China: Crossroads 2020—Understanding Uncertain Futures

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1

2020: Annus horribilis

- 2020 in Chinese culture is known as the Year of "Gengzi"
- Gengzi operates on a 60 year cycle
- And here are some other Gengzi years in Chinese history:
- 1840: The first Opium War that ushered in a "Century of humiliation"
- 1900: Boxer Rebellion that forever marred China's relations with the West because of its violence against foreigners
- 1960: The height of the Great Leap Forward that resulted in between 15 to 20 million deaths
- 2020: COVID-19 and negative GDP growth (6.8 percent) in the first quarter

2

My presentation

- US-China relations: Grim prospects
- We need a more rational and more cool-headed debate
- Potential implications of a decoupling between China and the United States for US high-tech industry
- (The role of technology in China's COVID-19 response)

3

US-China Relations: Grim Prospects

- Republican strategy in the 2020 election:
- Blame China for the failings of the Trump administration's handling of COVID-19
- China misreported and hid information from US
- Will attack Democrats for being soft on China
- Multiple lawsuits filed against China seeking damages associated with COVID-19 (although unlikely to succeed because of foreign immunity)
- But also lawsuits in some other countries too
- Europe and Japan joined the call for holding China accountable for lack of transparency and suppression of information
- Many calls for trust, safety and redundancy of global supply chains
- Japanese government to provide subsidies to firms to move their operations to Southeast Asia

4

We need to be rational and cool-headed

- Yes, Chinese government suppressed information and most likely misreported data
- Extremely costly delays in the initial response to COVID-19
- Containment and mitigation actions implemented three weeks earlier would have led to 95% fewer infection cases, according to a study by University of South Kempton
- But South Korea, Singapore, Taiwan, Hong Kong, Israel and Germany all acted on the same information from China
- They have done a far better job than the United States
- We do not need a less parsimonious explanation than a president who advocated injecting bleach as a treatment

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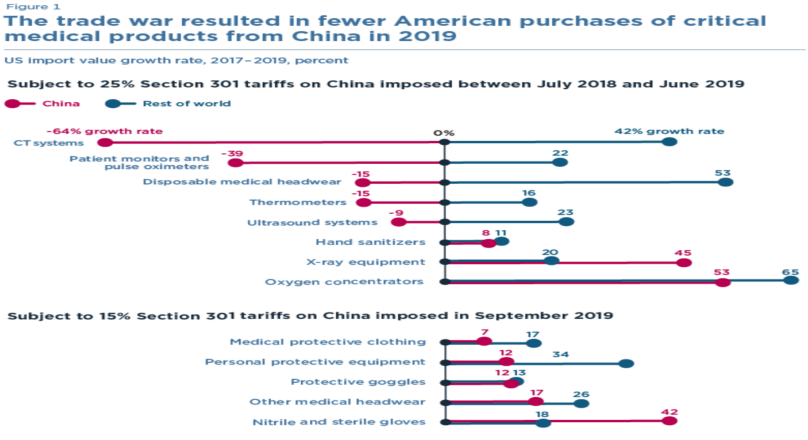
De-globalization in fact undermined US preparedness for COVID-19

- PIIE's study: Trump's trade war reduced US hospitals' imports of critical medical equipment from China



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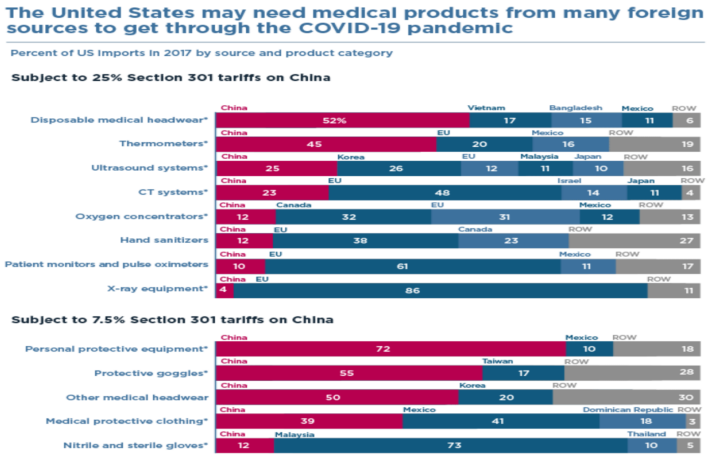
It is hard to replace China, at least in the short run



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Implications for US high-tech industry

8

Four perspectives on decoupling

- US high-tech business model
- Scale and structure of government's expenditure on R&D
- Applications market
- Human capital

9

The impact of a "decoupling" on business models of the US Tech Firms

10

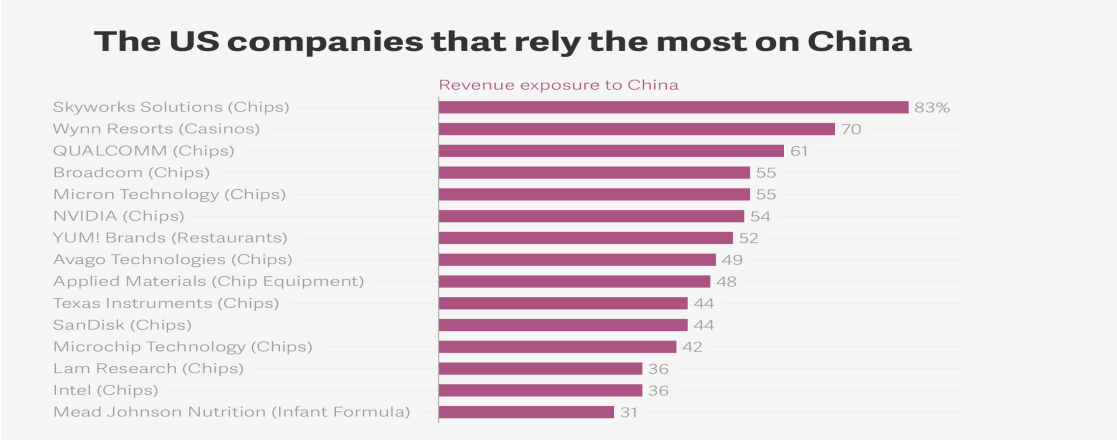
US Tech Firms Revenue in China

- US R&D funding by operating income and investors' money in anticipation of operating income.
- According to US investment Bank Jefferies's report in 2018, "U.S. technology companies generate roughly **$100 billion to $150 billion in revenues** from China annually."
- "Apple and Intel are on a list of 16 U.S. companies that made a total $105.5 billion from China last year, or 23 percent of overall revenues, the analysts said. Other names include Microsoft and Qualcomm."
- "Including HP, Dell and other companies that don't break out their China revenues brings the total estimate to around $150 billion."

