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Introduction

Thank you for the invitation to address this commission on the issue of China's industrial policy. Having made three trips to China over the last 6 months, let me state at the outset a simple but important fact: "the dragon is not sleeping." Chinese leaders at both the national and local level are less engaged in on-going debates about bailouts, bonuses, and cabinet appointments, and are more preoccupied with managing China's way out of the current economic and financial crisis facing their nation. They are making a concerted effort, using all the policy instruments and tools at their disposal, to re-fashion and re-shape China's development trajectory. Key cities such as Dalian are fully engaged in re-defining their economic and technology base as part of China's transition to the next stage in the country's modernization. While still somewhat "shocked" by the rapidity and comprehensiveness with which in the international financial crisis has engulfed the Chinese economy, the PRC leadership appears to be moving ahead with a high degree of self-confidence and conviction that is helping to moderate the "sense of gloom and doom" that seems to be steadily overtaking the economies of the US and the other industrialized nations. Even taking into account the fact that 2008 was a tumultuous year for China, especially in terms of the Wenchuan earthquake and the onset of a number of serious food and product safety issues, the Chinese leadership has been able to leverage the success of the 2008 Olympics to mobilize domestic resources and talent to attack the numerous economic and financial challenges facing the country.

In many respects, for China, the chaos and tumult brought on by the global financial crisis represents an important ideological and philosophical watershed moment in both world history and the 60 year history of the People's Republic of China. The "failure" of the market economies, led by the United States, to reign in the excesses and extremes of Wall Street and the banking industry, is viewed in Zhongnanhai as a reaffirmation of the Chinese proclivity for favoring more explicit state control and more overt regulation. From the perspective of the current leadership, in spite of all the adjustments and concessions made over the last 30 years of reform to allow more room for market forces and the market mechanism in the operation of the PRC economy, there always has remained an underlying commitment to the efficacy of the state as the ultimate source of control and guidance. For both important historical and cultural reasons, as well as political expediency, the role of the Chinese state has remained a necessary and ever-present feature in evolving visions of China's future. In this regard, it is quite clear that China's leaders see the current crisis as a unique, advantageous moment in time—as a strategic opportunity where China holds the philosophical high ground to reinforce its long-held position at home and abroad that unbridled capitalism and a "weak" state are a sure recipe for serious socio-political and economic problems.

It is against this backdrop that one must evaluate and assess the role and impact of industrial policy in China, especially with respect to the development of high technology capabilities in the PRC. Even though it is clear that one should not underestimate the salience of the global financial crisis as a precipitant to fostering badly needed economic change and restructuring in China, it also is the case that many of the challenges currently facing the PRC leadership with regard to the Chinese economy are rooted in a range of critical structural problems that predate the onset of the crisis. In effect, the global financial crisis exacerbated many of these structural problems and highlighted for President Hu Jintao and Premier Wen Jiabao the necessity of moving beyond the "factory to the world" economic model that helped support Chinese growth over the initial three decades of reform and the open policy--as quickly and definitively as possible. While it might be more natural as well as politically easier for the PRC leadership to play to the crowd of those Chinese workers whose jobs have been lost and whose lives have been dislocated by the progression of the financial crisis—and adopt a sort of "henny-penny, the sky is falling" motif, the fact is that Chinese officials seem to be moving in just the opposite direction; as Long Yongtu, China's former chief negotiator for WTO accession, remarked (paraphrase) to a group of business leaders in Wenzhou in December 2008, "while we [China] can be easily deterred by the difficulties brought on by global financial crisis, the fact is that the current crisis is a cloud with a silver lining—an opportunity to take on the underlying defects and shortcomings present in [our] prevailing economic model and to move the country to the next phase in its economic and technological development."

The External Environment

Just as policymakers and corporate executives in the US and EU read such reputable magazines and newspapers as Business Week, Fortune, Forbes, the Wall Street Journal, etc., so do their Chinese counterparts. Over the last 2-3 years, China's leaders have become familiar with stories about the fluidity and turbulence present in the global economy, about the intensification of international competition, about the impacts—positive and negative—of globalization, about the growing concerns surrounding energy and the environment issues, and about the heightened focus on intellectual property matters. They also have become familiar with the on-going provocative characterizations of international competition as reflected in phrases such as technology wars, patent wars, talent wars, and standards wars. And, they too have come to recognize what many corporate CEOs and some government officials have come to understand about the growing centrality and strategic importance of innovation. For the PRC, innovation, and by implication, strengthened capabilities in science and technology, hold the key to addressing China's three most pressing overall priorities: increased international competitiveness, enhanced national security, and long-term sustainability.

