



Key Drivers Underlying China's International S&T Relations

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China's Long March in Science & Technology

"China missed the first industrial revolution, and only caught the tail of the second industrial revolution; we are now in the forefront of the third industrial revolution, which as far as China is concerned, presents a rare strategic opportunity."



Remarks Written on the Closing
of the National S&T and Innovation
Conference
*"Stand at the Crossroads of the New
Technological Revolution"*
Keji Ribao, July 9, 2012

Innovation & the Financial Crisis

"Being faced with the current international financial crisis, various countries are competing with each other to capture the science and technology "commanding heights" and the whole world will enter an unprecedented era of intensified innovation and industrial revitalization."



Wen Jiabao to the 60th Anniversary
Gathering of the CAS in Beijing
November 2009

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The New Great Wall: China's Drive to Establish an Innovation-oriented Nation



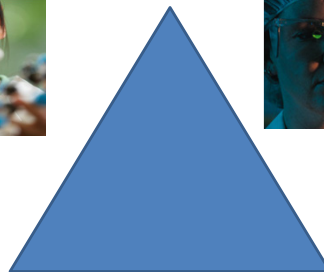
From Self-Reliance to Indigenous Innovation: Changing the Innovation Equation!

- Chinese S&T policy has been focused on a new strategy since 2006---- “indigenous innovation”– highly controversial
- Core priority within 11th & Current 12th FYPs
- The drivers behind this new focus derive from several considerations:
 - ✓ *Growing concerns about viability of current economic model*
 - ✓ *Growing pressures from global competition, e.g. Vietnam*
 - ✓ *Growing concerns about revenue loss/high fees, e.g. licensing*
 - ✓ *Growing concerns about loss of political leverage*
 - ✓ *Growing perception of rising global tech protectionism*
 - ✓ *Growing concerns about national security*
 - ✓ *Concerns about the overall lethargic performance of the R&D system*

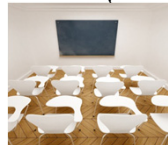
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The Strategic Innovation Triangle

15 Yr Medium-Long Term S&T Plan (2006-2020)



Medium-Long Term Education
Reform Plan (2010-2020)



Medium-Long Term Talent
Plan (2010-2020)



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China's S&T Dilemma

S&T System Shortcomings 1978-1999

- Insufficient financial support for R&D activities
- Insufficient numbers of scientists and engineers, especially in terms of newly trained talent
- Inadequate S&T infrastructure—poor equipment, poor facilities, etc.

S&T System Features 2000-Present

- Rapidly growing investments in R&D (1.98%)...average growth 20%+ per year over last 5-6 years
- Rapidly growing numbers of new S&E graduates and more returnees, esp. since 1999
- Increasingly modern, advanced S&T labs and infrastructure

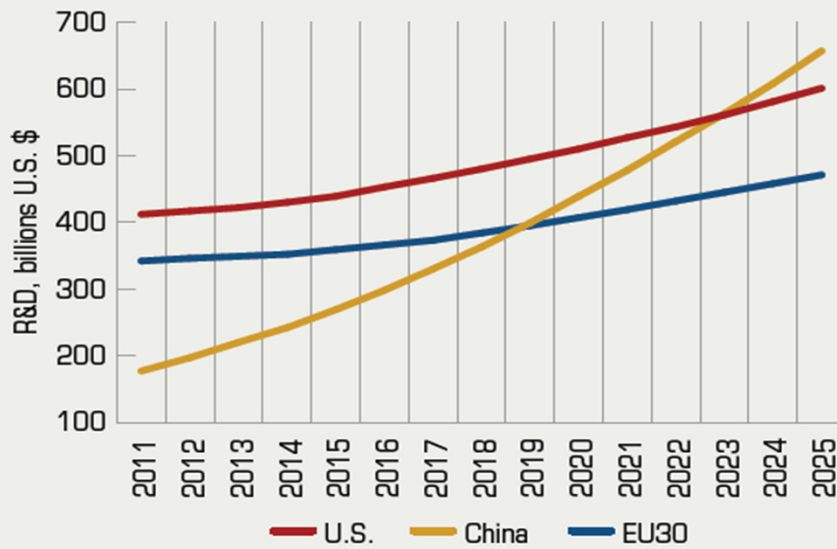
Resource Shortage



Resource Abundance

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U.S. - China - EU Annual R&D Spending



Source: Battelle/R&D Magazine

Wen Jiabao's "*Qiushi*" Article Raised Critical Questions about China S&T System, July 2011

