Can China build a state-of-the-art Fab by 2027?

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It seems possible that China might build a Fab by 2027

The largest current barrier for China is their lack of EUV Lithography machines.

Given, however, China's:

- Economic investment
- US export sanction avoidance
- Talent hunting success

There is good reason to believe that China has the potential to reach state-of-the-art Fab facilities by 2027.

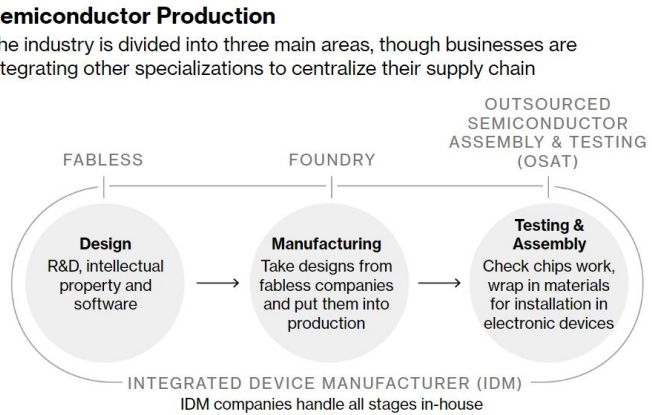
“Basically, there is air—and TSMC.”

Nvidia CEO Jensen Huang

The Case for AI

- Foundries manufacture chips designed by other firms
- Today, most well-known chip companies—Nvidia, Qualcomm, AMD, Broadcom — do not manufacture their own chips

- Taiwan (especially TSMC) produces over 60% of the world's semiconductors and over 90% of the most advanced ones
  - Only TSMC can build semiconductor chips for Nvidia's next generation H100 GPUs

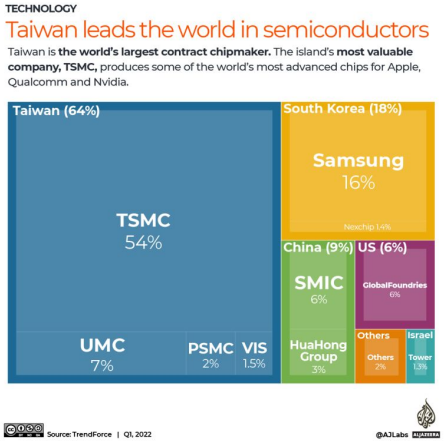


The Economic Argument

A Chinese TSMC

All figures in billions (USD)

	TSMC Revenue	TSMC Cost	TSMC Profit	SMIC Revenue	SMIC Cost	SMIC Profit
2022	70	29	41	7.3	5.5	1.8
2023	67	31	36	6.3	5.4	0.9



Future Investments

- Manufacturing chips requires tremendous upfront capital expenditure.
  - In 2021, TSMC announced that it would spend a whopping $**100 billion over three years** to expand its fabrication capabilities

  - China is set to launch a new state-backed investment fund that aims to raise about **$40 billion** for its semiconductor sector in **2023**

Strong Internal Demand

- In 2019, China imported USD 304 billion worth of semiconductors - more than oil, and more than its total imports from its largest trading partner, the European Union

- Only able to manufacture 15.7% of demand
  - The world's largest consumer market for semiconductors and ICs depends on foreign suppliers

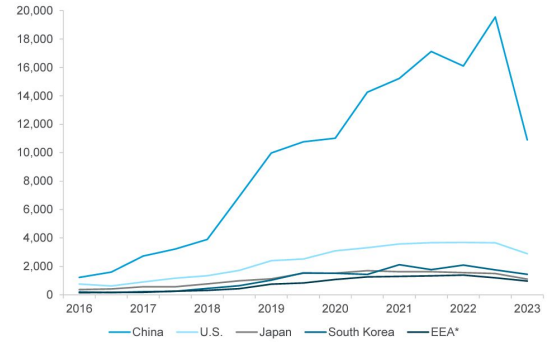
- Beijing wants to accelerate its plan towards self-reliance and its ambitious target of producing 70% of its own semiconductors in 2025

Internal Demand for AI

- China dominates the growth and technological investments in AI-related innovations
  - Over 30,000 applications over past year, more than all other countries combined!

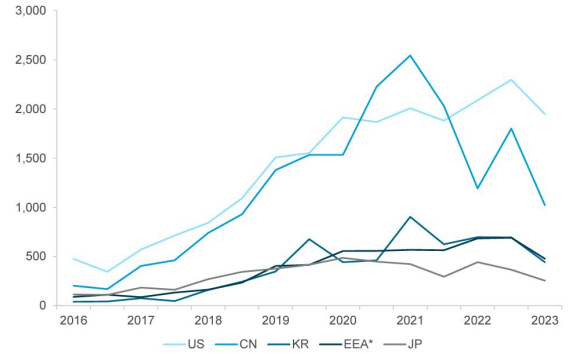
- However, filtering for top quality innovation shows a very different picture

