Innovation Attaché China
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Further Information

Sino-Dutch Research: Overview & Opportunities

Summary

Overall, the Netherlands manages to team up with the internationally most accredited universities and research institutes in China. Citation analyses suggest that the mean high impact of research at these universities is far surpassed in the publications that the Netherlands participates on, creating a beneficial situation for both countries. The downside of this daintiness is that the Netherlands remains largely on the international frontier of Chinese research. Dutch universities do not have as big a presence in more local research as countries like Australia and the United States have. This could prove to be a shortcoming when 2nd tier universities, like a select group of 1st tier universities now, start to surpass mean Western European quality from 2020 onwards.

Full message

In the past decade China has become one of the world’s most important scientific players. The country has quadrupled its scientific publication output from 2005 to 2014 and had its first modern national Nobel prize winner in sciences in 2015. It is expected that the country’s mean scientific impact will rise above the world average in a few years1.

Looking at figure 1, we see that in terms of citations2, China has already surpassed surrounding countries traditionally known for their innovative climate, like South Korea and Japan3. It is even drawing closer to countries like France and Germany. Those Western European countries will be surpassed between 2018 and 2025 if the trend continues.

With China’s enormous size, this means that at the moment there are already outliers in specific subject areas that are at least on par with the top research groups of those countries. Biomedical Engineering is such an area. See figure 2 for an illustration.

Note that citing documents do for a large part come from within China. An analysis reveals that of 2013 publications, 52% of citing documents had an affiliation in China, compared to 50% in 20084. However, it is logical that most citations are within the country, certainly as China’s own output has grown to such spectacular size. For the United States for example, the percentage was 46% in 2013.

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2 There is still much research being done on to which extent citations are useful as a measure of quality of research. However, it is generally the only way of doing quality analysis of research on a large scale, used by all major universities rankings for a part of their rankings. Apart from quality, impact is often also an objective in itself. What use is a qualitatively good publication anyway, when there is no one reading it? When dealing with the large quantities that whole organization produce over multiple years, figures are stable through time. Furthermore, the sophisticated measures used by the CWTS ranking and SciVal take care of factors that influence citations not directly related to impact, most notably field-specific citation habits.
3 As China becomes larger, its influence on the world average also grows, making its citation impact naturally draw towards world average. This is not corrected in the citation measures used here. With an increase from 9.4 to 12.7% of the world’s country affiliations, it is however not likely that this is the major cause of increase shown in figure 1. Apart from that, comparisons with other countries always remain valid.
4 Using a separate random sample of 40,000 articles in Scopus for each analysis. This corresponds to about 10 to 20% of all papers in those years. Unless otherwise stated, all scientific publication figures come from Scopus data in the period of 2011-2015.

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Figure 1: Trend in citation impact of a selection of countries. The measure used is the percentage of publications among the top 1/10/50% most cited. The middle panel is the measure most often used. The right panel shows the relative abundance of extra high impact publications. The measure in the left panel is a more general measure of overall impact. Data comes from all the countries’ universities in the Centre for Science and Technology Studies (CWTS) Leiden Ranking⁵.

Figure 2: Top 10 most highly cited universities in Biomedical Engineering 2012-2015 plus the highest from the Netherlands (of all universities with an output of more than 200 English language articles).

⁵ The CWTS Leiden Ranking is used for a few reason. Firstly, it focuses purely on research. Most importantly, it uses a transparent and advanced ranking algorithm based on world-class bibliometric research. In contrast to other rankings, reputation surveys play no part, such that universities with a long history of scientific excellence have no extra advantage. Furthermore, it is also more complete in terms of universities than most other rankings like the Times Higher Education ranking. The CWTS ranking uses an average of the four years ending two years before the year of the ranking, for each ranking.

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At the same time, even with the high growth rates, China’s research is becoming more international. From 2005 to 2016, the share of international research has increased 63%.

Next to that, the government is investing large amounts of money in scientific facilities – highlighted by projects such as the FAST radio telescope or the EAST fusion reactor. The 13th five year plan set a goal of increasing R&D spending from 2.1 to 2.5% of GDP in 2020. This will not likely bypass public research, especially if companies don’t manage to raise their R&D funding sufficiently.

