Implications and Challenges of China's Supremacy on the Global Rare Earths Market[1]

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Abstract: - China's spectacular economic development over the last four decades or so, and its atypical evolution during this process placed the country both at the forefront of the global rare earth trade, and at the centre of international concerns and debates on the implications this ascent has on the regulations governing global trade. Now an uncontested contemporary reality, China's supremacy on the global rare earth market has fuelled the fears of strongly industrialised countries for the future security of the supply of these raw materials, as a direct result of the extent to which Chinese governmental authorities will from now on choose to comply or not to comply with the international trade rules and practices in force. In these conditions, our article seeks to provide an overview of the evolution of Chinese policies in the field of rare earths, of how they helped transform natural resources endowment into a competitive advantage, and of the recent trends on this global market on which China is the leader.

Key-Words: rare earth, China's leadership on global rare earth production, rare earth world market
JEL Classification: L61, Q02, Q37, Q38, O13, O53

1 Uncertainties generated by China's dominance on the global rare earths market

Given the vital economic importance of rare earth elements[2] (REE) for the development of modern technologies, the international scepticism with regard to the exclusive dependency on China as a world leader in the production and exports of rare earths derives from the ample restrictive measures that the Chinese central authorities implemented in the past and which generated a supply deficit for the main developed economies, risking even to endanger the competitiveness of those countries' industries that rely on cutting-edge technologies and to slow down the performance of the emerging renewables sector (Ebner, 2014).

As shown by the international trade practice, in particular in the period preceding the global financial crisis, many countries used restrictive barriers such as export duties (Piermartini, 2004), seeking to limit external sales of metals and mineral products in order to: *i)* maintain the domestic supply of raw materials at an optimum level; *ii)* improve external marketing conditions; *iii)* lower the price on the domestic market for the benefit of local intermediary consumers; *iv)* comply with the environmental protection and natural resource preservation rules (Mancheri, 2015).

Invoking all these motives – which traditionally underlie the application of the trade barriers we refer to above –, at the launch of the Eleventh Five-Year Plan (2006-2010), the Chinese government put forth a strict rare earth regulation and export control policy based on three main lines of simultaneous action: *a)* the gradual reduction of quantitative export quotas; *b)* the limitation of the number of national companies authorised by the central authorities to trade in rare earths on external market; and *c)* the introduction of annual caps on the volume of operations allocated to these companies.

Evidently, all these export restrictions adopted by China generated a series of economic effects that were rapidly propagated at global level, causing an increase of the international price of rare earths and a disruption in the supply flows of the main manufacturers in the developed countries (which host the high-tech industries so

[1] This article is a synthesis of a more ample analysis developed by the author within the multiannual study entitled *China și competiția pentru supremație tehnologică în contextul strategiei de repoziționare și extindere a influenței sale globale* (China and the competition for technological supremacy in the context of the country's strategy to reposition itself and expand its global influence), coordinated by Sarmiza Pencea, Institute for World Economy (2020).

[2] In this article, we will alternatively use the terms "rare earths" (RE) and "rare earth elements" (REE) and their corresponding acronyms.

strongly dependant on imports from China). In these conditions, the US, Japan and the EU asked for consultations within the World Trade Organization (WTO) concerning the measures imposed by China on RE exports (e.g. duties, quotas, licences), invoking their incompatibility with the obligations assumed under the Protocol of Accession to the WTO (2001). Although following the WTO resolution against it China eliminated the RE export quota system, multiple uncertainties and fears still persist in the international economic environment because of the concentration of the global production of rare earths in this country.

Therefore, as shown by the experience of the last few decades, throughout its economic consolidation process China aimed to increase the added value of the wealth of its non-renewable natural resources, in particular rare earths. To reach this objective, the Chinese authorities restricted foreign participation in upstream sectors while encouraging foreign direct investments (FDI) in downstream industries – thus fostering the inflow of new technologies, know how, etc. – by not applying restrictions on the export of REEs from this sector (Wübbeke, 2013). This policy enabled a rapid transition from its status as a follower to the dominant position it holds now, when not only that China has surpassed the main leaders of the global REE industry, but has even gained control over the entire global value chain (Mancheri, 2015). In these conditions, developed countries have begun to feel more and more poignantly the fear of a new and increasingly acute dependency on China in relation to the sourcing of the new technologies that it develops for the processing of rare earths.

2 Rare earths: classifications, importance and main uses

Rare earths are 17 elements included in the periodic table[3], with the same physical and chemical properties: *i)* 15 of these belong to the lanthanides group, with atomic numbers from 57 to 71; *ii)* scandium (atomic number 21); and *iii)* yttrium (atomic number 39).

Because of their magnetic, optical and electrical characteristics, REs are essential elements for the modern high-tech industries, being used in a wide range of production processes and being incorporated in a variety of applications, whether independently or in combination with other chemical compounds and/or metal alloys (given that another property exclusive to rare earths is that even in very small quantities they help enhance the performance of end products) (Golev, Scott, Erskine, Ali, & Ballantyne, 2014).

Although they are called "rare earths", their abundance in Earth's crust exceeds that of widely used metals such as copper, zinc, nickel or lead (Gupta & Krishnamurthy, 2005). Instead, the limited availability of rare earth ores derives from the complexity of the extractive process, as they are found in mixtures with other mineral deposits and therefore require ample prospecting operations and expensive processing techniques. The most abundant category is that of lanthanides which, depending on their atomic number, are classified as "light" rare earths, while the elements included in the "heavy" RE group are less predominant.

