Conflict and Cooperation in the Development of US–China Relations in Science and Technology: Empirical Observations and Theoretical Implications

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Abstract Science and technology have played important roles in the development of US-China relations since the late 1970s. The mechanism of scientific and technological cooperation between the two countries has been a useful tool of diplomacy and remains so today. However, the use of that tool has become more complicated over the past three decades in the face of changing political, economic and security environments, the impact of China's growing capabilities in science and technology, a deepening of economic globalization and the growing role of global production networks, and the rise of global environmental and health issues. Ethnic identity as a basis for collaboration and the changing roles played by US-based ethnic Chinese scientists and engineers have played important roles. While the imperatives for building a long-term, sustainable cooperative science and technology relationship between the two countries are stronger than ever, the potential for conflict also has increased, pointing to the need for new approaches to governance in the bilateral relationship.

Keywords US-China relations • International scientific cooperation • Science and foreign policy • Science • Technology and international relations

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1 Introduction

Science and technology have played, and continue to play, an important role in the overall relationship between China and the United States. Not surprisingly, the S&T relationship reflects a distinct, rich historical experience of engagement and dis-engagement between China and the United States. But, this bilateral “science and technology relationship” (hereafter, S&T relationship) also provides especially rich case material for examining the ways in which science and technology are related to international relations.

In general, science and technology have not figured prominently in the conceptual apparatus of international relations in spite of their significance for understanding such central concerns as national security, economic competitiveness, foreign assistance, and sustainability. More often than not, questions of science and technology in international affairs are not seen as rising to the level of high politics and, indeed, scientific and technological relationships are often regarded, at best, as low politics or as of trivial interest. S&T relationships are typically considered derivative of political relations in spite of the growing importance of the internationalization of research and innovation and its growing implications for the wealth and power of nations.

The discussion below does not purport to offer significant theoretical breakthroughs but it does present a case rich with implications for the development of conceptual schemes to enhance understandings of international relations in the twenty-first century. In the discussion that follows, we explore the evolution of the relationship highlighting how changing asymmetries of scientific and technological capabilities alter the ways in which the two countries interact, and note the strong transnational elements of the relationship which raise interesting challenges for state to state interactions. We argue that the relationship has been strongly influenced by changes in the international political and security environments, as well as by the rise of new global issues associated with energy, environmental quality, and public health. We also explore governance mechanisms for the relationship and the approaches to managing it domestically in the two countries.

2 Background

Prior to the founding of the People’s Republic of China (PRC), many of China’s leading scientists were trained in the United States, American missionary educators played a key role in establishing and building up Chinese universities, and a variety of public and private US initiatives supported the founding and development of such key institutions as Tsinghua University and Peking Union Medical College. This important legacy of cooperation, however, was interrupted by the Communist victory in 1949, the failure to establish diplomatic relations between the two countries, China’s “leaning” toward the former Soviet Union for a decade thereafter, and the rise of anti-communism in the United States (Chang 1995). Nevertheless, the legacy never completely died and its enduring quality became evident in the early 1970s as political relations between the two countries began to thaw.

The ways in which science and technology were related to the establishment and improvement of diplomatic relations during the 1970s is an instructive example of the uses of S&T in diplomacy. There is no doubt that S&T relations would not have developed as they did without a significant political breakthrough, driven largely by shared geopolitical interests vis-a-vis the former Soviet Union. Nevertheless, shared interests surrounding science and technology offered assets to the political negotiation process that were quite distinctive. After the debilitating effects of the Cultural Revolution on its research and education system, China quickly grasped the critical importance of restoring the effectiveness of its science and technology system and, by the late 1970s, had come to understand just how damaging the country's interlude of more than a decade of radical politics had been in setting back its scientific and technological development during a time of rapid advances internationally. In particular, China largely missed the onset and contributions of the microelectronics and information revolutions that re-shaped the growth trajectories of the Western economies and became the foundation of high technology development in the US, Western Europe, and its East Asian neighbors.

