Resources Policy 50 (2016) 131–140

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

A systemic approach to the problems of the rare earth market

Polina Klossek*, Jakob Kullik, Karl Gerald van den Boogaart

Helmholtz Institute Freiberg for Resource Technology, Department Modeling and Valuation, Halsbruecker Str. 34, 09599 Freiberg, Germany

ARTICLE INFO

Article history:
Received 19 May 2016
Accepted 16 September 2016

Keywords:
Systemic approach
Rare earth elements
Supply security
State involvement
Resource markets

ABSTRACT

China's dominance of the rare earth market has been raising issues of major concern since 2010. Reduced export quotas and consecutive price peaks led to fears concerning supply security. Forward integration is shifting the rare earth-dependent high-technology value chain to China. China's export embargo to Japan showed the world the strategic relevance of its economic dependence on China's rare earth products. Despite multiple political and industrial efforts outside China, it has not been possible to diminish the dependence on China, e.g. by building up an independent rare earth supply chain. We think that this is prevented by systemic problems of the rare earth market. This paper examines these distortions of the rare earth market with a systemic approach. Problems are identified and structured qualitatively in order to expose their economic and political connections. The systemic problems are (1) *competing political-economic models*, (2) *resource nationalism*, (3) *market opacity*, (4) a *lack of trust*, (5) *weak cooperation* and (6) *short-versus long-term approaches and profit orientation*. These problems are interconnected and amplify each other. In this context, the potential of four solutions to influence the rare earth market system is discussed.

1. Introduction

The scientific and political debate on rare earth elements (REE) as "critical" or "strategic" for high-tech industry (smart phones, solar panels, wind turbines, e-mobility, weapon systems) is multifaceted and gained increasing attention in previous years (ERECON, 2015; U.S. Department of Defense, 2015; House of Commons Canada, 2014; EU Commission, 2014; EU Commission, 2010; Federal Ministry of Economics and Technology, 2010). REE demand growth in the next years is estimated to reach 6% p.a. by 2020 mainly due to an increased use of REE in catalysts, magnets and metallurgical products (Roskill, 2015). As long as the recycling and substitution rates of REE remain low, it can be assumed that supply security will be crucial for producers and consumers of REE all around the world (Graedel et al., 2015; Nassar et al., 2015).

Various analytical and methodological approaches regarding the REE market exist, but so far, all focus on specific aspects and none of them have analyzed the REE market as a system. Previous analytical foci on REE have been e.g. national supply security strategies (e.g. Bartekova and Kemp, 2016; Hilpert and Mildner, 2013), geopolitics of resources (e.g. Ebner, 2015; de Ridder, 2013), criticality assessments (EU Commission, 2014; Roskill, 2014a; Helbig and Achzet, 2013; Speirs et al., 2013; Buijs et al., 2012), international mineral markets and resource efficiency (Müller et al., 2015; Goldman, 2014; Massari and Ruberti, 2013; Morrison and Tang, 2012). Others draw attention to strategic aspects and the national security of REE (e.g. Gholz, 2014; Butler, 2014; Campbell, 2014; Humphries, 2013; Parthemore, 2011). Environmental issues of REE (Yang et al., 2013) and resource technology (Dutta et al., 2016; Seo and Morimoto, 2013) play also an important role. Due to China's current dominance on the REE market different aspects of this dominance have been scrutinized (Zhü et al., 2016; Mancheri et al., 2013; Hurst, 2010), e.g. the implications of the double REE pricing structure[1] (Müller et al., 2015), the future supply situation of heavy REEs (HREE) (Roskill, 2015; Roskill, 2011), or activities of REE producers outside China, e.g., Molycorp, Lynas, Great Western Minerals Group etc., (e.g., Machacek and Fold, 2014).

The REE market, however, is a complex economic and political system consisting of its stakeholder's interests, strategies, legal structures, incentives and perceptions. The aim of this paper is, thus, to provide a systemic view of the interconnected problems of the REE market. The special structure of the REE market generates, sustains, and is sustained by certain market distortions. E.g., there is high market uncertainty hindering investments into an

* Corresponding author.
E-mail addresses: mcmur@yandex.ru (P. Klossek), j.kullik@hzdr.de (J. Kullik), boogaart@hzdr.de (K.G. van den Boogaart).