- China's S&T system has experienced rapid development and has become a strong driving force for economic and social development since 1949, especially since the reform and opening up
- However, facing the new situation of China's S&T development, need to enhance the sense of **urgency**, sense of **crisis** and deepen the sense of **responsibility** and sense of **mission**
- China needs to:
 - ✓ *Speed up the development of S&T, seize the opportunity and fully participate in international competition*
 - ✓ *Rely on S&T innovation to accelerate the transformation of economic development*
 - ✓ *Strengthen basic research and cutting-edge research*
 - ✓ *Further deepen the reform of the S&T system*
 - ✓ *Improve people's scientific literacy*

<http://www.qsttheory.cn/zxdk/>



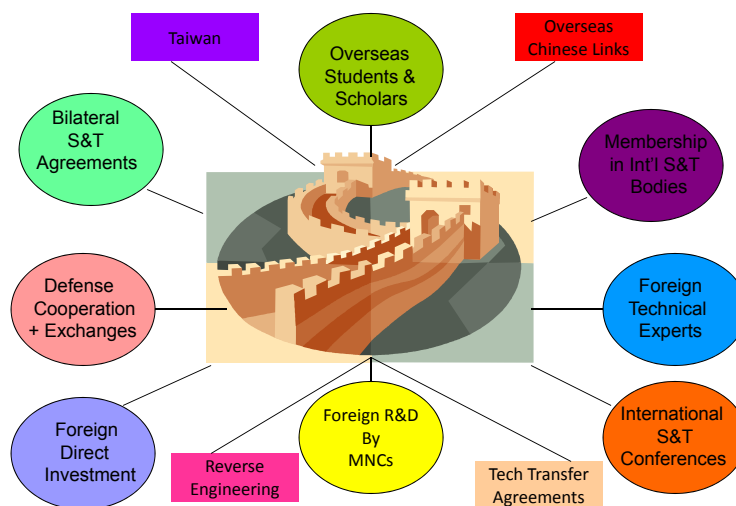
Strategic Underpinning of China's Growing Participation in International S&T Relations



Three Major Shifts in China S&T International Cooperation

- Keji Ribao article: *“From Domestic to Overseas---10 Years of China S&T International Cooperation Road,”* (9/29/12) pointed to three major shifts in China’s international S&T cooperation activities:
- In 2001, China started its systematic international S&T cooperation program, and in the past 12+ years, the role of China has shifted in three ways:
 - From “Go it alone” to “S&T Diplomacy”
 - From “Track & catch up” to “Peer Cooperation”
 - From “Passive work” to “Mutually beneficial and win-win”

Expanded Channels of Access: China has become more capable in terms of utilizing its expanded access for “strategic” S&T purposes