Figure 33. General AI Patent Semi-Annual Count by Country or Economic Area



* In this study, we include the UK and Switzerland in the EEA block of countries.
Source: Quant IP, Citi Global Data Insights

Figure 35. General AI Patent Semi-Annual Count Filtered on Top Quartile Quality



* In this study, we include the UK and Switzerland in the EEA block of countries.
Source: Quant IP, Citi Global Data Insights

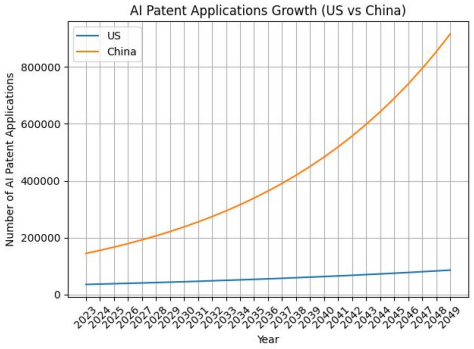
Can China's AI innovation outpace the US?

General

Figure 34. Country-Specific Count and Growth of General AI Patent Applications, 2016 vs. 2023

Country	Total	Growth	Country	Total	Growth
China	144,516	7.36	Canada	1,017	3.46
United States	35,385	3.46	France	955	7.86
Japan	17,012	2.08	Netherlands	854	4.41
South Korea	16,684	8.03	Hong Kong	811	4.73
EEA	11,667	5.99	Sweden	683	24.82
Germany	5,473	6.75	Finland	604	5.70
Taiwan	2,820	5.34	India	480	11.54
Switzerland	1,127	8.94	Israel	434	3.66
United Kingdom	1,049	1.21	Saudi Arabia	334	38.25

Source: Quant IP, Citi Global Data Insights

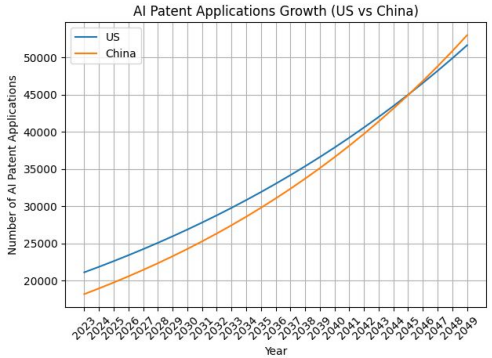


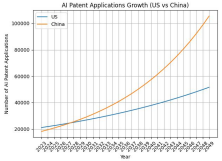
Top Quality

Figure 36. Country-Specific Count and Growth of General AI Patent Applications, 2016 vs. 2023 Filtered on Top Quartile Quality

Country	Growth	Total	Country	Growth	Total
USA	3.5	21,107	Switzerland	6.7	756
China	4.2	18,178	Taiwan	3.4	656
South Korea	10.5	5,909	Canada	4.1	510
EEA*	5.4	5,742	France	7.8	492
Japan	1.6	4,698	United Kingdom	1.0	476
Germany	5.6	2,485	Netherlands	2.6	442

Source: Quant IP, Citi Global Data Insights





Technical Barriers to Entry

EUV Lithography

Extreme-UltraViolet machines

- Wavelength: 13.5 nm
- Resolution 8nm
- Sole manufacturer: ASML
- Currently under export controls

How far is China from developing EUV machines?

- China poors significant resources into catching up on this front as well
  - Including stealing company secrets from ASML
- SMEE (Shanghai Micro Electronics Equipment) works on it
- It was recently rumoured that they have created a lithography machine capable of using 28nm wavelength light
- This would be significant
- (For comparison, DUV machines are using >200nm light.)

Unknown unknown: EUV alternatives

There is a possibility that new technologies will replace EUV

- Nanoimprinting techniques:
  - Simpler & Cheaper
  - But might be less precise
  - Recent breakthrough by cannon
- X-ray lithography
- Electron-beam lithography

Is EUV needed?

- 7nm production was recently achieved by SMIC using older DUV machines
  - Kirin 9000 smartphone chip → If successful, Huawei can use the same technology for making AI chips
  - **Ascend 910b AI Accelerator chip**:
    - produced in SMIC
    - Comparable to Nvidia A100
  - Some questions around yield (whether the process can produce functioning chips reliably)
  - Higher cost of manufacturing than TSMC (50-60%) – but: lithography is only 30% of the total cost, so it is only about 15-20% more costly than TSMC alternatives
- It is possible that various improvements in the whole pipeline would allow for leading-edge manufacturing with solely DUV machines

Effectiveness of US Sanctions

China's Resilience and Progress in the Face of Export Controls

- Significant advancements in chip production capabilities
- Domestic innovations in chip design and architectures
- Strong state support driving indigenous semiconductor industry

Gaps in Export Controls and China’s Adeptness in Navigating them

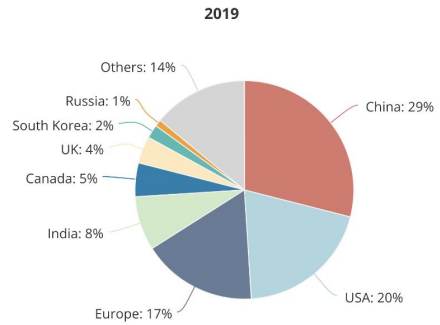
- Uneven restrictions and enforcement challenges
- China's resourcefulness in circumventing controls
- Equipment acquisitions before full restrictions

