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## Technological cooperation between Spain and China

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### Theme

Technological cooperation has become a basic component of bilateral relations between Spain and China. Today China is a technological power of the first order. Bilateral relations in this field should be strengthened, but they need specific complementary and reciprocal measures.

### Summary

Scientific and technological cooperation between Spain and China has significant potential to be developed for the benefit of both countries. However, such cooperation would need to be based upon the notions of complementarity and reciprocity. It would also require that Spain develop a specific strategy within its broader approach to technology. While Spain must act within the European framework for such relations, it also should deepen further its own existing institutional framework, building upon the recent creation of the Ministry for Science, Innovation and Universities. There are also important opportunities for Spanish companies in China (especially in the interior) and for Chinese companies in Spain. Together these two countries should develop a Strategy for Scientific and Technological Cooperation between Spain and China (like that which China continues to develop with Germany and with the UK). More scientific research exchanges should be fostered between the two countries. The Spanish Embassy in Beijing should be staffed with a science attaché and the Centre for Industrial Technological Development (CDTI) should expand and strengthen its representation in China.

### Analysis

#### Introduction

Technology has become a basic key to bilateral economic and cultural relations between China and Spain. Although these economies are very different in terms of size and priorities, the two countries have common and interlocking interests that bode well for productive and mutually-beneficial cooperation. But technological cooperation is still marked by a level of investment reciprocity far below that of other countries in Spain's neighbourhood, like the UK, Germany and France.<sup>1</sup>

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<sup>1</sup> Mario Esteban & Miguel Otero-Iglesias (2018), 'Chinese investment in Spain: open for business, but not at any price', ARI 14/2018, Elcano Royal Institute, 6/II/2018, [http://www.realinstitutoelcano.org/wps/portal/rielcano\\_en/contenido?WCM\\_GLOBAL\\_CONTEXT=/elcano/elcano\\_in/zonas\\_in/ari14-2018-esteban-oteroiglesias-chinese-investment-spain](http://www.realinstitutoelcano.org/wps/portal/rielcano_en/contenido?WCM_GLOBAL_CONTEXT=/elcano/elcano_in/zonas_in/ari14-2018-esteban-oteroiglesias-chinese-investment-spain).

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In just a few years, China has become a technological power of the first order, both in quantitative and qualitative terms. The International Monetary Fund (IMF) estimates that China will have surpassed the US in R&D spending by 2026. China has more than 5 million people dedicated to R&D and the country produces more than 1.6 million Science and Technology degrees every year.<sup>2</sup> China is now number two in the international ranking for citations of scientific articles, behind only the US. Today it no longer makes sense to pose the question once constantly asked by analysts just a few years ago: why does China not innovate?<sup>3</sup> Well, now China clearly does. Today China is shaping the technological future of the planet in terms of both products and users.

China now boasts some of the giants of the new digital economy, including Baidu, Alibaba, Tencent and JD.com. Such companies, already important manufacturers of a diverse range of products, are now becoming global. China is also now the country which in absolute terms is installing the most industrial robots. Furthermore, by October 2017, China had produced 17 'unicorns' (private technology companies worth US\$1 billion or more), only two less than the 19 from the US (out of a world total of 46). Today, however, China has 56 such 'unicorns' (while it had only eight in 2014), according to the World Economic Forum. When President Xi Jinping said that 'the international status of China as the largest developing country has changed', he was only describing a part of the reality. China constitutes many different economies at the same time. And in this field, China should be treated as a technological power –which is what it is– pursuing its interests for a more equitable development of its economy and society.

For example, China has surpassed the US on the landmark issue of investment in Artificial Intelligence (AI). It trails the US in patents in this terrain, but it is catching up rapidly. In July 2017, China published a national strategy for new generation AI. The objective of this plan is for China to be the leading global power in AI innovation by 2030. To achieve this objective, China's strategy includes improvements in the areas in which the country plans to deepen its human capital, focusing on education and the recruitment of AI talent.<sup>4</sup>

China also continues to push forward in significant ways in synthetic and genome biology, two other promising fields where research can proceed uninhibited by restrictive national legislation. The Beijing Genomics Institute (BGI) is the largest genetic research centre in the world, and it belongs to a Chinese company.

For its part, Spain is an advanced economy with some strong technological sectors and state-of-the-art research centres that could be of interest to China; but they continue to be hampered by insufficient R&D investment. Expenditure fell during the years of the

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<sup>2</sup> Data from 2017.