Due to the lower production and marketing costs, on the one hand, and to the versatility of their properties, on the other hand, light REEs and yttrium are used on a large scale, for a multitude of industrial applications, while heavy rare earths have a much lower applicability, limited to industrial activities that require high technological specialisation (Goonan, 2011).

Although REEs exhibit multiple similarities in terms of basic chemical properties, each has its own unique features, making it impossible to substitute one for the other in the technological processes and in the specific applications they are used for. Depending on these individual particularities, on the strategic importance of the field they are used in, on the degree of difficulty in finding comparable and reliable substitutes, and on the accessibility of the supply markets, the US Department of Energy has identified five rare earth elements that are of "critical importance": neodymium, europium, terbium, dysprosium and yttrium (US Department of Energy, 2011). This status is used as a reference in the geological feasibility studies and projects related to extraction and processing, because ore bodies with a high percentage of rare earths classified as "critical elements" are considered less exposed to the market fluctuation risk.

As we stated above, rare earths are dispersed in Earth's crust and are found in the form of oxide mixtures in association with a variety of ores – most commonly with bastnäsite, monazite and xenotime minerals –, each having a composition different from these elements. In these conditions, in the post-extraction stage, the ore that comprises rare earths must undergo a series of complex separation processes in order for each individual element to be obtained.

[3] Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pr), Samarium (Sm), Europium (Eu) Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Ytterbium (Yb), Lutetium (Lu), Scandium (Sc), Yttrium (Y).

As for their end use, rare earth elements have a double function: *a)* they act as *production enablers*, i.e. they are used in technological processes but are not incorporated in end products (for example, in the refining industry, they are used as catalysers in the fluid cracking process); *b)* they act as *enablers for the products they are incorporated in*, conferring key properties that enhance technological performance (e.g. through the addition of rare earths, the force of permanent magnets – used in the manufacture of electrical engines, turbines, etc. – increases by one unit). Also, because of their particularly versatile physical and chemical properties, rare earths are used both in the production activities of mature industries (metallurgy, glass processing, etc.), and in the highly specialised technological processes specific to more recent emerging industries (such as the production of permanent magnets) [Box 1]. Also, beyond their traditional applicability in technologically intensive sectors, over the last decade, rare earths have become essential elements in two new areas of strategic interest, namely the production of modern low emission power generation systems and the military and defence industry.

Box 1: Main fields of use of rare earths

1. Ceramic industry (La, Ce, Pr, Nd, Y, Eu, Gd, Lu, Dy): condensers, sensors, dyes, scintillation (luminescent) materials, refractive materials;
2. Metallurgical industry – alloys (La, Ce, Pr, Nd, Y): NiMH (nickel-hybrid metal) batteries, fuel cells, steel, light alloys, super alloys, magnesium/aluminium alloys;
3. Permanent magnet production (Nd, Pr, Tb, Dy): engines, disk drives, magnetic resonance imaging, electricity, microphones/speakers, magnetic refrigerators;
4. Phosphorus-based electronic materials (Eu, Y, Nd, Er, Gd, Ce, Pr): CRT, LPD, LCD monitors and screens, fluorescent light, medical imaging, lasers, optic fibre;
5. Glass processing/polishing industry (Ce, La, Pr, Nd, Gd, Er, Ho): polishing compounds/powders, dyes/dye removers, glass obtained using UV cutting/adhesion techniques;
6. Catalysers (La, Ce, Pr, Nd): oil refining, catalytic converters, additives (Diesel engines), chemical processing;
7. Other fields of use: nuclear energy (Eu, Gd, Ce, Y, Sm, Er); **defence industry** (Nd, Pr, Dy, Tb, Eu, Y, La, Sc, Sm); **water treatment; pigments** (Ce, Y); **fertilisers.**

Source: Author's schematic overview and synthesis based on the British Geological Survey (2011).

3 The transformation of resource endowment into a major competitive advantage for China

If until the mid-1980s the United States was the global leader both in the production of rare earths[4], and in the field of technological innovation on this market, presently it not only lost this supremacy but became totally dependent on imports from China. Also, the ample process of technological transfer that took place over the last few decades from the US and from other developed economies enabled China to develop a solid REE processing industry which at present outclasses strongly industrialised countries on many of the segments of the global value chain (US Geological Survey, 2014).

The spectacular evolution that China underwent from the beginnings of its exploitation of rare earth ores and up to the present shows that Chinese policy-makers realised early on how important REEs are for the country's economic and technological development and, as a result, successive governments drew up minute plans meant to lead China to a position of superiority on the global market (Mancheri, Sundaresan, & Chandrashekar, 2013). Therefore, China's current leadership position in the global REE production is due not only to its considerable reserves[5], but mainly to an active and sustained policy employed by the national authorities which fostered the growth of this sector.

Although rare earth production had started in China as early as the beginning of 1950s, the constraints the country was facing at the time – generated mainly by the low level of economic development – prevented the allocation of the funds required for the consolidation of this industry. Nevertheless, from this early stage, China conducted ample geological prospecting operations seeking to identify new mineral resources, including rare earths. Also, the *Baotou Institute for Rare Earth Research* was established in accordance with the *Twelfth*