In January 2006, Chinese leaders put into place their new 15-Year Medium-to-Long Term S&T Plan, which laid out an innovation driven roadmap for pressing ahead with the goal of re-orienting the economy away from excessive dependence on an economic model dominated by its strong emphasis on cheap-labor driven low-end manufacturing, over reliance on fossil fuels and extensive consumption of natural resources, and an apparent insensitivity to the environmental implications of that model. The focus of the MLP is explicitly on enhancing China's capacity for independent innovation (zizhu chuangxin); the goal is to ensure that more and more of the intellectual capital and know-how utilized across the Chinese economy—derives from indigenous sources rather than simply importing know-how and equipment from abroad. The Chinese emphasis on independent innovation does not mean, by any measure, a return to the self-reliance policies (zili gengsheng) that came into prominence during the Cultural Revolution; Chinese leaders have gone to great lengths to assure foreign observers of the Chinese S&T that China intends to remain fully engaged with the world. After all, globalization has proven to be a major windfall for China in terms of the increased access it has provided in terms of knowledge acquisition, investment, and trade opportunities. With globalization has come a massive explosion in foreign investment around the world, with China being among the top five recipients of FDI annually over the last decade. While it is not always the case, the growth in foreign investment to China has proven to be an important vehicle for technology transfer, including managerial know-how, that has helped China steadily move up the learning curve in terms of taking on more sophisticated, higher value-added production tasks and becoming more deeply integrated in the global supply chains of the world's most technologically advanced companies.

Nonetheless, with innovation having moved to center stage in the world of international competition, Chinese leaders have determined that continued dependence on external sources of technology is simply not a smart thing to do. For the time being, the "make versus buy" debate in China between technologists and economists seems to have been won by the former.[1] There is growing apprehension in Beijing that the technology-related benefits that China has been able to secure as a result of its openness to globalization may be starting to erode as access to "key" or "core" know-how remains restricted or limited and may become even more so as controls on IPR and related technology become even tighter. In other words, the hospitable world of last two decades of the 20th century may be giving way to an international environment that is less user-friendly than before. Added to this, we must also factor in Chinese national security imperatives, which continue to be a key driver behind China's desire for strengthening its internal innovation capabilities. While China's overall perception of world trends may be true in some key respects, it is ironic insofar as three countervailing trends that seem to be underway: first, the continued growth of foreign R&D centers in China—there are over 1200+ such centers in operation and indications are that more will be setup in the future—even taking into account the porous nature of China's IPR regime; second, the apparent increased willingness of many foreign firms to share technology with China in return for access to Chinese industrial and consumer markets—these decisions seem more the result of strategic business considerations rather than arm-twisting from the Chinese side; and third, the enhanced importance of China's high-end talent pool—which now has become an attractive magnet for both domestic and foreign firms wishing to tap into "Chinese brainpower" to drive advanced manufacturing and innovation activities in China. In fact, of all China's alleged comparative advantages, it may be "talent" -- effectively deployed and efficiently utilized--that ultimately stands out as the key source of the Chinese long-term competitive edge.[2]

It must be recognized, however, that there really is nothing novel or new about China's stated effort and pro-active attempts to build up its domestic S&T capacity. Starting from the early 1980s, one can easily chart statements by Chinese leaders across the board that identify "catching up with the West" and "closing the prevailing technological gap" as national priorities and goals. The drive to strengthen independent innovation as articulated in the MLP must be viewed within the context of a series of state-directed, S&T plans and initiatives that China has put in place since the mid-1950s. I mention this not so much as a lesson from history, but largely to indicate that China's drive to catch up with the West is not the product of secret internal Chinese deliberations and "neibu" "hongtou wenjian" (red-headed documents); rather, the drive to close the technology gap

[1] This does not mean that reverse-engineering, for example, has been rendered a lower priority, but rather that Chinese leaders increasingly have come to appreciate the need to generate more of their own know-how and IPR and that the best way to ensure China's on-going ability to "plug into" evolving technological streams around the world is to ensure that the PRC has the ability to generate key pieces of the overall know-how puzzle from indigenous sources.

