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Accessing Rare Earth Elements and Prospects for Manufacturing

Introduction

Unprecedented increase in global trade has been the hallmark of last five decades. Massive reduction in trade barriers, significant technological process in the area of logistics along with business innovations such as production outsourcing has propelled global trade volume from US$0.32 trillion in 1970 to US$ 19.48 trillion in 2018. This vertical increase in global trade has resulted in massive welfare gain, pulling millions out of poverty. Surge in global trade has also coincided with a shift in economic momentum from West to East in general and West to China in particular. China has emerged as the factory of the world. Its share in global merchandise exports has increased to whooping 13 percent in 2018 from just 1 percent in 2001. Chinese integration to the global economy has led to a significant welfare gain for China as well as for rest of the world (Giovanni et al 2013). Nonetheless, welfare gain has come at a cost of high dependence on authoritative China as it has nearly monopolize the global supply chain of few high-tech products and their raw materials.

Recent Chinese expansionist behaviour, its attempts to steal intellectual property rights to gain control on cutting edge technology along with its shoddy conduct during Covid outbreak has exposed the downside of China centric supply chains. These events have put a question mark on China being a reliable trade partner, forcing most of the big economies to find ways to reduce dependence on China, especially for strategically important high-tech products. Consequently, supply chain resilience/diversification has emerged as one of the key objectives of all democratic economies across the globe. Several developed countries have already started nudging their firms to reduce dependence China. India too has introduced certain measures to mitigate excess dependence on China for critical high tech products. However, these isolated initiatives so far have yielded limited results. Against this backdrop, this policy brief decodes the Chinese success in the realm of high technology products. It highlights that apart from other factors, Chinese success in high technology products especially electronics, computing equipments and electric machinery can largely be attributed to its ability to transform its Rare Earth Elements (REE) reserves in to industrial advantage. The brief argues that the prevailing global circumstances coupled with significant REE reserves offer a rare opportunity for India to not only reduce its dependence on China for High Technology products but also emerge as one of the hub for high tech manufacturing, provided Indian government takes reformative action to facilitate foreign technology and investment in rare earth exploration and processing.

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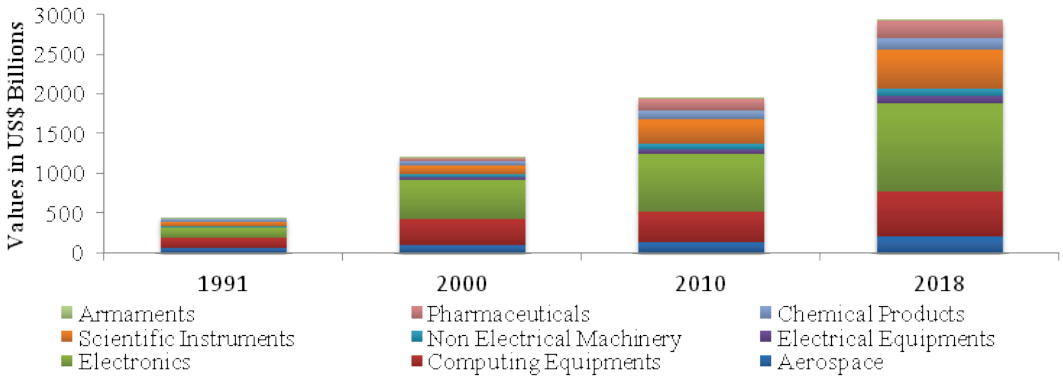
Mapping Global Trade in High-Tech Sector

Manufactured products which require very high Research and Development (R&D) efforts are defined as high-tech products. Based on R&D inputs, OECD has classified certain items of aerospace, armament, computing equipments, chemicals, pharmaceuticals, scientific instruments, electrical machinery and non electrical machinery as high tech products (Hatzichronoglou 1997). A country's involvement in the trade of these products reflects the sophistication of its economy and its future capabilities. Since only a handful of countries have the capacity to produce high tech products, these product has always been a significant part of global trade basket. Nonetheless, owing to the ongoing digital and energy transition, trade in high tech products has boomed particularly over the last three decades. Volume of global trade in high-tech products which was less than US$ 500 billion in 1991 has zoomed to roughly around US$ 3 trillion in 2018 (Figure 1). Global trade in high-tech product is highly dominated by electronics. With a volume of more than US$1.1 trillion, electronics alone accounts for one third of global exports of high-tech products. After electronics, computing equipments are second most important category of global high-tech exports. In 2018, computing equipments worth US$ 0.5 trillion were traded globally. Scientific instruments have been the third most important items of global high-tech trade basket. The dominance of electronics, computing equipments and scientific instruments in global high-tech trade can be gauged from the fact that these three products categories account for more than 70 per cent of global high-tech exports.