11

US Tech Firms Revenue in China

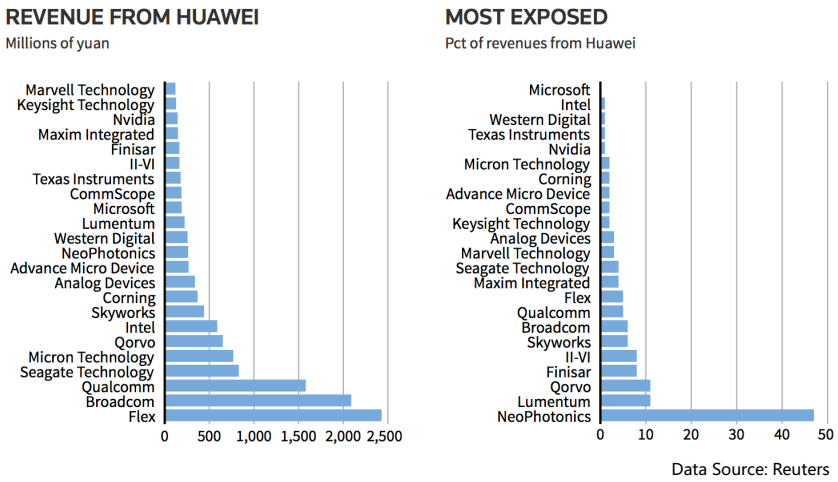
- The list of the US companies that rely the most on China: Many are tech firms



Data Source: Goldman Saches

12

Huawei's American Suppliers



13

The Scale and the Structure of R&D Expenditures in China and the US

14

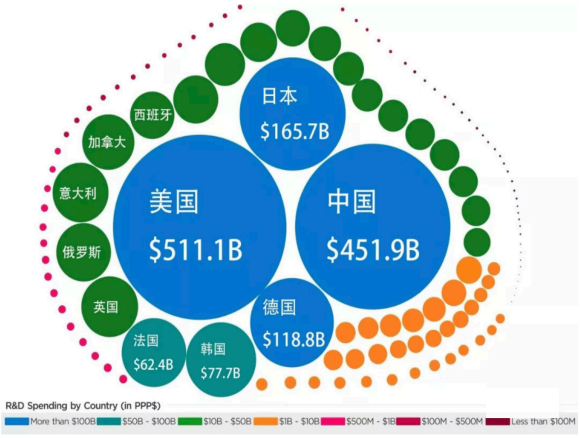
Overview

- The federal R&D investments have not increased for many years and the private tech firms are the main sources for the US R&D funding.
- Research in the US increasingly depends on the rising international, collaborative funding, including from China
- The R&D investments in the tech domain can be complementary between the US and China.

15

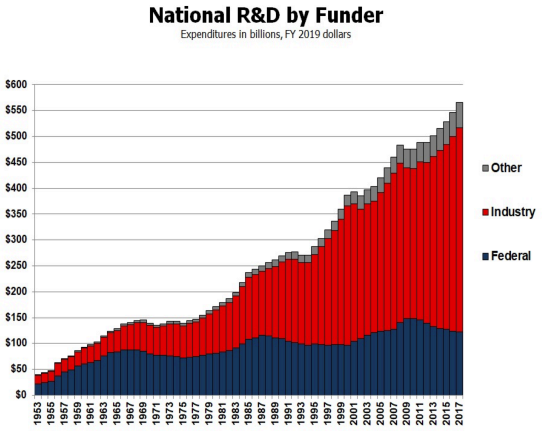
Global and US R&D Investments

Global R&D Investment in 2016 Comparison



Data Source: UN

US R&D Investment （1953——2017）

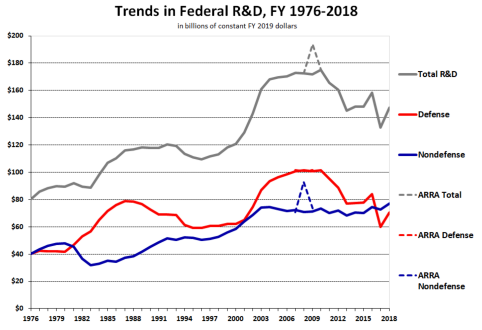


Data Source: AAAS

16

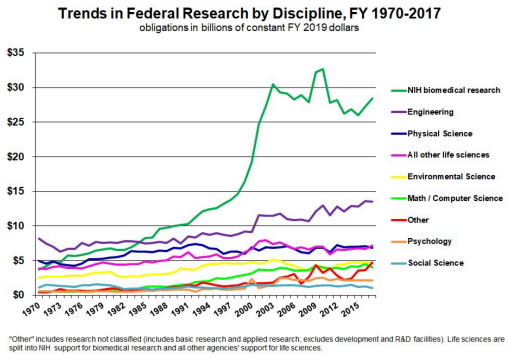
Analysis of the R&D Investment in US

- Rising Concentration of US federal R&D expenditure: 1) Defense and 2) Life science)



US Federal R&D Investment Trends (1976——2018)

Data Source: AAAS



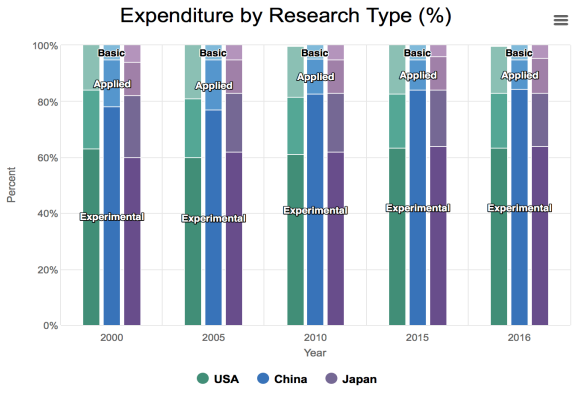
US Federal R&D Investment Trends (Discipline) (1970——2017)