[2] See Denis Fred Simon and Cong Cao, China's Emerging Technological Edge (Cambridge U Press, 2009).

has been a largely transparent effort situated at the nucleus of the modernization drive launched under Deng Xiaoping. The problem is that many in the US and abroad paid scant attention to Chinese ambitions, let alone China's actions and progress until recent years. Perhaps this was a product of our extensive concerns with the former Soviet Union or our preoccupation with the competitive threat from Japan in the 1980s; nonetheless, it is important to acknowledge the steadfastness with which China has carried forward its programs, policies, and initiatives to ensure that it has the requisite credentials and capabilities to sit at the table of global competition. China has built an extensive network of global S&T connections and international relationships, most clearly manifested in the plethora of bilateral government-to-government S&T agreements and student-scholar exchange programs that it has put in place, that have become a strategically important component of its industrial policy and technology strategy since the early 1980s.

The Domestic Perspective

From a domestic perspective, at the heart of China's state-driven technology initiatives have been a series of programs that have been in operation since the mid 1980s, foremost among them in the 863 Program and the Torch Plan, subsequently followed by the 973 Program almost a decade later. The 863 Program is a program under the Ministry of Science and Technology, first brought forth to Deng in March 1986 by four of China's top scientists who wanted to ensure that China could generate its own high-technology know-how. The program covers a broad range of civilian and military related technology fields; each year, applications are made for project grants and reviews are carried out to award these funds—some of which go to enterprises and others of which go to faculty members at various Chinese universities. Overseas Chinese scholars also are allowed to participate in 863 projects, and most recently, under an agreement with the EU, foreign scholars from Europe can work with their Chinese counterparts on projects funded under the 863 program. Projects in the IT field, microelectronics, semiconductors and integrated circuits have been a critical focal point for 863 support over the years—along with projects covering a broad range of other fields under the umbrella of high technology, e.g. lasers and biotechnology.

The Torch Program is a complementary project to the 863 Program; the Torch Program is focused on commercialization of R&D and ensure that research results get translated into usable, commercially viable new products and services. Torch operates many of China's technology incubators, where new, emerging technologies can be harvested and brought to market by young start-up companies who need assistance securing ample capital and/or talent. It also has responsibility for managing the 50+ national science and technology industrial parks under the aegis of the State Council.

It is clear that monies allocated to projects sponsored by these and related programs have yielded some impressive results (see below); it also is clear that Chinese officials remain generally disappointed by the pace of progress. China's R&D system continues to be beset by a range of problems and challenges, including the absence, in large part, of a culture that rewards risk taking, entrepreneurial behavior, individual initiative, and even creativity. There also have been a number of criticisms launched both internally and externally about the management of these programs and the use (or abuse) of government funds. On the success side stands the example of the SIASUN Robot and Automation Company in Shenyang, which was founded by Dr. Qu Daokui, a 48 year-old senior scientist who also serves as Deputy Director of China's National Engineering Research Center on Robotics. The company, which is affiliated with the Chinese Academy of Sciences, has a 90% share of the domestic robot market, with sales of 880 million yuan in 2008. It also controls 30% of the industrial robot market in China. SIASUN's CEO Qu studied with Jiang Xinsong, who is considered to be the father of robotics in China. He spent the early 1990s studying robotics and automation overseas in Germany and returned to China in 1993. After his return, he began the process of building his reputation and creating a commercial enterprise; he became CEO in 2000. His company has received funds and support from the 863 Program as part of MoST's support for establishing an "intelligent robot industrialization base" in China. The firm also is certified as a "national robot engineering center" by MoST as well. Along with the equipment developed by SIASUN that is used in the automobile industry, its robots and automation equipment also are deployed in rail transit, the energy sector, logistics and storage, and clean room automation. The company seems positioned to continue its steady, albeit gradual, march to becoming a global player in robotics.