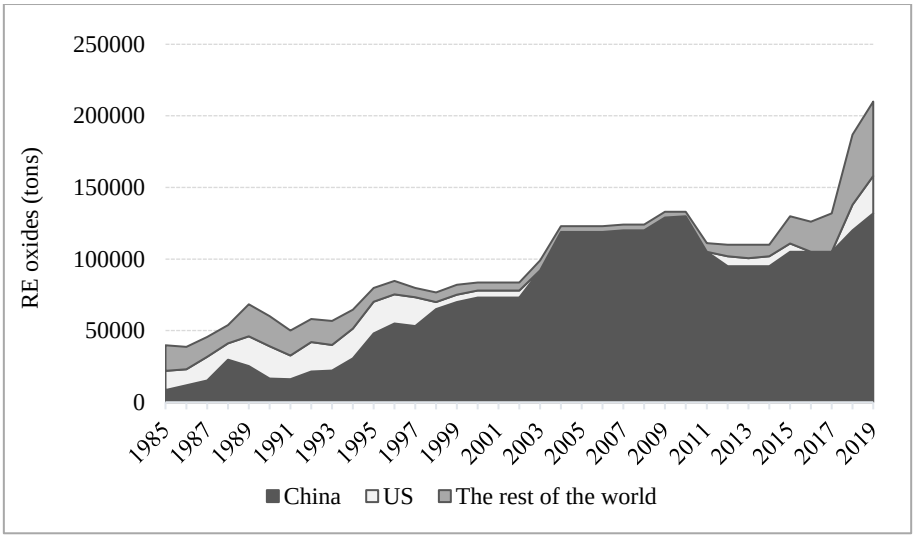
[4] In 1984, the production of the Mountain Pass mine (California) covered not only the US domestic demand, but also accounted for around 1/3 of the total global exports (Levkowitz & Beauchamp-Mustafaga, 2010).
[5] At present, China's rare earth reserves are at around 38% of the world total.

National Plan for the Development of Science and Technology (1958), and its activity led to significant achievements and progresses for the improvement of the REE extraction and separation process.

Under the leadership of Deng Xiaoping (1969-1997), who initiated an ample reform process in terms of economic liberalisation and modernisation, the Chinese development strategy took a new turn, in which scientific and technological advances gained significant ground. Because the launch of the initiative on the modernisation of the national economy meant acquiring and absorbing advanced technology from developed countries, the Chinese central authorities launched the so-called "open doors policy", with a strong focus on attracting foreign investment and directing it towards the science and technology sector and towards strategic industries (including towards the production of rare earths). By implementing this policy, China was seeking on the one hand to reduce the development gaps separating it from the main advanced economies and, on the other hand, to change the structure of national exports, by replacing low-processing REEs (predominant until then) with high added-value products.

As a result, towards the end of the 1970s, China's production capacity soared due to the massive government support granted for the improvement of mining technologies, and to the funds allocated to research and development (R&D) in the field of rare earth applications[6]. As shown by international statistical data (USGS, various years), in the period 1978-1989, the domestic RE production increased annually by around 40%, with China becoming the main global producer at the beginning of the 1990s (Graph 1).

Graph 1: Global rare earth production in the period 1985-2019 (tons)



Source: Author, based on data published by US Global Survey (USGS, various years).

Although at the stage when production capacity was being consolidated many of the national mining companies were not profitable, they managed to stay on the market as a result of non-performing loans and other forms of financial support received from the main commercial banks controlled by the Chinese government. The subsidies granted to large local companies in the RE industry was in line with the provisions of a more comprehensive government policy that sought to promote the internationalisation of the activity of companies involved in strategic fields, to enable them to acquire new production capacities using resources, technologies and know-how from the foreign markets.

As a result, the massive incentives received by the production companies – with an implicit effect on production costs – helped accelerate Chinese rare earth exports. Against this background, in the second half of the 1980s, global REE prices began to decrease, gradually forcing China's main competitors (the US in particular) out of the market.

Once almost all global production was transferred to China and once upstream industries were consolidated in accordance with the provisions of the five-year development plans, national policies began

[6] Among the government funded programmes aimed at intensifying production and innovation in the field of rare earths we mention: Programme 863, Programme 973, and a series of other national projects and initiatives which lead to the creation of specialised institutes, laboratories and research centres.

focusing on the acquisition of the technical expertise required for enhancing the technological level of the domestic rare earth production, to help expand the production capacity of related and downstream industries (e.g. the production of rare earth based alloys, powders and permanent magnets).

Although China had succeeded in overcoming the "Western monopoly" in the production of rare earth oxides and metals, in the 10th decade, these products represented relatively minor "links" in the REE production chains, on the one hand because of the development of numerous applications with a high-tech component suitable for REs[7] and, on the other hand, as a result of the fact that the price of rare earth oxides (REO) remained at a relatively low level on the global market, because of the increased competitiveness of the Chinese processing industry (De Medeiros & Trebat, 2014). As such, China was at the time only the main supplier of low-cost raw materials for the advanced industries of Japan and of the Western countries which had externalised almost all their polluting activities at the base of the value chain but had kept the added value industries domestically.

In this context, in 1990, the Chinese authorities declared the rare earth production a "protected strategic sector" (Jepson, 2012), a status that was transposed into a series of new restrictive regulations: a) total ban on foreign investments in the extractive business; b) the conditioning of FDI on a partnership with national companies (joint ventures), if the investment projects concerned activities in the REE separation and/or processing stages; c) the introduction of quantitative restrictions and of export duties.

The limitative and centralised control measures imposed on exports by the Chinese government sought to stimulate local downstream production, acting simultaneously in two directions – price decreases on the domestic market and price increases on the international market. This evolution of REE prices was meant to stimulate foreign companies to relocate their production operations to China, a move that also sought to help attract and acquire the technological capacities required for REE processing, in order to create national production chains.

Another line of strategic action adopted to increase the local companies' ability to access the upper segments of the production chains was the acquisition of foreign companies and, afterwards, their relocation to China.