Finally, overseas trained Masters, PhDs and Postdocs are increasingly lured back to China using a variety of policies, such as the CCP’s 1,000 Talents Program for the most highly talented. Where the first batch in 2008 started with 122 awardees, the 5th batch in 2011 already had 318 awardees. Next to that a youth program was launched in 2011 with similar numbers of awardees.

All of these developments make it likely that in the future a much larger part of the world’s relevant scientific research will be happening in China. Therefore it has become increasingly important for a country with an internationally oriented, knowledge driven economy like the Netherlands to anticipate on this and define a clear strategy on how to involve Chinese research in its academic roadmap.

This paper is part of a series that aims to provide an overview of Chinese research and Sino-Dutch collaboration, and how it compares to the research activities of China with other countries. The data that is used has been provided by Elsevier. This Anglo-Dutch, Amsterdam based company offers the world’s largest database of scientific publications Scopus, and the related research intelligence tool SciVal.

Overview and Comparison of Sino-Dutch Joint Research
An analysis using Scopus reveals that in terms of output, the Netherlands occupies the 10th place in the list of China’s biggest publication partners in the period 2011-2015. See figure 3 for an overview of the other partners.

Worldwide, the Netherlands is also the 10th most prevalent country on international scientific publications. However, the fact that the Netherlands also occupies the 10th place among China’s partners, seems in the first place a testimony to the presence of the Netherlands in international research network. On average, a paper from the Netherlands with an international partner has 1.2 extra participating countries. For those with China, this number is 2.9. To the Netherlands, China is the 12th biggest partner, while worldwide it is the 4th biggest producer of papers in international collaboration. In other words, the Netherlands is involved in Chinese research partly thanks to its international network, and bilateral papers are less common than for other Dutch partners.

Looking at figure 3, it seems more than 50% of all Chinese international research is conducted in collaboration with an Anglo-Saxon country, while worldwide, these countries only have a 30% share. It would seem logical that the lower language barrier has been an advantage to these countries to start and foster collaboration. This can be a direct consequence, or indirect, through the large number of Chinese students and PhDs these countries have received.

In research networks such as the one in figure 7 (appendix), these countries are also at the frontier of the mixing of Chinese and international research. The Netherlands is at the forefront of continental Europe in terms of integrating with Chinese research. Interestingly, there are some good universities that are still largely outside the international network. Especially Hunan University, and Guangzhou’s South China University of Technology come to mind.

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6 Elsevier’s Scopus includes over 21,500 peer-reviewed journals, books series, and conference proceedings in all areas of science, together entailing more than 10 million records the last five years.

7 A publication counts as a joint publication if there is an affiliation present from at least both countries. This can be two or more authors from a Chinese and a Dutch university, but also one author with multiple affiliations.

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Figure 3: Top 10 of biggest partners of China, as measured by number of country affiliations on Chinese publications compared to all foreign affiliations.

Figure 4 displays the growth rate of each country’s share in Chinese international research. The two biggest and smallest growers among China’s top 10 closest partners have been displayed, plus the biggest European partners, France, Germany and the UK. When looking at the trend since 2005, we can see that the Netherlands and China have had the most important period of research merging between 2008 and 2011. Note that China’s research output has grown enormously in this period and its research has become more international at the same time. Therefore, the growth in absolute number of Sino-Dutch papers from 2005 to 2015 was about 350%.

In more recent years however, the growth of the Sino-Dutch research has slowed down. At this rate the Netherlands will not catch up with Germany, and definitely not China’s biggest Anglo-Saxon partners, who are still taking up a bigger share.

Impact of Joint Research

Impact of collaboration as measured by citations is displayed in figure 5. This data comes from Elsevier’s SciVal. Of the 10 biggest partners of China, research with the Netherlands pays off best to China in terms of impact. The joint research scores highest in citations impact on an absolute scale. On a relative scale, the Netherlands also benefits from joint research with China more than average. The joint research has more than 1.5 times the impact of Dutch research on average. In this respect the difference with the Anglo-Saxon countries and Singapore, relatively big partners of China, is clearly noticeable.