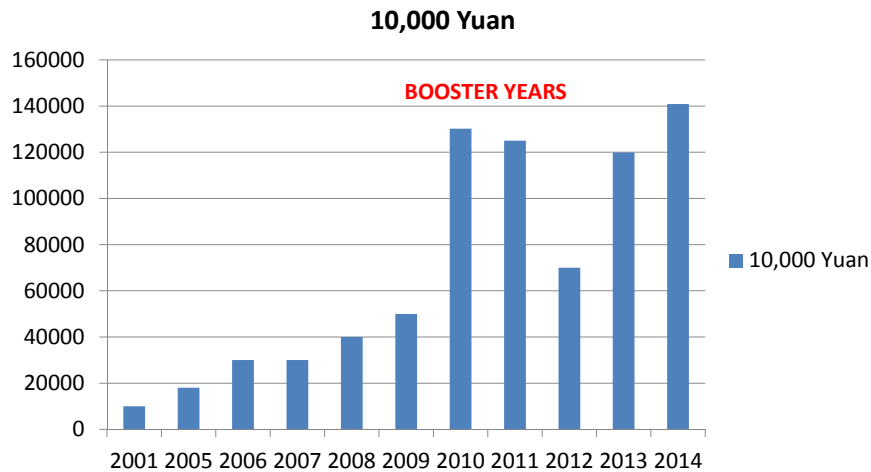


Some Major International S&T Cooperation Successes

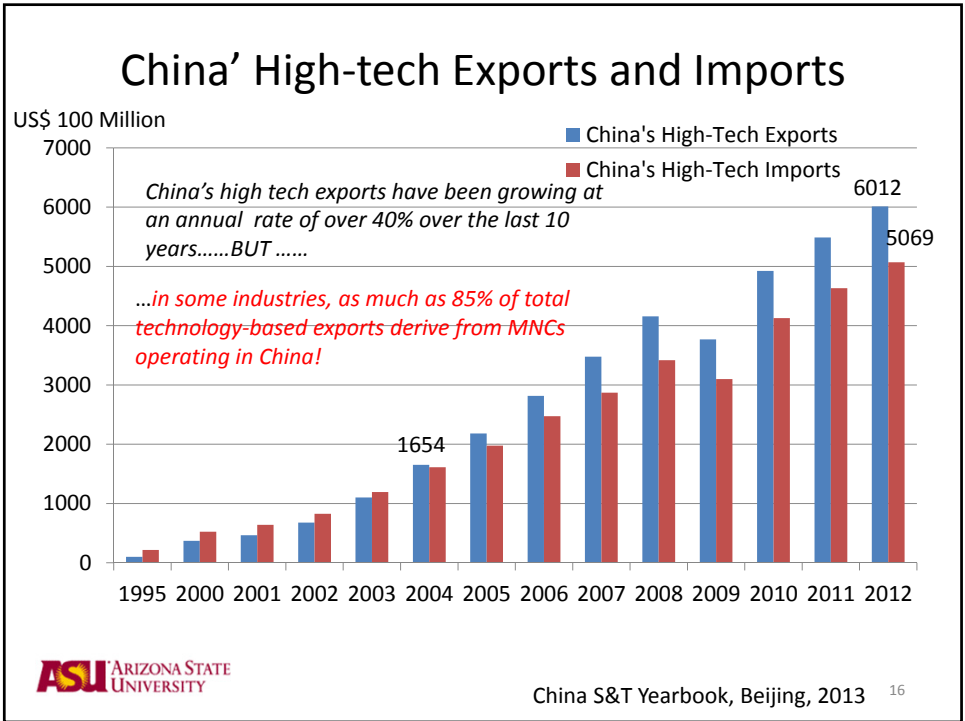
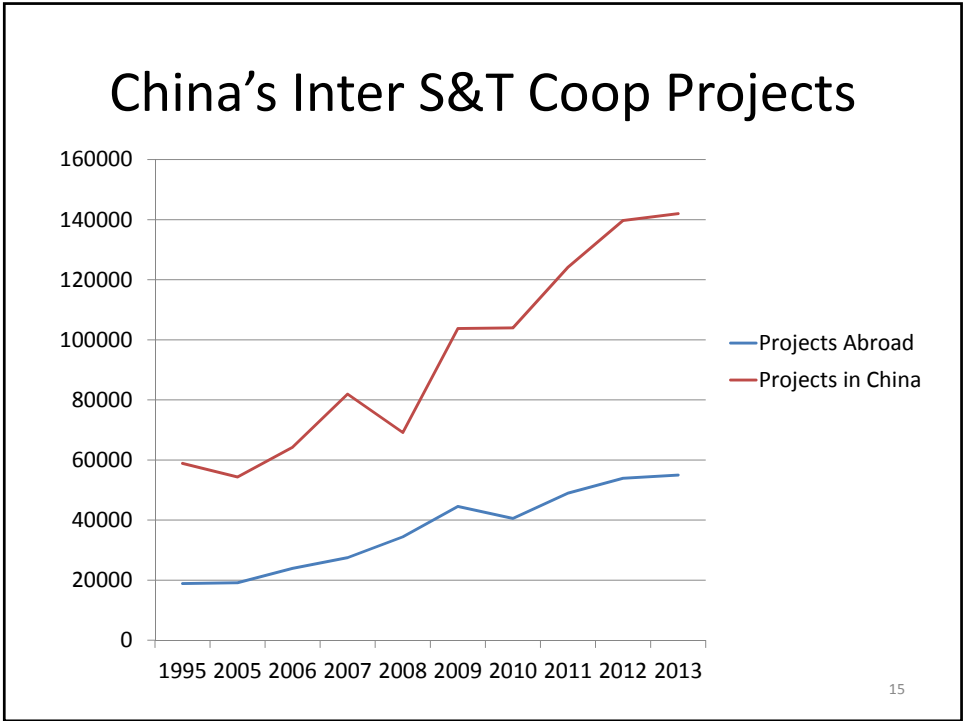
- By early 2013, China has established formal S&T cooperation relations with over 150 countries and regions ;
- Signed over 100 inter-governmental S&T cooperation agreements with 97 countries and regions;
- Stationed 144 S&T diplomats in 70 institutions and 47 countries;
- Joined more than 200 inter-government international S&T cooperation organizations and initiated formation of a complete diversified intergovernmental framework for cooperation in S&T
- Strengthened local level—provincial and municipal organizational capabilities for global S&T engagement

