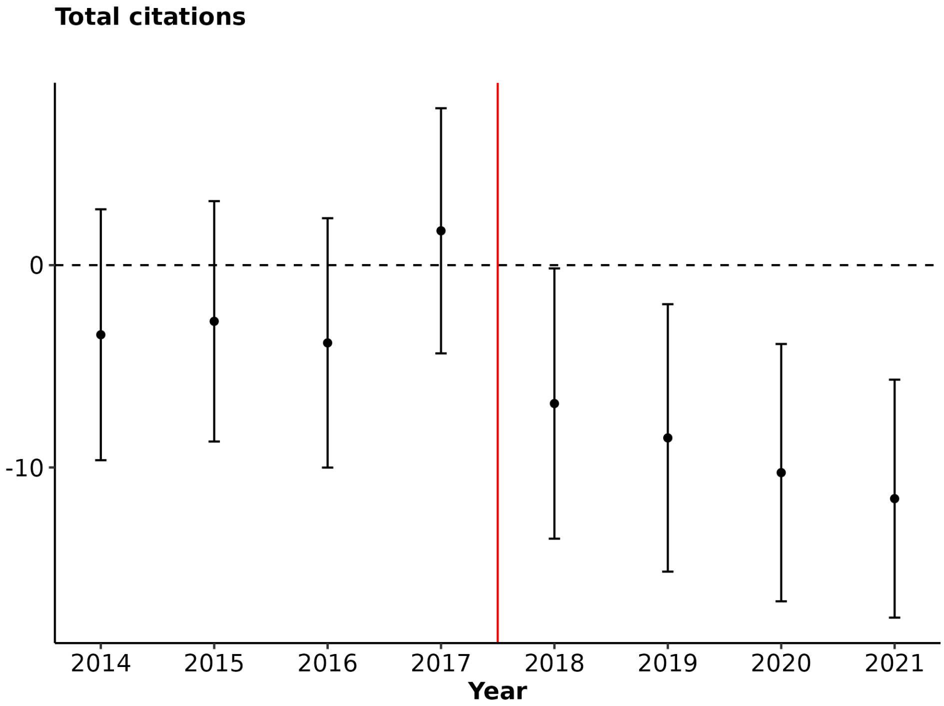
Table 2: Predictions of the number of citations (5 and 10 years windows) using the average h-index of coauthors.

Dependent Variables: Model:	Citations (5 years post. publication) (1)	Citations (10 years post. publication) (2)
Variables		
Average H-index of coauthors (a posteriori)	1.088^{***} (0.0808)	1.508^{***} (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*

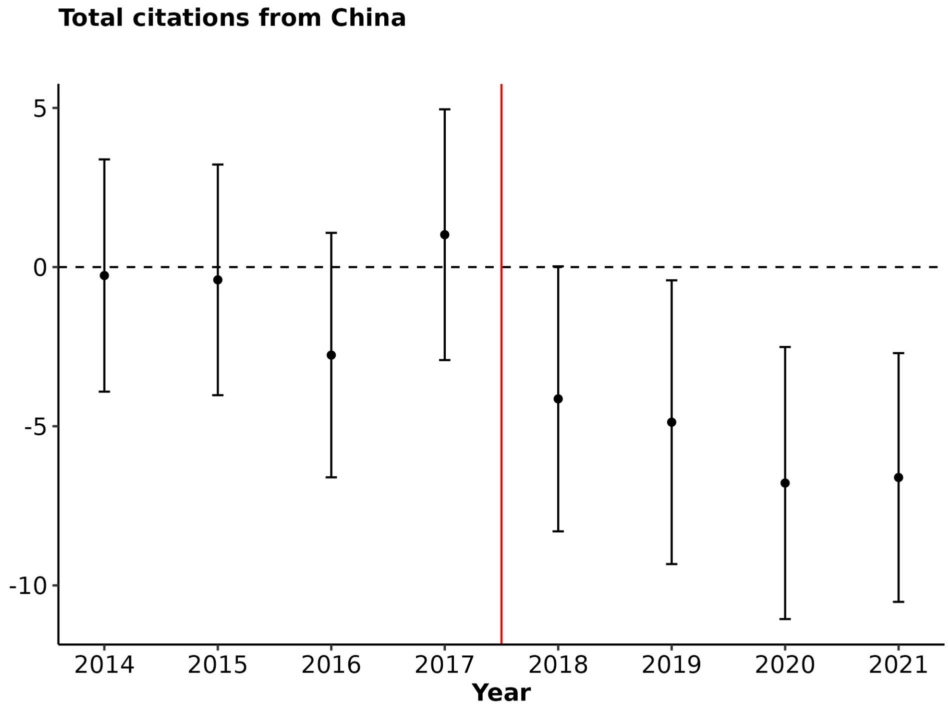
Notes: The table above reports estimates for a fixed-effects regression of the citations received in the next 5 and 10 years by a paper based on the average H-index of its authors. The fixed effects include time and main domain of study (life, health, physical sciences).

Figure 10: Effect of the China Initiative on the number of citations



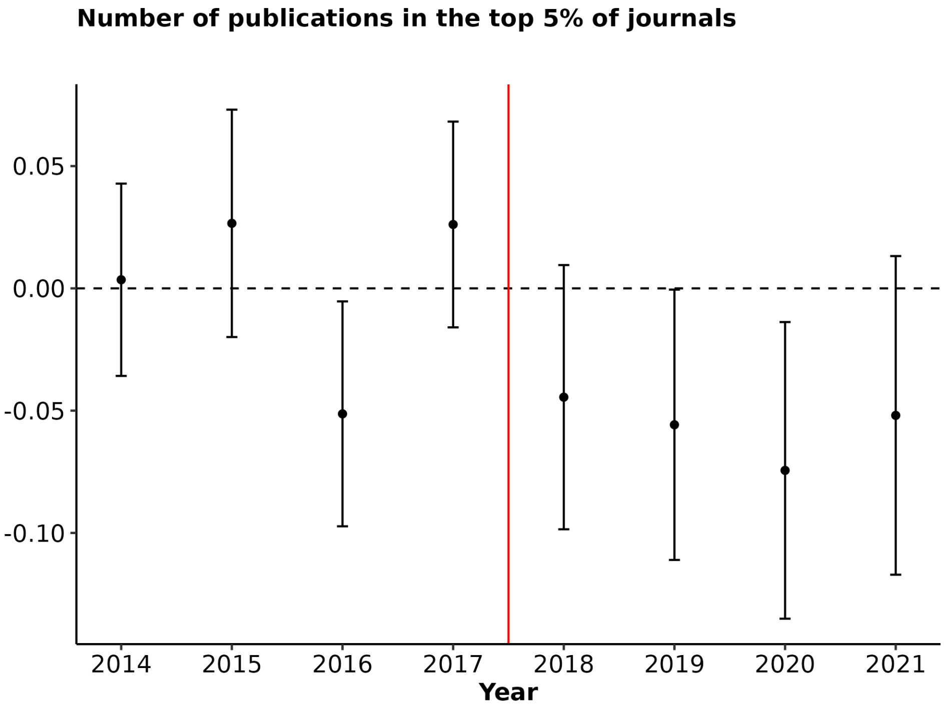
Notes: The graph above reports regression estimates for the difference in number of total citations received until today for an article published in a given year between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 11: Effect on number of total citations from Chinese papers



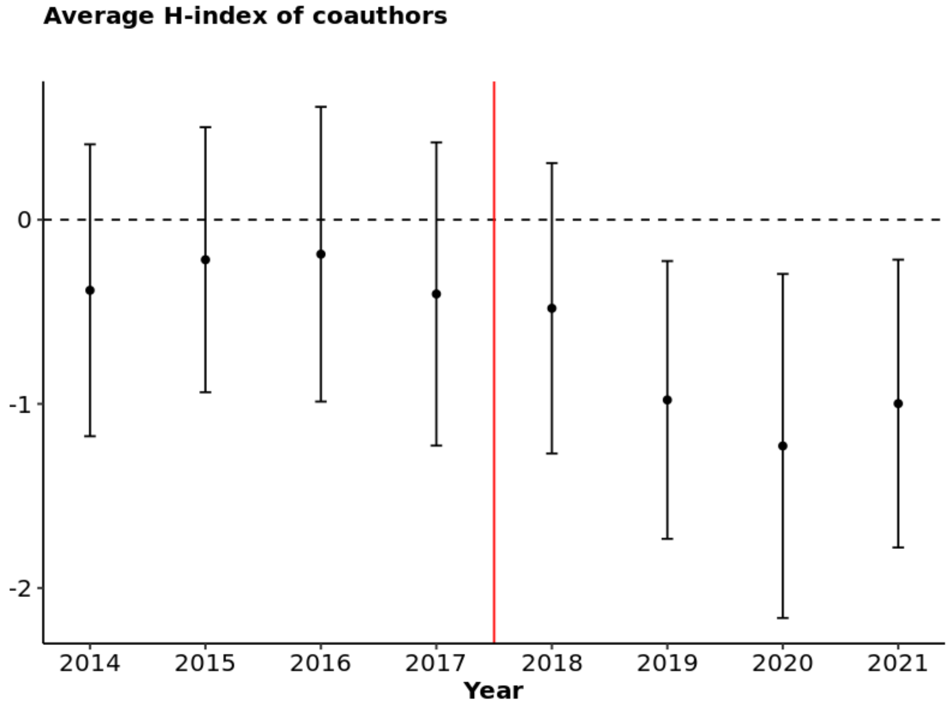
Notes: The graph above reports regression estimates for the difference in number of citations received from papers published by authors with a Chinese affiliation between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). 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 publications in top 5% of journals



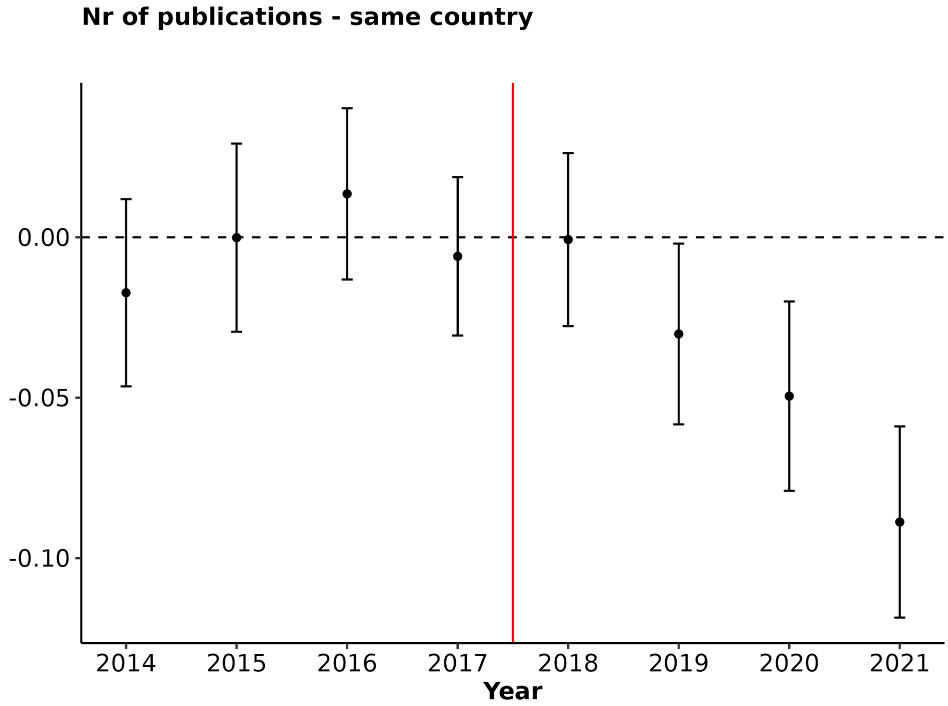
Notes: The graph above reports regression estimates for the difference in number of publications in the 5% most cited journals within a discipline between the treated and control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