Confronted with the starkness of Chinese backwardness at the time, Chinese elites were primed to give scientific and technological development an important place on their domestic policy agenda. Key American scientists, principally those of Chinese descent, encouraged this policy orientation, and many of China's senior, US trained, scientists helped revive the spirit of the pre-1949 legacy. Together, these factors made the prospect of establishing science and technology cooperation especially appealing, a fact which was appreciated by officials of the Carter administration. These various strands of interaction and engagement came together in efficacious new ways in 1978 when, prior to normalization, the US government sent a delegation of its senior science officials to China, a mission which resulted in the signing of the first of many formal government to government agreements for educational exchanges and scientific and technological cooperation. This high level visit led directly to the reestablishment of diplomatic relations in early 1979 (Smith 1998: 114–136; Suttmeier 1998: 137–164).

3 The Evolution of the Relationship

The S&T relationship was formalized with the signing of the bilateral Agreement for Science and Technology Cooperation (hereafter, Agreement) in January 1979. The Agreement called for government to government cooperation among the technical agencies of the two countries, and quickly led to the signing of a series of protocols between those agencies. Over the years, some of these have endured with new activities added, while others saw only limited activity. The Agreement called for the establishment of a Joint Commission on Science and Technology which serves as the overall governing body of the relationship. The Commission meets every 2 years and has as co-chairs the Chinese minister for science and technology and the US president's science advisor. The Ministry of Science and Technology (MoST) provides executive support on the Chinese side, with the Department of State providing overall support on the US side. (The US does not have an exact counterpart agency to China's Ministry of Science and Technology, a fact that often adds complications in terms of the way the two countries approach bilateral S&T engagement). On alternate years when the Joint Commission is not meeting, the two sides convene a lower level meeting of these executive secretaries. Over 30 years, the number of active interagency protocols has risen to more than 30.[1] While not every agreement or initiative has been successful, taken together, they have created a network of sustained interactions and on-going relationships that, in general, have proven mutually beneficial over time.

While the Agreement represents the politically most visible sign of the relationship, and has facilitated widespread cooperation via government channels, it is also useful to think of the government to government relationship as providing a framework for a broader range of other S&T related activities outside of the Agreement. These include, academic exchanges facilitated by the government to government Agreement on the Exchange of Students and Scholars, signed in 1978, which has led to hundreds of thousands of Chinese receiving advanced education in the United States. Indeed, some officials in both the US and China believe that the exchanges of talent and the professional training that has occurred represents the most tangible and significant contribution of the S&T relationship.[2] Cooperation through academic ties has by now led to expanding research cooperation and a growing number of university to university relationships.

The S&T relationship also has helped provide a framework for the growth of cooperative activities via commercial channels, which are also facilitated by the government to government Agreement on Commerce and Trade overseen by The Joint Commission on Commerce and Trade. The development of these commercial channels has facilitated a massive transfer of technology, especially as foreign direct investment expanded as a result of FDI liberalization policies in China during the 1990s. By the end of the 1990s, we also began to see a growing commitment from US companies to the establishment of R&D centers in China. Today there are over 1,300 of these foreign R&D centers—with top US multinational firms such as GE, IBM and Microsoft being among the most active in the effort to tap into China's talent pool. Thus, over the course of some 35 years, there has developed a complex web of relationships in science and technology involving governmental, academic, and commercial channels.[3] Some of the key drivers and shapers of that development include the following set of issues.

[1] For recent discussions of the extent of the US-China government to government S&T relationship, see White House (2012).

[2] Interviews conducted in Beijing in May 2013.

[3] For a fuller account of the evolution of the relationship, see Suttmeier (1998, 2010).

4 Issues of Asymmetry

One of the interesting characteristics of the bilateral S&T relationship is the ways in which its asymmetries have evolved and been managed. At the outset, Chinese science and technology had been seriously set back by the effects of the Cultural Revolution, as noted above. In addition to the interruptions in research and innovation agendas in most fields, the disruption of university life also meant that China had lost a generation of new scientists and engineers. Hence, the special appeal of getting access to the US university system as an expeditious way to compensate for this loss of talent. In most ways, then, in those early years, China brought little to the relationship in scientific terms other than a pool of smart, highly motivated young students and scholars and the opportunity to access distinctive natural and social phenomena in China (seismicity and other geological phenomena, climate, disease patterns, village life and social structure, etc.), which unfortunately had long been denied to US investigators.