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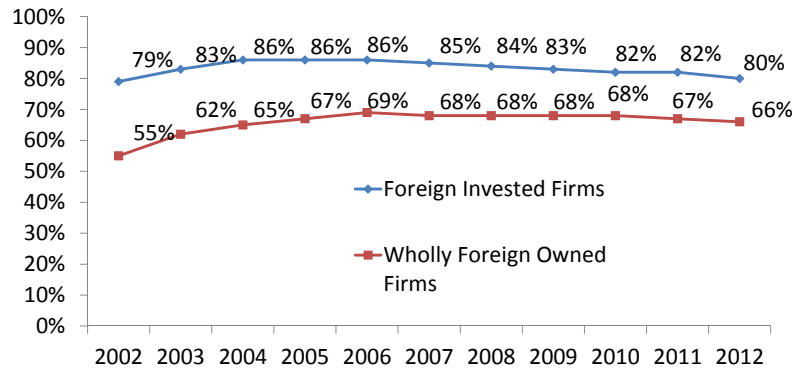
China's Budget for Inter S&T Cooperation (Central Government)



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Foreign Invested Firms' s Contribution to China's High-tech Exports (%)



China's IPR Deficit

According to IMF data (2009), China had a \$10,635,818,562 deficit in its overall IPR balance of payments (royalties, license fees paid/received). This is several orders of magnitude greater than other deficit countries. The US had a surplus of over \$64,561,000,000!

China's IP Challenge

"China's total patent filings grew 26% from 2003 to 2009, dwarfing growth in all other regions: 6% in the USA, 5% in South Korea, 4% in Europe and 1% in Japan.⁴ Yet, China remains far behind all of these countries in terms of licensing revenue. This may be due to a time-lag between patent ownership and monetization. However, it is more likely the result of policies that incentivize the filing of patents without adequately emphasizing the importance of patent quality for generating licensing income. These incentive systems precipitated a rush in patent filing, often for inventions of little or no value. The rapid rise in utility-model patents, which do not require inventions to be 'novel' and last only 10 years, is a problem in terms of patent monetization. A Thomson Reuters survey in China shows that only one-fifth of patent professionals believe Chinese patents are of high quality, a smaller portion than any other country in the world included in the survey."

From: "Promoting Intellectual Property Monetization in Developing Countries" by Roya Ghafele and Benjamin Gilbert, World Bank, 2012 (WPS6143)

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The Changing Thrust of China's International S&T Relations



8th National Foreign S&T Affairs Conf



Five Lessons from Previous Experience —former Minister Xu Guanhua

- 1) Opened up multiple channels for expanding S&T cooperation—open policy
- 2) Effectively utilized S&T diplomacy to promote economic & trade cooperation
- 3) Adapted to the new imperatives of economic and S&T globalization— participation in several global mega-projects
- 4) Have grown channels to attract S&E talent
- 5) Created multi-layer, multi-faceted structure

Xu, Guanhua, former Minister of S&T

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Five Major Strategic Shifts

- **Shift** from *general* international S&T coop to cooperation focused on the needs and mission of the MLP—from passive to pro-active
- **Shift** from project-based collaboration to “the integration of projects, talent and R&D bases”
- **Shift** from tech import orientation to a combined process of “inviting in” & “going abroad”
- **Shift** from cooperation driven by govt to cooperation driven by multiple players
- **Shift** from bottom up to top down project identification and approval according to outline and reqts of MLP

The New Pro-Active Approach

“In the past, China’s international S&T cooperation was aimed at creating more channels for cooperation and the collaborative research projects were mainly defined on the basis of basically similar technical levels on both parties or taking advantage of the respective strength of each party in the cooperation. Such co-operation mode was dominated by four studies and seeking assistance, but that has gradually given way to the new mode of joint investment, cooperative R&D, and results sharing. The *Program on Priority International Cooperative Projects* will play the coordination roles of the central govt through pooling of domestic resources, attracting international S&T resources, enhancing China’s S&T strength, and organizing major international cooperative projects at the national level. *China will change its position of “working for other bosses” as typified in the past cooperative activities through establishing dedicated funds for international S&T cooperation, supporting major international; S&T cooperation projects, raising China’s position in international S&T cooperation, making China’s participation in such cooperation on an equal footing, and realizing results sharing and reciprocal benefits.”*

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9th National Foreign S&T Affairs Conference , Beijing, August 2011



The Conference Promulgated:

