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In Chips We Trust: Semiconductors and rare-earth strategic plays in the Indo-Pacific

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Newly elected U.S. President Joe Biden has signed an executive order to initiate a 100-day review into American supply chains of wide-ranging critical products and services, including semiconductor chips, high-capacity batteries and strategic minerals like rare-earth elements (REE).

This comes amid a global shortage of semiconductor chips, which is impacting industries from military equipment to medical devices. Automakers around the world have been severely affected, with vehicle assembly plants forced to cut down production.

The Empire Strikes Back…using Licens-abers?

In December 2020, the Trump administration added China's largest foundry, SMIC, and its affiliates to the Entity List for their ties with the Chinese military, effectively prohibiting U.S. companies from supplying them chipmaking equipment that is essential to manufacture cutting-edge semiconductors.

While older equipment can still be exported to the blacklisted companies after obtaining "routine" licenses, the U.S. government is (unsurprisingly!) taking its time to process them. The two largest semiconductor manufacturing equipment vendors in the world, both from the U.S., have been struggling to obtain export licenses for selling old equipment to SMIC, as government officials conduct rounds of questioning to determine whether the U.S-made equipment could be diverted for manufacturing more advanced chips. The majority of license applications from U.S. suppliers have been pending since the blacklisting.

…but the wheels of Geoeconomics go round-and-round

This episode paints just a tiny portion of the bigger picture; a power in relative decline when challenged for its primacy in the world order, is seeing no shame in adopting tactics of its geo-strategic rival, in stark contrast to its own enshrined liberal values.

However, governments should understand that intervening in markets to achieve 'favourable' geoeconomic outcomes has strings attached! Chinese technology companies like Huawei have been hoarding chips and other critical inputs for months now, in preparation for the inevitable technology denial from U.S, and this has been one of the leading causes of the current global shortage. Besides, many industries don't require cutting-edge chips, like automaking, instead they rely on older technologies that SMIC specialises in. U.S. sanctions motivate the Chinese government to invest more heavily in its own self-sufficiency and technological catch-ups. With demand for its chips at an all-time high, SMIC is largely a winner from the confrontation.

Will the Taiwanese Tiger bow?
After months of cajoling by the Trump administration, TSMC, the world's most advanced chipmaker, announced plans to open a factory in the U.S. producing its current flagship 5nm chips.

While it is certainly a win in the U.S. quest to 'revitalise domestic supply chains', there are several 'holes' in the picture. By 2024 when the factory opens, its production capacity will only be 0.25 million (by then non-flagship) 5nm chips per year. The closest domestic substitute, Intel, will be nowhere near the expected cutting-edge chips by then.

Shifting production of the most advanced semiconductors to the U.S. can also be detrimental for Taiwanese national security. As China inches ever closer towards 'reunification', and with doubts whether U.S. would intervene, TSMC is the bargaining chip that is protecting Taiwan. If the U.S. doesn't have 'chips' at stake in Taiwan, Beijing could be persuaded to take a calculated risk and finally invade the island nation.

Towards REE security for the U.S: Casting the Quad 'dies' in place
One of the many strategic reasons behind the Quad reinvigoration is their mutual interest in diversifying their REE supply chains away from China. China's crippling grip over rare-earth supply spooked the world in 2010, when amid its Senkaku Island dispute with neighbour Japan, it placed quotas on the export of REE. Prices jumped nine times, and whether it was intentional or not, Chinese rare-earth exports to Japan tanked, which quickly led Japan to invest in production in Australia. Similar threats were made against Lockheed Martin last year.

The U.S. has dramatically stepped up its own rare-earth production from negligibility in 2017, just before its trade war with China heated up, to now being the world's second largest producer (15%), followed by Australia with 7% market share in 2020. India is also being nudged by the alliance to bolster its production of REE.

Future of Pax Americana: Playing Minecraft in the Indian Ocean?
At a time when critics argue that increasing U.S. commitments in the Indian Ocean will lead to strategic overstretching, the region around India's coastline is being explored to be rich in mineral sands, which after refining can produce rare-earths as one of the many useful by-products. As the technological costs of seabed mining come down, the Indian Ocean region can become a cheap and sustainable source for rare-earths. The Chinese realise this significance, and have been aggressively campaigning for long-term seabed mining contracts with countries in the Indian Ocean and Africa. The ball is with United States now, let's see how the Biden administration responds in the coming years.

(792 words)

Referenced version

Newly elected U.S. President Joe Biden has signed an executive order[1] to initiate a 100-day review into American supply chains of wide-ranging critical products and services, including semiconductor chips, high-capacity batteries and strategic minerals like rare-earth elements (REE).

This comes amid a global shortage of semiconductor chips, which is impacting industries from military equipment to medical devices.[2] Automakers around the world have been severely affected, with vehicle assembly plants forced to cut down production.[3]

The Empire Strikes Back…using Licens-abers?