4 The evolution of Chinese rare earth production and export policies

4.1 The promotion of upstream production exports phase: 1975-1990

In 1978, Chinese officials at the time, under Deng Xiaoping's leadership, concluded that the Maoist vision of the centrally planned economy could no longer generate efficient economic growth and was causing China to lag behind both the industrialised Western countries, and the new industrial powers in Asia. Given the low level of development that characterised the national economy at the time, the input of technology and the accumulation of foreign currency reserves could represent important sources both for the reduction of the development gaps, and for the launching of the economic modernisation initiative that was assumed in the context of the reform. Against this background, given the importance of REs for the developed economies, the Chinese authorities initiated an ample policy to promote production and exports, which started with the creation of the *National Group for the Development of Applications in the Field of Rare Earths* (later renamed the *Rare Earths Office*) (Shen, Moomy, & Eggert, 2019).

One of the relevant measures adopted by the Chinese government along these lines (1985) is the decision to reimburse export duties and apply a value added tax discount for producing companies, as a result of which the REO production doubled during the period 1985-1990 (from 8,500 tons in 1985, to around 16,500 tons in 1990; Graph 1). At the same time, as we have shown above, at this stage, decision-makers were focusing mainly on attracting foreign investments in the field of REE processing but restricted FDI in the extractive activity.

Although the upstream industrial activity initially proved profitable, as a result of the low production costs compared to the market price, the uneven regulation of the RE industry favoured an increase in the number of market competitors, determining a significant reduction of the REE price, despite the expansionist tendency and then the increased demand for these products. Also due to the poor administrative regulation, illegal production gained increasing ground during this period and, based on the low costs generated by tax avoidance, put pressure on price reductions.

4.2 The lax production and export restrictions phase: 1991-1998

Although the national RE industry was in full expansion, the negative aspects characterising the domestic market – low prices, the presence of illegal producers and the difficulties the local authorities had in implementing their

[7] Which contributed to an increase of the price of downstream products (UNCTAD, 2014).

verifications and controls – determined the adoption of more restrictive measures, meant to help remedy these shortcomings.

As a result, beginning in 1991, to restrict the number of companies operating in the RE production sector, decision-makers took a series of measures aiming to: *a)* suspend certain previously granted licences for geological exploration and mining extraction; *b)* provide for the possibility of licence renewal only based on an approval from the Ministry of Commerce (MOFCOM); *c)* limit the issuance of new licences (Su, 2009). Although the licence suspension provision was, in the authorities' view, an administrative tool that could resolve the issue of overinvestment, this measure also affected the companies that were complying with the government regulations in the field.

Also, after RE production gained the status of "protected strategic sector" which was granted in order to eradicate illegal activities and resource waste, central decision-makers included REE in the category of "nationally protected minerals in terms of extraction", the processing of which required an approval from the Chinese government in all the stages of the production chain (He, 2014). More exactly, the *Rare Earth Office* was given new powers related to: *i)* the long-term planning of RE resources allocation; *ii)* the preparation of projects for the development of RE-based compounds and products obtained from their processing; *iii)* the organisation of the domestic REE trade. At the same time, state-owned mining companies authorised by the *Rare Earth Office* were given priority in the organisation and performance of production activities, while joint ventures could only exploit limited reserves and private companies had restricted access to separation and melting activities.

Despite the stricter government policies in the field of REs and the increased state control over this sector, in 1998, China's REO production reached a record annual volume of 65,000 tons, accounting for a share of 85% of the world total, compared to the 30% share of 1991 (Graph 1).

4.3 The strict production and export restriction phase: 1999-2014

Because the deficiencies caused by the rapid development of the RE industry during the first phase had not been resolved and the measures adopted during the second regulatory interval were considered insufficient, the dilemma decision-makers faced was whether to opt for a consolidation of the economic growth process, or to take steps to comply with the environmental and natural resource preservation rules, given the high level of pollution generated by the rare earth extractive and processing activities.

In these conditions, according to the official arguments invoked by political leaders, it was imperative to implement more drastic measures that could effectively contribute to the limitation of production and, as a result, to the achievement of the environmental protection goals. The new government regulations adopted in the RE field provided for the application of: *a)* export quotas; *b)* production quotas; *c)* export duties; and for a stricter regime for the approval of foreign direct investment *(d).*

Box 2: Summary of the main restrictive measures adopted by China in the period 1999-2010

Export quotas
To be able to exercise increased control over the entire national production, in 1999, the Chinese central authorities introduced a system of quantitative export restrictions (in force in the period 1999-2014), based on which specific individual limitations were allocated to each rare earth based product, seeking to support the development of the downstream sector (Tse, 2011). Under the direct coordination of the government, the Ministry of Commerce established the export quotas based on this strategic objective, applying limitations in a way that favoured companies that were generating high added value and large state-owned companies. For example, in 2000, export quotas were reduced for primary goods and increased for intermediary products (rare earth oxides and metals), while permanent magnet elements were not subject to regulatory export quotas (Shen, Moomy, & Eggert, 2019). This trend persisted during the entire phase, with China continuing to maintain strict restrictions on the export of primary products and facilitate the external marketing of advanced products. At the same time, in particular towards the end of the interval, export quotas also took into consideration the production companies' compliance with the environmental rules (Wübbeke, 2013).
Production quotas
Another economic policy measure with a direct impact on the consolidation of the national production chain was represented by the application of production quotas, determined based on: i) the concentration of rare earths (a provision introduced in 2006, for which the Ministry of Land Resources (MLR) was responsible; and ii) the concentration of rare earths and the complexity of the separation process (the Ministry of Industry and Information Technology - MIIT). Although initially the MIIT would set up quotas for individual companies, beginning in 2016, production limitations were allocated to groups, which took over the responsibility of allocating quotas to the companies in their subordination

and then reported them to the MIIT and to the central authorities. The complexity of this system created great confusion among producers, in particular because of the discrepancies existing between the two categories of quotas (Kalantzakos, 2018).
Export customs duties
To achieve its proposed objectives, China introduced a progressive customs duties regime on RE exports: 10% of product value in 2007 (for RE ores, oxides and compounds) and, from 2008, 15-25%, depending on the degree of REE processing. After 2010, the authorities imposed duties for NdFeB alloys that were not used in the production of permanent magnets. In addition to stimulating downstream production, these measures were intended to protect non-renewable REE resources. Although they resulted in the quantitative reduction of exports, customs duties discouraged the export of REEs with a lower degree of processing, leading to a restructuring of the Chinese RE industry.