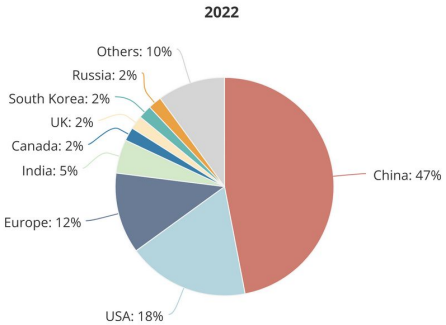
The Rising Domestic Chip Ecosystem and Its Role in Fab Development

- SMIC's advancing process technologies
- Huawei-SMIC partnership driving cutting-edge chips
- Rapid growth of domestic equipment manufacturers

The Importance of Attracting Talent

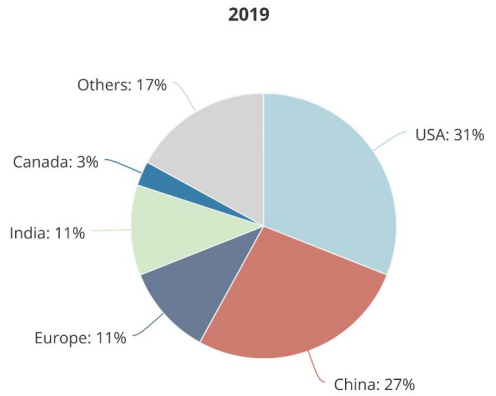
China’s AI Talent Surge

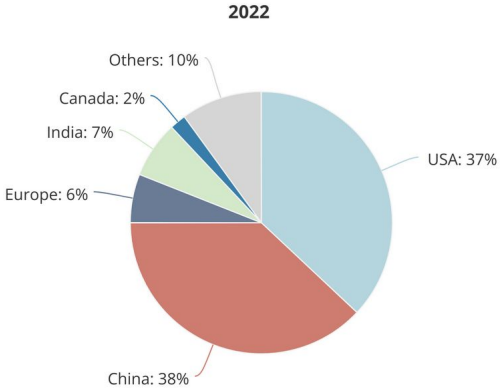




- China producing largest share of top-tier AI researchers globally
- Rapid growth in domestic AI talent pool to meet industry demands
- Heavy state investments in AI education and research initiatives
- Talent key enabler for China's AI chip ambitions

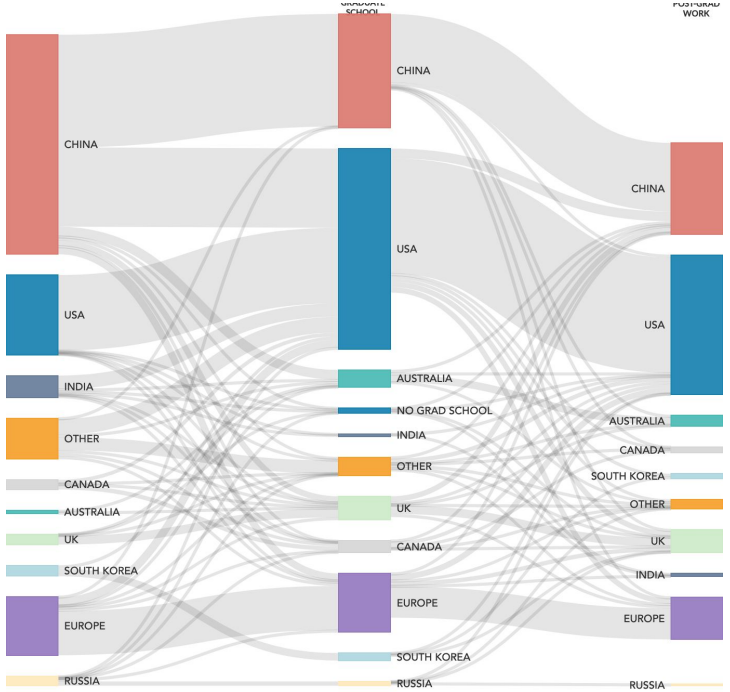
-Right = Leading countries where top AI talent work
Left = Countries of origin of leading AI talent





Challenges and Implications of the AI Talent Race

- Global competition for limited pool of top AI experts
- Brain drain concerns for US and other countries
- Geopolitical tensions and export controls impacting talent flows
- Long-term implications for AI leadership and chip supply chains



So can China build it?

Yes

- Strong government commitment
  - Huge public investments
- Domestic AI chip ecosystem progress
  - Domestic suppliers and consumers
- Advances in manufacturing tools
- Growing talent base

No

- Export controls restrict key equipment
- No access to EUV lithography
  - Limited to less advanced DUV
- Current Chinese chip firms don’t have economies of scale