Unfortunately, such cases do not always appear to be the norm. Problems within 863 and similar plans, as suggested earlier, have emerged due to oversight and monitoring issues. In 2006, two serious scandals were uncovered that reflect the huge pressures that exist for progress among those receiving high-level and often substantial government support. The first case, known as the Hanxin chip scandal, involved a returnee scientist (Professor CHEN Jin) at the prestigious Shanghai Jiaotong University. Dr. Chen was found guilty of scientific fraud after he claimed to have developed an indigenous microchip (digital signal processing chip), but was later discovered to have faked his research. It is said that Chen received in excess of 114 million RMB; his work was allegedly reviewed by a team of experts during each new funding phase of his research. Initially, his research achievements and results had been applauded as a prime example of the utility of close university-industry ties, but he was later totally discredited after the fraud was uncovered. A second example involves a Chinese company named ARCA Technologies, which was viewed as a rising star within the Zhongguancun Science Park in Beijing. After receiving approximately 100 million RMB from the Chinese government for developing Arca-1 and Arca-2 CPU chips for lower end computers, ARCA was awarded another 15.38 million RMB under the 863 program to develop an Arca-3 version. Unfortunately, the monies allocated to the firm did not seem to end up in the research lab, but rather in real estate investment and high salaries to the firm's top executives. These two scandals rocked the Chinese S&T system and raised many questions about the status of China's actual domestic capabilities in the microelectronics field. It also generated a broader discussion about the line between business and academia—a line that seems to have become blurred on many occasions as efforts were made to ensure closer links between university-based research and enterprises to foster the commercialization of technology. Prompted by the possibility that further examples of research fraud might exist in other areas, to its credit, China's MoST immediately stepped up its due diligence efforts to ensure improved compliance.

The ICT Sector

One of the constants of China's industrial policy and technology development efforts over the last ten years has been the high priority attached to the development of microelectronics, telecommunications, and information technologies.[3] In the space of a few minutes, it is not possible to do justice to the full range of issues that need to be discussed when assessing China's progress in this strategic field. Few persons realize that China's efforts to develop its own indigenous computer industry date back to the 1950s, when with Soviet assistance and training, China began its march to establish a viable computer design and production capability; were it not for the damaging effects of the Cultural Revolution, China might have been one of the world's major players in the global computer industry today. At the center of China's efforts has been the desire to develop a domestic capability in semiconductors and integrated circuits as these are the building blocks for advancement in computers, telecommunications, and programmable machine tools. The effort to develop a competitive capability in advanced microelectronics reflects both the strengths and weaknesses of Chinese industrial policy and technology strategy. In the midst of some ample progress, especially since 2000, there have been many false starts and stops that have slowed down the overall momentum in this sector and have done little to diminish China's overall reliance on imports to service the country's growing demand for semiconductor products and components.

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[3] Michael Pecht, China's Electronics Industry (Norwich: William Andrew Publishing, 2007)

In 2006, in conjunction with the S&T MLP and program such as 863, China's State Council set forth the country's new national informatization strategy, 2006-2020. The initial phase of that strategy was reflected in the priorities and policies set forth in the 11th FYP (2006-2010). The goals for the informatization strategy include building a vibrant nationwide IT infrastructure, strengthening the country's innovation capabilities in IT, improving information security, enhancing the application of IT across the economy and public, and optimizing the structure of the IT industry. There are nine key aspects to the strategy, the bulk of which are focused on ways to promote overall informatization of the national economy and government sector. In 2008, IT spending in China grew by 9.1%, commensurate with the overall rate of economic growth; while IT spending will probably slow down somewhat in 2009, the fact is that within the country's national stimulus package of US$586 billion, investments in railways, telecom, and education will provide opportunities for continued growth of IT.

Driving the country's IT agenda is the newly formed Ministry of Industry and Information Technology. The new ministry absorbed many of the responsibilities of the former MII (Ministry of Information Industry) in terms of the IT sphere. In addition, however, the new MIIT, will play a larger role in establishing industry standards, driving technology innovation, shaping the development of the IT infrastructure, and promoting information security. Of special importance will be three areas: 1) overall development of the software industry; 2) growth and expansion of IT services; and 3) continued development of the local semiconductor industry. In 2007, China's annual software output topped US$84.5 billion, making it the fourth largest producer of software in the world, with an 8.7% share of the global software industry. Software exports, however, were only US$930 million. With respect to IT services, the market value reached US$10.9 billion in 2007—leaving China far still behind India both in terms of capacity and capability.