Source: Author's synthesis based on the cited literature.

As regards the international practice of using trade restrictions to reach environmental objectives, the literature (e.g. Gavin, 2013) shows that the optimum ways in which this market failure can be resolved are generally the application of domestic taxes on the polutting industries or the application of production taxes. Also, it must be said that export restrictions are generally applied in order to achieve the political objective of promoting downstream industries, seeking to increase the price of raw materials on the external market and decrease domestic prices. In China's case too, this government policy had a direct effect on the stimulation of internal development, on the one hand by facilitating the access of local companies to RE raw materials at low costs and, on the other hand, by incentivising FDI and cutting-edge technology inflows as a result of foreign companies relocating their production companies on the Chinese market.

A turning point for the introduction of stricter regulations in the Chinese RE sector was the adoption by the State Council of the *Decision to rectify and standardise the order on the development of mineral resources* (2005), which provided for a major industry reorganisation (State Council, 2005), meant to remedy the deficiencies related to poor management, resource waste and non-compliance with the environmental standards. The document also expressly set out a series of requirements concerning the reorganisation of mining operations and of production, the REE processing and marketing standards, and the beneficiaries. Based on the new provisions, decision-makers established both how quota systems were to be implemented (export and production quotas), and the competent authorities responsible for verifying and controlling their implementation.

Because despite the application of all the restrictive measures listed above illegal production continued to be significant in 2010 (estimated at around 30% of the total), the Chinese government imposed even stricter conditons, in particular with regard to the reduction of export quotas (Table 1).

Table 1: Evolution of export quotas in the period 2000-2014

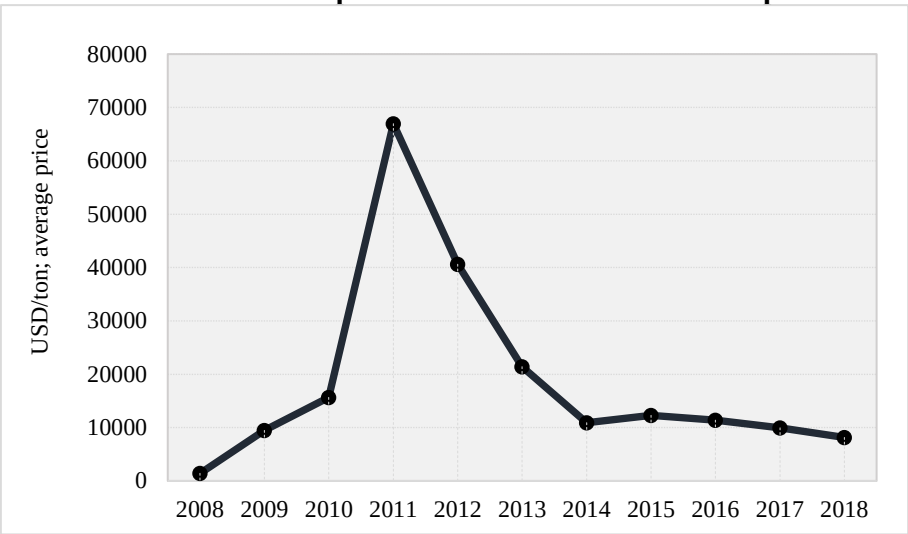
Year	Rare earth oxides (tons)	Annual changes (%)
2000	46,000	-
2001	data unavailable	-
2002	40,000	-
2003	data unavailable	-
2004	57,000	-
2005	65,580	+1.2
2006	61,070	-6.9
2007	59,643	-2.3
2008	49,990	-16.2
2009	48,155	-3.7
2010	30,259	-37.2
2011	30,184	-0.3
2012	30,996	+2.7
2013	data unavailable	-
2014	31,000	-

Source: Data published by USGS (various years)

The increasingly stricter control measures imposed by the Chinese authorities on commercial outflows of RE-based products – culminating in the significant decrease of export quotas in 2010 (by around 37%) – immediately resulted in the steep increase of the REE price on the international market (by approximately 430%),

in 2011 (by approximately 160%)[8] (Graph 2). Prices returned to the levels of the years prior to the application of trade restrictions in 2014, when following the unfavourable WTO decision, China announced the lifting of export quotas beginning in 2016.