Figure 13: Effect on average real-time H-Index of coauthors



Notes: The graph above reports regression estimates for the difference in average H-Index of coauthors 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 14: Effect of the China Initiative on the number of publications by the treated group with US coauthors compared to the number of publications of the control group with European coauthors



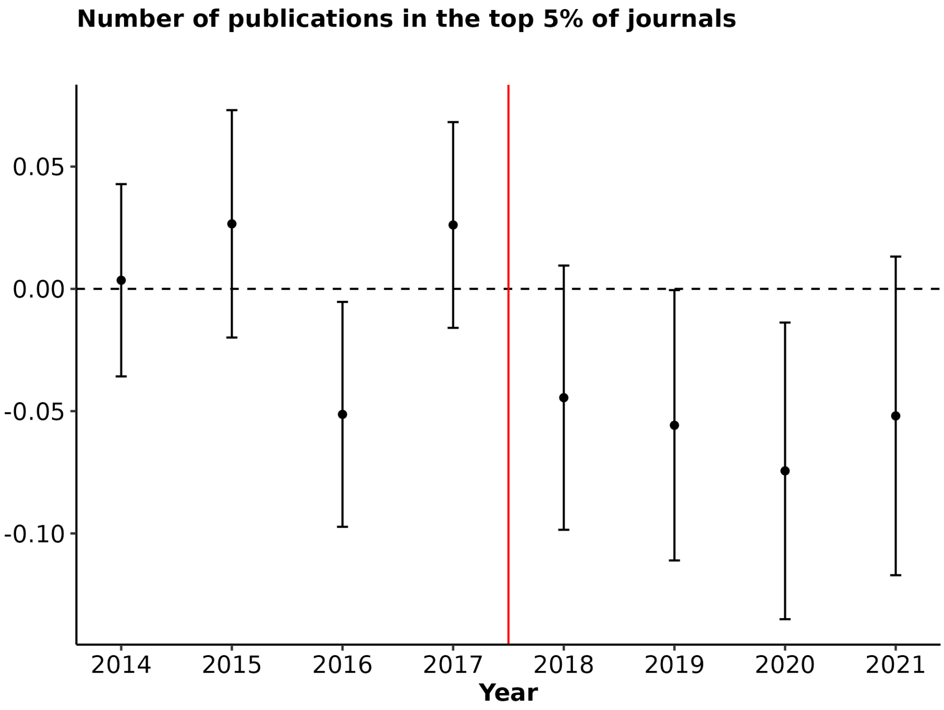
Notes: The graph above reports regression estimates for the difference in number of publications by the treated with US coauthors and number of publications by the control with European coauthors for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

4.2 The reallocation effects of the China Initiative

We next investigate how the China initiative affected the reallocation of co-authorship across countries and the resulting effect on research output. We proceed by investigating the extent to which researchers with a high dependence on one country group in the pre-period continued to coauthor with researchers from the *same* country group in the post-period. In other words, we investigate the development of US co-authorship of treated Chinese authors with the EU co-authorship of control authors.

Figure 14 shows that treated authors write markedly fewer articles with US coauthors after the shock, compared to the evolution of the European coauthorship of control Chinese researchers. Since the total number of publications by treated Chinese authors is only moderately affected by

Figure 15: Effect of the China Initiative on the number of publications in top journals by the treated group with US coauthors compared to the number of publications of the control group with European coauthors



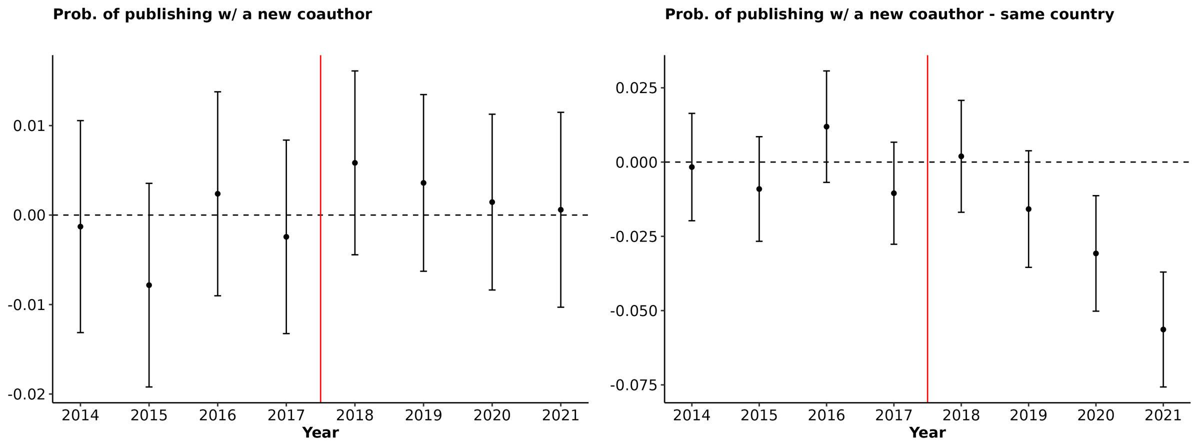
Notes: The graph above reports regression estimates for the difference in number of publications in the top 5% most cited journals within discipline by the treated with US coauthors and number of publications in the top 5% most cited journals within discipline by the control with European coauthors for 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

the China Initiative, this effect is mainly driven by a reallocation away from US coauthors.

We see evidence of the impact of the reallocation away from US coauthors when looking at top 5% journals. In Figure 12, we showed that the China Initiative reduced the treated authors' number of publication in these journals. Looking at coauthors' affiliations helps understand better what underlies this aggregate dynamic pattern. Figure 15 shows that most of this fall can be attributed to a corresponding fall in top publications with US coauthors. The number of publications by treated authors in top journals with US coauthors declines sharply after the shock compared to the number of publications in top 5% journals by Chinese control authors with European coauthors. The comparison with the aggregate fall in Figure 12 implies that there is no increase in top 5%

journal publications with 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 coauthors.

Figure 16: Effect on having a new coauthor: global and US compared to control with Europe



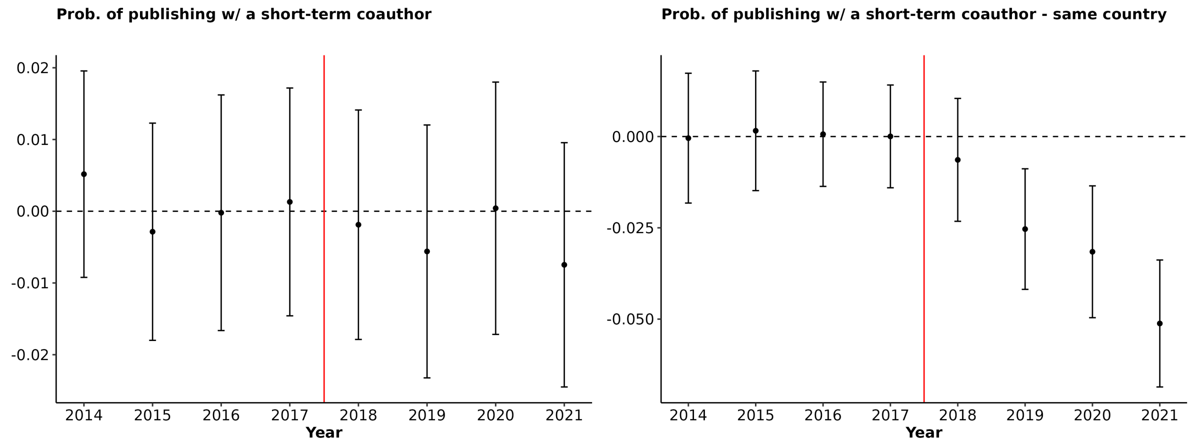
Notes: The graphs above report regression estimates both for the difference in the probability of publishing with a new coauthor (left) and publishing with a new US coauthor for the treated and a new European coauthor for the control (right) between the treated and the control group for each year between 2013 and 2021. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

Finally, we look at whether the China Initiative had a larger impact on new and short-term relationships than on long-term coauthor relationships. Figure 16 shows that there is a decline in the number of new US coauthors 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 coauthors of treated Chinese authors compared to control Chinese authors after the shock. Hence the decline in new US coauthors 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 negative effects of treated authors new coauthor relationships with US coauthors, Figure 17, shows a significant decline in short-term coauthorship of treated Chinese authors with US coauthors. However, as shown in Figure 18, we do not see a decline in long-term coauthorship of treated Chinese authors with US coauthors. This indicates that Chinese researchers have managed to maintain their research collaborations with long-term US co-authors.

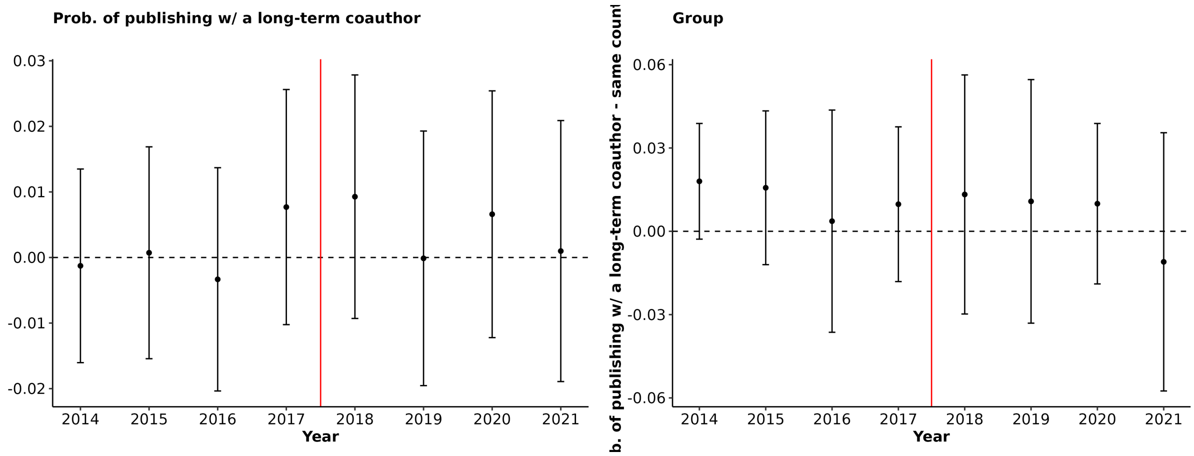
Taken together the results in this section point to a reallocation of the coauthorship network

Figure 17: Effect on having a short-term coauthor: 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 coauthor (left) and publishing with a short-term US coauthor for the treated and a short-term European coauthor for the control (right) between the treated and the control group for each year between 2013 and 2021 (short-term meaning a coauthor 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

Figure 18: Effect on having a long-term coauthor: 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 coauthor (left) and publishing with a long-term US coauthor for the treated and a long-term European coauthor for the control (right) between the treated and the control group for each year between 2013 and 2021 (long-term meaning a coauthor 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

of Chinese researchers following the China Initiative away from US coauthors. Most, if not all, of the reduced research quality, for example, publications in top journals, can be attributed to this reallocation and the resulting fall in coauthor quality. However, the fact that so far Chinese researchers have managed to maintain their research collaborations with long-term US co-authors, has 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