- *S&T International Cooperation 12th FYP Special Program Plan*
- *Regulations for National S&T International Cooperation Management and Administration*
- *Regulations for National S&T International Base Cooperation Management and Administration*

http://www.most.gov.cn/tpxw/201108/t20110828_89315.htm

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Wan Gang, Minister of S&T, at the 9th National Foreign S&T Affairs Conference

- ❑ Wan Gang fully affirmed the outstanding achievements and progress of China's international cooperation in S&T work in recent years and he also made a thorough analysis of the current situation of international S&T cooperation
- ❑ Pointed out **four key tasks**:
 - ✓ *First, to strengthen the level and design for S&T cooperation between governments*
 - ✓ *Second, to expand the opening up of national S&T planning*
 - ✓ *Third, further enhance the role of China in major international S&T affairs*
 - ✓ *Fourth, to innovate S&T assistance mode; launch and implement "Technology Partner Program"*

http://www.most.gov.cn/tpxw/201108/t20110828_89315.htm

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New Face of International S&T Cooperation

New Platforms

- *International Innovation Parks (21)*
- *International Joint Research Centers (93)*
- *International S&T Cooperation Innovation Union*
- *International Technology Transfer Centers (26)*
- *International S&T Cooperation Bases (301 w/500 goal)*
- *International R&D Outsourcing Services Ctr*
- *International Business Incubator (1,239)*

New Initiatives: Bilateral & Multilateral

- US-China CERC: a pet project of Wan Gang!
- Sino-Russia High Level S&T Engagement
- China-EU S&T Partnership Plan
- Sino-Korea S&T Minister's Meeting
- China-Korea-Japan "trilateral" research coop (on hold!)
- China-India S&T Cooperation Steering Committee
- China-Latin America Innovation Forum
- China-Africa Forum on Science and Technology
- China-Arab Cooperation Forum
- SCO-Central Asia S&T cooperation

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China's Presence in Large International S&T Projects

Selected Examples:

- International Thermonuclear Experimental Reactor (ITER)
- Galileo
- Integrated Ocean Drilling Program (IODP)
- Fourth Gen Nuclear Energy (GIF)
- Global Earth Observation System (GEOSS)
- CERN
- Large Hadron Collider (LHC)
- Human Genome Project (HGP)
- Alpha Magnetic Spectrometer (AMS)
- World Climate Research Program (WCRP)

Objectives:

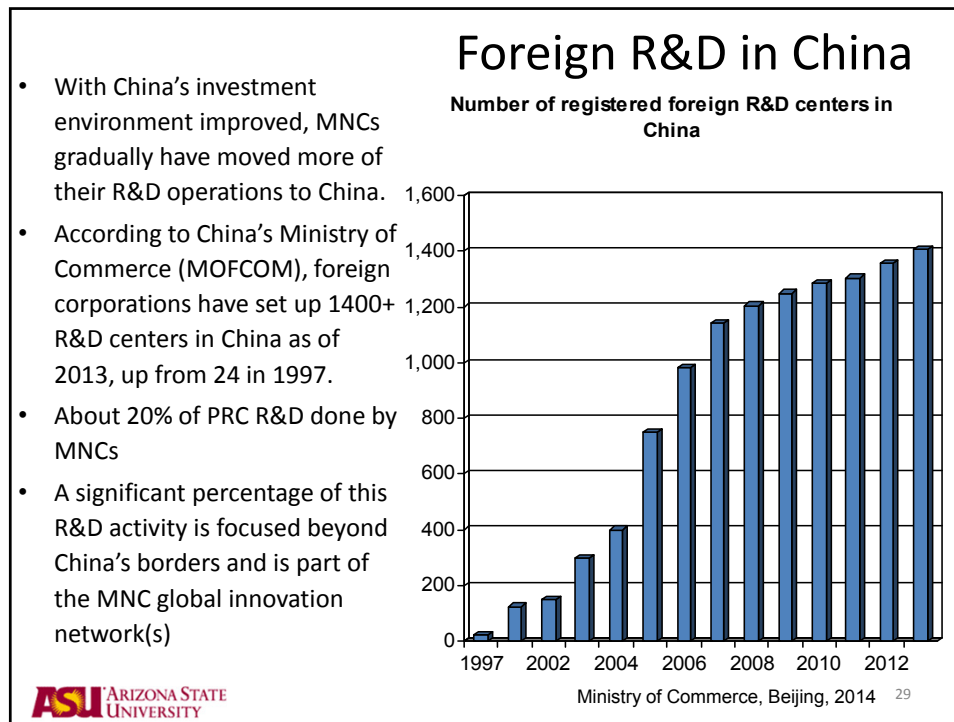
- Get key international S&T organization to set HDQs in China
- Enhance influence and voice in international S&T organizations
- Participate in inter technical standards setting organizations
- Increase funding, personnel and support to enhance role in S&T I.O.s
- Expand participation in regional S&T organizations
- Build infrastructures to attract "big science" to China