Data Source: AAAS

17

Comparative Analysis on Global R&D Investment

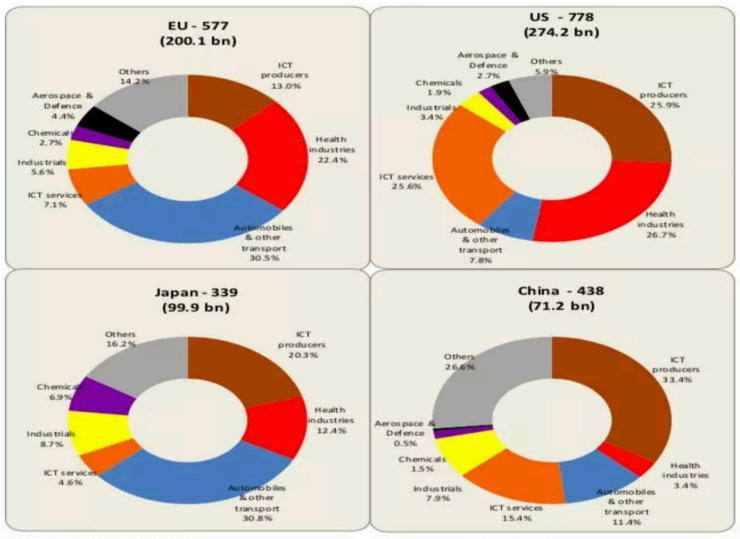
- Complementary structures of US and Chinese R&D spending: US's basic research and China's experimental research



Data Source: OECD

18

Comparative Analysis on Global R&D Investment

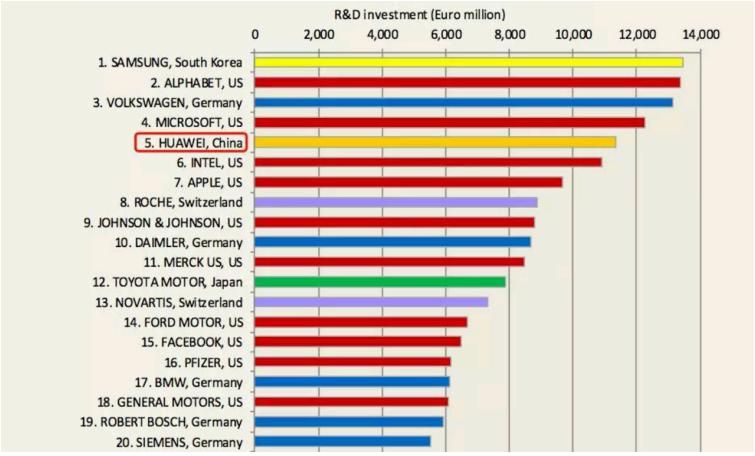


- China has a more even distribution of funded disciplines (excl "Others"): 1) Top three in US: 77.6% and 2) Top three in China: 60.2%

Data Source: EU

19

Comparative Analysis on Global R&D Investment



- Huawei is now a R&D Powerhouse
- Huawei ranked in the 5th place in the 2017-2018 on R&D investment among all private enterprises in the world.

Data Source: EU

20

The applications of S&E Innovations

21

Overview

- In some areas, China may have a larger application market than US, such as AI, materials and renewable energy.

22

Case Study — AI

- China's advantage in AI applications over US and EU.

Table 1: Rankings, absolute metrics

Category	China	European Union	United States
Talent	3	2	1
Research	3	2	1
Development	3	2	1
Adoption	1	2	3
Data	1	3	2
Hardware	2	3	1

Table 5: Adoption metrics and scores, absolute values[12]

			Metrics			Scores		
Year	Metric	Weight	CN	EU	US	CN	EU	US
2018	Number of Workers in Firms Adopting AI (Rank)	5	1	2	3	3.8	0.7	0.5
2018	Number of Workers in Firms Piloting AI (Rank)	5	1	2	3	3.9	0.6	0.5
	Total Scores	**10**				**7.7**	**1.3**	**1.0**

Data Source: Center for Data Innovation

23

Case Study — AI

- China's data capabilities run long and deep

24

Case Study — AI

- Chinese high-tech firms are all conglomerates
- Alibaba, Tencent, Baidu all operate in multiple business arenas:

E-commerce

Gaming

Search engine

Finance

Insurance

Entertainment

Social media

25

Case Study — AI

- Implications of conglomeration business model:

BIG data:

Volume of data

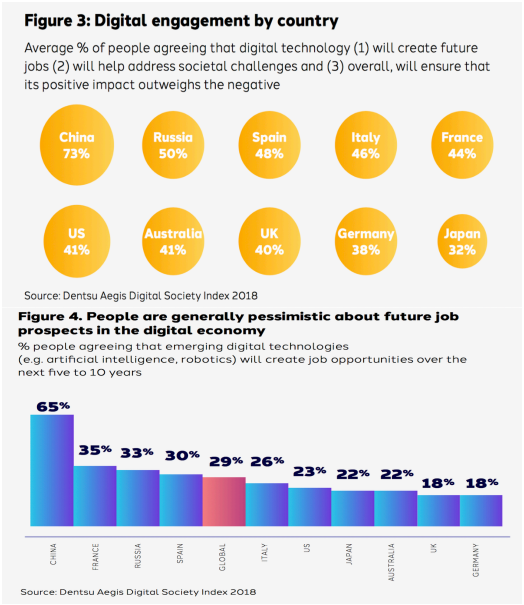
Diversity and multiplicity of data

Integration and aggregation by Chinese firms are unrivaled

26

AI — Attitudinal Support

- The 2018 Digital Society Index (DSI): 73% of Chinese believe that the future impact of digital technology will be positive overall, as well as in terms of its ability to create jobs and address societal challenges.
- Also according to DSI, in comparison to negative perceptions in the West, 65% believe that emerging digital technologies (e.g. AI, robotics) will create job opportunities over the next 5 to 10 years.