The effort to promote further development and deepening of the semiconductor sector stands out as an example of the mixed results from Chinese industrial policy. Today, China absorbs about 1/3 of the worldwide market for semiconductors, reaching about US$88 billion in 2007. At the same time, however, the Chinese share of global semiconductor production accounted for only about 9% of worldwide output. China's IC market grew to almost USD$74 billion in 2007, accounting for 33.8% of the global IC market. Trade data from MIIT and from China's Ministry of Commerce indicate that the primary market for semiconductors in China continues to be the export market. Foreign companies are the main suppliers for meeting Chinese needs. According to a recent study by PWC, there were no Chinese companies in the top 55 suppliers to the

Chinese semiconductor market in 2007.[4] The PWC study goes on to indicate that "even if the largest Chinese semiconductor companies sold all their output within China, no Chinese semiconductor company would be among the top 50 suppliers to the Chinese semiconductor market in 2007." The situation regarding ICs is even worse—with the consumption/production gap reaching US$54.9 billion in 2007. This is a strong indictment of Chinese efforts heretofore to enhance their capacity to meet the growing PRC demand for semiconductor and IC products—which continues to exceed the international growth rate by a significant margin.[5]

In 2000, the Chinese government issued State Council Document #18 which lays out a new strategy for developing the country's semiconductor and integrated circuit industry. Under this new plan, the PRC government has invested a total of US$ 6.6 billion over the last five years and is expected to invest over US$20 billion in the next five years (2009-2013) in projects in Suzhou, Wuxi, Shandong, Shanghai, Shenzhen and Dalian. Overall, it is estimated that between 2008-2020, the Chinese government will invest a total of US$30 billion in the semiconductor and software sector. Whether these huge investments will materialize and whether they will yield desired results are major questions; nonetheless, moving ahead is considered to be a critical priority for the government. Key to this new strategy is the recognition that foreign investment can play a critical role in helping to stimulate the overall growth and expansion of the industry. Much of this foreign investment has located in and around Shanghai and the Yangtze River Delta area. One key exception, however, is the recent US$2.5 billion investment by Intel in Dalian—which reflects Intel's intent to remain not just a major supplier to China (it was #1 in 2007), but also to help shape the evolution of the industry and to use its "insider" position to influence the direction of Chinese policies and technical standards. The plant known as Fab 68, which when approved in 2007 intended to deploy 90 nanometer technology to produce 300 mm integrated wafers, is intending to move into the 65 nanometer range once operational in 2010. It is clear that as demand for semiconductors in China has risen and as electronics and IT-related manufacturing has moved into the higher valued added segments in computing, communications and consumer products, many of the world's major semiconductor firms have decided to set up shop in China, bringing with them advanced equipment and know-how needed to support their increasingly advanced operations. China is continuing to absorb more and more of the world's semiconductor production activities, especially as demand seems likely to continue to rise across the board—but with foreign firms occupying the largest portion of the market.

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[4] See, PWC, "China's Impact on the Semiconductor Industry: 2008 Update," 2008.

[5] According to PWC, since 2001, China's semiconductor market has grown at a 31.5% compounded annual growth rate, while the world market has grown at 10.6%.

Of course, China's semiconductor sector has not gone unscathed by the recent financial downturn. Experts project that the market will decline in 2009. Reverberations and bankruptcies occurring around the world are clearly making themselves felt in China. To remedy the situation, Wen Jiabao chaired a special meeting of the State Council in mid-February 2009 to address the challenges facing the electronics and information industry. Domestic producers in China are seeking more favored treatment by the government with respect to import duties on equipment, financing, and chip procurement. The premier outlined four core tasks to assist the industry get through the tough times ahead: a)improve the industrial structure of the industry; b)increase investment in technological upgrading, including the integrated circuit industry, LCD technologies, and new generation mobile telephony; c) strengthen the capacity for independent innovation; and d) increased support for service outsourcing as well as the globalization of Chinese firms in R&D, manufacturing and marketing. To their credit, Chinese leaders seemed less inclined to adopt a "circle the wagons" strategy and appear to be more interested in preparing the industry for its future challenges.