As a result of these asymmetries in capabilities, the balance of benefits seemed very much to favor the Chinese side, especially as large numbers of Chinese students were accepted into US graduate programs with some funding from the Chinese government but with the bulk of support coming from the US side. On the other hand, both sides from the beginning were sensitive to the balance of benefits question, and attempted to allocate costs on a “benefitting side pays” formula.

Interestingly, the approaches taken by the two respective countries to conduct their evolving S&T relations differed in many ways. The US side, in general, took the position that activities under the various protocols should be paid for out of existing agency budgets in the belief that spending on activities with China would only be justified if they supported agency missions. While guaranteeing a degree of discipline in China related activities, this approach also meant that US technical agencies were somewhat constrained on the kinds of initiatives they might take, constraints which became more evident when government budgets were tight, as they often were following the “Reagan revolution” in the early 1980s. While the US government through the White House Office of Science and Technology Policy endorsed a growing Sino-US S&T relationship, the fragmented nature of American engagement often left the Chinese side disappointed in terms of the tangible aspects of the US commitment. On the Chinese side, on the other hand, special funds were set aside by the central government for international cooperation activities including those with United States. Chinese officials clearly viewed these activities as highly strategic in nature and extremely critical to China’s program of so-called “four modernizations”—agriculture, industry, national defense and science and technology.

To some extent, these alternative approaches reflected fundamental institutional differences, though over time it has become clear that the Chinese approach also can be construed as more of an investment orientation in which the relationship with the US was a critical part of a national effort to re-build and modernize scientific and technological capabilities. As the poorer, less capable partner, paying for these investments was not easy, but could be readily justified in the face of manifest benefits. With the US enjoying unchallenged leadership in most areas of science and technology when the relationship began, it is perhaps not surprising that an investment orientation was less in evidence. In the 1980s, the principal focus of American civilian technological worries was the rising competition from Japan; China seemed of little immediate concern given the serious competitive challenges posed by what seemed like the Japanese technological juggernaut.

To be sure, some members of the technical community in the US saw cooperation with China in its various forms as an investment opportunity to add to the global stock of knowledge and technical talent necessary for the continuing development of science. For foreign policy decision-makers, on the other hand, the S&T relationship provided policy tools for keeping the political relationship on track. Few on the US side might have imagined in the 1980s that Chinese science and technology would progress to the extent that it had by the beginning of the second decade of the twenty-first century. This apparent lack of vision and foresight—whether viewed from the threat or opportunity perspective—has helped create some of today's uneasiness and discomfort felt by US officials in the face of the technological foundations of China's rapid economic and military progress.

For China, as suggested above, the building of national scientific and technological capabilities in the post-Mao era became a matter of high national priority. Thus, in addition to exploiting opportunities for scientific and technological development in the international environment—the richest of which were in the relationship with the US—China also set about trying to get things right domestically. This led, in particular, to the initiation of a series of on-going reforms in its system of science and technology institutions, with many of these—such as the establishment of the National Natural Science Foundation of China (NSFC)—inspired by expanding international experience, especially with the US.

This reform experience, which continues today, has involved mixing successful policy and institutional models from abroad with Chinese political and institutional realities. While not always successful, overall, the transformation of the Chinese science and technology system of 1978 into the system of 2013 is truly remarkable.[4] Thus, in contrast to the situation in the 1980s when China's S&T system suffered from a lack of funds, a dearth of talent, and a very backward infrastructure, the Chinese S&T system today is characterized seemingly by a high level of abundance—with substantial resources committed to R&D spending, the training of more high end talent, and the establishment of a large number of well-equipped modern facilities.

During this same period, US leadership in research and innovation was maintained, but its relative position as a science and technology power was changing. Advanced scientific and technological capabilities had diffused to more parts of the world, and the US faced a growing list of problems, including budget constraints, an aging S&T workforce, and seemingly intractable problems with STEM

[4] See Suttmeier and Cao (1999), Springut et al. (2011), and OECD (2008).

education (See, for instance, National Science Board (2012), Wilsdon and Keeley (2007)).