In December 2020, the Trump administration added China's largest foundry, SMIC, and its affiliates to the Entity List[4] for their ties with the Chinese military, effectively prohibiting U.S. companies from supplying them chipmaking equipment that is essential to manufacture cutting-edge semiconductors.[5]

While older equipment can still be exported to the blacklisted companies after obtaining "routine" licenses, the U.S. government is (unsurprisingly!) taking its time to process them. [6] The two largest semiconductor manufacturing equipment vendors[7] in the world, both from the U.S., have been struggling to obtain export licenses for selling old equipment to SMIC, as government officials conduct rounds of questioning to determine whether the U.S-made equipment could be diverted for manufacturing more advanced chips. The majority of license applications from U.S. suppliers have been pending since the blacklisting.[8]

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[1] Executive Order on America's Supply Chains, White House, 24 February 2021.
[2] Why We're in the Midst of a Global Semiconductor Shortage, Harvard Business Review, Bindiya Vakil and Tom Linton, 26 February 2021.
[3] Germany urges Taiwan to help ease auto chip shortage, Reuters; Chip shortage leads Japan automakers to post 4.5% slump in January global output, Reuters; Semiconductor shortage puts brakes on Ford truck production, CBS News.
[4] Ban is on equipment to make 10nm and smaller semiconductors, see U.S. Federal Register, Vol. 85, No. 246, page 1, 22 December 2020.
[5] U.S. Blacklists China's Top Chip Maker, Escalating Tech Fight, The Wall Street Journal, Dan Strumpf, 10 December 2020.
[6] Chipmaking equipment for larger than 10nm semiconductors can still be exported after getting approval from the U.S. government. Intentional application of "License permit Raj", though used in a completely different context, is how I would describe the current situation.
[7] Applied Materials and Lam Research.
[8] The processing time for such licenses is usually one month! Lam Research has not even had an initial response back from the government! See Reuters story in 6.

technology denial from U.S[9], and this has been one of the leading causes of the current global shortage.[10] Besides, many industries don't require cutting-edge chips, like automaking, instead they rely on older technologies that SMIC specialises in.[11] U.S. sanctions motivate the Chinese government to invest more heavily in its own self-sufficiency and technological catch-ups.[12] With demand for its chips at an all-time high, SMIC is largely a winner from the confrontation.[13]

Will the Taiwanese Tiger bow?

After months of cajoling by the Trump administration, TSMC, the world's most advanced chipmaker, announced plans to open a factory in the U.S. producing its current flagship 5nm chips.[14]

While it is certainly a win in the U.S. quest to 'revitalise domestic supply chains'[15], there are several 'holes'[16] in the picture. By 2024 when the factory opens, its production capacity will only be 0.25 million (by then non-flagship[17]) 5nm chips per year. The closest domestic substitute, Intel, will be nowhere near the expected cutting-edge chips by then.[18]

Shifting production of the most advanced semiconductors to the U.S. can also be detrimental for Taiwanese national security. As China inches ever closer towards 'reunification'[19], and with doubts whether U.S. would intervene[20], TSMC is the bargaining chip that is protecting Taiwan.[21] If the U.S. doesn't have 'chips' at stake in Taiwan, Beijing could be persuaded to take a calculated risk and finally invade the island nation.

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[9] Some Chinese companies stockpiled almost two years' worth of chips. Huawei Outhustles Trump by Hoarding Chips Vital for China 5G, Bloomberg News, 22 October 2020; China Stockpiles Chips, Chip-Making Machines to Resist U.S., Bloomberg News, 3 February 2021.

[10] Joseph Moore, Semiconductor Industry Analyst at Morgan Stanley, Interview on Squawk Box, CNBC Television, 12 February 2021.

[11] In 2019, a quarter of SMIC sales were to North American customers. The bulk of its sales are in older process chips (40nm-0.35um), and only 4% sales from 14-28nm chips. See SMIC 2019 Annual Report

[12] China's top chipmaker to build a $2.35 billion plant with government funding, CNBC, Arjun Kharpal, 18 March 2021; Biden set to double down on China tech denial, Nikkei Asia, James Crabtree, 10 March 2021.

[13] China's most important chipmaker SMIC could be a big winner from the global semiconductor shortage, CNBC, Arjun Kharpal, 1 March 2021.

[14] A new $12 billion US chip plant sounds like a win for Trump. Not quite., MIT Technology Review, Karen Hao, 19 May 2021.

[15] Ibid 1. Executive Order Section 1, third sentence, "Resilient American supply chains will revitalize and rebuild domestic manufacturing capacity, maintain America's competitive edge in research and development, and create well-paying jobs."

[16] Pun intended. Electron holes are instrumental in the working of semiconductors.

[17] TSMC 2nm Process Makes A Significant Breakthrough, GizChina, 23 September 2020.