27

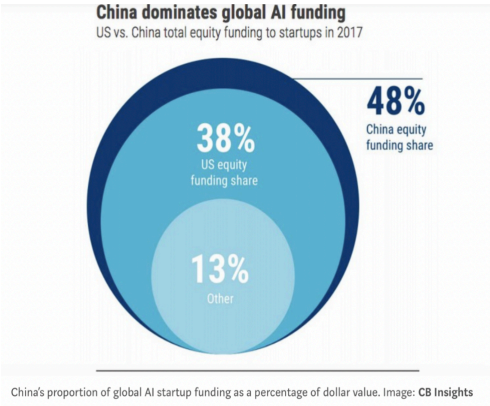
AI — Big Data and Surveillance State

- Survey by German sinologist Genia Kostka in China in 2018: 80 percent of respondents approve of social credit systems in China, with just 1 percent reporting either strong or moderate disapproval.
- Genia Kostka shows socially advantaged citizens — wealthier, better-educated urban residents — report the strongest approval levels of social credit systems, along with older people.
- Genia Kostka shows 76 percent of respondents flagged a general lack of trust in Chinese society as a problem. Respondents see social credit as a helpful means of striking back at con artists, or punishing polluting and otherwise negligent firms.

28

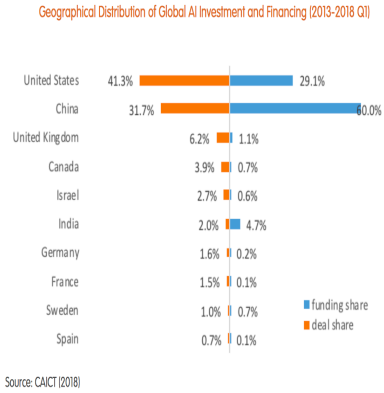
AI — Global Trend

- China's Dominance in Global AI Funding



China's proportion of global AI startup funding as a percentage of dollar value. Image: **CB Insights**

- Geographical Distribution of Global AI Investment and Financing (2013-2018 Q1)

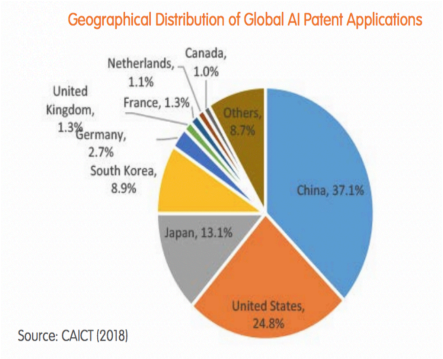


Note: Deal share means number of projects, Funding share means amount of money

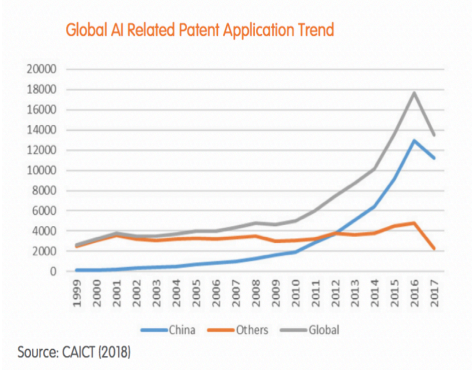
29

AI — Global Trend

- Chinese AI patents 37.1% of the global share



- Fastest growth trend



30

The power of data and contact-tracing in China's COVID-19 response

31

China Unicom: Using cell phone data to track population mobility

- China Unicom: One of China's largest mobile service providers
  - Assembled a big-data team on January 20th, 2020 (the same day Xi Jinping signaled his decision)
  - On January 22nd, China Uniform shared mobile phone data with China's health commission, Chinese CDC and provincial authorities on population movement, especially that out of Wuhan
  - One day before lockdown of Wuhan
  - Provided key data that justified decisions to implement lockdown and shutdown
- → This is a concrete example of data-based decision

32

Tracking individual health status: Zhejiang

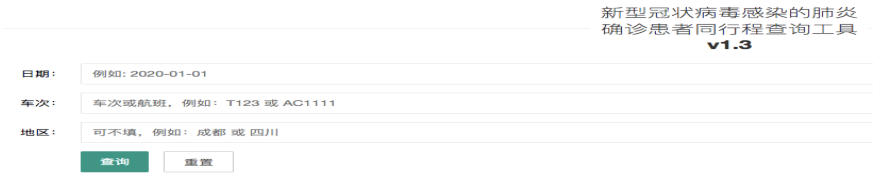
- Zhejiang Province: Widely considered as success story in mitigating virus spread
  - On February 11th, Alibaba launched smartphone app Hangzhou Health Code to monitor health conditions of Hangzhou residents
  - Most likely implemented with a decree of the city: Every resident required to fill out questionnaire on personal health condition and recent travel history
  - Information shared with police according to NYT
  - Questionnaire data checked against Alipay/WeChat account history in verifying travel history
  - All-in-one function is extremely important
  - App then generates color-based QR code:
    - Green: Movement permitted with few restrictions
    - Yellow: Self-quarantine for 7 days and report personal health condition on the app on a daily basis
    - Red: Self-quarantine for 14 days and report personal health condition on the app on a daily basis

33

Contact Tracing

- Tracking individual travel history:

  Qihoo360: Internet security company known for antivirus and web browser: Using user interface to construct travel history



34

Robots and applications during COVID-19

35

Industrial Robots

- Industrial robotics applications are driven by the size of manufacturing sector.

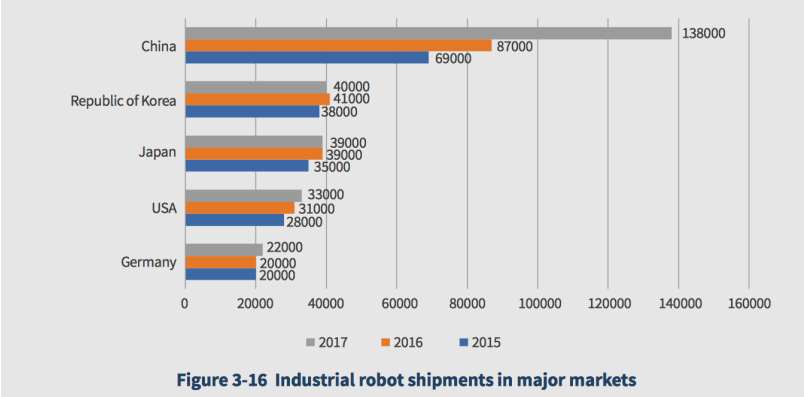


Figure 3-16 Industrial robot shipments in major markets

Data Source: Tsinghua University

36

- **Huawei**
  - According to newspaper *Yangtze Daily* (the newspaper of Wuhan government), Huawei sent first two **5G self-driving medical vehicles** to Wuhan on Feb 4th. Huawei kept sending more after Feb 4th.
  - The vehicles are used in the isolated wards of the hospitals to transport patients.
  - Traditional transportation methods in the isolated wards of the hospitals would create risks for medical care workers to be infected. Self-driving medical vehicle reduces the risk by minimizing the contacts between patients and medical care workers.