<sup>3</sup> Regina M. Abrami, William C. Kirby & F. Warren McFarlan (2014), 'Why China cannot innovate', Harvard Business Review, March, <https://hbr.org/2014/03/why-china-cant-innovate>.

<sup>4</sup> Paul Scharre (2017), 'China's Pursuit of Emerging and Exponential Technologies', testimony before the House Armed Services Committee, Center for a New American Century, <https://s3.amazonaws.com/files.cnas.org/documents/Scharre-HASC-ETC-testimony-1.9.18-FINAL.pdf?mtime=20180108162914>.

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economic crisis, and only with the recovery has it begun to rebound (although at a pace below the average rate of economic growth). Investment in research, development and innovation is now 1.19% of GDP, compared with 1.4% in 2010 and an EU average of 2%.<sup>5</sup> In 2016 and 2017 the private sector increased its investment in R&D by 3%. This is good news, although public R&D spending fell by 3%. In total, R&D spending was only €3.26 billion in 2016. That year, 205,873 people worked in R&D in Spain (of which 126,633 were researchers),<sup>6</sup> and Spain had only four ‘unicorns’.

However, unlike China –and despite having its own State Plan for Scientific and Technical Research and Innovation for 2017-2020– Spain has failed to design a strategy which prioritises technology sectors (even in a general sense and not just with respect to China). Spain must define a technological strategy as a country. The establishment once again, in June 2018, of a Ministry for Science, Innovation and Universities points that way. However, while this addresses the knowledge triangle with targets, it also requires budgetary funding. A catalogue of technological capacities of Spanish companies could also be prepared by the government, along the lines of the commercial strategy which has pushed the ‘Spain brand’ (*Marca España*).

### Chinese objectives

China has clear strategic objectives for its technological cooperation: to progress, to gain knowledge and to eliminate its technological dependence on other countries. Often it does this by acquiring technologies through partnerships with foreign technology companies or, alternatively, through the acquisition of foreign companies.

China is following a plan. In 2017 the total implementation of the reform of China’s Science and Innovation System reached its culmination. The reform was organised in five categories: (1) Natural Science funds; (2) large national Science and Technology (S&T) projects; (3) key national plans for R&D, both in basic and applied research; (4) a technological innovation fund; and (5) a fund for basic science and technology and special talents.

The 13<sup>th</sup> Five-Year Plan for S&T (2016-20), now in force, points to opportunities for foreign companies in advanced manufacturing technologies, the Internet-of-Things, agricultural machinery and seeds, green technologies and smart-cities.

China frames all of this within its *Made in China 2025* industrial strategy that focuses primarily on 10 sectors: new information technologies, robotics and high-quality digitally-controlled machinery, aerospace equipment, marine engineering equipment and high-quality ships and also railway transport, automobiles with new energy-saving and new energy technologies, electrical equipment, agricultural machinery, new materials, and biomedicine and high-quality medical equipment.

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<sup>5</sup> Fundación Alternativas (2018), 1, Madrid, <http://www.fundacionalalternativas.org/las-publicaciones/informes/informe-sobre-la-ciencia-y-la-tecnologia-en-espana>.

<sup>6</sup> Informe Cotec (2018), [http://informecotec.es/media/Informe-Cotec\\_2018\\_versi%C3%B3nweb.pdf](http://informecotec.es/media/Informe-Cotec_2018_versi%C3%B3nweb.pdf).

### Complementarity, reciprocity and opportunities

Chinese technological power suggests that reciprocity and balance should be sought as soon as possible when cooperating with China. European companies and institutions have very limited access to Chinese R&D and face growing problems in contracting Chinese researchers on the ground –another sign of the imbalance in the relationship–. Furthermore, there are some high technology sectors –like the manufacture of solar panels– in which Spain and China are competitors.

China also has a series of ‘prohibited sectors’ which are cordoned off from foreign penetration and imply a serious limitation. The ‘black list of industries’, however, has shrunk in size, from 36 sectors in 2015 to 18 in 2017, and is also increasingly less technological. Nevertheless, foreign activities are still limited in information services, Internet and investment in research centres devoted to the humanities and social sciences.<sup>7</sup>

There are other ‘restricted’ sectors that limit the percentage of shares that foreign entities may own in particularly companies and require upfront approval from the Commerce Ministry for any such investment. China continues to reduce the number of both its prohibited and restricted sectors.