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New S&T Reforms and Inter Coop

- The Sept 2012 "Decision" document on mgt of S&T system has had major impact on mgt system for international S&T cooperation
- Audit and analysis of situation regarding inter S&T cooperation projects during 2011-2013 reveals affirmation for tightening up mgt oversight and project budget mgt
- With the expansion of inter S&T cooperation activities have come new stresses on the mgt infrastructure and critical challenges regarding project monitoring, development, implementation and evaluation
- Even push for greater local initiative often has not been accompanied by strategic thinking on the part of local leaders

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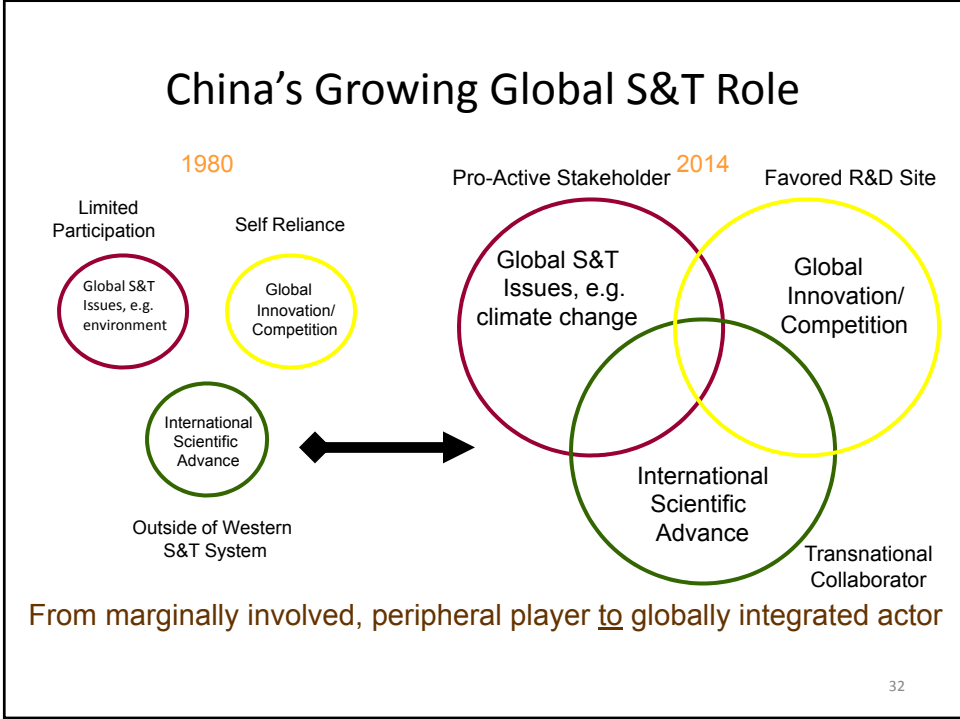


Impact of Foreign R&D in China

- Foreign R&D in China as part of NIS is still a fairly new phenomenon—too early to measure full impact
- Policymakers need to strategize around “capture” options
- Links between domestic R&D growth and foreign investment, e.g. focus largely on process innovation & product re-design
- Contributions may be more intangible than tangible
 - *Training—technical, methodology (design), teaming*
 - *Technology transfer—codified + uncoded know-how*
 - *Standards—best practices, industry standards, quality*
 - *Management—project mgt, business mgt, work environment*
 - *Networks and Access to Resources—knowledge networks*
 - *Spinoffs—new business ventures*
 - *Spillovers—assistance to vendors & suppliers...plus labor circulation/turnover—may be key vehicle for local benefit*
 - *Contribution to forming an environment supporting creativity*



Whither China's International S&T Relations: A New Global Paradigm Emerging?



What are the Challenges?