Source of the pictures: Yangtze Daily & Zhihu

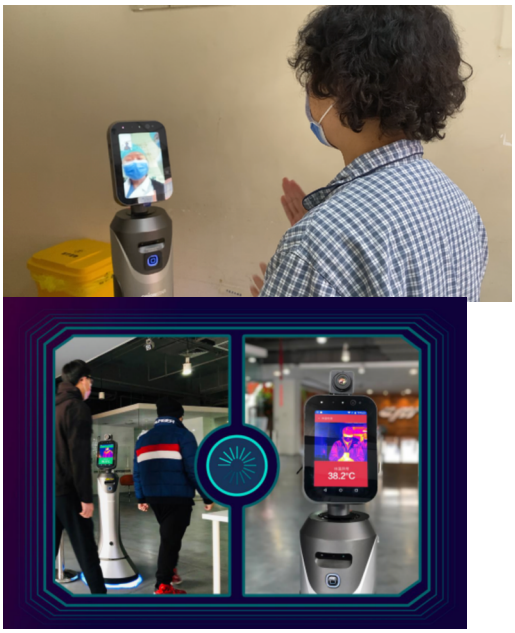
37

- **DaLu Robotech**
  - DaLu Robot, a tech company in Changshu City, Jiangsu Province, collaborated with Huawei to produce an intelligent inspection robot: ANDI.
  - ANDI has been delivered to hospitals in Wuhan in early March.
  - ANDI can achieve multiple tasks:
    - Contactless body temperature detection based on infrared thermal imaging device
    - 24 hours non-stop patrol based on pre-determined route
    - Spraying disinfectant sprays based on pre-determined route
    - Detecting and warning people who don't wear masks based on AI facial recognition

Source of the pictures: Changshu Party Media

38

- **Cheetah Mobile**
  - Cheetah Mobile delivered dozens of robots to hospitals in Beijing and Hubei province in late January/early February.
  - The robot can:
    - Connect the patient with doctors remotely.
    - Deliver supplies, clinic laboratory sheets, medicines.
    - Detect a fever within an accuracy of 0.3°C based on a combination of AI algorithms and infrared thermal technology.



Source of the picture: Xinhua

39

- **Saite Robot**
  - Saite Robot, a robotic firm based in Guangdong province, delivered multiple robots to hospitals in Guangdong and Hubei provinces in late January/early February.
  - The robot can:
    - Take elevators and swipe ID before gates automatically
    - Deliver food/medical supplies within the hospitals
    - Spray infectant sprays
    - Detect body temperature

Source of the picture: voorp

40

Material Science

China's efforts on material science application:

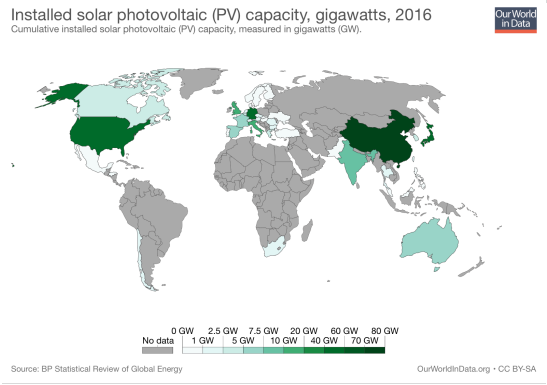
- Launched in 2016, the Materials Genome Engineering (MGE) project of China aimed to match the scope of the Materials Genome Initiative in the United States, a $250-million federal program designed to shepherd advanced materials science into industrial applications. The project has a budget with 1-billion-yuan (US$150-million).
- In the nanoscience domain, China now (2019) has the highest number of graphene businesses in the world — nearly 3,000, according to government figures. The country also accounts for around two-thirds of global production.

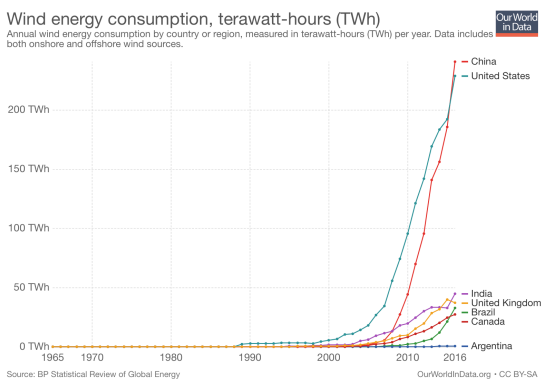
Data Source: Nature

41

Renewable Energy

- China has more applications on solar PV and wind energy than any countries in the world.





Data Source: Oxford

42

The human capital perspective

43

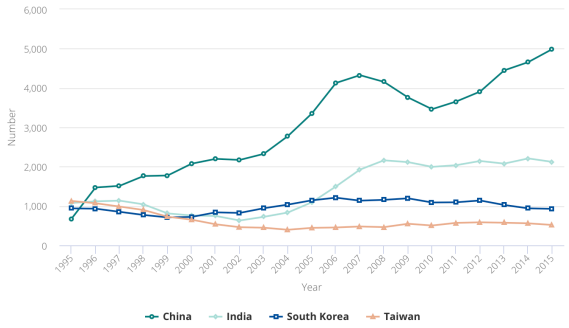
Overview

- The S&E labs in the US universities depend heavily on human capital from abroad, China in particular.

44

Higher Education in the US

U.S. S&E doctoral degree recipients, by selected Asian country or economy of origin: 1995–2015



Note(s)

Degree recipients include temporary visa holders and non-U.S. citizens with unknown visa status. Data for China include Hong Kong.