At the same time, there could be even more opportunities for Spanish companies in the regulated sectors –which the Chinese government considers of special importance– in the form of tax incentives and higher operational autonomy. These are the ‘encouraged’ sectors that the Chinese government wants to see attract more foreign investment. They embrace various technologies, including: intelligent emergency medical rescue equipment; the production of hydrological monitoring sensors; the research, development and manufacture of virtual and augmented reality equipment; the design and manufacture of 3D printers; and the construction and operation of hydrogenation stations.

China also has a number of free-trade zones. The latest ‘black list’ applying to the free trade zones (from June 2017) reduced restrictions in more than 20 industries, including railway transport equipment, pharmaceutical products, road transport, insurance, accounting and auditing, and other commercial services.<sup>8</sup>

In June 2017 China’s National Commission for Development and Reform and its Ministry of Commerce (MOFCOM) published a new version of the Catalogue for Investment Orientation for Foreign Investment. The foreign investment restrictions on industries which were either loosened or eliminated in the new Catalogue include railway transport equipment, motorcycles, new-energy vehicle batteries, civilian satellites, unconventional oil and gas production, and credit research and rating services. A few high-tech industries, like virtual and augmented reality equipment, have also received special

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<sup>7</sup> The comparative list has been provided by the European Chamber in China.

<sup>8</sup> China Briefing (2017), ‘China’s new FTZ negative list removes restrictions on foreign investment’, 28/VI/2017, <http://www.china-briefing.com/news/2017/06/28/china-removes-27-restrictions-on-foreign-investment-in-new-ftz-negative-list.html>.

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incentives to encourage foreign investment. But many key industries like banking, health and telecommunications continue to be highly restricted to foreign investment.<sup>9</sup>

A central key for technological cooperation between Chinese and Spanish institutions and companies is the possibility for complementarity in advanced sectors, or sectors in which such cooperation has especially large potential. For instance, in certain sectors the Spanish side might be stronger in one area, while the Chinese side –in a complementary manner– might be superior in some other way. Spanish companies enjoy a strong reputation as ‘integrators’ of diverse technologies, even though they do not always produce them themselves. Green technologies, ecological automobiles, smart cities, the health sector, food and agriculture are all central in China’s Five-Year Plan. Mention should also be made of civilian space infrastructure, new generation information networks, integrated circuits, new materials, biomedicine, aviation engines, gas turbines and defence R&D.

Among the sectors in which China stands out, and in which Spain is also advanced, are 5G mobile communications, crucial for the Internet-of-Things and self-driving vehicles. Others include modern agriculture and food processing, green energies, biotechnology, biomedicine, nanotechnology and new materials (like graphene), pharmaceuticals, smart cities, the aerospace industry and 4.0 industries. And in basic sciences, there is the possible development of a wider network of astronomical observatories.

In all these areas, Spain has many interesting and attractive assets to contribute and a strong interest in cooperation in the face of future competition from increasingly capable Chinese companies. Technological cooperation is a very good tool for the two countries to get to know each other better, and an opportunity for companies from both sides to help each other gain access to the global market. Many Spanish technology companies are present in China, but not as much as other European tech companies.

There should also be complementarity in public-private actions.

### The European framework

Spain-China technological cooperation is part of the general framework of EU-China cooperation, because that is its frame of reference, which is now being redesigned for all Europeans and because they are complementary.

Since 1988 Europe and China have cooperated in this area in accordance with an Agreement on Science and Technology which is renewable every five years. Cooperation is co-directed by the UE’s Directorate for Research and Technology (RTD) and China’s Ministry of Science and Technology through annual meetings.

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<sup>9</sup> China Briefing (2017), ‘China’s 2017 foreign investment catalogue opens access to new industries’, 11/VII/2017, <http://www.china-briefing.com/news/2017/07/11/china-releases-2017-foreign-investment-catalogue-opening-access-new-industries.html>.

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The EU-China 2020 Strategic Agenda for Cooperation, adopted in November 2013, covers cooperation in science and technology.<sup>10</sup> The Agenda was renewed in 2017 with an emphasis on innovation, cross-border transfer of R&D results and reciprocity in access to research (as the EU has insisted since 2016). The Agenda has stimulated initiatives in energy, aerospace, urbanisation, biodiversity and social issues.<sup>11</sup> In addition, almost all the Member States of the EU have bilateral agreements with China. It should also be noted that while trade is an exclusive competence of the EU, investment is not.