Major Sectorial Players

Surge in global high-tech trade has coincided with a significant shift in geography of high-tech exporters. Given the fact that high-tech products require high level of sophistication and R&D, it's not surprising that global exports of high-tech have traditionally been dominated by advanced countries. Till early 1990s, European Union (EU) and United States of America (USA) accounted for more than two third of global high-tech exports. However, country composition of global high-tech exporters has witnessed a drastic change since then. With outsourcing gaining momentum, developed countries started losing market share to Asian economies such as Singapore, Taiwan and South Korea in early 1990s. Nonetheless, the most radical shift took place after 2000 when China made an astonishing gain in the global exports of high-tech products. Chinese success in high-tech sector can be gauged from the fact that its exports of high-tech products increased from negligible in 1991 to US$ 492 billion in 2010 and further to US$ 715 billion in 2018. In line with this, China's share in global high-tech exports increased to 25.6 per cent, making it the numero uno in the exports of high tech product (Table 1). Though, China has made gains in all nine segments of high tech exports, its performance has been particularly spectacular in electronics, computing equipments and electrical machinery sub segments. These three segments accounts for more than 84 per cent of total high-

Figure 1: Global Trade in High-tech Products



Source: Calculated from UNComtrade data, based on OECD classification of high tech trade

tech exports from China. At present China accounts for more than 41 per cent of global exports of computing equipments, more than 35 per cent of global exports of electronics and more than a quarter of global exports of electrical equipments.

The phenomenal rise of China has increased dependence of all major economies on China for high-tech products. India, Australia, USA, Japan and France all these economies are sourcing a lion share of their high-tech imports from China. However, their dependence on China is significantly pronounced in computing equipments segment. India is sourcing more than 55 per cent of its total computing equipments imports from China, while figure for USA, Australia, Japan and France are 68 per cent, 76.2 per cent, 77.6 per cent and 81.2 per cent respectively. Similarly, these countries also rely heavily on China for the imports of electronics. Their dependence on China for electronics ranges from 41.9 per cent for France to 65.7 per cent for Japan (Table 2). Apart from computing equipments and electronics, these countries dependence on China for electrical machinery has also increased recently, with Japan and USA being most dependent.

Decoding Chinese Success

China has been dominating in the exports of computing equipments, electronics and electric machinery segments of high tech products. An analysis of these sectors suggest that China's success in these sectors is purely driven foreign firms. Production and exports of computing equipments and electronics from China have been heavily dominated by foreign enterprises. The role of foreign enterprises is clear from the fact that with 93 percent share, foreign firms have been the prime exporters of computing equipments from China. Similarly, foreign firms accounts for 74 percent of total electronics exports from China (Lovely and Huang 2018).

Why China has emerged as the favoured destination for high technology multinational firms. There is no doubt that China has been able to created an investor friendly regime with a mix of proactive regulatory reforms, infrastructure up-gradation and various fiscal incentives in the form of cheap land, concessional loans. However, in case of high technology sector, especially computing equipment, electronics, electrical machinery and certain segments of scientific instruments such a high quality imaging, Chinese success in attracting foreign tech giants is linked more with its ability to transform natural resource (Rare Earth Elements) in to industrial advantage. Rare Earth Elements are 17 minerals[1] which are critical for the production of high-tech products. These REE are crucial inputs for the production of technology devise such as computer memory, DVDs, rechargeable batteries, autocatalytic converters, super magnets, mobile phones, LED, semiconductors, glass additives, fluorescent materials, phosphate binding agents, solar panels and magnetic resonance imaging, etc. (Balaram (2019).

Most rare earth elements are relatively abundant. However, processing of these materials to make them usable is complex, expensive and environment damaging. China realise the importance on REE quite early and started

[1] Anthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium, Scandium, yttrium are 17 rare earth elements.

Table 1: Chinese Share in Global Exports of High Tech Products (%)

Category	1991	2000	2010	2018
Armaments	0.0	0.2	0.8	1.0
Pharmaceuticals	0.0	2.4	3.9	6.4
Chemical Products	0.0	6.5	11.9	17.7
Scientific Instruments	0.0	3.1	12.9	13.8
Non Electrical Machinery	0.0	0.6	3.0	4.5
Electrical Equipments	0.0	4.4	18.6	26.4
Electronics	0.0	3.3	21.9	35.2
Computing Equipments	0.0	5.3	46.9	41.6
Aerospace	0.0	0.2	1.1	2.6
Total High-tech	**0.0**	**3.6**	**21.1**	**25.6**

Source: Calculated from UNComtrade data, based on OECD classification of high tech trade