U.S. S&E Doctoral Degree Recipients (Asian country or economy 1995——2015)

Data Source: NSF

45

Higher Education in the US

Recipients of U.S. S&E doctorates on temporary visas, by country or economy of origin: 1995–2015

(Number and percent)

Country or economy	Number	Percent
All recipients on temporary visas	220,684	100.0
Top 10 total	155,259	70.4
China[a]	63,576	28.8
India	30,251	13.7
South Korea	20,626	9.3
Taiwan	13,001	5.9
Turkey	6,610	3.0
Canada	6,350	2.9
Thailand	4,564	2.1
Mexico	3,502	1.6
Japan	3,473	1.6
Iran	3,306	1.5
All others	65,425	29.6

[a] Includes Hong Kong.

Asian recipients of U.S. S&E doctorates on temporary visas, by field and country or economy of origin: 1995–2015

(Number)

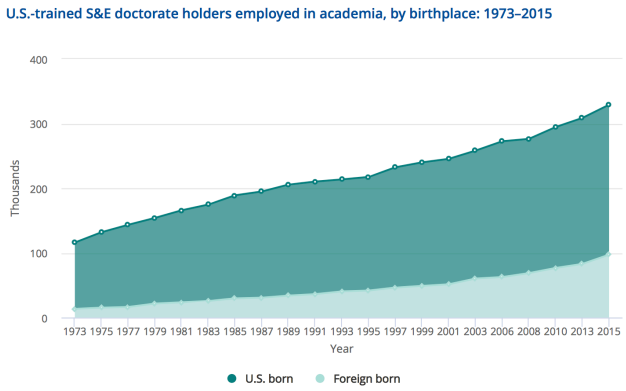
Field	Asia	China[a]	India	South Korea	Taiwan
All fields	166,920	68,379	32,737	26,630	16,619
S&E	146,258	63,576	30,251	20,626	13,001
Engineering	55,215	23,101	13,208	8,274	5,045
Science	91,043	40,475	17,043	12,352	7,956
Agricultural sciences	4,927	1,745	823	720	441
Biological sciences	25,149	12,202	5,654	2,459	2,374
Computer sciences	9,287	4,229	2,477	1,015	597
Earth, atmospheric, and ocean sciences	2,803	1,563	357	338	228
Mathematics	7,494	4,493	805	967	503
Medical and other health sciences	5,298	1,368	1,371	672	878
Physical sciences	20,528	10,816	3,516	2,216	1,305
Psychology	2,053	530	277	481	320
Social sciences	13,504	3,529	1,763	3,484	1,310
Non-S&E	20,662	4,803	2,486	6,004	3,618

[a] Includes Hong Kong.

Data Source: NSF

46

S&E PhDs in US academia



Data Source: NSF

US Trained S&E PhDs in Academia (1973—2015)

47

US Academy of Sciences

- In 2019, 2 Chinese passport holders were elected into the US Academy of Science as academicians and 2 Chinese Americans were also elected into the US Academy of Science.
- By 2019, 107 Chinese or Chinese American scientists have been elected into the US Academy of Science,
- Among all Chinese American academicians in the history of the US Academy of Science, 26 of them were born or lived in mainland China.
- The picture on the right shows that among all international scholars at MIT, 44% of them are from Asia.

Many MIT staff are international scholars (i.e., non-US citizens, non-US permanent residents) from around the world who come to the United States for teaching, research, collaboration, and other purposes. This diverse group of professionals includes visiting scientists, professors, artists, and scholars, as well as postdoctoral fellows and associates, lecturers, instructors, research associates and scientists, and tenure-track faculty. During academic year 2017–2018, MIT hosted 2,345 international scholars (75% men, 25% women) from 92 countries.

International Scholars, by Region	
Asia	44%
Europe	35.5%
Middle East	8.5%
North America	5%
Mexico, Latin America, and the Caribbean	4.5%
Africa	1.5%
Oceania	1%

* Last updated: 6/28/2019.

Data Source: MIT

48

Research Collaborations

- Coauthored papers between Chinese and American scientists have increased dramatically

Figure 9: Internationally Co-authored S&E Articles – World, China and the U.S., 1995 and 2010

	1995	2010	Percentage change
World-World	79,128	185,303	134.18%
U.S.-World	36,361	79,581	118.86%
China-World	2,914	24,164	729.24%
U.S.-China	1,112	10,917	881.74%
The share of U.S.-China papers in U.S.-World	3.06%	13.72%	•
The share of U.S.-China papers in China-World	38.16%	45.18%	

Data Source: NSF

49

Research Collaborations

- R&D collaborations are particularly substantial in AI.

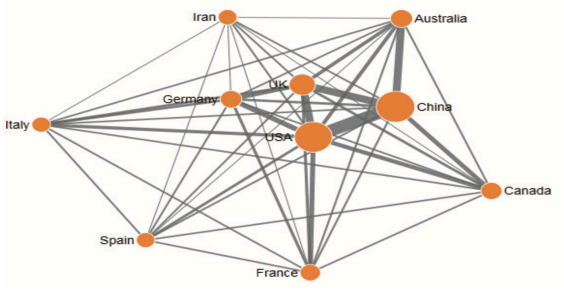


Figure 2-13 Collaboration network of the top 10 countries in the output of top papers on AI

Data source: Tsinghua University

50

A decoupling will have a substantial, long-term damaging impact on BOTH countries

- Undermining US high-tech industry will slow down global rate of scientific and technological progress
- US is still the global powerhouse of science and technology
- US progress benefits the whole world, including China
- Drug discoveries, discovery of gravitational waves, new algorithms benefit and satisfy the curiosity of Chinese as well
- Wrong for the Chinese to cheer Donald Trump for undermining US

51

Are there smarter ways to challenge China? Some general principles

- Goals should be specific and targeted
- Current trade war fails this test
- Multiple and unclear objectives:
  - Trade imbalance
  - Intellectual property
  - Market entry
  - Investment reciprocity
  - Human rights
- This is a “maximum pressure” strategy that will likely fail or will be gamed