In short, the conditions which characterized the early asymmetries were changing. Chinese scientific and technological development had progressed to the point where distinctive natural phenomena, and the promise of smart people, were not the only appeals making cooperation attractive. Gradually, albeit steadily, China became a far more important locus for research and innovation, offering in some cases distinctive facilities and research environments not found elsewhere. In addition, the supply of Chinese scientists and engineers, along with those from India and other countries, became increasingly important for sustaining the innovative performance of US research and technology-oriented enterprises.

5 New Directions

Thus, in a variety of ways, the material conditions as well as the policy environment for productive cooperation between the two countries have changed. In some ways, these changes have recast the basic premises and assumptions underlying the foundation of the bilateral S&T relationship. In some instances, questions have been raised in the US about the continued value of closer S&T cooperation, especially because of the growing uneasiness regarding alleged Chinese behaviors—whether state directed or not—concerning IPR protection, industrial espionage, and cyber hacking. On the other hand, a record of some success over the past 30 years and a series of new challenges facing the technical communities of the two countries have created opportunities for new directions in the relationship.[5] There clearly are a series of new imperatives—bilateral and multilateral—that suggest that perhaps the time has come to reframe and re-structure the agenda and nature of Sino-US S&T interactions.

5.1 Global Issues

This is increasingly true with regard to the growing importance of global issues, especially climate change, the energy-environment nexus, and global health concerns. Among the latter, concerns for international cooperation in approaching pandemics has become prominent, especially after the outbreak of SARS in 2003. The growing concern for global health issues has led to a more active involvement in China of the US Centers for Disease Control, for instance, which has cooperated with the Chinese Ministry of Public Health in establishing a Chinese CDC. The

[5] For recent discussions of the extent of the US-China government to government S&T relationship, see Department of State (2012), White House (2012).

value of these interactions has yielded a variety of meaningful payoffs as illustrated by the more transparent and more collaborative approach the Chinese government has taken to handling the recent Asian flu outbreaks in contrast to the defensive, secretive way the initial SARs epidemic was dealt with by Beijing.

While energy and environmental issues have been on the agenda for quite some time, they gained importance during the Bush administration and acquired a new focus on the US side at the beginning of the Obama administration under the leadership of Energy Secretary Steven Chu and Presidential Science Advisor John Holdren. Out of this has come an interesting new experiment in international cooperation known as the Clean Energy Research Center (CERC) which some observers believe could serve as the basis for taking Sino-US S&T cooperation to the next level.

CERC is less a physical center than a coordinated program of cooperation in which both sides have contributed equal financial resources and both have organized domestic research consortia with members drawn from industry, universities, and government research institutes in the target areas of research and development: clean coal, clean vehicles, and energy efficient buildings. CERC is notable in that costs are shared equally, and the consortia are, by design, intended to facilitate intersectoral cooperation among the three main types of institutions—industry, government, and academe—which in the past often worked separately with China. Needless to say, the establishment of the domestic consortia was itself a challenge of cooperation for both countries which added to the challenge of bilateral cooperation between them. Because much of the work entails the potential for developing commercial products, the development of understandings about intellectual property rights has consumed a fair amount of effort in the early stages of the Center. In many ways, the success of CERC will depend heavily on the ways in which the IPR issues are handled by the respective parties; there clearly is a need for CERC to help build and reinforce trust between the two sides so that meaningful collaboration can occur without apprehension about the disposition of new, commercially relevant IPR (CERC 2013).

5.2 Security Concerns

An enduring security concern and irritant in the relationship is the issue of US export controls. In the early years of the relationship, the export control question was a function of Cold War policies and multilateral controls exercised through CoCom. Over the course of the 1980s, however, China's status in the export control regime was changed and controls were liberalized substantially, and by the late 1980s, the two sides even were exploring the possibilities of transferring military technologies to China. The end of the Cold War and the abolition of CoCom might have led to an acceleration of liberalizing trends had these not coincided, roughly, with the June 4, 1989 events in Tiananmen and the imposition by the US of new sanctions against China. US-China cooperation in space, for example, was halted at the time and even today continues to be inactive as a result of Congressional budgetary mandates. Ironically, some have suggested that US refusal to cooperate with China's high priority space program has been one of the key factors behind China's rapid indigenous progress in space technology—with the help of Russia instead of the US.[6]

The gradual improvement of relations after the Tiananmen tragedy, especially with the rapid growth of FDI in the early 1990s, led to new thinking about export controls. On one hand, the deeper involvement of foreign corporations in the Chinese economy occasioned by the growth of FDI created pressures for further liberalization, especially as the share of high-technology industry in the foreign invested sector increased. On the other hand, forces resisting further liberalization within the US government meant that controls often still had teeth. As a result, the Chinese side has remained frustrated with US export control policies, as have some US companies who allegedly have lost business opportunities to European and Japanese firms who no longer are constrained by CoCom restrictions.