❖ Domestic

- ❑ At National S&T Education Leading Group Meeting (February, 2012), former Premier Wen Jiabao noted:

“Although China has made significant progress in increasing investment in S&T and enhancement in S&T innovation strength, China's S&T system is not well adapted to the needs of economic and social development and international competitiveness”

- ✓ “The allocation of scientific resources faces numerous problems: excessive administrative burdens, overlaps, and redundancies
- ✓ S&T and economy stand as “Liang Zhang Pi” (“两张皮”), they may have some connection originally, however, they exist separately in fact.
- ✓ The system suffers from lack of relevant evaluation mechanisms”

❖ International

- ❑ Digestion, absorption, & assimilation of knowledge: not enough focus
- ❑ Lack of trust regarding IPR, standards, etc.
- ❑ Agenda setting deficiencies
- ❑ Role of returnees and “amphibians” who straddle the Pacific

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China's Technological Forecast(s): CAS Science & Technology Roadmap 2050

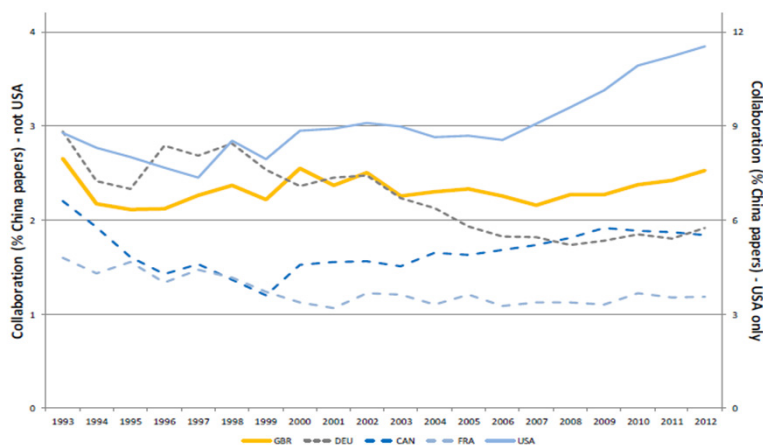
Necessity of CAS Research on China's S&T Roadmap to 2050

Why does CAS launch this research? As is known, CAS is the nation's highest academic institution in natural sciences. It targets at making basic, forward-looking and strategic research and playing a leading role in China's science. As such, how can it achieve this if without a foresighted view on science and technology? From the perspective of CAS, it is obligatory to think, with a global view, about what to do after the 3rd Phase of the Knowledge Innovation Program (KIP). Shall we follow the way as it used to? Or shall we, with a view of national interests, present our in-depth insights into different research disciplines, and make efforts to reform the organizational structure and system, so that the innovation capability of CAS and the nation's science and technology mission will be raised to a new height? Clearly, the latter is more positive. World science and technology develops at a lightening speed. As global economy grows, we are aware that we will be lagging far behind if without making progress, and will lose the opportunity if without making foresighted plans. S&T innovation requires us to make joint efforts, break the conventional barriers and emancipate the mind. This is also what we need for further development.

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PRC S&T Collaboration with US Dominates China's Other S&T Ties in terms of Research Co- Authorship

Figure 6. China's research co-authorship with leading Western research economies. Data for the USA are scaled against the RH vertical axis while other countries are scaled against the LH axis.



Source: China's Absorptive State, NESTA, UK, 2013

China's International Collaboration in Nanotech Publications is Rapidly Growing – and Paying Off

- **Chinese authors account for 21% of the ~804,000 SCI-indexed journal articles published globally between 1990-2012**
 - **2012: Chinese share increased to 27% (U.S. share ~ 20%)**
 - **18% involve international collaboration**
 - **China now accounts for 27% of all citations (> any other Asian country)**
- **U.S. co-authors are (by far) the leading collaborators with Chinese authors**
 - **2000: Japan and U.S. ~ 25% of co-authorships**
 - **2012: U.S. = 40%; Japan = 10%**
 - **U.S. institutions account for 6 of top 15 foreign institutions that collaborate (G-Tech is #4; U Michigan is #8; UC Berkeley is #10; Oak Ridge National Labs is #12; MIT is #13; U Tennessee is #14)**

Source: Center for Nanotechnology & Society, CNS-UCSB, 2014

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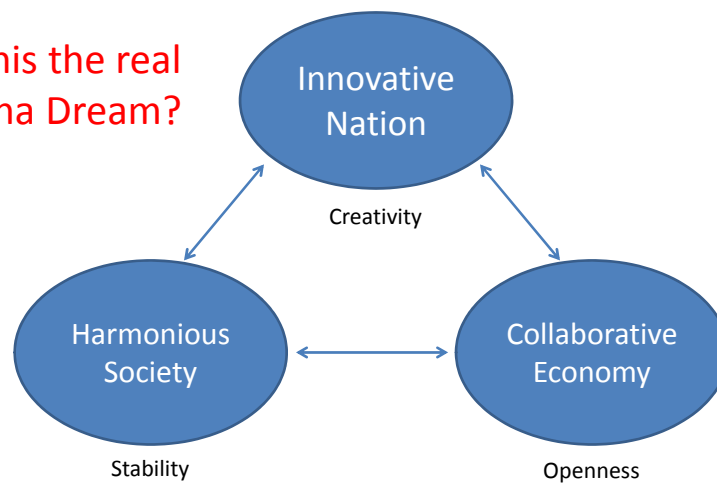
Whither PRC's International S&T Relations?