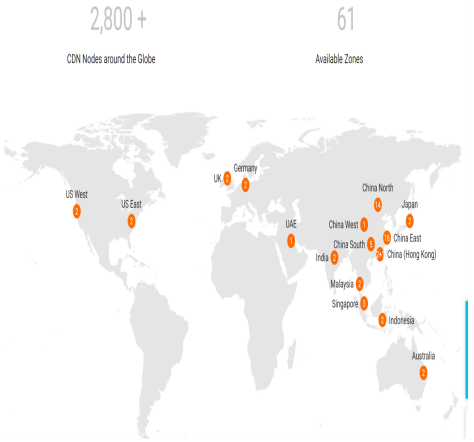
52

Some general principles

- Tit-for-tat is the most effective bilateral strategy (known as Axelrod Tournament):
- Use the market access to demand reciprocity and revoke that access if reciprocity fails to be supplied
  - Create business-specific licensing power
  - Give the government this power on a case-by-case basis of market economy determination
- Combine tit-for-tat with a linkage strategy:
  - CFIUS conditions inward investment approvals on host treatments of outward investments
- The countermeasure should be proportional to the measure being countered

53

Alibaba operates content delivery network (CDN) freely across the globe



- But the ability of US high-tech industries to provide cloud computing services in China is severely limited
- Joint ventures required
- Minority equity stakes are mandated

54

We need a new approach

- Many other examples
  - New York Times vis-a-vis China Daily
  - CNN vis-à-vis CCTV
  - Google vis-à-vis Baidu
- Devise specific investment approval, market access controls, and licensing power to deal with these asymmetries
- A fundamental challenge is whether our system based on process compliance (such as disclosure requirement) is capable of this approach
- The unprecedented challenge of China warrants a rethinking of our system

55

Thank you!

56

Case Study——Sino-US R&D Cooperation on Energy

- Chinese and the US governments have jointly established U.S.-China Clean Energy Research Center (CERC) in 2011. The total investment by the U.S. and China reach 150 million USD spread over five years. It is the chance to prove the long-term utility of meaningful and deeper S&T cooperation. CERC will promote collaborative approaches in clean energy technology research, development and commercialization.

57

What is "decoupling"?

- According to Oxford Dictionary, "decoupling" means "a situation in which two or more activities are separated, or do not develop in the same way."

- According to an article on NYT in 2019 April, *"The move, known as **decoupling**, is a major goal of those who believe the world has grown far too dependent on China as a manufacturing giant. "*

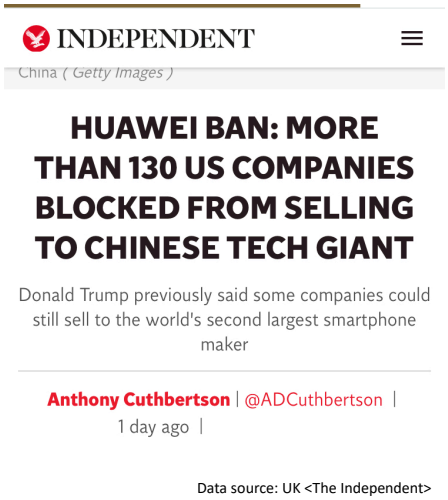
58

Overview

- Many Tech firms in the US depend on the Chinese market and the partnerships with Chinese firms. The “decoupling” could harm these firms and thus harm the overall development of technology in the US.

59

Huawei’s American Suppliers


INDEPENDENT

China (Getty Images)

HUAWEI BAN: MORE THAN 130 US COMPANIES BLOCKED FROM SELLING TO CHINESE TECH GIANT

Donald Trump previously said some companies could still sell to the world's second largest smartphone maker

Anthony Cuthbertson | @ADCuthbertson | 1 day ago |

Data source: UK <The Independent>

60

The Impacts of Export Controls on the US Tech Firms

- The U.S. Commerce Department's Bureau of Industry and Security (BIS) is developing (2019) rulemaking regarding extending export controls to an enlarged set of emerging and foundational technologies (EFTs). Information Technology & Innovation Foundation (ITIF) has calculated the impacts on the US tech industries when the export control reduce export by 5%, 10% and 20%.

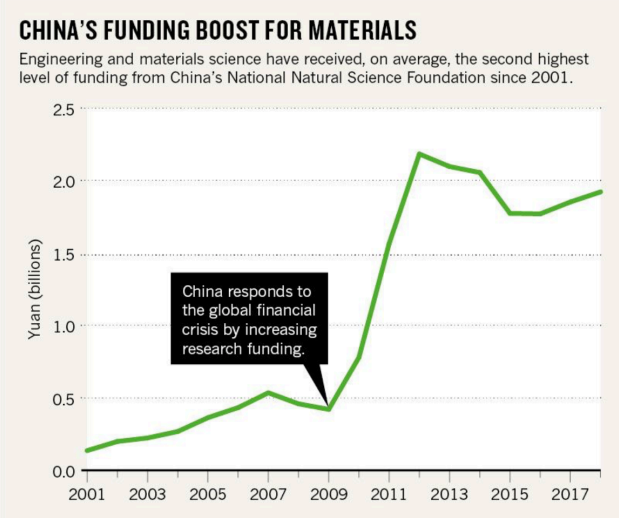
Table 3: Direct economic losses by magnitude of export controls and industry after one year[23]

	5 Percent		10 Percent		20 Percent	
	Exports (Millions)	Jobs	Exports (Millions)	Jobs	Exports (Millions)	Jobs
Pharmaceuticals	$206	1,185	$413	2,370	$825	4,739
Industrial Machinery	$224	1,286	$448	2,572	$896	5,144
Computers	$120	688	$240	1,377	$479	2,753
Wireless Communications	$67	386	$134	772	$269	1,544
Semiconductors	$397	2,281	$794	4,561	$1,588	9,122
Navigation, Measurement, and Control Instruments	$310	1,779	$619	3,558	$1,239	7,116
Aerospace	$930	5,339	$1,859	10,679	$3,718	21,358
Medical Equipment	$137	789	$275	1,577	$549	3,154
Telecom Services	$12	68	$24	137	$48	273
Computer Services	$39	221	$77	442	$154	885
Information Services	$8	46	$16	92	$32	184