The export control question and the role of strategic technologies in the relationship more generally, acquired high political visibility following allegations in the mid-1990s that Loral Space and Communications Ltd. and Hughes Electronics Corp. had transferred sensitive technologies to China in connection with launch services provided by China for US satellites.[7] The issue was rapidly picked up by a Republican controlled House of Representatives which led to the establishment of a special committee, under the leadership of then Representative Christopher Cox, which rapidly expanded its mandate to the question of the transfer of strategic technologies to China more generally, including information relating to the miniaturization of nuclear warheads.

The Cox report, released publicly in redacted form in 1999, suggested in multiple ways that the PRC has been engaged in a sustained effort to gain access to a wide range of sensitive, controlled military and dual use technologies.[8] As a result of the Commission's work, to which the Chinese side took exception and offense, US export controls took on a new importance, and assumptions about the generally positive relationships between S&T cooperation and constructive

[6] From the US point of view, the effectiveness of export control policies is closely related to the availability of alternative suppliers; US unilateral controls, for instance, are recognized as being somewhat limited if advanced technologies are available from other countries. Less attention has been given to the question of whether the denial of technology through export controls has been a spur to successful indigenous technological development in China, as many Chinese observers allege.

[7] China was experiencing several commercial launch failures at the time having to do with the separation of the satellite from the launch vehicle. Allegedly, Loral and Hughes supplied critical information in attempt to solve the problem. The information was subject to export controls, but the companies failed to acquire the proper license.

[8] See US House of Representatives (1999). For a critical analysis of the work of the Cox Committee, see May et al. (1999)

political relations with China became reevaluated on both sides, and began to generate a serious trust deficit.

That deficit worsened after 2000. Although the 9/11 terrorist attack on the United States led to new forms of political cooperation with China, the changes in US immigration policy in response to 9/11 had significant impacts on Chinese citizens hoping to travel to the United States, including scientists and engineers. Security issues, especially US concerns about the leakage of strategic technologies to China through S&T cooperation as well as Chinese espionage, in short, were becoming more troubling for the relationship on both sides, and political opportunists in Congress and elsewhere have been only too happy to seize upon these, unfortunately often with some justification.

The work of the Cox Committee and the post-9/11 attention to immigration policy have led to an increasing focus on "human embodied" technology transfer resulting from professional visits and meetings and cooperative research activities. By the early years of the Bush administration, attention increasingly turned to what has come to be known as "deemed exports" involving the movement of people possessing technical knowledge across international borders. Export controls thus increasingly focused on the acquisition of technical knowledge and the travel patterns of people possessing knowledge thought to be sensitive, with the result that immigration policy, and the issuance of visas, came to play a far more central role in national security policy. Although progress has been made on resolving some of the visa issues pertaining to Chinese coming to the United States, concerns for "deemed exports" have made the process of getting a US visa often difficult for some travelers, have led to certain fields of research being off-limits to Chinese visitors, and in some cases have led the organizers of professional meetings to choose sites outside of the United States (especially Canada) for their gatherings.

5.3 Trade, Investment, and Competitiveness Issues

In addition to national security concerns, science and technology issues also have become far more politically prominent in economic relations between the two countries as well. China's redoubling of its efforts to foster scientific and technological development, especially with the launching of its Medium to Long-Term Scientific and Technological Development Plan (MLP) in 2006 has, in some ways, led to the further erosion of trust.[9] While the plan, and the increased R&D spending it entails, clearly offer new opportunities for cooperation, it also contains a variety of industrial policy tools that have often alienated China's key international partners (McGregor 2010; Atkinson 2012). More specifically, many Western observers have viewed China's emphasis on strengthening its indigenous innovation (*zizhu chuangxin*) capacity as a statist, neo-mercantilist type of policy which ignores the

[9] For discussions of the MLP, see Cao et al. (2006), Schwaag Serger and Breidne (2007).

principles of comparative advantage in favor of an attempt to establish “absolute advantage” (Atkinson 2012). Whether these views represent an embellishment of the efficacy of Chinese technology acquisition efforts or strategic technology policymaking has remained less important in gaining momentum in the media and business circles, especially in view of the highly-charged “anti-China” political environment emerging in Washington DC over the last 4–5 years.