Within the Strategic Agenda and the Horizon 2020 programme, the European Commission expects to continue devoting around €100 million a year to European entities involved in H2020 projects with Chinese participants, while China expects to spend ¥200 million (around €25 million) a year on Chinese entities. The priorities targeted by the funding include sectors like food, agriculture, biotechnology, ecological transport, energy and health.

Some European projects –such as the manufacture of Airbus planes in China at centres in Beijing, Tianjin and Harbin– directly favour Spain because they incorporate Spanish technologies in many ways. In this respect, Spain-China cooperation is complementary with Europe-China cooperation. H2020 is focused on intermediate technology levels of interest to Spanish companies. Furthermore, the EU has additional mechanisms that could also prove of great interest to Spanish firms, especially small and mid-sized companies. One of these is the IPR Help Desk, which offers free advisory services for small and mid-sized companies on issues related to intellectual property rights (IPR) and patents; another is ENRICH, a new European centre for the promotion of technological cooperation.

There is also a Europe-China ‘connectivity platform’ embedded within the Chinese initiative of the New Silk Road, also known as ‘One Belt, One Road’. So far, the platform has had a fund for small and mid-sized enterprises, financed by the European Investment Bank and the ‘One Belt, One Road’ initiative fund. This enormous project offers a wide range of possibilities in the technology sector, especially activities related to efficient resource distribution, connectivity and market integration.

Despite the framework being European, there is much competition in Europe for cooperation with China between companies and between Member States, particularly Germany, France and the countries of Central and Eastern Europe with which Beijing seeks to have a special relationship.

Nevertheless, a combination of obstacles faces Europe in its pursuit of cooperation with China. These include the asymmetry produced by China’s relatively closed economy and Europe’s relatively open one, differences in the protection of intellectual property, the

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<sup>10</sup> European External Action Service, “EU-China 2020 Strategic Agenda for Cooperation,” available at: [http://eeas.europa.eu/archives/docs/china/docs/eu-china\\_2020\\_strategic\\_agenda\\_en.pdf](http://eeas.europa.eu/archives/docs/china/docs/eu-china_2020_strategic_agenda_en.pdf).

<sup>11</sup> François Godement & Abigaël Vasselier (2017), *China at the Gates: A New Power Audit of EU-China Relations*, ECFR, London. We also draw on other data and analysis from [http://www.ecfr.eu/publications/summary/china\\_eu\\_power\\_audit7242](http://www.ecfr.eu/publications/summary/china_eu_power_audit7242).



growing Chinese demand that foreign investment be accompanied by the transfer of technologies from the investing companies, the general difficulties faced by foreign investment in China and a massive Chinese plan for the acquisition of civil and military technology abroad.

As the European Council for Foreign Relations pointed out in the study mentioned above, 'The demand of the Europeans for *reciprocity* has become a key issue frequently inserted into their declarations on China. But it has become increasingly clear that the European Union should also design policies appropriate for an epoch in which China might reject reciprocity'. Some go further in their projections. The geopolitical consultancy Eurasia highlights the risks of a Global Tech Cold War and a 'Global Cold War for Technological Supremacy', in which the major powers appropriate the ground-breaking scientific and technological discoveries and seek to dominate the markets.<sup>12</sup>

In light of this situation, protectionism is growing in Europe (as well as in the US) in the face of increasing Chinese investment in sectors considered to be strategic. The feeling is greatest in France, Germany and Italy (with a certain amount of support in Spain, compared with the opposition of the Nordic countries). One option is to establish an agency to regulate investment at the European level, like the Committee on Foreign Investment in the United States (CFIUS). Spain supports such an initiative as long as the final decision authorising investment projects remains in the hands of the Member States.

To prevent the acquisition by China of companies with high technological value (as occurred in 2017 with Kuka, the German robot manufacturer), the European Commission proposed to the Council and the European Parliament in October 2017 a screening system for all investments that might affect the interests of the Union, especially those with security implications or whose technologies have been subsidised. The proposal, along Chinese lines, also creates a list of critical technological sectors for the industries of the future, including in the military realm. The Member States would have to inform the European Commission of their own screening processes, although some still lack such procedures. The entire system could make technological cooperation between China and the countries of the EU more difficult, particularly if it is undertaken primarily through the acquisition of companies.