Graph 2: Evolution of rare earth prices at international level in the period 2008-2018*



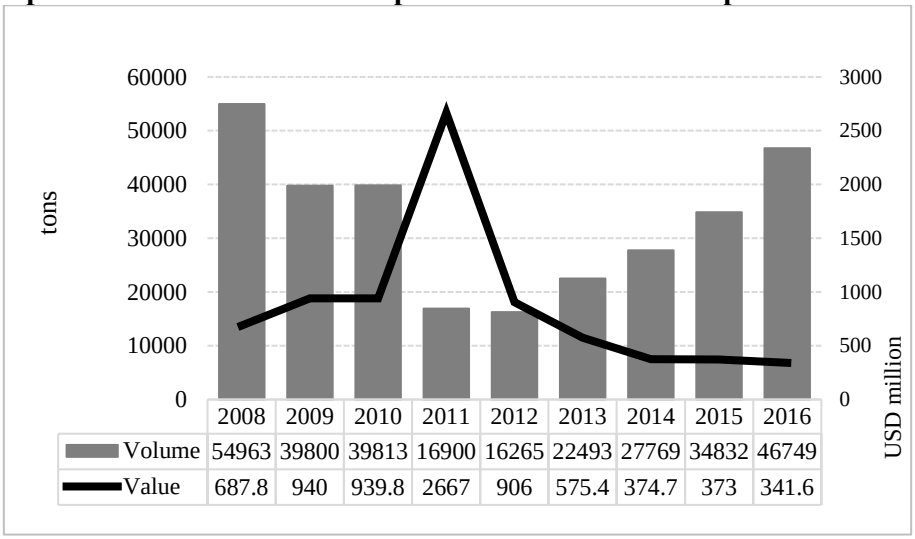
Note: *Latest available data at the time when the analysis was prepared.
Source: Author, based on statistical data published by China Power Project (2020).

Also, as shown by the data presented in Graph 3, beginning in 2011, the objectives of the restrictive commercial policy applied by China where achieved, in the sense that despite the 42% reduction in terms of volume, the value of REE exports the same year grew by approximately 3%, based on the structural change of these exports, i.e. the increased share of higher added value products.

Nevertheless, according to some authors (e.g. Mancheri, 2015), a possible adjacent cause of the considerable reduction of Chinese REE exports in 2011 could be the lower demand from developed countries – US, Japan and the EU, China's main trade partners for the export of these products –, who were still facing the negative effects of the global financial crisis.

From 2013 onwards, in the years before the quotas were lifted, the export volume resumed its upward trend, with increases of around 23% and 25%, respectively.

Graph 3: Evolution of Chinese exports of rare earths in the period 2008-2016



	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volume	54963	39800	39813	16900	16265	22493	27769	34832	46749
Value	687.8	940	939.8	2667	906	575.4	374.7	373	341.6

[8] After the years 2000 – when China's entry on the international market caused a major decline of REE prices and eliminated the main competitors from the market, in particular the US –, rare earth prices remained relatively stable until 2007. With the major cut of export quotas by the Chinese authorities in 2011, the price of certain rare earth-based products on the international market increased by as much as 850%. In these conditions, a significant number of mining projects became operational in many countries (including the US) (Machacek & Fold, 2014).

Source: Author, based on the statistical data published by US Geological Survey (USGS, various years) and China's General Administration of Customs (CGAC, various years).

As regards RE production, in the period 2005-2010 China held a constant share of approximately 97-98% of the global total (Graph 1). However, against the background of the effects the restrictive trade measures adopted had on market price and supply stability, which determined certain producing countries (e.g. the US, Australia, the Russian Federation) to resume their productive activity, in 2015, China's share of the global REE production decreased to around 80%

4.4 The post-restrictions phase

The restrictions imposed by China on rare earths production and trade triggered a series of protests from the US, Japan and the EU, whose high-tech industries were strongly dependent on the imports from China. As such, in 2012, the three great economic powers brought an action against China before the WTO, based on several grounds: a) the export duties on ores and primary rare earth products (as well as on tungsten and molybdenum) were not listed in the WTO Accession Protocol and, therefore needed to be eliminated; b) the major restrictions imposed by China on the export of rare earths infringed the WTO and Protocol terms; c) the regulations on the granting of export licences did not comply with the commitments assumed at the time of the accession to the WTO (WTO, 2014).

Despite China's claims that its export policies were comparable with the exceptions set out in Articles XX and XI of the GATT[9] (1994), as their main objectives were the protection of non-renewable resources, environmental protection and the protection of population health, the WTO ruled against it and considered that the measures did not meet the requirements of the exemptions from the Protocol. As a result, beginning with 2015, China cancelled its RE export quotas and duties system. Therefore, at present, companies no longer need approvals to carry out export activities, and licences can be obtained on the basis of trade agreements only.

After losing the dispute before the WTO, China focused more on the use of political and legislative tools to attain the government's objectives related to industrial restructuring, environmental issues and the fostering of rare earth use in the downstream sector. For example, more recently (2018), the National Congress adopted the *Law on the environmental protection tax*, which provides for the obligation of national companies to internalise environmental costs.

Another initiative (2015) is the aggregation of the state-owned companies into six large production groups through mergers and acquisitions, coordinated and controlled by the central government, each of these groups covering various segments of the REE production chain. This new strategy allows government authorities to exercise their control function over the entire industry in a more efficient manner.

At the same time, the new policies focused on the production of primary RE goods, to increase the profitability of the companies in the extraction and separation field, and at the same put pressure on companies producing end goods. These measures determined an improvement of the financial performance of upstream companies and the increased competitiveness of the downstream sector.

5 Recent trends in China's rare earth trade

As results from the above, as the economic development process advanced, Chinese leaders tried to turn the country into a key player in the rare earth industry which was considered to be of major strategic importance. This trend has continued through the recent years, when China strengthened its leadership position in the field of production and global exports, reaffirming the fact that despite the propensity for market change, this hierarchy is unlikely to change during the coming years.