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8 Hong Kong and Taiwan are excluded as entities in this analysis to make it more insightful, while they are not included with mainland China in the database. Furthermore, CERN publications were also excluded in the rest of the paper, as they have lists of hundreds of authors and more than 30 countries on each paper, which makes it unclear how big the contribution of each country really is.

9 SciVal is an analysis tool developed by Elsevier, closely linked to Scopus, but with much more possibilities to do advanced analyses. Note that in this analysis, CERN papers were not excluded.

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Figure 4: Growth in share in Chinese international research for a number of countries, compared to 2005-2008. 100% means the same share in Chinese international research as in 2005-2008. In absolute terms this would still mean growth, as the Chinese research output has also grown in this period, and next to that has also become more international.

Figure 5: Left panel: Citation impact of joint research with China. The measure used is Scopus’ field normalized citation impact. A score of 1.00 is world average, and a score of 2.00 essentially means this research is cited once as much as average. Normal scores range from 0.5 to 2.0. Right panel: Field normalized citation impact with China, compared to the country’s average. Thus, a score of 1.00 means as much (effective) citations per paper for the partner country with China as in general for the partner country.

The field normalized impact is a parameter derived from the mean amount of citations received per paper, but corrected for time effects, and field and publication type specific citation habits. The metric has recently been updated to assign on publication level instead of journal level, making it much more reliable. For more information, see the SciVal manual.

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Combining the research, growth rates and impact, the picture arises that the Netherlands is following a path of quality over quantity\(^\text{11}\). Only 5.1% of Dutch international papers have a co-author affiliated in China, while for the UK this share is 8.2%, and for Australia even 16%. The Netherlands is keeping up with China’s growth, but hardly expanding its share. It collaborates with China mostly in larger scientific collaborations. An average Sino-Dutch scientific publication has 2.9 extra countries participating, while the UK has 1.2 and Australia only 1.0.

It would seem logical that being picky causes a higher impact of shared research, like for France and Germany. However, with continuing major investments in science and a visible increase in impact, at some point it might prove worthwhile to expand the Dutch research presence in China. If the trends continue, this phase will be reached between 2018 and 2025. Foundations for lasting partnerships then can be laid now.

**Geographical Distribution of Joint Research**

The image of a certain amount of cautiousness towards expanding Dutch research share in China is reinforced when taking a look at the geographical spread of international research in China.

International Collaboration is not spread equally around China. Publications without a second or first tier city are quite rare, but nowadays second tier cities\(^\text{12}\) are the largest producers of publications, and in absolute sense also of publications in international collaborations. However, universities and research institutes in first tier cities remain in relative sense the most international. 35% of all publications from first tier cities in Scopus are international publications, while the Chinese average is 28%. Figure 6a shows how collaborations of France, Germany, United Kingdom, United States and Australia are distributed in China compared to the Netherlands.

The countries with whom China collaborates most, in recent years also those with the highest relative and absolute growth rates, are overrepresented in second and third tier cities. One could argue that they have ‘saturated’ the first tier cities, or that their strong presence in first tier cities has caused spill-over to second and third tier cities. The Netherlands is severely underrepresented in second tier cities, while remarkably it is overrepresented again in third tier cities\(^\text{13}\).

This would lead us to believe that **most room for growth with China lies in collaborations with second tier cities**. Especially since universities in these cities are barely inferior in research impact compared to 1\(^{\text{st}}\) tier cities (see figure 6b). Also in the reputation based research ranking of Times Higher Education, there are now six 2\(^{\text{nd}}\) tier city universities in the top 300, compared to five 1\(^{\text{st}}\) tier. Still, the highest ranked universities with traditionally the best international reputation are mostly 1\(^{\text{st}}\) tier cities universities (Tsinghua, Beijing, Shanghai Jiaotong, Fudan and Sun Yat-Sen University).