Spain has its own mechanisms that allows it to suspend the principle of investment freedom, in line with the assumptions also held by the Commission.<sup>13</sup> Therefore, such a new European system would not distort Spain's own vision, or the defence of its interests.

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<sup>12</sup> Ian Bremmer & Kliff Kupchan (2018), *Top Risks 2018*, Eurasia Group, [https://www.eurasiagroup.net/files/upload/Top\\_Risks\\_2018\\_Report.pdf](https://www.eurasiagroup.net/files/upload/Top_Risks_2018_Report.pdf).

<sup>13</sup> Mario Esteban (2018), '¿Deben limitarse las inversiones chinas en Europa?', Comentario Elcano 17/2018, Elcano Royal Institute, 22/II/2018, [http://www.realinstitutoelcano.org/wps/portal/rielcano\\_es/contenido?WCM\\_GLOBAL\\_CONTEXT=/elcano/elcano\\_es/zonas\\_es/comentario-esteban-deben-limitarse-las-inversiones-chinas-en-europa](http://www.realinstitutoelcano.org/wps/portal/rielcano_es/contenido?WCM_GLOBAL_CONTEXT=/elcano/elcano_es/zonas_es/comentario-esteban-deben-limitarse-las-inversiones-chinas-en-europa).

### The Spain-Latin America-China Technological Triangle

Europe is not everything. Spain is intimately linked to Latin America, and in the technological realm as well. Technology –particularly the digital dimension– will be very present at the next Ibero-American Summit in November 2018, as well as at other regional and international meetings. Latin America must truly enter the Fourth Industrial Revolution; this is one of the big topics that the Argentine Presidency of the G20 in 2018 wishes to address. China is also very present in the region, through investment and trade. Although this is especially the case with respect to raw-material extraction, China is also interested in the technology question in Latin America. For this reason, Spain's focus on the region should also consider China and its technological contributions so that experiences in technological cooperation between Spanish, Chinese and Latin American companies and research centres might crystallise. There is a technological relationship between Spain and Latin America, another between Latin America and China and, finally, another between China and Spain. Triangulation in this area could be interesting and could strengthen all three vectors of cooperation. For triangulation to be acceptable to both Latin Americans and the Chinese, however, it should be designed as a process of exchange between companies and/or research centres and not as an inter-governmental strategy.

### The institutional framework

The institutional framework for technological cooperation between Spain and China is relatively well-developed, although it should be deepened and improved. Nevertheless, China has a Strategy for Scientific and Technological Cooperation with Germany and another with the UK, but it has not developed such an instrument for its relations with Spain. The creation of the Ministry for Science, Innovation and Universities might be able to stimulate the development of such a strategy. In 2013 the two countries signed an agreement for cooperation in R&D+I but there is still no effective bilateral mechanism for the two governments to promote it.

Currently cooperation is largely undertaken by the Spanish CDTI and by the Chinese Torch Centre (High Tech Industry Development Centre), which has been gradually developed over the years. The CDTI is a public business entity –currently part of the Ministry for Science, Innovation and Universities (and previously the Ministry of Economy, Industry and Competitiveness)– that promotes innovation and technological development by Spanish companies. Given the stakes involved, the CDTI still has an insufficient presence in China: the Centre has only one delegate and an assistant in Shanghai. Bilateral technological cooperation would certainly gain from a stronger CDTI presence in China.

Torch –China's counterpart to the CDTI– is a public entity under the Ministry of Science and Technology, focused on the commercialisation of R&D products, the industrialisation of technological products and the internationalisation of China's technology industry.

Among the instruments available for achieving its objectives, the Torch programme has the High Technology Zones, Technology Business Incubators (TBIs), the so-called 'landing parks' for technology initiatives, project financing and tax incentives. A 15% reduction in corporate tax on high-tech and new technology companies is foreseen,



along with deductions of up to 150% on eligible spending on new product, process or technical development. Eligible companies must be based in China and develop their activities in the priority sectors mentioned above.

The CDTI and Torch signed an MOU in 2002 and the former opened an office in Shanghai. In 2006 the bilateral Chineka programme was launched to support the joint development of technological innovation projects between Spanish and Chinese companies (with the participation of at least one from each country). Such projects are intended to develop innovative and market-oriented products, processes and services. For a project to obtain the Chineka stamp of recognition implies a quality and international endorsement from both the CDTI and Torch. Once the Chineka stamp has been awarded, the Spanish counterpart can request finance from the Ministry's PID fund (soft loans of up to 75% of the total, and up to 33% of the non-refundable component) or Innoglobal (based on subsidies).