[18] Intel has been losing its 'cutting-edge' status in recent years, and plans to outsource significant portion of its manufacturing to TSMC (and Samsung) over time, Intel 2020s Process Technology Roadmap

[19] China could invade Taiwan in next six years, top US admiral warns, The Guardian, 10 March 2021.

[20] Would the American Public Really Defend Taiwan?, The Stimson Center, James Loomis, 19 January 2021.

[21] Semiconductors as a shield for Taiwan?, The ASPI Strategist, Elena Yi-Ching Ho, 16 March 2021.

Towards REE security for the U.S: Casting the Quad 'dies' in place

One of the many strategic reasons behind the Quad reinvigoration is their mutual interest in diversifying their REE supply chains away from China.[22] China's crippling grip[23] over rare-earth supply spooked the world in 2010, when amid its Senkaku Island dispute with neighbour Japan, it placed quotas on the export of REE.[24] Prices jumped nine times, and whether it was intentional or not[25], Chinese rare-earth exports to Japan tanked, which quickly led Japan to invest in production in Australia.[26] Similar threats were made against Lockheed Martin last year.[27]

The U.S. has dramatically stepped up its own rare-earth production from negligibility in 2017, just before its trade war with China heated up, to now being the world's second largest producer (15%), followed by Australia with 7% market share in 2020.[28] India is also being nudged by the alliance to bolster its production of REE.[29]

Future of Pax Americana: Playing Minecraft in the Indian Ocean?

At a time when critics argue that increasing U.S. commitments in the Indian Ocean will lead to strategic overstretching[30], several areas in the region are being explored to be rich in mineral sands, which after refining can produce rare-earths as one of the many useful by-products.[31] As the technological costs of seabed mining come down,[32] the Indian Ocean region can become a cheap and sustainable source for rare-earths.[33] The Chinese realise this significance, and have been aggressively campaigning for long-term seabed mining contracts with countries in the Indian Ocean and Africa. [34] The ball is with United States now, let's see how the Biden administration responds in the coming years.

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[22] Rare-earths are vital for manufacturing any technological product, from high-capacity batteries to electric vehicles, from F-35 jets (420 kgs per plane) to American Virginia class nuclear submarines (4.2 tonnes of rare-earths per sub), not to mention semiconductors! China hosts both the world largest reserves of rare-earths, as well as a near-monopoly in their processing. See 2021 US Geological Survey Annual Publication on Rare Earths. For more in-depth coverage, see Market structure and economic sanctions: the 2010 rare earth elements episode as a pathway case of market adjustment, pgs 8-9, Review of International Political Economy, Eugene Gholz & Llewelyn Hughes, 25 November 2019; Japan to pour investment into non-China rare-earth projects , Nikkei Asia, 15 February 2020.

[23] A useful analogy given by none other than Deng Xiaoping in a Jan 1992 speech, that "the Middle-East has oil, and China has rare-earths"!

[24] Amid Tension, China Blocks Vital Exports to Japan, New York Times, Keith Bradsher, 22 September 2010.

[25] Did China really ban rare earth metals exports to Japan?, East Asia Forum, Amy King and Shiro Armstrong, 18 August 2013.

[26] Ibid 22, pg 12 of Gholz and Hughes article.

[27] China's Rare Earth Threat Sparks An International Backlash, Forbes, Tim Treadgold, 7 August 2020. Lockheed Martin is a premier U.S. defence and aerospace company, with close ties with U.S. military.

[28] See 2021 US Geological Survey Annual Publication on Rare Earths. Calculated using world 2020 production figures.

[29] See 22 US Geological survey report. India has the fifth largest global reserves of rare-earths (6.9 million tonnes), more than Australia (4.1 million tonnes) and U.S. (1.5 million tonnes) combined. Despite this, India exploits a tiny proportion (just three thousand tonnes in 2020) of what the other two Quad countries mine (roughly 55 thousand tonnes in 2020). India has recently overhauled its mining laws to promote the sector. Also see Quad tightens rare-earth cooperation to counter China, Nikkei Asia, 11 March 2021.

[30] America's Indo-Pacific Folly, Foreign Affairs, Van Jackson, 12 March 2021.

[31] Scramble for the Indo-Pacific Seabed, The Diplomat, Drake Long, 16 November 2019.

[32] Is Mining The Ocean Bottom For Metals Really Better Than Mining On Land?, Forbes, James Conca, 24 February 2021.

[33] Rare earth refining is very environmentally polluting, so until recently most countries thought best to take advantage of China's lax environmental laws, but this view is increasingly changing.

[34] China leads the race to exploit deep sea minerals: U.N. body, Reuters, 23 October 2019; China's search for sand is destroying Mozambique's pristine beaches, Quartz Africa, Lynsey Chutel, 23 October 2018.