While there is no doubt that Chinese officials are seeking to enhance the performance of their R&D system and to get more Chinese enterprises to focus resources on generating commercially viable innovations indigenously, there are many factors driving Chinese behavior. Some of these factors are historical in origin dating back to the rupture in Sino-Soviet relations in the late 1950s and others have to do with the fact that the current manufacturing oriented model that has driven Chinese economic development for the last three decades is no longer sustainable from a cost, environment, and energy perspective. Even more important, however, is a third factor, namely the recognition among China’s top political and S&T leaders that innovation driven competition is becoming the paramount key factor for determining and sustaining economic success across the globe. Based on their reading of the economic tea leaves, Chinese officials have stated that if their country does not evolve into a knowledge economy driven by a high level of innovative performance, it will sit at the margins of the international economy for much of the twenty-first century (Suttmeier and Cao 1999). Chinese policies to realize these objectives, however, have nevertheless caused considerable conflict with its trading partners, and have had the effect of politicizing the S&T relationship with highly contentious trade policy concerns. In the process, new actors from the trade policy bureaucracies across both the OECD countries and China’s Asian economic partners have become growing participants in the management of the S&T relationship.

Although the China of the first two decades of the twenty-first century is a far cry from the China of the 1980s in terms of scientific and technological capabilities, a substantial degree of asymmetry in those capabilities persists. PRC officials remain chagrined that despite the substantial increase in resources being made available for S&T upgrading, the results, especially on the innovation side, have been largely disappointing. Chinese public policy is committed to overcoming current defects in their national innovation ecosystem, and in doing so have introduced a series of new policies to foster the development and acquisition of advanced technologies. These include policies for the development of technical standards and patents, configuring the foreign investment regime to maximize technology transfer, and apparent support for illicit technology acquisition strategies through human and cyber espionage having both commercial and national security implications (McGregor 2010).

6 Science, Technology and Ethnic Identity

As noted at the outset, ethnic Chinese scientists and engineers, naturalized citizens and long time residents in the United States, all have played important roles in reestablishing relations in the 1970s, as did senior Chinese scientists who had been trained in the United States prior to 1949. The importance of these ties of ethnic identity has continued over the years, though with the passage of time, the nature of the Chinese diaspora itself changed.

Whereas leadership in promoting expanded cooperation between China and the United States in the 1970s and 1980s came from well-established ethnic Chinese scientists and engineers who came to the US largely before 1949, beginning in the late 1980s, Chinese scientists and engineers who came to the United States after 1978, and established careers in the US, became increasingly important actors in the development of the S&T relationship. These exemplars of the "brain drain" became tenured university professors, high-tech entrepreneurs, key members of the engineering staffs of major corporations, and in some cases, government officials, establishing families in the US and usually becoming US citizens. Since the 1990s, they have had an important part in building bridges to China for universities, corporations, and professional societies.

As a measure of the growth of scientific cooperation, there has been a steady increase in Sino-American co-authorship of professional papers since the mid-1990s, and a major share of these involves collaboration between ethnic Chinese investigators on both sides of the Pacific (Suttmeier 2008; Jin et al. 2007). While ethnic networks have played a very positive role in building constructive relationships between the technical communities of the two countries, questions about ethnic ties also have contributed to the elements of distrust, noted above. This is especially true with regard to high profile cases of espionage involving ethnic Chinese, and more generally, concerns about accelerated flows of science-based technology facilitated by ethnic Chinese scientists and engineers wanting to see a strong and prosperous China. It also has been exacerbated by Chinese government "talent recruitment" programs such as the One Thousand Talents Program which seeks to attract highly experienced Chinese scientists working in overseas universities, technology-based companies and think tanks to return back to China on either a full time or part time basis. Many ethnic Chinese faculty members working in the US and other countries have active laboratories in China with their own local Chinese graduate students supported with substantial funds from the PRC government. Issues have been raised about the time allocations of these faculty members as well as the likelihood that the handling of intellectual property within such "transpacific" networks can be rather relaxed, to say the least, and can contribute to the further erosion of trust.[10]

[10] See, for instance, Larson and Xin (2013) and Hannas et al. (2013).