Data source：ITIF

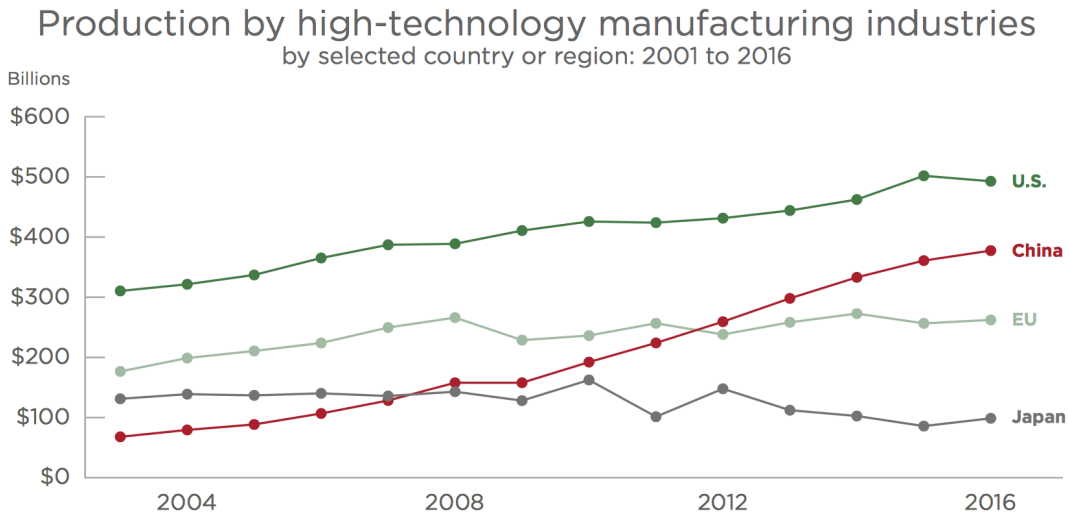
61

Back Up Graphs



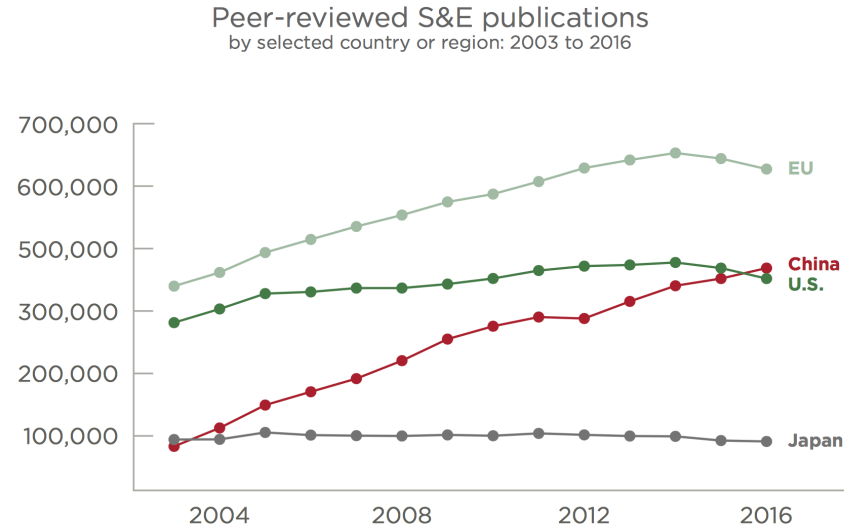
62

Back Up Graphs



63

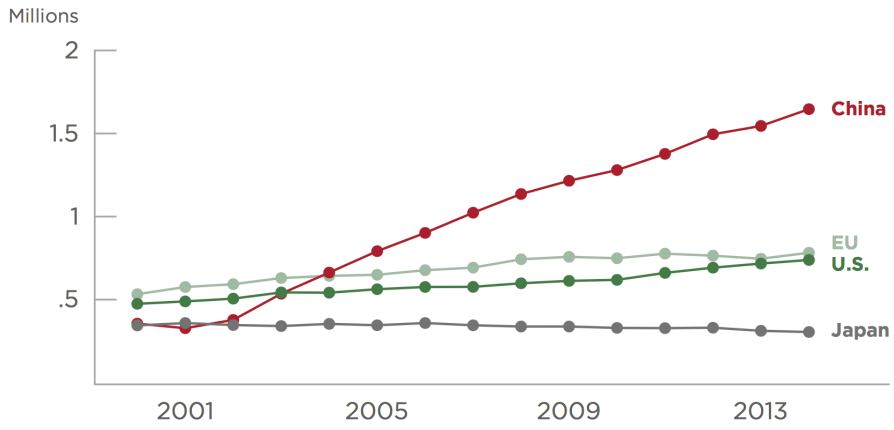
Back Up Graphs



64

Back Up Graphs

Bachelor's degrees awarded in S&E fields
by selected country or region: 2000 to 2014



65

Back Up Graphs

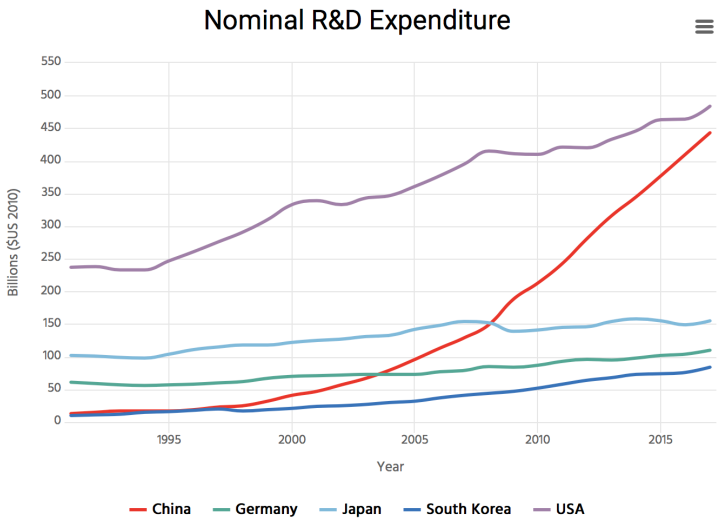
R&D Financed by Business and Government for Key Countries (2016)

Country	Business (%)	Government (%)
China	74.1	20
US	62.3	25.1
Japan	78.1	15
Germany	65.2	28.5
UK	49	27.7
France *	54	34.8
Italy *	50	38
Canada	40.6	33.1

*Data only available for 2015

66

Back Up Graphs



67