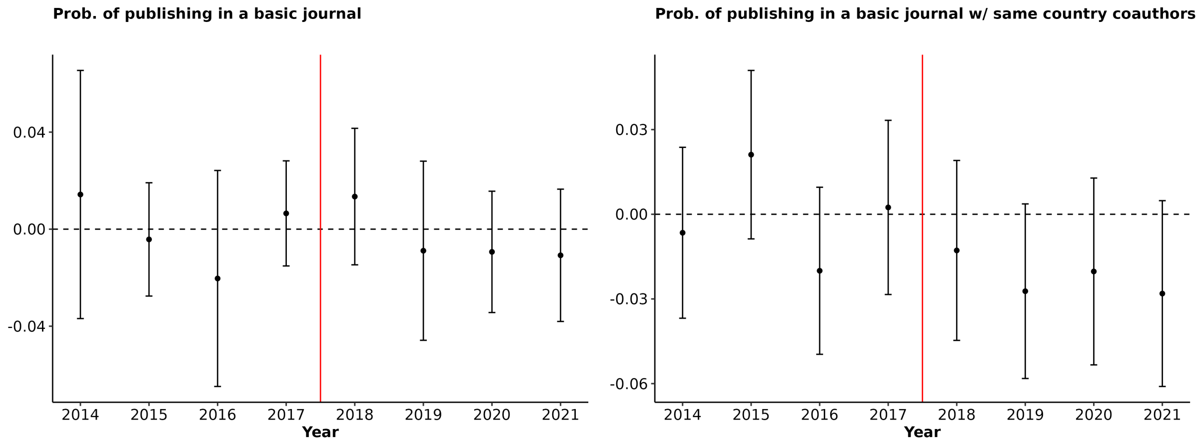
The China Initiative did not only affect the amount and quality of publications by Chinese researchers with prior US coauthorship, but also the direction of Chinese research. In the introduction we mentioned recent work by Liu and Ma (2021) pointing at a positive effect of deglobalization on the basicness 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 coauthors, 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 (*nr basic*), and we also consider a dummy equal to one whenever she published any such article at all during the year (*any basic*). Finally, we use more recent data to retrain the machine-learning algorithm developed by Boyack et al. (2014)(also based on the CHI Index) to obtain an estimate of basicness again on a scale from 1 to 4 for each article published by sample authors (*score research level ml*).

Figure 19 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 coauthors* after the shock, compared to the evolution of the number of basic publications by control Chinese authors with European coauthors. 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 coauthors by increasing its reliance on collaborations with non-US coauthors for basic research.

Figure 19: 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 coauthor for the treated and a European coauthor 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

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 with a US coauthor (second row) ; (ii) publications by Chinese researchers in top five journals (fifth row), all the more if the Chinese researcher has a US coauthor (sixth row) ; (iii) citation counts for Chinese researchers (third row from last) ; (iv) citations truncated after 5 and 10 years (next to last and last rows respectively). Together, these confirm our findings in the event studies depicted in Figures 4 to 7, of a negative effect of the China Initiative on the 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 3% of the median for the number of citations (2). However, on average, there is a decline in citations of the order of 9 citations on all publications in a given year for the treated authors; this corresponds to about 12% of the median number of citations (76) for the years before the shock. Furthermore, given that the average number of publications during that period published in the top 5% journals is 0.43, the -0.057 coefficient corresponds to a decline of around 13% of the pre-shock mean value of the number of such publications.

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

outcome	ATT	Std.Error	LB_{95}	UB_{95}	t
Number of publications	-0.0770**	0.032	-0.139	-0.015	2.420
Number of publications w/ *same country* coauthors	-0.0423***	0.009	-0.060	-0.025	4.741
Number of publications in top 5% journals	-0.0567***	0.016	-0.089	-0.025	3.464
Number of publications in top 5% journals w/ *same country* coauthors	-0.0205***	0.004	-0.028	-0.013	5.326
Total citations	-9.2946***	2.179	-13.564	-5.025	4.266
Total citations received within 5 years of pub.	-0.6476***	0.178	-0.996	-0.299	3.643
Total citations received within 10 years of pub.	-0.9245***	0.249	-1.412	-0.437	3.717
Total citations from China	-7.3252***	1.484	-10.234	-4.417	4.936

Notes: The table above reports regression estimates for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2013-2017 for variables related to research productivity and quality. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Table 4 computes the Average Treatment Effects (ATT) of the China Initiative on the reallocation and quality of Chinese researchers' coauthors. The table shows : (i) a significantly negative effect of the China Initiative on new US coauthors (second row) ; (ii) a significantly positive effect of the China Initiative on new European coauthors (third row) ; (iii) a significantly positive effect on long term coauthorship for treated Chinese researchers with a US coauthor ; (iv) a significantly negative effect on real-time H-Index of coauthors; (vi) a significantly negative effect of the Initiative on the average H-Index of coauthors for treated Chinese researchers with a US coauthor ; (vii) a significantly negative effect on H-Index of coauthors based on today's information; (viii) a significantly negative effect on H-Index of coauthors for their publications in the last 10 years. Together this confirms and extends the findings of the event studies depicted in the above Figures 14 to 18.

On average, the negative effect on the probability for the treated of publishing with a new coauthor in the US drops by 3.5 points compared to the probability for the control of publishing with a new coauthor in Europe; this is an effect of 15% compared to the pre-shock mean (0.2285). The effect on the (real-time) average H-index of coauthors is more measured, reaching 7% of the median of the pre-period (12).

Table 4: Average Treatment on the Treated (ATT) for coauthors' activity-related outcomes of researchers.

outcome	ATT	Std.Error	lb95	ub95	t
Prob. of publishing w/ a new coauthor	0.0037	0.006	-0.007	0.015	0.662
Prob. of publishing w/ a new coauthor - *same country*	-0.0357***	0.009	-0.054	-0.018	3.859
Prob. of publishing w/ a new Chinese coauthor	0.0156	0.016	-0.015	0.046	1.007
Prob. of publishing w/ a short-term coauthor	0.0039	0.006	-0.008	0.016	0.646
Prob. of publishing w/ a short-term coauthor - *same country*	-0.0479***	0.011	-0.070	-0.026	4.222
Prob. of publishing w/ a short-term Chinese coauthor	0.0160	0.012	-0.008	0.040	1.313
Prob. of publishing w/ a long-term coauthor	0.0027	0.013	-0.023	0.028	0.208
Prob. of publishing w/ a long-term coauthor - *same country*	0.0057	0.015	-0.024	0.036	0.373
Prob. of publishing w/ a long-term Chinese coauthor	0.0126	0.014	-0.014	0.040	0.920
Average H-index of coauthors	-0.9216***	0.281	-1.473	-0.370	3.276
Average H-index of coauthors - *same country*	-0.8480	1.022	-2.851	1.155	0.830
Average H-index of Chinese coauthors	-0.8961**	0.461	-1.799	0.007	1.945
Average H-index of coauthors (a posteriori)	-0.3397**	0.150	-0.633	-0.046	2.270
Average H-index of coauthors (a posteriori) - *same country*	-0.5470	0.473	-1.474	0.380	1.156
Average H-index of Chinese coauthors (a posteriori)	-0.2262	0.174	-0.567	0.115	1.299
Average H-index of coauthors (over last 10 years)	-0.3658**	0.163	-0.686	-0.046	2.240

Notes: The table above reports regression estimates for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2013-2017 for variables related to coauthor networks. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

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 with a US coauthor (*resp.* a European coauthor) for the treated (*resp.* control) is 0.2, meaning that the -0.02 effect represents a 10% decrease in the 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 pre-shock characteristics, and more specifically upon their research performance prior to the shock and their exposure to US scientific dominance in their field

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

outcome	ATT	Std.Error	lb95	ub95	t
Prob. of publishing in a basic journal	-0.0039	0.011	-0.025	0.018	0.355
Prob. of publishing in a basic journal w/ *same country* coauthors	-0.0221**	0.009	-0.040	-0.004	2.453
Prob. of publishing in a basic journal w/ Chinese coauthors	-0.0205**	0.011	-0.043	0.002	1.800
Nr of pubs in basic journals	-0.0106	0.037	-0.083	0.062	0.287
Nr of pubs in basic journals w/ *same country* coauthors	-0.0166	0.024	-0.063	0.029	0.706
Nr of pubs in basic journals w/ Chinese coauthors	0.0031	0.036	-0.068	0.074	0.084

Notes: The table above reports regression estimates for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2013-2017 for variables related to research direction. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable, except for probabilities of publishing basic articles.

or in their research topics.

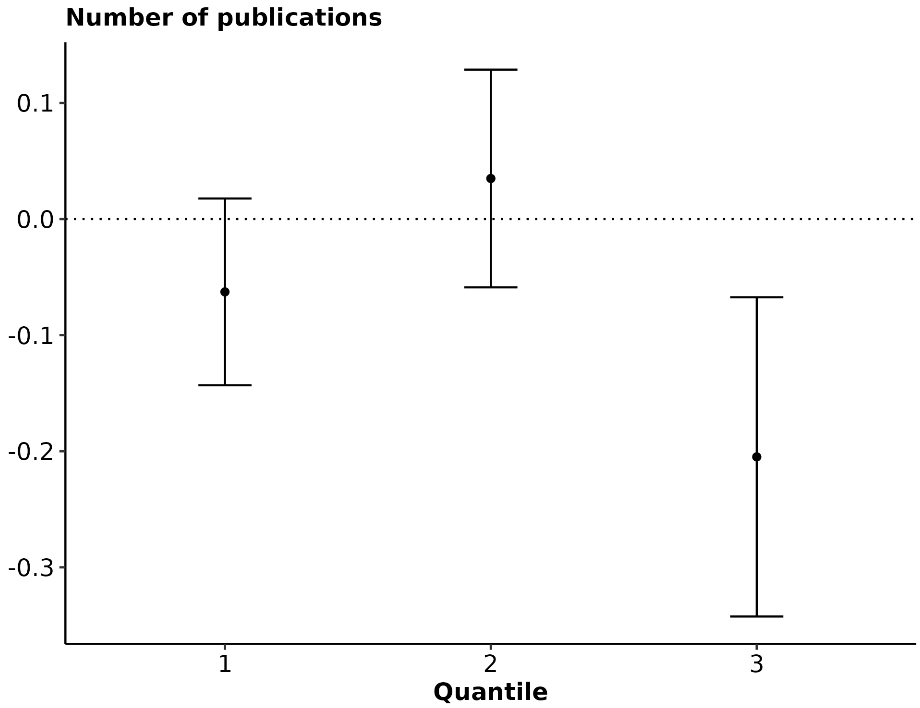
4.5.1 Heterogeneity across productivity levels

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 and middle tercile Chinese researchers in the treatment group compared to those in the control group, whereas the publications of top tercile Chinese researchers in treatment group appear to drop significantly compared to those in the control group (Figure 20). However, the effect of the China Initiative on the number of publications in top 5% journals by top 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 21).

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

Figure 20: Effect of the China Initiative on publications: effect by terciles.