There are also other important organs within the Chinese Science and Technology system, such as the Ministry of Industry and Information Technologies (which undertakes China's industrial planning, policies and regulation), the Ministry of Education (which is responsible for many of the human resources in Science and Technology) and the China Academy of Sciences (made up of 124 institutions, including 104 research centres and two universities), which since 2016 has a new MOU with the Higher Centre for Scientific Research (the Spanish CSIC) for exchange of researchers, the development of joint research and the training of doctoral and postdoctoral students (substituting the previous MOU of 1988).

At the same time, high-technology industrial parks –with incubators, finance instruments and tax incentives– have become more important as they offer further new opportunities. In the opposite direction, the China-Belgium Technological Park has also been inaugurated and is now considered the 'first Chinese incubator in Europe', even though the experiment is not yet yielding the expected results. Another Chinese incubator could be proposed for Spain after a study of the problems encountered by the first attempt.

To strengthen the whole of Spain institutionally, it would also be good for the Autonomous Communities to coordinate both among themselves and with the Central Administration –through the CDTI– to undertake technological cooperation with China. Each Community currently operates on its own. Some of them have their own agencies (similar to the CDTI). For instance, in Catalonia the role is taken up by the Agència per la Competitivitat de l'Empresa (Acció, the Agency for Business Competitiveness). In the Basque Country the equivalent is Tecnalía, which has a high-quality technology centre and relationships with certain Chinese institutions such as the Chinese Association of Automobile Manufacturers (CAAM). But Spain's image would benefit internationally, and in China, if it had a coordinated network of technology centres.

## Geography

The most interesting areas for technological industrial activities are in eastern China and especially in the most developed cities, like Shanghai, Beijing, Shenzhen and Tianjin. But the areas that are of highest interest for China in this regard are cities inland towards

the west of the country, like Chengdu and Chongqing, and in the north-east in places like Shenyang and Harbin, where the government wants to promote further development and growth. The government has also designated special zones for such purposes in which even more opportunities could emerge.

In Spain there is a certain amount of competition, not only between companies, but also between cities, Autonomous Communities and the government itself to attract Chinese technology and to offer Spanish technology to China. It would be highly convenient to coordinate these processes because, in its absence, their potential to be a positive factor of strength could easily become a weakness in the face of much more centralised decision-making on the part of China.

Finally, there is the question of language. Much Spanish-Chinese cooperation is conducted in English, and Spanish companies are still behind in language skills. With the newer generations, however, the gap is rapidly being eliminated. Nevertheless, there is still a need for interaction in Chinese.

It should not be forgotten that the knowledge of foreign cultures possessed by both Spain and China has a heavy influence on technological cooperation (just as it does for all types of economic cooperation) since it influences personal relationships and builds trust. On the other hand, there is still a relative lack of mutual knowledge, in this case between Spain and China, and particularly in the field of technology.

### Research and researchers

Scientific and technological cooperation between Spain and China also requires a greater exchange of researchers. There is still much ground to cover, especially with respect to Chinese students and researchers in Spain. Although the number of Chinese students has increased to more than 8,000 in 2016, most come to Spain to study Spanish, just as, in the other direction, most students from Spain in China study Chinese. More campaigns should be undertaken in China to make known the wide possibilities available in Spain. In general, Spain remains off the map for the Chinese scientific elite when considering an attractive place in which to engage in research. On the other hand, the perception in Spain of the possibilities for research in China, or of the quality of its human capital, is also insufficient.

In the field of Science and Technology (excluding the social sciences), the Higher Council of Scientific Research (CSIC) –including both its central headquarters and its various dependent organisations in the Autonomous Communities– has 13 agreements –and other accords, some of which have been mentioned, like MOUs (Memorandums of Understanding)– with Chinese institutions, including the Academy of Sciences, the Centre for Mathematical Sciences at the University of Tsinghua and the Hong Kong University of Science and Technology, to mention just a few examples. Three of the projects cover a broad range of technological materials (mercury and catalysis, titanium and the geometry of tailor-made equations and string theory), but much more activity could be undertaken by the CSIC if it had the requisite funding.