Table 2: Selected Countries Dependence on China for Selected High Tech Imports (%)

Product Group	USA	Japan	Australia	France	India
Computing Equipments	68	77.6	76.2	81.2	55.3
Electronics	55.0	65.7	60.5	41.9	47.5
Electrical Machinery	43.5	56.2	34.9	32.5	30.0
Non Electrical Equipments	4.5	14.9	7.5	6.1	13.4

Source: Calculated from UNComtrade data, based on OECD classification of high tech trade

investing in mining and processing of REE aggressively. During 1990s, China used all possible measures including tax rebate, production and export subsidy to gain competitive edge in the global REE market. These efforts paid quickly as China nearly monopolise the production and export of REE within a decade (Table 3). With just one third of global REE reserves, China started producing more than 90 per cent of REE by the end of 1990s. After developing upstream REE industry and gaining control on global supply chain, China started exercising its monopoly on REE supply to attract foreign direct investment in downstream manufacturing. Starting from 1999, China introduced several measures to reduce the supply of REE in global market. First, it gradually eliminated export tax rebate between 2000 and 2005. Second, it introduced export quota in 1999, which was gradually reduced from 65609 metric tons (MT) in 2005 to 30184 MT in 2011. Third, numbers of export licences issued were drastically reduced. Fourth and most importantly, export duty of 10 per cent was imposed in 2007 which was increased to 25 per cent in 2012 (Shen et al 2020).

The export control measures created uncertainty in the global market, forcing multination firms to relocate to China for securing uninterrupted access to REE (Bradsher 2011). Between 2000 and 2010, almost all leading multination firms engaged in the high tech manufacturing which uses REE as input established manufacturing facility in China. These multination's successfully integrated China in to the global value chains of high-tech products and helped it to quickly leapfrog from low and medium tech exports to high tech exports. Influx of global tech giants also benefited local firms through positive technological spill over. Later cheap and reliable supply of REE along with active government support also enabled Chinese state own enterprises to quickly venture in to the production of green technology equipments such as solar panels, permanent magnet for turbine and advance batteries, making China leading producer of green technology products. In a nutshell, availability REE has played the most important role in transforming China from low tech to high tech exporter.

Indian Rare Earth Sector

India is endowed with rich REE reserves. With almost 7 million tonnes of REE reserve, India accounts for more than 5 per cent of global REE reserves, fifth largest in the world (Table 3). Interestingly, India has also been one of the early countries to recognize the importance of REE. It started efforts to develop domestic REE production capacity in 1950s, when it established the Indian Rare Earth Ltd (IREL) for mining and processing of REE. Nonetheless, in spite of rich reserves and an early start, India has not been able to develop the REE industry of any significance and its share in global REE market has remained negligible. Ironically, IREL, which was established to produce REE, never actually focused on REE production. Instead, IREL gave more importance to thorium and other minerals such as ilmenite, zircon, rutile etc. Consequently, for years, REE production in India remained stagnant at around 2000 tonnes before increasing to 4215 tonnes in 2018-19 (MOM 2020). Extremely low domestic supply of REE ensured that downstream REE industry virtually remained absent in India, forcing Indian manufacturers to rely on the imports of finished REE derivates from China to meet the booming domestic demand of consumer electronics, computing equipments, electric machinery, solar panels etc., leading to a massive increase in trade deficit.

India's inability to realize REE potential

Table 3: World Reserves and Production of REE by Principal Countries

Country	Global Reserves in 2018		Percentage Share in Global Production			
	Reserves in tonnes	**% Share**	**1995**	**2000**	**2017**	**2018**
Australia	34,00,000	2.56	4.2	0.0	15	11.8
Brazil	2,20,00,000	16.67	0.6	1.7	1.5	0.6
Canada	8,30,000	0.63	0.0	0.0		0.0
China	4,40,00,000	33.33	41.7	85.9	78.7	70.6
Greenland	15,00,000	1.14	0.0	0.0		0.0
India	69,00,000	5.23	3.5	3.3	1.1	1.1
Malaysia	30,000	0.02	0.3	0.3	0.2	0.1
Malawi	1,40,000	0.11	0.0	0.0	0.0	0.0
Russia	1,80,00,000	13.64	8.3	2.5	2.2	1.5
South Africa	8,60,000	0.65	0.6	0.0	0.0	0.0
Vietnam	2,20,00,000	16.67	0.0	0.0	0.07	0.2
USA	14,00,000	1.06	39.9	6.1	0.0	8.8
ROW	1,09,40,000	8.29	1.00	0.1	1.2	5.3
World	**13,20,00,000**	100	100	100	100	100

Source: (U. S. Geological Survey, 2018).

can mainly be attributed to passive government attitude. REE exploration and processing is fraught with financial, technological and environmental challenges and therefore needs government support in terms of clear policy and financial handholding in the initial phase of development. However, in spite of recognizing the importance of REE, Indian government failed to devise a clear policy or road map for the development of REE sector. Instead of having a separate policy for REE, government clubbed REE with atomic minerals which ensured state monopoly and kept the foreign and private domestic investors away, leading to a stagnant REE sector. Global tech leader such as Japan has tried to source REE from India. In 2014, PM Modi and PM Abe signed deal to produce 2000 tonnes of REE in India and export it to Japan. However, due to state monopoly, lack of technology, environment clearance hurdles and absence of any viability gap funding nothing has been materialised till date.