7 Political Visibility and Political Commitment

In interesting ways, the 35 years of S&T cooperation between China and US has led to complex patterns of growing interdependence. The S&T activities of the two countries already have become steadily intertwined at multiple levels and across multiple domains. However as China increasingly approaches the status of a peer competitor, in which scientific and technological development is a critical component for achieving that status, the US appears to be reconsidering the wisdom of its 35 year engagement with China on science and technology. Increasingly, therefore, questions of trust and intent as the basis for sound political relations have come to shape the S&T relationship. There is an appreciable sense in which the prospects for building trust are not bright. While both sides approach the relationship with a sense of enhancing national interests, the extent to which those interests are served by positive, as opposed to zero sum interactions, seemingly differs between the two countries. Yet, the complexities of the relationship makes the drawing of accurate conclusions about this matter continuously difficult; there are many stakeholders on both sides, but their objectives and expectations differ considerably.

The ways in which national interests are served by the S&T relationship is not independent of the institutional configurations in the two countries and the ways in which they approach the management of the overall relationship. While China indeed is not without its problems of institutional fragmentation and lack of coordination, it is nevertheless the case that over time China has had significant institutional assets committed to a successful exploitation of the relationship. These include the dedicated funding streams, noted above, and a bureaucratic structure and continuity of personnel that have served it well. On the other hand, as we have seen, the US in general has been reluctant to make major investments in the relationships in terms of funding, institutional structures, and staffing. In general, staffing at the OSTP largely has been inadequate and staffing the executive secretariat in the State Department also has been a low priority.[11] This is especially problematic at a time when the multi-dimensional complexities of the Sino-US S&T relationship have been increasing.

For the US, however, it has been difficult to develop coordinated strategies for dealing with China in science and technology and for responding to the challenges that China's progress has created. For some, this is as it should be. Relations with China in science and technology should be driven by clear scientific opportunities and the interests of science are served best when the relationship does not acquire a high political profile. Within the current environment that exists in both countries at the moment, however, this seems almost impossible.

[11] In a comparative study of how six nations manage the challenges of reconciling science and technology policies with foreign affairs, Tim Flink and Ulrich Schreiterer identify a number of weaknesses in the US approach which accord with the more specific details of the US-China relationship (Flink and Schreiterer 2010).

To cite one specific constraint, the recent conflicts between Congressman Frank Wolf and OSTP illustrate the ambiguities associated with political visibility. Congressman Wolf, based on his human rights and national security concerns, has been a longtime critic of China. More recently, he has used his influence to forbid NASA from having contacts with China in the areas of space science and technology, and has worked to limit OSTP flexibility in dealing with China by proscribing OSTP expenditures involving China (See Mervis 2012). For increasing numbers of members of Congress, US engagement with China must result in a series of "wins" or policy victories to be recorded on a scorecard of Sino-American interactions; it is no longer politically acceptable for US policy initiatives to be seen as somehow "helping China." The increased centrality of China within both US domestic and foreign policy invites the higher political visibility associated with greater Congressional activism, and this, in turn, works against the building of a higher level cooperative relationship with China in S&T affairs. In this sense, Congressman Wolf's assault, intended to constrain OSTP activities with China, may actually work against the ability of the US to exploit the relationship more effectively for national interest.

8 Conclusion

The case of US-China relations in science and technology over the past 30 plus years points to a number of interesting, but complex, aspects of science, technology and international relations. In many ways, S&T relations normally have not been the stuff of "high politics" in relations between nations and in the foreign policy machinery of individual countries. On the other hand, S&T are not entirely isolated from high politics either. Science and technology issues, for instance, received high-level attention preceding and following diplomatic normalization with China, and were part of the formula for normalization, yet the convergence of political interests between China and the US vis-a-vis the former Soviet Union seemingly was a precondition for the rapid growth of relations in S&T.