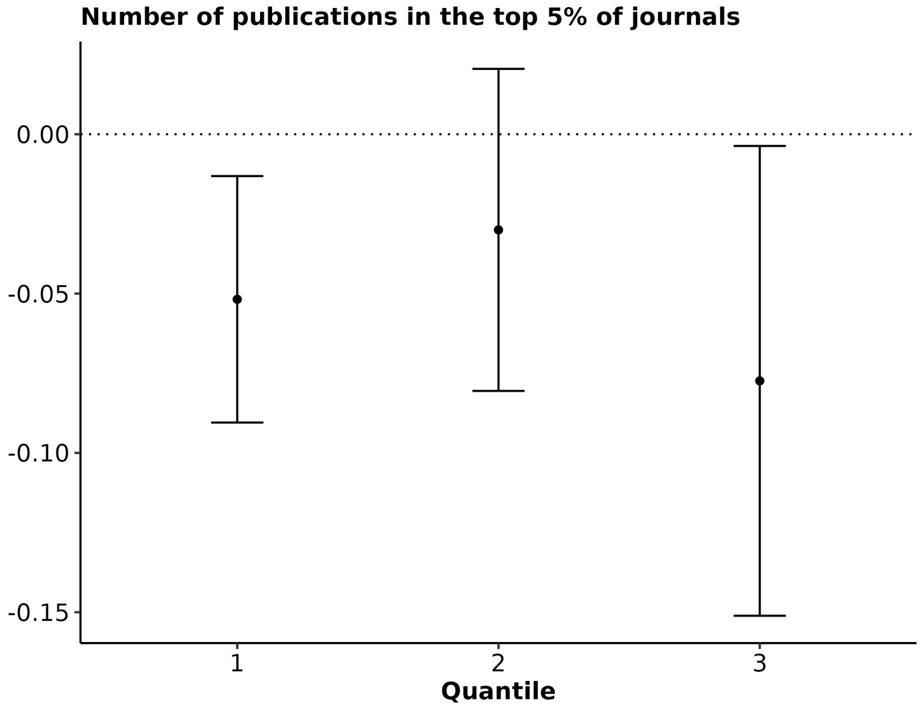
Notes: The graph above reports regression estimates for the difference in the total number of publications between each tercile of the distribution of citations of the treated and its counterpart in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

compute the average aggregate ATT coefficients on the number of publications (Figure 22) and on the number of citations (Figure 23), for treated Chinese researchers in each field separately, to identify which fields have been most notably affected by the China Initiative shock.

Figure 22 shows that treated Chinese researchers whose number of publications has been significantly negatively affected by the CI shock, are those whose main publication fields are physics (Material Science, Energy,.) and chemistry (particularly in Pharmacology and Chemical Engineering).

Figure 23 shows that when it comes to citations, researchers in most fields have been negatively affected by the CI 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).

Figure 21: 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

Interestingly, Figure 24 shows a monotonic relationship between the magnitude of the negative CI effect on treated Chinese researchers' citations 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 of total citations to papers in top 5% journals, that treated Chinese researchers' citations are more negatively affected by the CI shock[18].

Finally, Figure 25 and Figure 26 show that, whenever significant, the effects of the CI shock respectively on the publications and on the citations of treated Chinese researchers in each field, are driven by researchers in the top half of the distribution of citations in the selection period.

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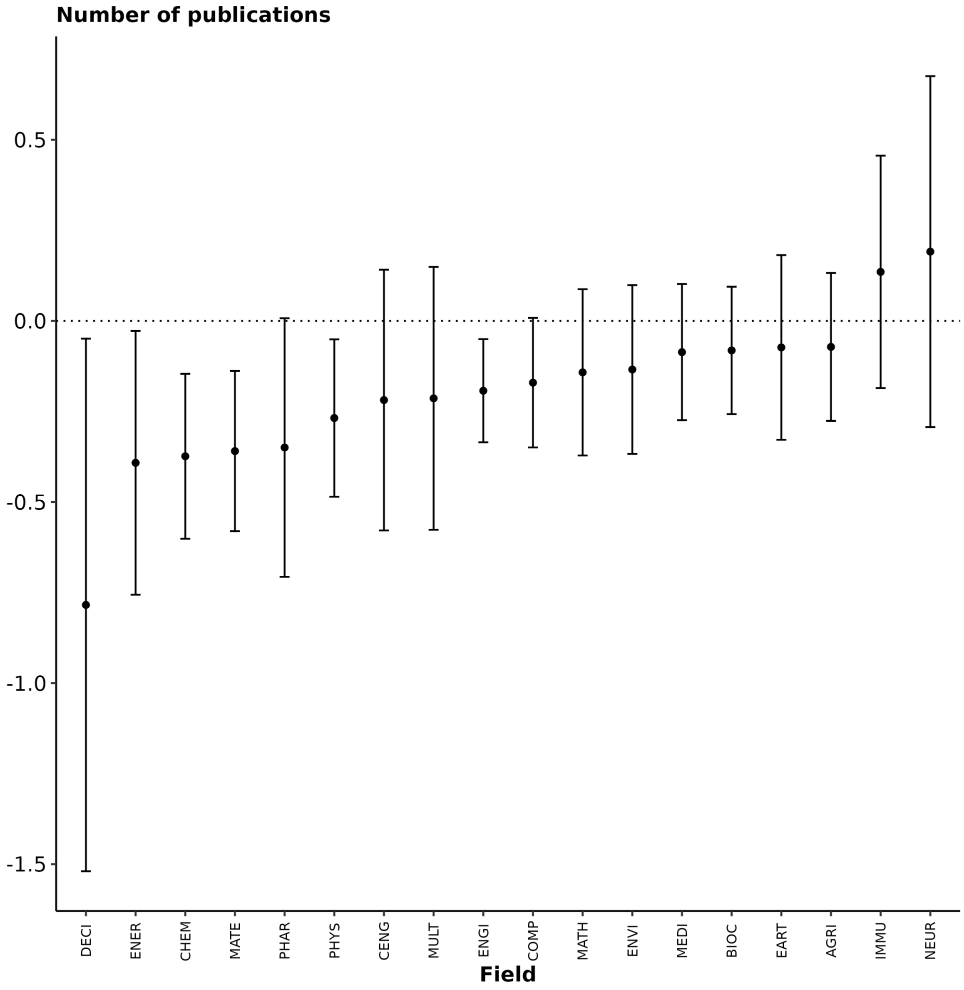
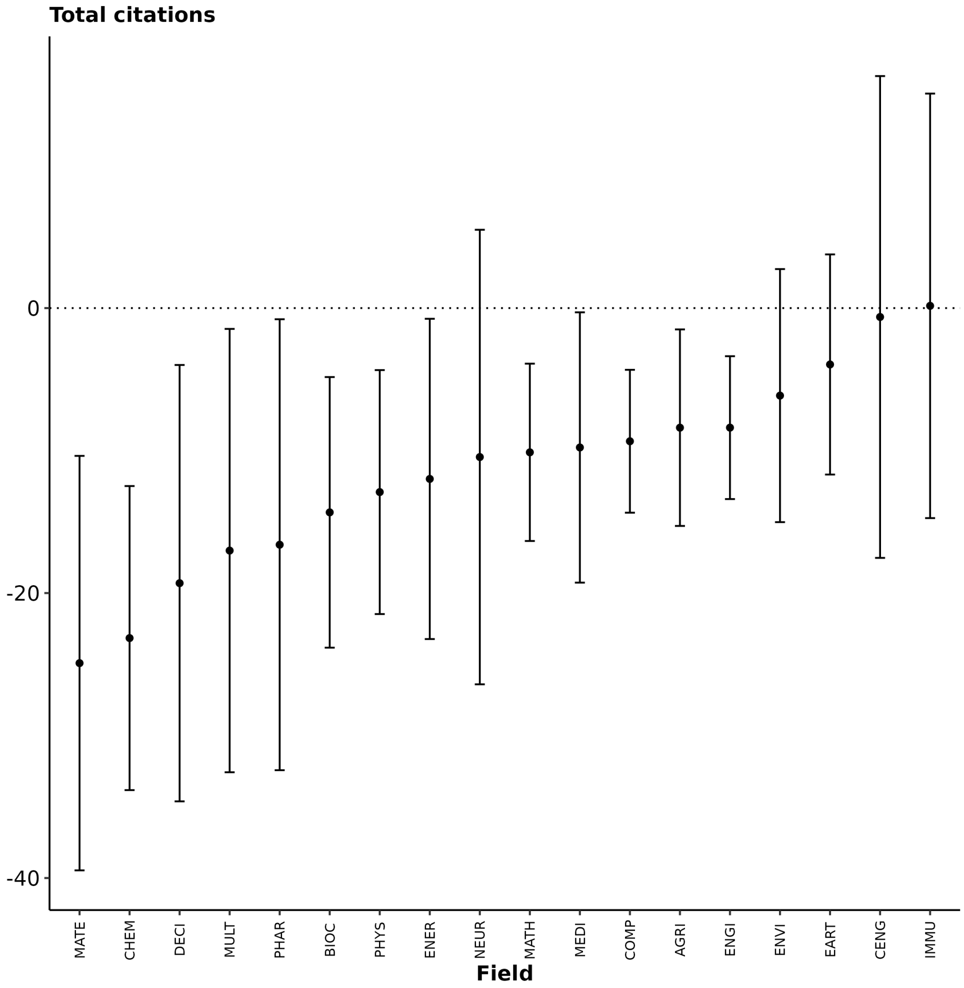
[18] The outlier for citations is the field of Chemical Engineering, in which we find that China is also dominant.

Figure 22: Effect of the China Initiative on publications: effect by field.



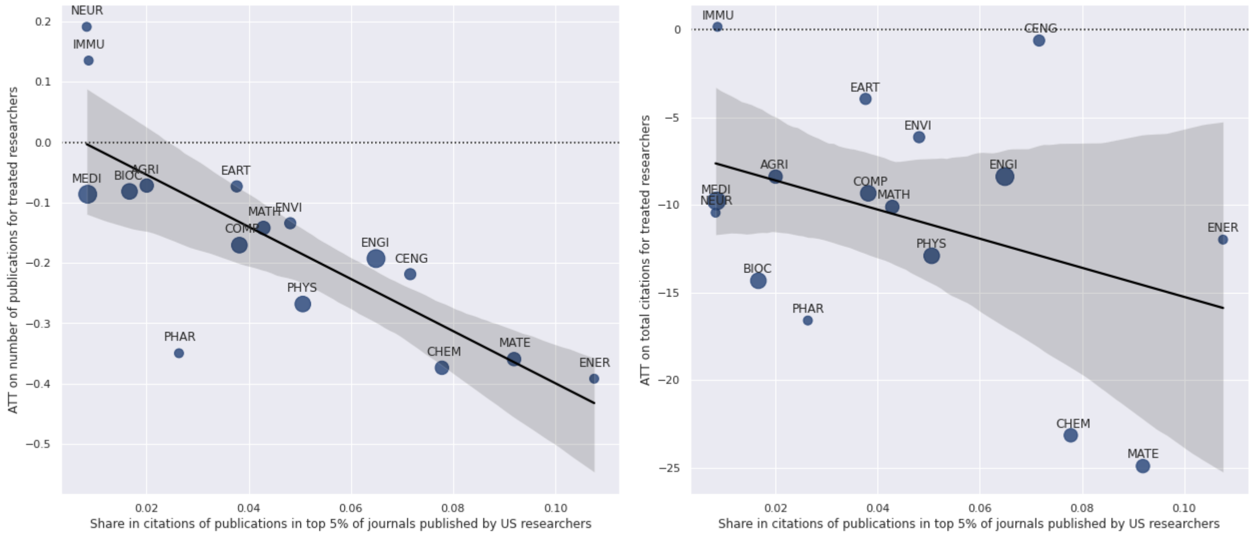
Notes: The graph above reports regression estimates for the difference in the total number of publications for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained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