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\(^{11}\) Note that the situation in particular fields of science can be very different. An earlier IA China analysis of Engineering & Technology publications revealed a citation impact that was actually below Dutch average. Another database was used for this analysis. Also in Scopus, it seems that other areas of science mostly produce the high average for Sino-Dutch papers. IA China is planning to do a follow-up paper to differentiate fields of science.

\(^{12}\) The definition of tiers used here is: Beijing, Shanghai, Guangzhou and Shenzhen are 1\(^{\text{st}}\) tier cities. All provincial capitals plus Beihai, Dalian, Ningbo, Qingdao, Sanya, Suzhou, Wenzhou, Wuxi and Xiamen are 2\(^{\text{nd}}\) tier cities, and the rest are 3\(^{\text{rd}}\) tier cities. See: https://en.wikipedia.org/wiki/List_of_cities_in_China.

\(^{13}\) There is no clear Chinese partner in 3rd tier cities, Northwestern A&F University is the biggest, but the major part is scattered across other universities and institutes of the Chinese Academy of Sciences.

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**Dutch Universities in the Chinese Network**

Dutch universities have their own interests and strategies for joint research with China. Figure 8 (appendix) shows how individual Dutch universities are situated in the Chinese network. The three technical universities are most embedded, which is logical as Engineering & Technology is the largest area of research in China. Delft University of Technology (TU Delft) is in fact the biggest partner of China in the Netherlands. Groningen University is the only non-technical university fully embedded in the Chinese network.

Furthermore there are some close collaborations with small individual research institutes. The Dutch National Institute for Subatomic Physics (NIKHEF) shares many papers with University of Science and Technology of China in particle physics. This is an area with traditionally large conglomerations of countries appearing in publications (a mean of 17 per paper in this collaboration). It would seem that a shared paper in this area of science is therefore a less strong indicator of collaboration between two countries in particular. This phenomenon of huge author lists has been described as “hyperauthorship”, and can create false suggestions of collaboration. For example, every contributor to an instrument is often mentioned in every experiment it is used for, such that using a Chinese and a Dutch instrument already counts for a collaborative

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14 Publications for 1st tier: publications where there is a first tier affiliation present, but not a second tier. The reverse was used for 2nd tier cities. 3rd cities publications were defined as a Chinese publications where neither a first nor a second tier city appeared in the affiliations list.

15 There might be a selection effect for universities collaborating mainly in the field of Health Sciences, as university hospitals are sometimes excluded from the university they belong to in Scopus, which makes them too small to appear among the top 40 biggest universities included in these maps. IA China is planning to do a follow-up paper to differentiate fields of science.

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Still, the large international scale of projects in this discipline makes it likely that Chinese and Dutch scientists come into contact with each other more than in other disciplines.

More real in that sense seems the productive collaboration going on between the CBS-KNAW Fungi Biodiversity Center in Utrecht and Sun Yat-Sen University in Guangzhou, producing up to 186 publications in five years. In this collaboration on average only 3.7 extra countries collaborate per publication.

Generally, Dutch universities seem to group around overall high impact Chinese universities, see for example TU Delft with its first and second partner in China, Wuhan University of Technology (not among the top 40 biggest in China, but with a higher citation impact than Hunan University) and Beijing’s Tsinghua University. See also Groningen University with Peking University and Wuhan University. The two biggest partners of the Netherlands, Peking and Tsinghua University are also the highest ranked in the Times Higher Education research ranking, and of the three that follow, two are also among the top five. Note that this does not mean the universities are also the better ones in the particular field of collaboration. In fact, an earlier analysis showed that in Engineering and Technology research, Dutch Universities shared most papers with the better half of the universities, graded on overall quality. However, when doing the same analysis on the level of eleven sub fields, the reverse was true. In other words, the partner universities were high impact universities, but collaboration happened in the “wrong” disciplines. There is no evidence that the same is true for other fields of science.

A few high impact universities do not share more than 100 papers with the Netherlands in 5 years. These are South China University of Technology (Guangzhou), Xiamen University, Beijing Institute of Technology and Huazhong University of Science & Technology (Wuhan). Of course it is very well possible that an overall low impact university might have high impact in a particular niche of collaboration, like the other way around.