The number of scientific projects undertaken between Spain and China has increased from less than 300 to more than 1,500 in 2015 according to data from the Spanish Foundation for Science and Technology.<sup>14</sup> In this respect, China has risen from number 30 to number 17 during these years in terms of scientific cooperation with Spain.

To cooperate often means to co-finance projects, joint notifications, pre- and postdoctoral scholarships, short visits by senior researchers, exchanges of technical personnel, etc. China is very open to this type of cooperation and has agreements with many European countries and with the EU. But Spain does not seem to be in a position to bear its part of the cost of such exchanges. Nevertheless, China should be an absolute priority and the required resources should be assigned to it if Spain is not to fall far behind. The Max Planck Institute (Germany), the CNRS (France), the Wellcome Trust (UK), the Newton Fund (UK) and the Royal Society (UK), along with the Howard Hughes and McGovern Institutes (US) are all financing researchers, laboratories, centres and projects that are clearly attempts to position themselves in China.

Since 2017 there is a Spanish Scientific Network in China with approximately 50 researchers –half from the hard sciences (and half of these biologists) and the other half from the social sciences and humanities–. The presence of Chinese researchers in Spain is much more limited. The administration does not have reliable data in this respect. However, in some important universities and research centres in the US more than 20% of the researchers are Chinese. So there is ample scope for the further development of possibilities and for greater contact between Spanish researchers in China and Chinese researchers in Spain.

The Spanish Foundation for Science and Technology (FECYT) –under the Secretary of State for R&D+I (SEIDI) of the Ministry of Economy, Industry and Competitiveness– publishes a catalogue of opportunities for all foreign students (including the Chinese). But there has been no specific action directed at China thus far.

Spain could take further advantage of the European EURAXESS Initiative (financed by the European Commission) to promote scientific relations between Europe and China, and to attract talent to the Union. Within this initiative, there is a special Spain section with much information for foreign researchers on Spain.

A science attaché for the Spanish Embassy in China should also be assigned to Beijing or Shanghai. At the least there should be a coordinator such as those that are currently present in Washington, London and Berlin.

## Conclusions

- Technological cooperation between Spain and China is a key to re-launching the entire bilateral relationship.

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<sup>14</sup> <https://services.icono.fecyt.es/indicadores/Paginas/default.aspx?ind=609&idPanel=1>.

- It is an asymmetrical relationship, given the respective sizes of the two countries and their respective levels of R&D spending in absolute terms. But a mutually beneficial relationship can be developed between Spain and China.
- There are significant opportunities in China for Spanish companies and in Spain for their Chinese counterparts.
- Most of these opportunities are in inland China (given the development interests of the Chinese government) and in a number of non-prohibited sectors.
- Technological cooperation between Spain and China and between the EU and China should be complementary.
- Given the lack of reciprocity in this field between Spain and China, along with European fears that Chinese acquisitions will lead to Chinese control of European critical technology, the EU is preparing protectionist measures that will restrict the scope of cooperation.
- The institutional framework, particularly CDTI and Torch, works relatively well but could be reinforced and given a boost.
- A Strategy for Scientific and Technological Cooperation between Spain and China should be developed, along the lines of the strategies that China already has with Germany and the UK.
- The CDTI should broaden and deepen its presence in China.
- Coordination between the Autonomous Communities and the central administration should be established for cooperation through the CDTI.
- More exchange of researchers between Spain and China should be promoted, and a scientific coordinator should be posted to the Spanish Embassy in Beijing.
- It would also be important to propose triangular technological cooperation between companies and research centres from Spain, Latin America and China.<sup>15</sup>

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<sup>15</sup> I am grateful for information and comments from Carlos Quintana, CDTI Delegate in China, and particularly for his presentation: *China and Taiwan*, Madrid, 19 December 2017; and for the information provided by Alicia Mas Martínez, CDTI representative in China. I additionally appreciate the exchange of analyses with Ángeles Valbuena Puente, manager of the CDTI's Asia-Pacific R&D Programme, and also the data and points of view contributed by José Pastor, researcher in Life Sciences at the University of Tsinghua and coordinator of the Spanish Scientific Network in China. The Spanish Foundation for Science and Technology (FECYT), of the Secretariat of State for R&D+i (SEIDI), the Ministerial Cabinet of the Ministry for Science, Innovation and Universities, and the International Department of the CSIC also provided me with valuable information.