As time has passed, the convergence of political interests that marked the early years of the relationship has given way to a far more complicated picture characterized by its share of divergence in many spheres of activity. In some ways, the strength of the S&T relationship provided a degree of continuity and cohesion when political relations became especially strained. Yet, it would seem that there are firm limits to the positive contributions of science and technology under conditions where political tensions rise (cf. Skolnikoff 2002). This is especially true where tensions over science and technology matters become the basis for the rise in political tensions and mistrust.

The US-China case, thus, points to a highly complex pattern of dynamic interactions. Political interests and common political understandings provide an indispensable framework for the development of S&T relationships. The strength of the latter, though, once developed, can contribute notably to the integrity of the framework, rather like a strong strand can help maintain the integrity of a web. The strength of the S&T relationship and the integrity of the framework however, are, as illustrated in the US China case, contingent on several factors.

The first of these is the evolution of science and technology itself. It has been argued that international cooperation in basic science can be furthered with minimal political constraints. As one moves toward areas of applied research, engineering, and technological development, the mix of cooperation and competition changes as the implications of scientific and technological development for national security and economic competitiveness loom larger (Suttmeier 1998). In a world where there is now often little space between basic science and new technology, and where the stakes of the latter are high for a nation's sense of well-being, it is not surprising that competitiveness and, possibly, conflict between nations arises. In this sense, science and technology issues again can rise to the level of high politics, as we have seen them doing increasingly over the past half-century in some issue areas.

Of course, the intensity of competition is related to the issues of asymmetry noted above. The notable increases in Chinese scientific and technological capabilities since 1978 have altered the asymmetries in significant ways and have contributed to changes in the political understandings constituting the core framework conditions.

Both the framework conditions and the strands of the relationship are also influenced, as we have seen, by a variety of transnational factors as well. It is remarkable that the original government to government agreement so quickly facilitated the growth of nongovernmental interactions between the two countries, involving corporations, universities, and NGOs. The clearly most powerful transnational force, however, has been that of Chinese ethnicity which has facilitated the growth of cooperative ties through governmental, corporate, and academic channels. But, as the political interests shaping the framework conditions have changed, as the asymmetries have been altered, and as continued scientific and technological development comes to be seen in zero sum terms vis-a-vis national security and economic competitiveness, ethnicity has become a far more complicating factor, contributing both to enhanced cooperation and possibilities for new forms of conflict and mistrust.

The state of US China scientific and technological cooperation in the second decade of the twenty-first century, thus, has evolved into a multifaceted and complex relationship. In many ways, the complexity has developed—and continues to develop—more rapidly than innovations in the mechanisms for governing the relationship, in spite of progressive efforts at institutional innovation; witness, for instance, the lack of meaningful engagement within what should have been an inspired US-China Innovation Dialogue. In a variety of ways, both sides exhibit notable institutional deficiencies for achieving enhanced cooperation and the furtherance of mutual interests. In addition, bilateral ties are only as good as the respective China watchers and America watchers inside and outside of government can effectively communicate accurate pictures of what is happening in both countries. Too often, bilateral communications have also suffered from excessive hyperbole in the media, especially with respect to S&T issues.

The lag in the creation of new mechanisms for governance, inaccurate mutual understandings, and media hyperbole are all evident in current discussions of cyber security. The steady intensification of serious bilateral tensions over cyber security issues in the relationship, especially in the first half of 2013, highlights the degree to which political trust issues—even among existing stakeholders on both sides—have begun to erode the once solid, but now increasingly fragile foundations for enhanced S&T cooperation between the two countries.

As the cyber security issues illustrate, there are interesting questions as to whether the search for institutional innovations in the governance of the S&T relationship in a more globalized world should be, or can be, conducted solely in a bilateral framework. These questions are likely to increase in salience throughout the current decade. At the same time, the broader implications of a failure to construct a new US-China bilateral foundation for responding to the key global issues of the twenty-first century will have a critical impact not only on these two countries but also on the economic, environment, and technological futures of many other nations in the coming years.

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