Recommendations

Growing disenchantment with China has opened an interesting opportunity for India. Building a resilient supply chain of high tech product by reducing dependence on China has emerged as an important objective of major economies across the globe. USA, Japan, Australia, France, EU all have come up with their Indo-Pacific Strategies which along with other objectives also emphasis on supply chain resilience/ diversification. Some of these countries have already started nudging their firms to reduce dependence on China. However, these isolated attempts have yield limited results. Therefore, a closely coordinated approach is required to secure supply chains of high-tech products. Policy makers in these countries have realised this and consequently, multi country co-operation for supply resilience has gained momentum in the form of India-Japan-Australia, India-France-Australia trilateral co-operation and Quadrilateral security dialogue. India-Japan-Australia have gone a step ahead and have formally launch a Supply Chain Resilience Initiative (SCRI) which envisage investment promotion events and buyer-seller matching events along with joint trade and investment diversification measures to achieve the objective of supply chain resilience.

Growing clamour for reducing tech dependence on China and Supply chain resilience provides a rare opportunity for India, which has fifth largest REE reserves in the world. Given the Chinese experience, India too can use its REE reserve to establish a thriving high technology manufacturing sector. The prevailing circumstances are most conducive for India to opt for a REE

centric approach for mitigating tech dependence on China. Tech leaders of the world are actively trying to build REE supply outside China. Japan's financial co-operation has helped Australian firm to restart REE production. USA is also cooperating with Australia to increase production of REE. These efforts have helped Australia to produced 15 per cent of global REE in 2018, despite having just 2.5 per cent of global REE reserves. India on the other had has more than 5 per cent of known global REE reserves. However, it production has remained stagnant at around 3000 tonnes. There is a huge scope for India and its emerging strategic partners in Indo-Pacific to co-operate in the extraction and processing of REE. Australia is an ideal partner for technology co-operation in the field of production and processing of REE. Similarly, Japan, USA and France will be happy to financially co-operate with India to bridge the viability gap in REE production project. However, before seeking international co-operation, India needs put its house in order. Two steps are required to boost upstream REE industry in India. One, India should urgently chalk out a clear policy for REE sector with realistic objectives. Second, it should amend Atomic Mineral Concession Act (2016) which has reserved all beach Sand Mines deposits containing more than 0.75 per cent Monazite (source of REE) for government owned companies. These two measures if taken immediately have potential to transform India in to a major REE producer. Development of upstream REE industry can then stimulate economically more valuable downstream manufacturing leading to an Atamnirbhar Bharat.

References

Balaram. 2019. "Rare earth elements: A review of applications, occurrence, exploration, analysis, recycling, and environmental impact", Geoscience Frontiers, Vol 10, pp 1285-1303

Bradsher K. 2011. "Chasing Rare Earth, Foreign Companies Expands in China", New York Times, August 24.

Giovanni J., A. A. Levchenko and J. Zhang. 2014. The Global Welfare Impact of China: Trade Integration and Technological Change", American Economic Journal: Macroeconomics, Vol. 6, No. 3, pp. 153-183

Lovely M.E. and and Z. Huang. 2018. "Foreign Direct Investment in China's High-Technology Manufacturing Industries", China and World Economy, Vol, 26, issue 5, pp 104-126

Reynolds I. and E. Urabe. 2020. "Japan to Fund Firms to Shift Production Out of China", Bloomberg, April 08 2020, available at at: https://www.bloombergquint.com/global-economics/japan-to-fund-firms-to-shift-production-out-of-China

Ministry of Mines. 2020. Indian Mineral Yearbook 2019, Minisry of Mines, Government of India. Available at https://ibm.gov.in/writereaddata/files/10012020172151RareEarth_2019_AR.pdf

Shen Y. R. Moomy and R. G.. Eggert. 2020. "China's public policies toward rare earths, 1975–2018", Mineral Economics, Vol. 33, pp 127–151

Hatzichronoglou T. 1997. "Revision of the high-technology sector and product classification", OECD Working Paper 1997/2

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