- Clear that we have entered an important transition point in China's international S&T relations—more assertive, more pro-active, more determined & more tied to diplomacy
- Cut waste, avoid ineffective programs, and seek out the “best” partners
- Emphasis on raising PRC visibility and image in global and regional S&T affairs: better link between S&T coop and open policy overall
- More links between MLP and international S&T cooperation
- More confident, more comfortable, more sophisticated China— more autonomous actor...but also more anxiety about failure to close prevailing gaps
- How can we incentivize a China to remain “globally” and positively engaged?
- China likely to take more active stance/presence in S&T IOs

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Can China Achieve All Three Goals?

Is this the real
China Dream?



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XIE XIE!

Questions and Comments



ASU ARIZONA STATE
UNIVERSITY

China's Technological strengths: World Bank "China 2030" report



- Auto assembly & components
- Biopharmaceuticals
- High density power batteries
- High speed trains
- Telecom equipment
- Wind turbines
- Supercomputers
- Booster rockets
- Space satellites
- Electric power turbines
- PVCs
- Stem cell therapeutics
- Nanotechnology
- Single aisle passenger aircraft (C919)

China's Key S&T Relationships

US-China S&T

- Bilateral Accord signed 1979
- Building block of relationship
- Expansion of fields w/ limits
- Emerging constraints tied to IP, security issues, e.g. NASA/OSTP
- Innovation Dialogue holds promise: more innovation focus

EU-China S&T

- China is a priority partner
- S&T not stand alone—tied to sustainable development focus
- Innovation & SMEs key areas
- China growing importance in FP 7: from 81 to 268 projects FP5->FP7
- EU-China 2020 Agenda partnership

Japan-PRC S&T

- S&T relations forged in 1980, but S&T & diplomacy not closely tied
- Growing focus sustainability & energy issues
- Driven more by Japan companies
- Crisis serious impact: S&T coop
- Korea-Japan-China coop halted

China-Israel S&T

- Growing ties in R&D field—alternative to US
- Collaboration w/MoST strong
- Unique relationship with Jiangsu in mgt of tech and training
- Leverage Israeli knowledge in agric
- Technion project in south China

International Collaboration Benefits Chinese Authors More Than Their Foreign Collaborators

Chinese authors who collaborate with US co-authors increase their impact by nearly two-thirds (64%) over Chinese nano pubs authored solely by Chinese; US authors who collaborate with PRC co-authors have an impact that is 9% lower than articles solely written by US authors (91%).

Relative Citation Rates of Internationally collaborative Publications (all nano papers published between 2000 and 2008)

Incidence-rate ratios from negative binomial regressions

	Brazil	China	Germany	India	Japan	Korea	Netherlands	Russia	Singapore	USA
Brazil		0.52	1.16	1.26	0.67	0.76	1.00	0.67	1.38	1.72
China	0.43		1.35	0.83	1.05	0.91	1.26	0.56	1.37	1.64
Germany	0.75	1.09		0.70	0.98	1.07	1.38	0.63	0.86	1.40
India	1.12	0.98	0.98		1.31	1.00	1.02	0.41	1.10	1.17
Japan	0.60	1.12	1.33	1.22		0.98	1.79	0.73	1.11	1.59
Korea	0.86	1.02	1.59	0.99	0.99		1.40	0.46	1.30	1.53
Netherlands	0.42	0.86	1.06	0.56	0.95	0.63		0.38	0.94	1.32
Russia	1.33	1.31	1.80	0.91	1.43	0.99	1.60		2.27	2.83
Singapore	0.76	0.91	0.70	0.61	0.73	0.75	0.93	0.97		1.15
USA	0.77	0.91	0.97	0.59	0.81	0.74	1.28	0.70	0.97	

Note: Coefficients in each row come from a regression in which the sample only includes papers which the row country has co-authored. Only papers in English, involving one or two countries, and no countries outside this table, are included. All regressions correct for field dummies, number of authors, number of pages and year of publication. Darkness of shading denotes significance, orange < 1, blue > 1.

Slide prepared by Aashish Mehta, CNS-UCSB, Santa Barbara, 2014

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