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



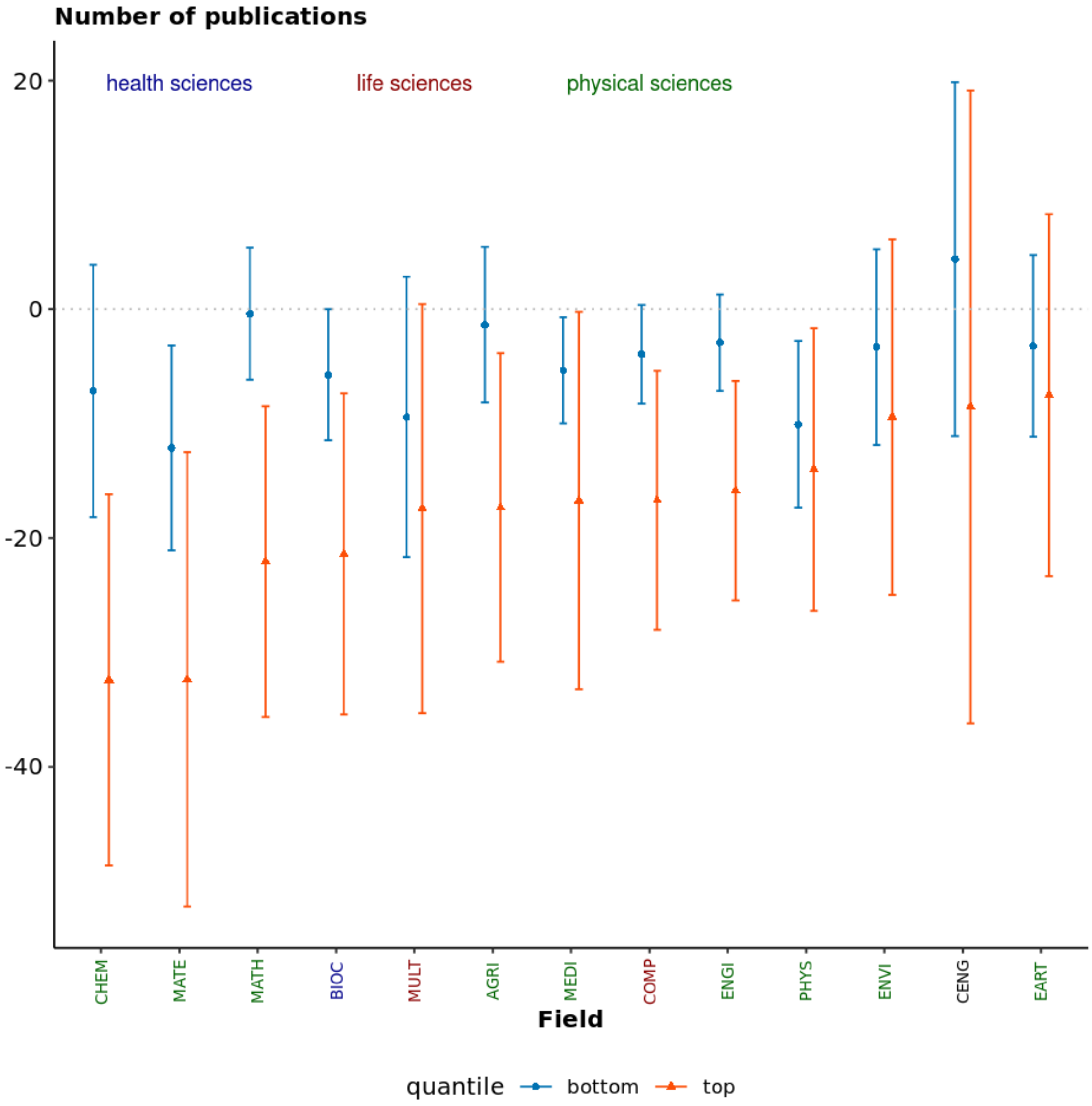
Notes: The graph above reports regression estimates for the difference in the total number of citations for treated researchers writing in each field compared to their counterparts in the control group on average over the period 2018-2021 compared to the period 2013-2017. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and first year of publication in Scopus. 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 by field compared to US dominance by field



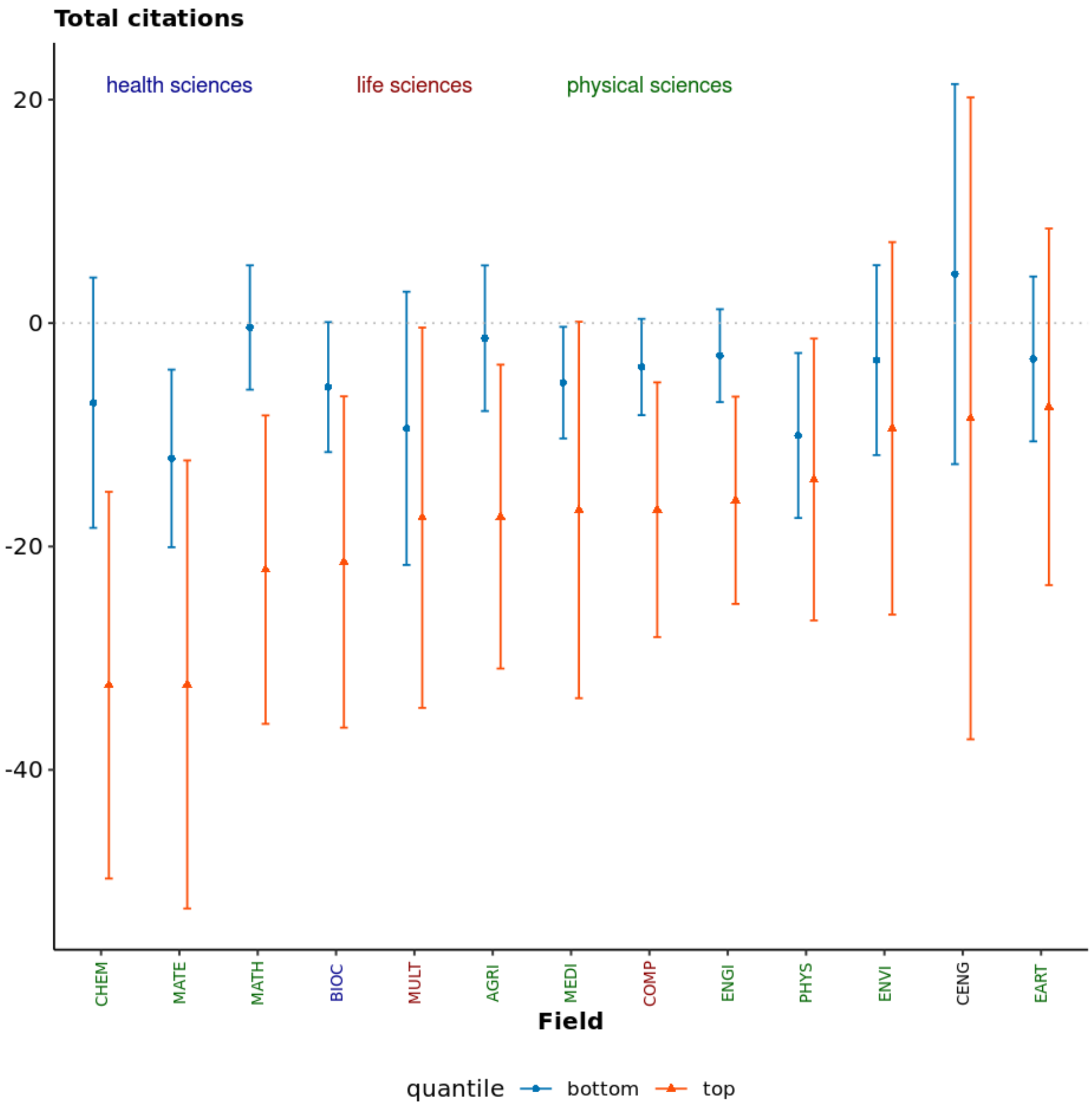
Notes: The graphs above report regression estimates both for the difference in publications (left) and citations (right) in 2018-2021 compared to 2013-2015 between the control and treated group inside each field (obtained with Callaway and Sant'Anna (2020) propensity scores based on publications (total and with US and European coauthors 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 oublished between 2000 and 2012 in top 5% journals in that field that accrue to papers with at least one US author.

Figure 25: 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and first year of publication in Scopus. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 26: Effect of the China Initiative on citations: effect by field.



Notes: The graph above reports regression estimates for the difference in the total number of citations 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and first year of publication in Scopus. The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

4.5.3 Heterogeneity across research topics

One can move from field-level to more disaggregated topic-level analysis when looking at the effect of US dominance on the magnitude of the effect of the China Initiative on the research performance of treated Chinese authors. For example Topic Cluster n°340 corresponding to” Solar Energy, Photovoltaic Cells, Solar Radiation” is not US dominated, even though it belongs to the field of Energy, which is the most US dominated field according to our above metrics. At the opposite, Topic Cluster n°12 corresponding to” T-Lymphocytes, Neoplasms, Immunotherapy”, is a US-dominated topic even though it belongs to the field of Medicine, which is among of the fields with lower degree of US dominance.

For each of the 1495 topic clusters defined by Scopus based on proximity of articles by keywords[19], we construct a dummy equal to one if over 50% of articles published in the top 5% of journals on the topic, involve US researchers.

Using a simple fixed effects model, Table 6 shows that this is indeed the case and that such researchers are, contrary to Chinese researchers in general, negatively impacted in terms of their number of publications. Moreover, the loss of good US coauthors appears to explain most of the decrease in quality for treated authors who do not publish in US-dominated topics. For those who publish in US-dominated topics, the decrease in quality appears to be caused by the fact that their new European coauthors are not as good in the US-dominated topics as the US coauthors in the corresponding fields.

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

Table 6: Regression results: effect on number of publications and citations of being treated differentiated by topics

	log(1+papers)		log(1+citations|papers>0)	
	(i)	(ii)	(iii)	(iv)
treat × post	0.0139*	0.0117	-0.0394*	-0.0304
	(0.0075)	(0.0076)	(0.0204)	(0.0200)
treat × post × high_us	-0.0380**	-0.0438**	-0.1283***	-0.1205***
	(0.0164)	(0.0161)	(0.0335)	(0.0325)
Observations	259,776	259,776	196,875	196,875
R^2	0.68023	0.68160	0.61045	0.61247
auid fixed effects	✓	✓	✓	✓
year fixed effects	✓	✓	✓	✓
pre.feature×year		✓		✓
Dep.mean	1.133	1.133	3.468	3.468

Notes: The table above reports regression estimates for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2011-2017, including an interaction term for authors working at least on one topic in which most of the articles published in top journals comprise at least one US author. Those estimates are obtained with a fixed-effects model, respectively with and without controls. The controls used are publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

4.6 Discussion

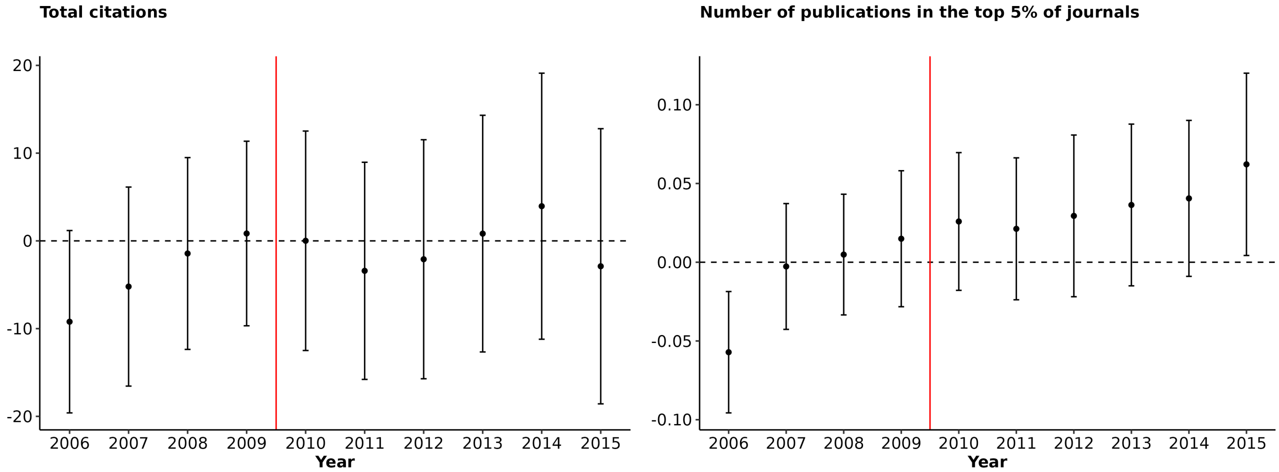
First, we can make the case that our results are not driven by intrinsic differences between researchers in the treatment versus the control group. Indeed, Figure 27 shows that there are very few significant absolute mean differences between the treatment and control groups after weighting observations by propensity scores, and moreover these remaining differences are no longer significant when using Kolmogorov-Smirnov statistics. Furthermore, our researchers are not systematically different in seniority and in fields of study, which could be the cause of differential trends between them.