Perhaps the two best examples of the early success of Chinese industrial policy in the ICT sector involve a) the development of the Godson (also called Loongson) computer chip and b) the development of the high performance super-computer. In an effort to dislodge itself from total dependence on foreign imported CPUs for computers, China has been engaged in a research initiative designed to create an indigenous computer chip. Supported by both the 863 Program and the Knowledge Innovation Program (KIP) under the Chinese Academy of Sciences, the Institute of Computing Technology (ICT) seems to have achieved its mission with the design and production of the Loongson IIE chip. The chip emulates early series Intel Pentium IV processors in performance, but cost less to produce. Also, most important, Loongson PCs use a Linux operating system, which also plays to China's desire to wean itself off excessive dependence on the Wintel platform. The chips are manufactured in China by a French-Italian firm named ST Microelectronics in conjunction with BLX IC Design Corporation, which was founded by ICT and the Jiangsu Zhongyi Group. The chip is a much improved and enhanced version of Loongson-1 (a pure 32-bit CPU which was used for running cash registers and similar equipment). A Loongson-3 version is now in development; the new version will have four cores and an eight core version is being planned.[6] The unique aspect of the Loongson design is that it is not based on the x86 instruction set, and instead uses a modified version of the MIPS

[6] Tom Halfhill, "Fast Forward: China's Newest CPU," Maxiumumpc, February 26, 2009, #5418.

instruction set.[7] In July 2008, two foreign manufacturers—one in Holland and one in France—announced that they would adopt Loongson products for sale outside of China.

China's success in building its own supercomputer reflects another example of Chinese efforts to target needed technologies and create an indigenously designed and manufactured product. The global market for high performance computing systems reached US$11.6 billion in 2007 and is expected to reach US$15 billion by 2011. Currently, among the world's 500 fastest supercomputers, 15 are in China. In mid-2008, Chinese officials at the Dawning Information Industry Company announced the production of the Dawning 5000A, a Chinese-made high performance server that rivals the 7th fastest in the world for computing speed. The machine has a capability of 160 trillion computing operations per second. The Dawning 5000A remains no match for the fastest computer in the world, the Roadrunner—designed by IBM for the US Department of Energy's Los Alamos National Laboratory—which at one quadrillion operations per second is 5.4 times faster than the Dawning 5000A. The computer is installed at the Shanghai Supercomputer Center, which specializes in computing outsourcing services for genome mapping, earthquake appraisal, weather forecasting, mining surveys, and stock exchange data analysis. Originally, the Dawning 5000A was to utilize the Loongson computer chip produced domestically, but instead a decision was made to rely on the AMD Barcelona quad-core processor. The choice of AMD was largely based on the fact that Dawning relies on a Windows-based operating system instead of Linux. The cost of the Dawning 5000A, even with imported AMD microprocessors, was about US$29 million in contrast with the IBM Roadrunner, which cost the US Department of Energy US$100 million. Chinese officials clearly hope domestically designed and manufactured machines will make their way into the international market; the Chinese Electronics Standards Association already has a process underway to help PRC manufacturers become suppliers of their machines to the developing world.[8]

These two examples attest to the extensive commitment made by the Chinese government to enhance its indigenous technological capabilities. While neither product is state of the art in terms of carving out a new technological frontier or leading the pack in terms of a new technology roadmap, they represent part of an important learning curve that is occurring in Chinese technology circles across many industrial sectors and technology fields. With compressed product and technology life cycles and new opportunities for cross border collaboration emerging, China is now part of a series of

[7] According to Li Guojie, Director of ICT, these devices cannot compete head on with Intel on mainstream desktops and laptops, but rather will focus primarily on embedded applications, including set-top boxes, auto electronics, and industrial control. Use in low-end computers also is a possibility.
[8] South China Morning Post, June 24, 2008, p.7.