As we have shown, China's current dominance is the result of the industrial policies adopted by the government authorities over several decades, having as main objectives both to increase the competitiveness and efficiency of the national rare earth industry, and to outclass the developed economies and acquire global supremacy on this market. Although at present the majority of strongly industrialised countries have taken

[9] According to Article XI of GATT, each WTO member state has the right to temporarily apply export restrictions to prevent or relieve "critical" shortages of food products or other essential products in the exporting country; Article XX allows for the application of exceptional quantitative restriction to achieve certain political goals (e.g. the preservation of depleting natural resources) and to ensure the essential materials for the domestic processing industry, with certain "qualifications" (WTO, 2014).

concrete steps to limit their exposure to the risks generated by further discontinuations of the supply flow, as shown by statistical data, they continue to be strongly dependent on China.

In the period following the elimination of the restrictions, Chinese RE exports increased substantially (Graph 3 and Table 2), culminating in 2018 with a record volume of 69,296 tons, which exceeds the export volume of the preceding year by around 35%. In terms of export structure, the majority share (around 86%) is held by rare earth metal compounds.

Table 2: Chinese rare earth trade flows in the period 2017-2019*

EXPORTS						
	2017		**2018**		**2019**	
	Volume (t)	**Value** (USD mil.)	**Volume** (t)	**Value** (USD mil.)	**Volume** (t)	**Value** (USD mil.)
Total export, of which:	51,200	416.0	69,296	648.2	46,331	440.2
RE metal compounds	45,685	336.2	59,296	449.9	39,481	324.2
RE metals	5,515	79.8	10,000	198.3	6,850	116.0
IMPORTS						
	2017		**2018**		**2019**	
	Volume (t)	**Value** (USD mil.)	**Volume** (t)	**Value** (USD mil.)	**Volume** (t)	**Value** (USD mil.)
Total import, of which:	34,403	181.0	81,967	277.8	41,068	274.2
RE metal compounds	34,322	174.4	7	1.7	41,042	272.2
RE metals	81	6.6	81,960	276.1	26	2.0

Note: *Although for other products, China's General Administration of Customs database provides statistical information for the period 2015-2019, for RE-based goods, at the time this chapter was being prepared, the data published only captured the interval stated, in annual terms.
Source: Author's calculations based on the statistical data published by China's General Administration of Customs (CGAC, 2020).

In 2019, against the background of a declining demand from the main export markets, the sustained growth stage (started in 2013) was interrupted, and Chinese RE export contracted severely both in terms of volume (decreasing by around 33% compared to the previous year), and in terms of value (-32%). The main cause that contributed to the decline in demand from the main trade partners is represented by the success of the measures taken by the developed economies over the recent years to find alternative supply sources that could curb the increasing dependency on China. For example, the US recently tried to reconquer the position it had held in the past on the global market by reopening the Mountain Pass mine, which resumed production in 2017[10]. The EU also launched a series of actions meant to reduce dependency on China, by financing an initiative for the recycling of permanent magnet waste and turning it into RE-based materials and alloys (2018). At the same time, South Korea tried to diversify its supply of rare earths both by increasing imports from Japan, and by finding innovative ways to lower consumption.

Despite all these progresses however, China continues to be the main global RE exporter (Table 3), in particular for rare earth metal compounds.

Table 3: Evolution of global rare earth exports in the period 2008-2018
(cumulated values)

Country	**Cumulated export volume (tons)**	**Share in global total (%)**	**Cumulated export value (USD mil.)**	**Share in global total (%)**
China	407,886.6	42.3	8,112.2	46.3
US	89,467.1	9.3	953.6	5.4
Malaysia	87,696.1	9.1	942.4	5.4

[10] However, the extractive production of the Mountain Pass mine is at present sent to China for processing.

Austria	87,055.1	9.0	867.8	5.0
Japan	68,412.9	7.1	2,172.6	12.4
Rest of the world	223,172.0	23.2	4,467.7	25.5

Source: Author, based on US Comtrade data (2020).

Geographically, Japan is the main destination of Chinese rare earth exports, receiving around 50% of the total in 2019 (Table 4).

Table 4: China's main RE trade exchange partners in the period 2017-2019

EXPORT						
Country	**2017**		**2018**		**2019**	
	Export value (USD mil.)	% of total	Export value (USD mil.)	% of total	Export value (USD mil.)	% of total
Japan	188.2	45.2	240.3	37.1	216.2	49.1
US	68.4	16.4	88.5	13.7	79.3	18.1
South Korea	36.6	8.8	29.4	4.5	33.3	7.6
France	17.4	4.2	X*		X	
The Netherlands	34.7	8.3	49.3	7.6	25.0	5.7
Hong Kong	X		12.4	2.0	X	
Italy	X		X		8.5	1.9
IMPORT						
Country	**2017**		**2018**		**2019**	
	Import value (USD mil.)	% of total	Import value (USD mil.)	% of total	Import value (USD mil.)	% of total
Malaysia	138.7	76.6	81.6	29.4	75.6	22.6
Myanmar	12.4	6.8	63.9	23.2	152.8	55.7
Japan	6.4	3.5	8.5	3.1	8.8	3.2
France	4.0	2.2	2.2	1.0	X	
US	2.9	1.6	37.8	13.6	8.6	3.1
India	X		X		1.8	0.7