**Conclusion**

Sino-Dutch research is paying off to both parties. Citation impact is the highest among China’s top 10 partners, and also relative to national research amongst the highest. It is tempting to conclude that this has in part been due to a prevalent strategy or state of mind among Dutch researchers and universities that ensures that they only work with the best from China. Here the best means having at least a strong reputation or high overall impact. In this situation, the Netherlands is different from the USA, UK, Canada and Australia. This notion is strengthened by a number of observations.

First of all, the high impact relative to country average is similar for France and Germany, which are, like the Netherlands, lagging behind compared to Anglo-Saxon countries in their presence in Chinese research networks. Secondly, the Netherlands, France and Germany are underrepresented in 2nd tier cities, whose universities are often internationally less known for their scientific excellence. Thirdly, the main partners of Dutch universities in China are mostly universities with high impact research, and a solid reputation. Finally, joint research with China is significantly less bilateral than for partners of China that seem to follow the other strategy, like Australia. Note that Australia is apart from this very comparable to the Netherlands in terms of research. Its output is only 50% larger than the Dutch output, and both have about 50% international publications. Sino-Dutch research is also less bilateral than for the Netherlands with other countries. The Netherlands has 1.2 extra partner countries for an average international paper, compared to 2.9 with China, and for Australia the numbers are 0.8 and only 1.0 with China. This suggests that the Chinese scientists the Netherlands collaborates with, are already more included in international networks.

In principle this is a strategy that makes sense. The Netherlands, like France and Germany, has received way less Chinese students than Anglo-Saxon countries and countries in China’s cultural and physical environment.

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16 See for example: [http://berkeleysciencereview.com/too-many-authors/](http://berkeleysciencereview.com/too-many-authors/)

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proximity. For example, according to EURODATA, among every 1000 tertiary students there were 2.5 Chinese in the Netherlands in 2002/2003, compared to 13.5 in the UK, more than four times as much\textsuperscript{17}. It would be logical that as a consequence of this, there is much less bottom-up collaboration going on than in those countries, for example by Chinese researchers that have a degree from both countries. After all, it is hard for a university to push a collaboration upon its scientist if it will not pay off in terms of research impact, which is becoming more and more important as a performance measure. Researchers of Chinese origin with much more contacts at Chinese universities could have other motivations besides this.

However, there are also some arguments for expanding share in Chinese research, even if it would mean an initial drop in quality or impact. Chinese research’s fast growth and large investments offer interesting opportunities for future science collaborations. Furthermore, if the trend continues, after 2020 Chinese research will start to become similar in citation impact to Western European countries. In some niche areas it is already among the world top. Also in rankings with a broader focus, Chinese universities are climbing up. If the Netherlands decides it wants to have a larger part in this research, the foundations for durable collaborations after 2020 can be laid today. IA China is planning a follow-up article to give suggestions on strategies.

**Sources, Further Reading**

4. Elsevier’s Scopus scientific publication database: www.scopus.com
7. CWTS Leiden ranking: www.leidenranking.com/ranking/2016/list

\textsuperscript{17} See Kelo M., Teichler, U. and Wächter, B. (2006), *Eurodata: Student mobility in European higher education*

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Appendix

Figure 7: Co-authorship based research network of the top 40 biggest Chinese universities with the top 50 biggest scientific producers worldwide. Universities are ranked and color coded on overall research impact per publication. The Chinese Academy of Sciences and its affiliated university are not included in this ranking, but they generally house the best of China’s researchers.

18 The widely used network visualization software Gephi was used to create these maps, with the standard force-directed layout Force Atlas 2. Each sphere in these maps has a natural tendency to repel other spheres, but this force is countered in this case according to the percentage of shared publications to overall publications. Forces between countries have been suppressed by a factor a five to make the graph more insightful. The shown maps are one of the possible lay-outs that can arise when activating these forces. For more information, see www.gephi.org.

19 Research impact from CWTS Leiden Ranking 2016, using the percental top 10% impact measure.

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Co-authorship based research network of the top 40 biggest Chinese universities. By giving Sino-Dutch publications a 10 times larger weight, it is shown how Dutch research institutions are positioned in this network.