Second, we check that our results are robust to using simpler selection methods solely based on any coauthorship. 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 coauthor and no European coauthor. Similarly, our alternative control group comprises all Chinese researchers with at least one European coauthor and no US coauthor. The corresponding tables in the Appendix show 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 the H-Index of coauthors and of publications in top journals. More precisely, we use as an alternative to our own metrics Scopus's CiteScore for selecting top 5% journals (see Figure E.1). We then replace the 5% threshold in our metrics by a 10% threshold (see Figure E.2). We also show that using a seniority-normalized H-Index for coauthors to avoid lifecycle effects on their H-Index as provided in Figure E.3 does not change our result. Table E.2 in the Appendix summarises the ATT for these variables on average over the period.

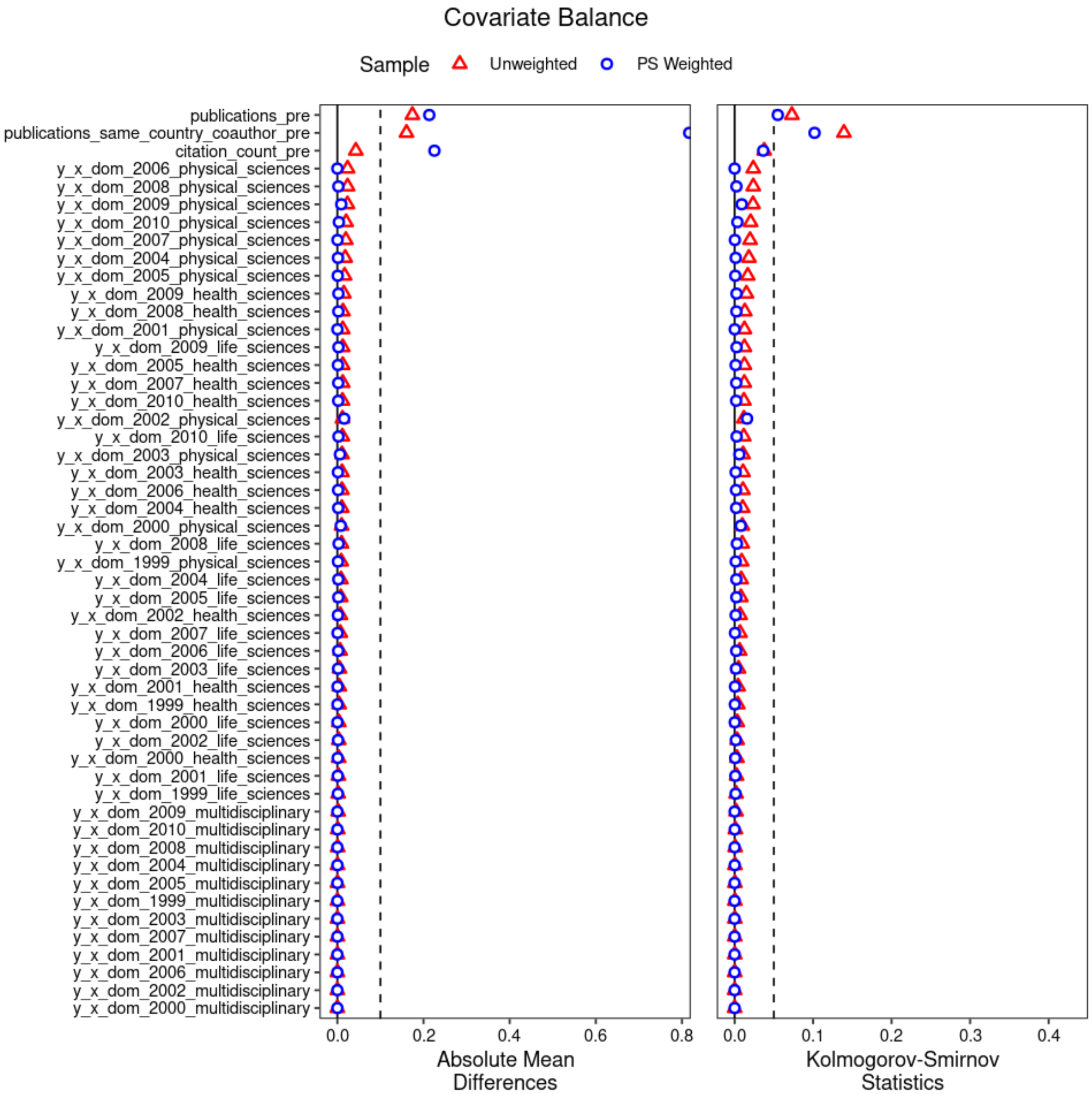
Finally, we perform a placebo test where we take 2010 instead of 2018 as the alternative time dummy. As shown in Figure 28 for the volume of publications, and in Figure 29 for our two main measures of publication quality, no trend breaks are observed this time in these outcome variables for treated Chinese 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 29. 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.

Figure 29: ATT on total number of citations (left) and publications in top 5% of journals (right) for a placebo shock in 2010



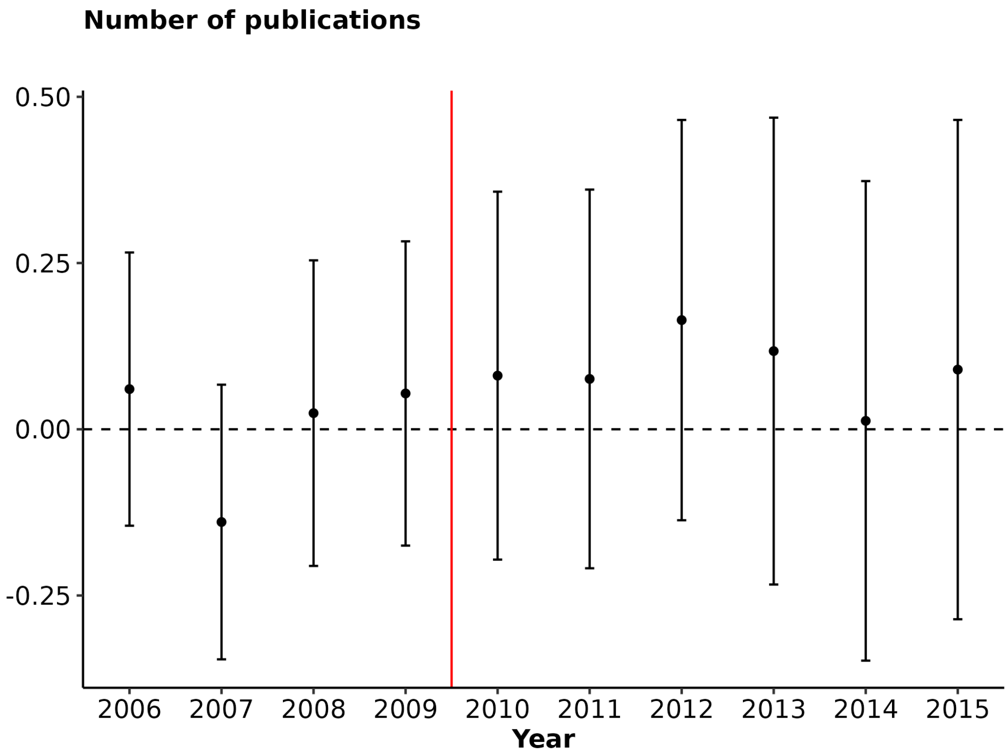
Notes: The graph above reports regression estimates for the difference in number of total citations (left) and in number of publications in the top 5% most cited journals (right) between the placebo treated and control group for each year between 2001 and 2015, for a placebo shock happening in 2010. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Figure 27: 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 28: 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 (total and with US and European coauthors respectively for treated and control groups), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

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.

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Appendix

A More descriptive statistics about our sample

In this section, we provide additional information about sample balance and the methodology that we use to build the datasets. Table A.1 shows the distribution of authors in the sample accross 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.

We also provide Figure A.1 as a supplement of information for Figure 5 and Figure 6. Here, we can see that the number of publications of China-based researchers actually surpasses those of US authors when removing influence of each country on each other, contrarily to what is shown with top publications by both metrics.

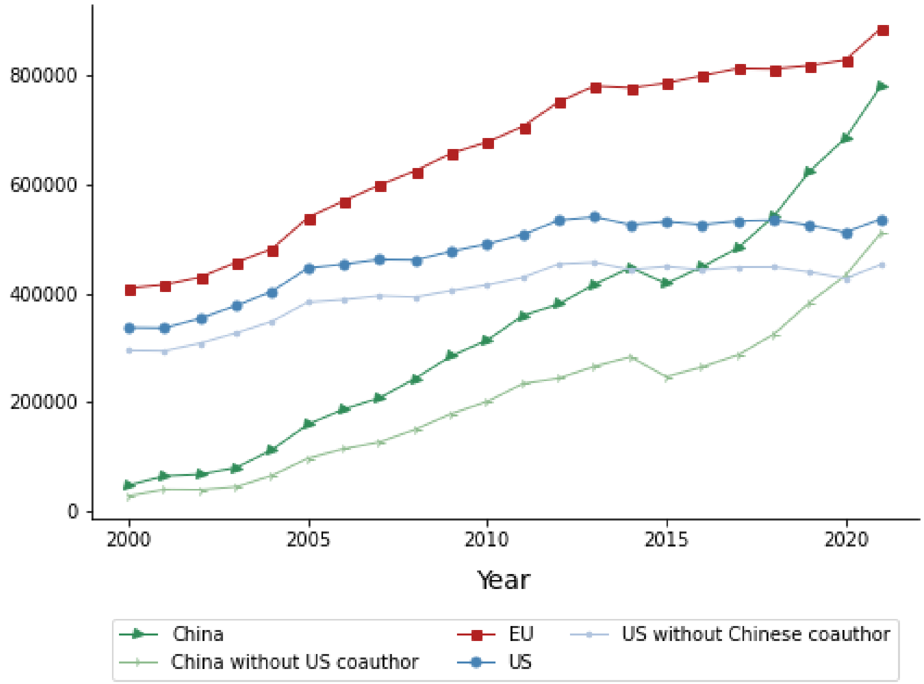
Table A.2: Summary Statistics - Individual level - Controls

	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.