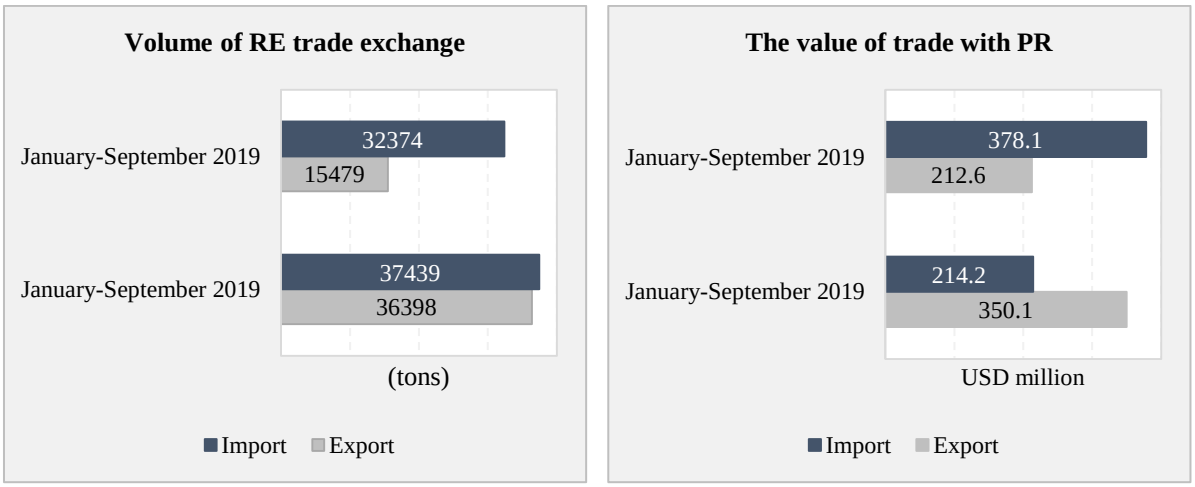
Note: * X – The country in question is not included among the Top 5 trade partners in the reference year.
Source: Author's calculations based on the statistical data published by China's General Administration of Customs (CGAC, 2020).

The same year, the US, ranking second in the hierarchy of main importers, recorded a growing share of China's total exports, albeit a decrease by around USD 24 million in terms of value.
China's economic development and its advancement along the global RE value chain increased domestic consumption and determined an increase of imports. As such, in 2018, RE import grew by around 240% compared to 2017, reaching a record volume of approximately 81,967 tons and placing China first among global importers (China Power Project, 2020).

Although this trend did not continue in 2019, when RE imports fell by around 50%, certain analysts estimate that by mid-decade China will become a net importer of rare earths. In these conditions, its influence on the global rare earth industry could diminish and new the players on the market could consolidate their competitive position.

As illustrated by the most recent data published by China's General Administration of Customs, against the background of the effects generated by the Covid-19 pandemic, which led to a steep decrease of the global demand for rare earths, in the months of January through September 2020, the volume of Chinese exports saw a major decline (by around 135%) compared to the same period of the preceding year (Graphs 4 and 5).

Graphs 4 and 5: Comparative evolution of Chinese RE trade flows in the period 2019-2020 (January-September)



Source: Author's calculations based on the statistical data published by China's General Administration of Customs (CGAC, 2020).

According to national analysts (Lei, 2020), this decrease occurred in the context in which, for several months, production was discontinued or operated well below potential in the main industrialised economies. At the same time, the factors that additionally contributed to the decrease in demand on the international market include export delays, and the stock growth tendency seen during the recent years.

Nevertheless, some experts have expressed the opinion that this decline could also be generated by the growing geopolitical tensions with the US, as a result of the warning launched by the Chinese government (July 2020) regarding the application of financial sanctions on US companies involved in the sale of weapons to Taiwan. In the first half of 2020, exporters of rare earths to the US recorded a volume of 5,184 tons, which in annual terms means a decrease by around 35%. According to estimates by Chinese analysists, this trend will continue until the end of this year, due to both the slowdown in production, and to the ineffective measures adopted by the Donald Trump Administration for combatting the pandemic.

6 Conclusions

China's current global monopoly in the extraction, production and export of rare earths is based on a series of major comparative advantages (whether acquired or created), which are impossible to replicate or equal by the country's potential competitors.

a) China has the largest rare earth reserves, estimated at present (2020) at around 40% of the global total. From the discovery of the first rare earth deposits in the Bayan Obo region (as early as the 1930s), significant resources were found in 21 other Chinese provinces and autonomous regions.

b) As the RE sector was formed and grew, the country had access to cheap labour, which resulted in low production costs, thus enabling China to rapidly surpass the US production capacity and consolidate its monopoly based on cost advantages.

c) China's spectacular economic growth over the recent decades enabled the acquiring of the funds required for investments in the development of the domestic RE production and the acquisition of mining operations and production capacities on the external market.

d) The government authorities' sustained efforts to expand knowledge and technological capabilities, through the promotion of RE research and development and through the stimulation of technological transfer,

transformed China into a global leader in the field of expertise and cutting-edge technology development with applicability in the extractive and production sector. Because the US and the other strongly industrialised economies did not invest equally large amounts of money in research and development related to new REE production and separation technologies (in particular in the context of outsourced production), China gained supremacy on all the four segments of the global chain: extraction, processing, separation and production.
e) The Chinese legislation – more permissive in terms of compliance with environmental protection rules – also played an important part in the quest for global market leadership. While at the beginning of the 1990s industrialised countries imposed stricter environmental standards which considerably hindered progresses in the extractive sector, China continued to expand the RE mining operations.
f) Acknowledging the strategic importance of these resources, the national long-term development plans prepared at central level included from a very early stage ample policies meant to lead to the development of the ER production sector.
g) Most Chinese companies involved in the ER production and processing activity are state-owned companies, financially supported by the government. In these conditions, because of the subsidies they receive, they are able to react quickly to market changes.
All the above-mentioned advantages helped China gain the current monopoly position on the international rare earth market, a position which it is unlikely to lose, at least on the short and medium term.

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