global knowledge networks that are helping to define the new technological frontiers of the 21st century. Unlike the hierarchical forms of one-way technology transfer that characterized international technology markets from the 1960s through the early 1990s, the process of engagement in global technology collaboration networks has become the new modality for technological learning and advance. A nation does not necessarily need to have ownership or control of state-of-the-art knowledge to enjoy the benefits of collaboration in these new knowledge networks; rather, the nature of specialization and cross-border collaboration are increasingly focused on the merging of technological complementarities that provide new channels for less advanced players to enter into these collaborative activities. As Chinese talent progresses ahead in the coming years, there is little doubt that China will become further embedded in these networks, moving from being a "taker" and lower end contributor to a high value added contributor. Developing and maintaining incentives and opportunities for China to remain engaged in these networks fully and collaboratively represents not only a technological challenge but also a political challenge in the years ahead.

Whither Industrial Policy in China?

There is little doubt that China remains strongly committed to further enhancing its own industrial base and indigenous technological capabilities. During the course of the next 5-10 years, China will continue to strengthen its domestic institutions, especially at the enterprise level, to promote an enhanced commitment to technological innovation. At the same time, global competition, transplanted to the Chinese market, will mean foreign firms will continue, willingly and actively, to bring advanced technology and equipment to China as part of their global strategic positioning. While the Chinese system may lag the US in most areas of innovative capability, the fact that it currently has become a preferred site for R&D suggests it is now strongly embedded in the global knowledge system. And, as China becomes more integrated into the fabric of global R&D activities, it will no doubt steadily seek a greater voice in negotiations about standards, markets, etc.

At the same time, however, it also is clear that China is not an unstoppable technological juggernaut that will soon dominate international product and technology markets, especially in terms of high technology. There are two large unknowns regarding China's technological potential and the role that it will play in the global economy: 1) the "software" side of the technology equation; and 2) the issue of strategic intent. With respect to the software side of the equation, many questions remain about China's ability to adapt, shift and operate with the high degree of flexibility, agility and responsiveness required for competitive success in the globalized world of the 21st century. For example, do Chinese policymakers and enterprise executives have the skills and comfort levels to manage in a highly fluid, fast changing environment? Do they have the ability to manage technologies across borders and cultures, especially outside of Chinese ethnic and guanxi networks? Does China have the ability to fully absorb the new cohort of Chinese returnees who are seeking to come back to the PRC to launch new research projects and businesses? And, does the leadership have the global outlook and understanding needed to compete effectively in a world where collaboration and cooperation are the new hallmarks of innovation and new knowledge creation?

In terms of the uncertainties regarding strategic intent, the unknowns may be even greater. Chinese perceptions regarding global trends and developments, especially in view of the global financial crisis, need to be better understood. It is clear that China remains frustrated with the US in a number of areas, especially with respect to bilateral S&T cooperation and the continued imposition of export controls. On the other hand, there are few global problems, if any, that can be addressed adequately without full cooperation and participation from the Chinese side. American and Chinese business are inextricably linked together, and if trends persist, they will become even more intimately coupled. The fact is that the US and China have reached a level of interdependence that few could have predicted when Deng Xiaoping made his historic visit to the US in the late 1970s. Simply stated, at present, China's rise represents a strategic opportunity for the US, not a zero sum game or threat.[9] The real challenge for the US, in this regard, is to better appreciate Chinese sensitivities as well as vulnerabilities, to identify and capitalize on the emerging pockets of excellence in the Chinese technology system, and to engage China as a full partner. While we may be a long way from the G-2 model being put forth by some in Beijing and other places around the world, the reality is that both countries can benefit a great deal from easing the continued political distrust that exists. Deeper engagement and closer articulation with one another in science and technology affairs provides one mechanism for building bridges and understanding as well as trust. In emerging fields such as new energy development and environmental management, such bridge building could become the impetus for a new era of more mutually beneficial "collaborative innovation" and technological advance that will not only benefit the people of both countries, but also other parts of the world as well.

[9] In many respects, the strategic opportunity derives from the fact that the US-China S&T relationship has become less one-sided than before and is much less hierarchical due to the fact that the PRC has more to contribute of value and interest to the US science and engineering communities in key fields such as nanotechnology, life sciences, and new materials.

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