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

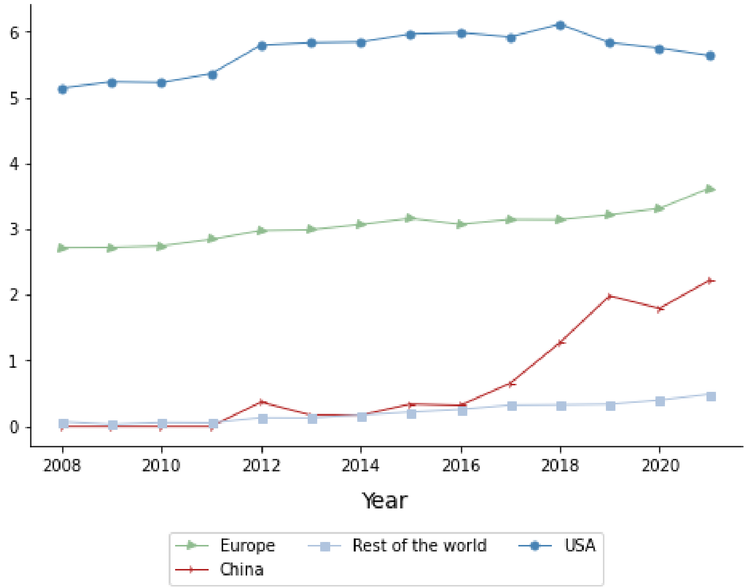


Notes: This figure shows evidence of the Chinese catch-up in the total number of publication. The curve labelled with the mention *no US coauthor* (*resp. no Chinese coauthor*) accounts for publications without any US-affiliated (*resp.* China-affiliated) author or an author who have ever been affiliated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

B Discussion of our variables

Place of publication of journals and quality: One could argue that the vast majority of journals that are in the upper 5% of the distribution of citations per paper in the database for a given year and field are published in the US. According to *CiteScore*, Scopus's own metrics for journal quality, this appears to be the case as shown in Figure B.1, although European publications also account for almost a third of all these sources. In this case, the effect we observe on publication quality could well be mechanical. This would mean that treated researchers write less with US coauthors, making publication in top US journals less desirable.

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



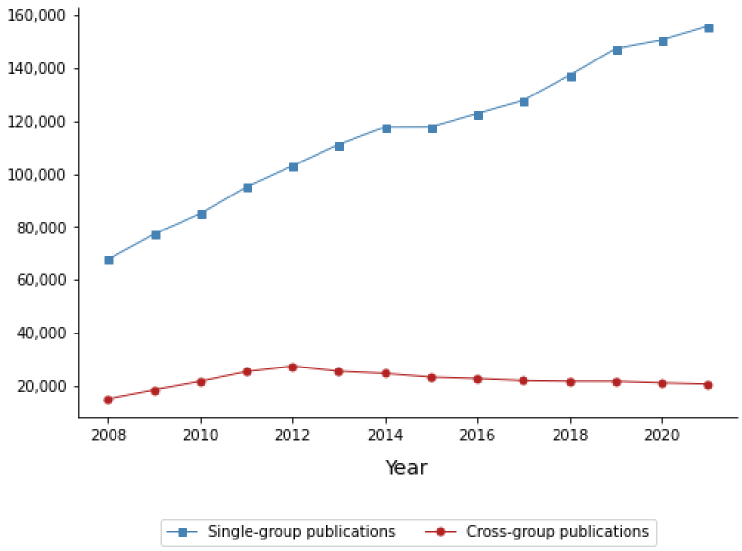
Notes: The graph above represents the share of all sources of publications per region of publication that are in the top 5% of the distribution of citations received over a rolling window of 4 years, within their academic field.

However, by performing the transformation at a higher level (field rather than ASJC code) than CiteScore, we find a different trend than can be shown in CiteScore in terms of country of publication of journals. Our metrics allows for more flexibility in the ranking of journals, and during the very same period as the China Initiative, it captures a rise of journals published in China in the top 5% of articles. If we expect treated researchers to keep seeking publication in top-ranked sources, we believe that they could choose to submit in this expanding pool of top-ranked China-based journals instead. Due to these dynamics in the affiliation of top-ranked sources in our variable, we believe that the concern for a mechanical effect due to place of publication of journals can be somewhat relaxed.

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

It could be argued that a consequence of the China Initiative would be that authors in our sample reallocate away from US coauthors 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 coauthorship with Chinese coauthors from one group would be mirrored on the other side. However, Figure C.1 shows that while the number of papers outside of collaboration between the two 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 coauthored respectively by at least one coauthor 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 coauthors of the control group. Selecting US coauthors of the treated and European coauthors of the control during the pre-selection period[20], we compute how many of them carry one writing only

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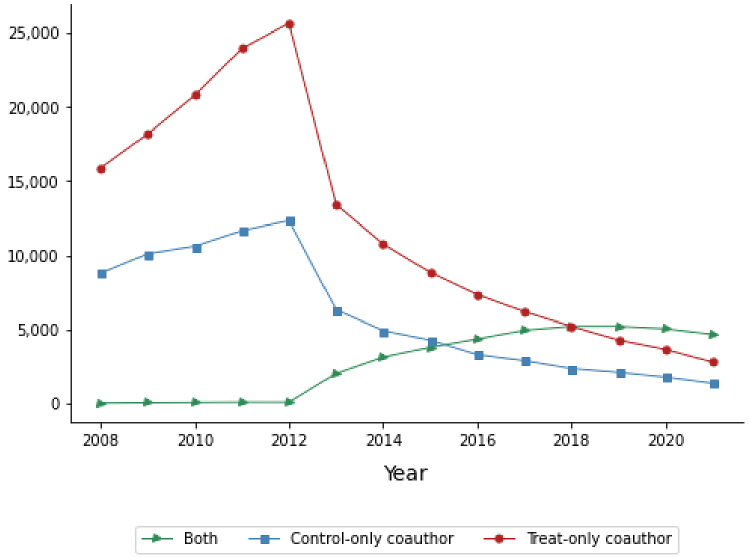
[20] Due to attrition of the sample of coauthors, if we condition on being a coauthor before 2018, the change in trend that we want to check for is going to be partly absorbed by a mechanical drop in the number of coauthors.

with authors who are treated, only with authors in the control group, and how many carry on coauthoring with both types of authors. Figure C.2 shows the evolution of the number of coauthors in each category. If authors of the treated group were coauthoring more with long-term coauthors of the control, we would observe a trend break at the moment of the intervention in the "Both" and the "Control-only coauthor" lines; this does not appear to be the case.

Figure C.2: Number of coauthors from the selection period for each group in the US and Europe by category: collaborations only with the control or the treated, or any of the two



Notes: The graph represents the number of active US and European coauthors 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).

D Reallocation away from the US, but where to?

Although we show that treated authors publish less with the US after the China Initiative than control authors publish with Europe, we cannot say that the treated authors write more with European researchers than before the shock. Indeed, the natural outcome corresponding with this quantity for the control authors is the number of publication with US coauthors. This cannot be used as due to the China Initiative, control coauthors are also hindered in their ability to coauthor with the US, and their collaborations with the US drop as well. This means that there would be a positive bias in the effect that we would observe in the observation of any outcome realised with European coauthors for the treated compared to outcomes realised with US coauthors for the control.

However, outcomes realised with coauthors of any other country are not subject to this bias and can be compared directly by region of coauthors. Therefore, we are able to understand whether there is reallocation to other coauthors *outside* of both the US and Europe. Figure D.1 shows evidence that there is no reallocation towards Chinese coauthors, be it in number of publications or chances to have a new Chinese coauthor. Moreover, Figure D.2 shows that there is a significant negative effect in reallocation towards the rest of the world.

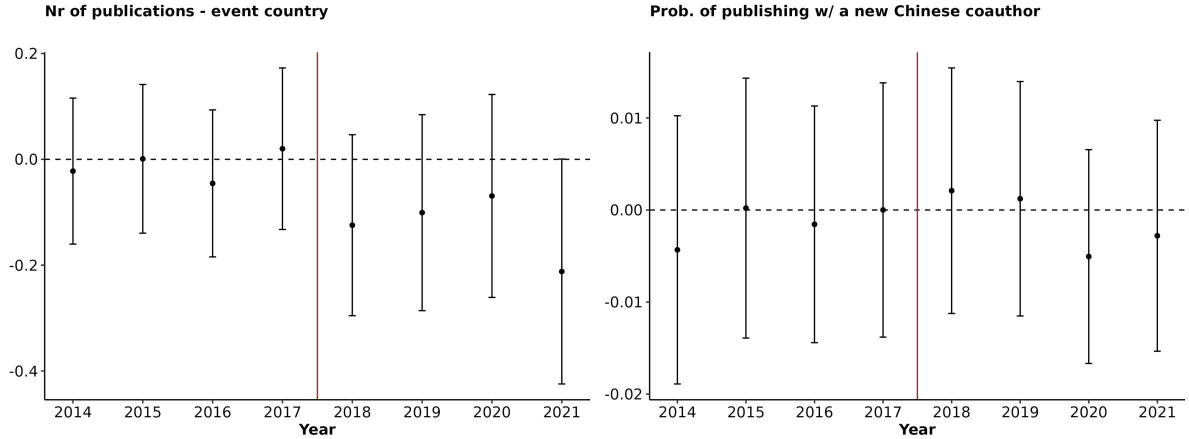


Figure D.1: Effect on reallocation to Chinese coauthors: number of publications and having a new Chinese coauthor

Notes: The graphs above report regression estimates both for the difference in the number of publications with a Chinese coauthor (left) and in the probability of publishing with a new Chinese coauthor (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 (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the number of publications.

Taken together with what is shown in section 4.2, these results tell us the following. First, reallocation does not go towards China, which reinforces our conclusion that top Chinese research is still dependent on international collaboration with regions at the frontier rather than self-reliant. Second, reallocation does not seem to go towards other countries than the US or Europe. This could mean either that the treated authors do not change their relationships with the rest of the world but that the control authors increase their collaborations with it, or that they both but not at the same pace (or only the treated) are moving away from their coauthors in the rest of the world to compensate for the loss of quality. Although by construction this is not a hypothesis that we can test for, both of these explanations would be consistent with reallocation towards Europe for the treated authors, possibly to the detriment of control authors.

E Discussion and Robustness

E.1 ATT in alternative sample

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

outcome	ATT	Std.Error	lb95	ub95	t
Number of publications	-0.012	0.075	-0.159	0.134	0.166
Number of publications w/ *same country* coauthors	-0.093***	0.021	-0.134	-0.052	4.462
Number of publications w/ Chinese coauthors	0.0001	0.083	-0.163	0.163	0.001
Number of publications in top 5% journals	-0.025**	0.015	-0.055	0.005	1.643
Total citations	-9.241**	4.028	-17.135	-1.346	2.294
Prob. of publishing w/ a new coauthor - *same country*	-0.051***	0.008	-0.067	-0.035	6.311
Prob. of publishing w/ a new Chinese coauthor	0.004	0.004	-0.004	0.012	0.893
Average H-index of coauthors	-0.051***	0.017	-0.084	-0.018	2.991
Average H-index of coauthors (a posteriori)	-0.252**	0.104	-0.456	-0.048	2.422
Average H-index of coauthors (past 10 years)	-0.020	0.190	-0.393	0.353	0.104
Prob. of publishing in a basic journal	0.002	0.006	-0.009	0.013	0.349
Prob. of publishing in a basic journal w/ same country coauthors	-0.011**	0.005	-0.022	-0.001	2.066
Nr of pubs in basic journals w/ same country coauthors	-0.017	0.020	-0.056	0.021	0.880
Score of basicness w/ *same country* coauthors	-0.074***	0.015	-0.102	-0.045	5.047

Notes: The table above reports regression estimates in our alternative sample for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2011-2017 for our main outcome variables. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable when it is not a probability.

E.2 Alternative variables

We provide here the event study results for 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-normalized H-Index for coauthors to avoid lifecycle effects on their H-Index as provided in Figure E.3 does not change our result. Table E.2 summarises the ATT for these variables on average over the period.

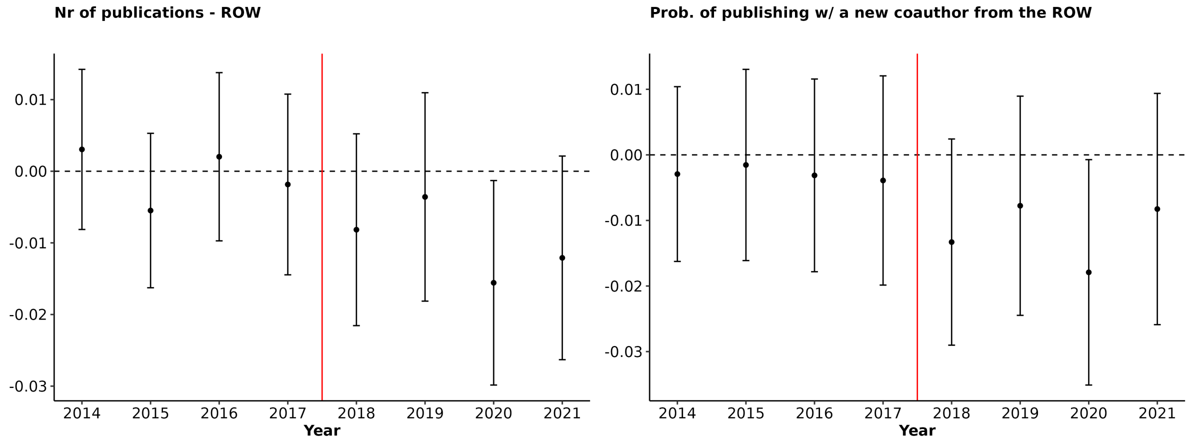


Figure D.2: Effect on reallocation to ROW coauthors: number of publications and having a new ROW coauthor

Notes: The graphs above report regression estimates both for the difference in the number of publications with a coauthor from the rest of the world(left) and in the probability of publishing with a new coauthor 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 (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the number of publications.

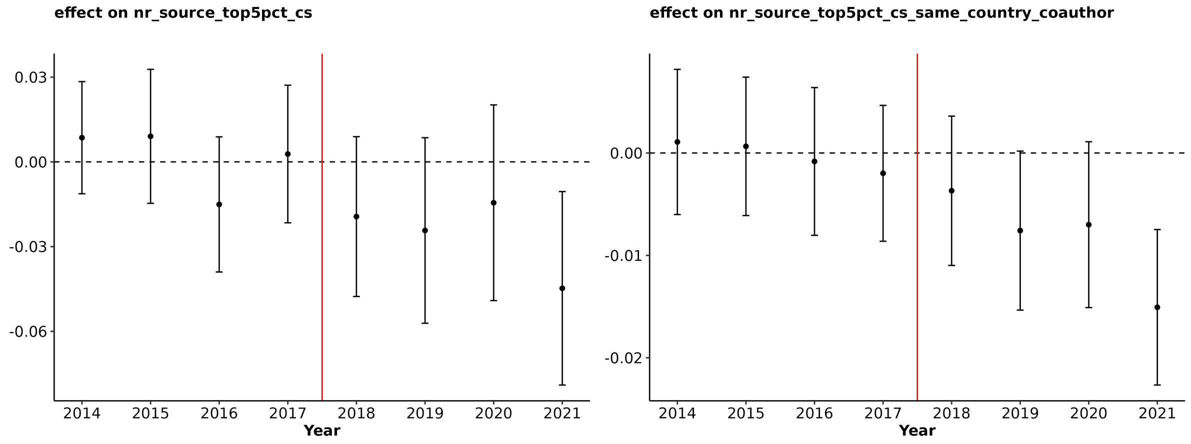


Figure E.1: Effect on publishing in the top 5% of journals based on CiteScore: global and treated with US compared to control with Europe

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 coauthor for the treated and a European coauthor 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 (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

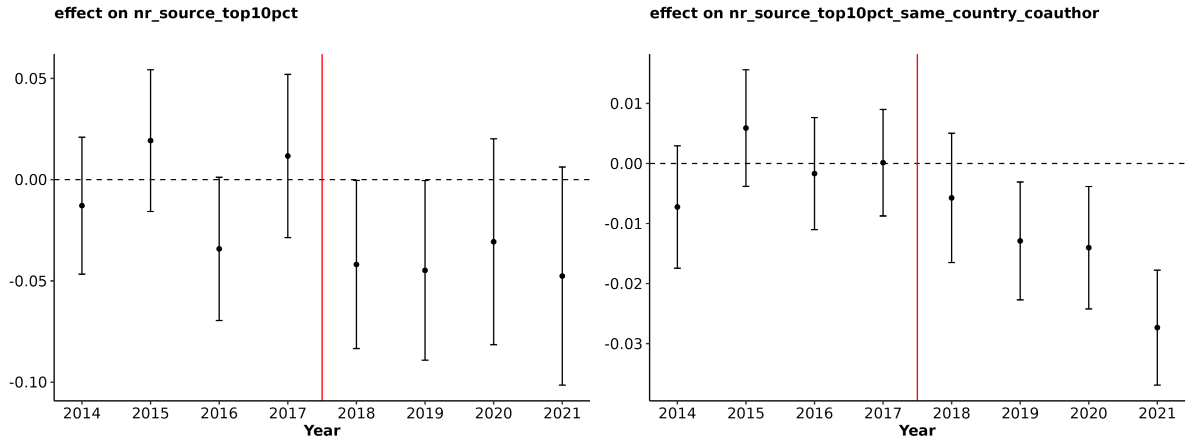


Figure E.2: Effect on publishing in the top 10% of journals: global and treated with US compared to control with Europe

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 coauthor for the treated and a European coauthor 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 (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable.

Table E.2: Average Treatment on the Treated (ATT) for alternative specifications of measures of publication and coauthor quality

outcome	ATT	Std.Error	lb95	ub95	t
Publications in top 5% journals (CiteScore)	-0.0257***	0.010	-0.045	-0.007	2.639
Publications in top 5% journals (CiteScore) w/ same country	-0.0083***	0.002	-0.013	-0.004	3.519
Publications in top 10% journals	-0.0412***	0.014	-0.068	-0.015	3.027
Publications in top 10% journals w/ same country	-0.0150***	0.003	-0.021	-0.009	4.749
Age-normalized H-index of coauthors (real-time)	-0.0313***	0.006	-0.043	-0.020	5.210
Age-normalized H-index of coauthors (a posteriori)	-0.0085**	0.004	-0.017	-0.0001	1.992

Notes: The table above reports regression estimates for the difference between the treated and the control on average over the period 2018-2021 compared to the period 2013-2017 for alternative choices for our custom outcome variables. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable when it is not a probability.

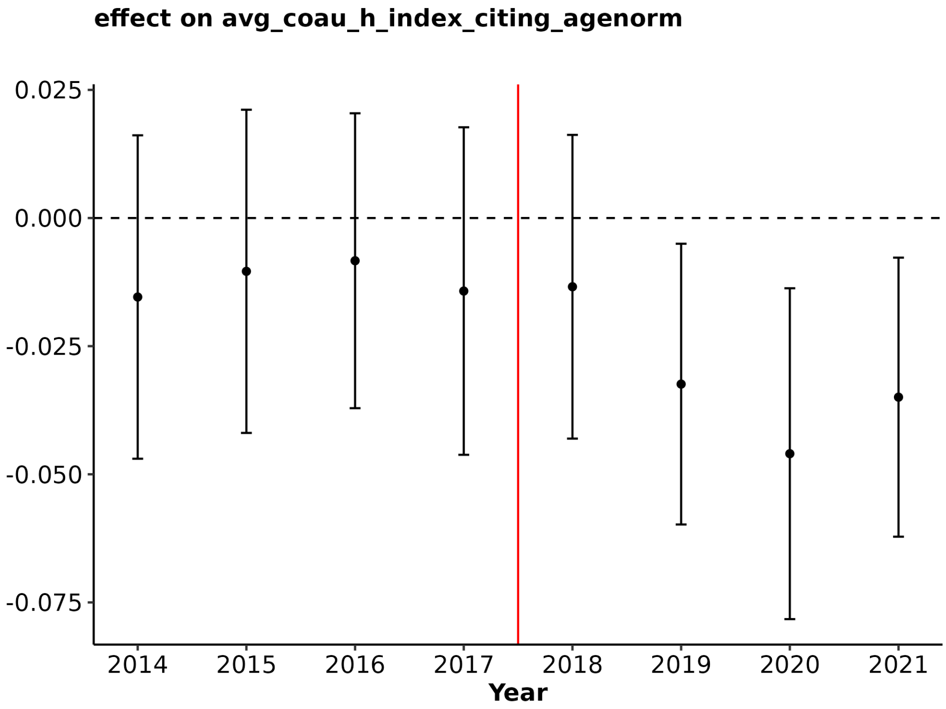


Figure E.3: Effect on H index of coauthors normalized by seniority

Notes: The graph above reports regression estimates for the difference in average H-Index of coauthors 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 (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences).

E.3 Placebo test

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

outcome	ATT	Std.Error	lb95	ub95	t
Number of publications	0.0901	0.094	-0.095	0.275	0.953
Number of publications w/ *same country* coauthors	0.0460	0.035	-0.024	0.116	1.295
Number of publications in top 5% journals	0.0359∗∗	0.015	0.007	0.064	2.461
Number of publications in top 5% journals w/ *same country* coauthors	0.0181∗∗	0.008	0.003	0.033	2.357
Total citations	-0.6015	4.035	-8.510	7.307	0.149
Prob. of publishing w/ a new coauthor	0.0044	0.008	-0.011	0.020	0.553
Prob. of publishing w/ a new coauthor - *same country*	0.0159	0.012	-0.008	0.040	1.298
Prob. of publishing w/ a new Chinese coauthor	0.0265∗∗	0.011	0.004	0.048	2.364
Average H-index of coauthors	-0.8094∗∗	0.315	-1.428	-0.191	2.567
Average H-index of coauthors (a posteriori)	-0.3334∗∗	0.194	-0.714	0.048	1.716
Average H-index of coauthors (past 10 years)	-0.4862∗∗	0.197	-0.873	-0.100	2.464

Notes: The table above report regression estimates for the difference between the treated and the control group on average over the period 2010-2015 compared to the period 2006-2009 for our main outcome variables. Those estimates are obtained with the method of Callaway and Sant'Anna (2020). Propensity scores are computed using publications (total and with US and European coauthors respectively for treated and control), total citations, and interaction between first year of publication in Scopus and main domain (life, health, and physical sciences). The dataset is winsorized at the top and bottom of the distribution at the 2.5% level for the outcome variable when it is not a probability.

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