[1] Lower Chinese prices versus higher Free on Board (FOB) prices.

http://dx.doi.org/10.1016/j.resourpol.2016.09.005
0301-4207/

alternative REE supply chain. The systemic approach reveals the causes, interconnections and consequences of different problems of the REE market as a complex system. A major additional value of this approach is the ability to judge the viability of proposals to tackle the problems. There are no simple solutions. Simple solutions for one problem can strengthen other problems through feedback loops, e.g. the consequences of state involvement to other market distortions. This has practical consequences for political decision-making, e.g. according to the European Rare Earths Competency Network (ERECON): "With the threat of policy intervention hanging over global REE markets, companies face additional uncertainty and risks that reduce the willingness of private investors to enter these markets." (ERECON, 2015 p. 70).

The structure of this paper is organized as follows: Section 2 gives a very brief discussion on the methodology and definitions. Section 3 thoroughly identifies and explains six systemic problems of the REE market and discusses their possible causes. Based on the findings in Section 3, Section 4 makes a proposition of how these problems are interconnected and amplify each other. Section 5 discusses four possible solutions proposed in literature to deal with the problems of the REE market. Section 6 summarizes and concludes.

2. Methodology and definitions

For the purpose of the analysis, a qualitative systemic approach is used. It is qualitative to allow for sufficient overview despite missing or opaque quantitative REE market data. The stakeholders relevant to our analysis are private and state-owned companies, investors, consortia and states. Their actions are interconnected and together they constitute the REE market system.

This particular market is characterized by major systemic problems identified and discussed in this paper. In the following, something is considered a problem if it is a cause for a deviation from the free market.[2] We consider a problem systemic when it is an integral and persistent part of the system and cannot be treated without secondary effects on the system. We call it major if it is more relevant than any usual market problem like e.g. transient supply/demand imbalances or corruption.

To identify the systemic problems of the REE market the following sources were analyzed: scientific literature, official sources on strategies and raw material policies, statistics, company and market data. Based on these sources, six major systemic problems were identified (see Fig. 1). Some of these problems are directly and repeatedly mentioned in the literature on the REE market, while others are derived from more general theories, and proved to be relevant by examples. No other suggestions were found, therefore, it is assumed that the mentioned problems cover most phenomena described in literature..

Based on the studied literature and evidence from the praxis, the paper discusses possible causes of the identified problems and, consequently, makes a proposition of how these problems generate and sustain each other in the case of the REE market (see Fig. 1).

The gained insight provides a better understanding of the potential impact and the viability of policy options addressing the REE market (e.g. a buyer consortium or an international REE database). In discussing possible solutions (policy options) the authors took the perspective of the rest of the world (ROW) states (i.e., all states which are involved in the REE market except for China) and industries and their ability to influence the REE market system.

[2] The principles of the free market are described in, e.g., Bremmer, 2010.

3. Problems of the REE market

3.1. Competing political-economic models

The competition between market-based and state-capitalist economies (McGregor, 2012; Bremmer, 2010) shapes the REE market. Both models approach the market completely differently. Market based economies usually see raw materials in the responsibility of the private industry. The state is only supportive (Federal Ministry of Economics and Technology, 2010). In reaction to the REE price peak in 2010–2011 and the high REE import dependence, Western governments have taken an unusually high influence on this market. There has been substantial investment into rare materials related research (e.g., R4 research program of the German government focusing on technology development and domestic mining; Rare Materials Hub; Horizon 2020 by the EU fostering a circular economy in Europe; Canadian Rare Earth Elements Network (CREEN)), supportive international resource diplomacy (e.g. bilateral resource partnerships, trilateral dialogue USA-EU-Japan), and filing a WTO complaint against China in order to enforce free-market rules on the REE market. Despite the verdict, the REE market did not structurally change so far. The industry started initiatives like Rohstoffallianz in Germany and numerous exploration projects, tried to commence an alternative production outside China, which however did not succeed due to unfavorable market conditions. In summary, the Western approach had little influence on the market structure so far.

As demonstrated in the following, China as a state-capitalist economy substantially intervenes into the market (Biedermann, 2014; Bremmer, 2010). This market intervention is in China's interest as it provides the country with a strategic leverage against the competing Western industry model. In this China-dominated market, a state-defined business logic is changing market mechanisms, rendering classical market balancing mechanisms[3] ineffective, and removing the level playing field required for free-market based industry to flourish (Humphreys, 2012). In this context, the U.S. Congress has called China's REE policy an "increasingly aggressive mercantilist behavior" (U.S. Government Publishing Office, 2014, p. 2; Humphreys, 2013). The primary objective of the Chinese government was to build up its current position as the leading player in the global REE mining and processing industry in order to control the entire value chain in the long run (e.g., Biedermann, 2014; ERECON, 2015; UNCTAD, 2014). This, e.g., led to the situation that no independent REE supply chain exists in the ROW. Hence, Western countries attempt to substitute REE in high-tech products in order to minimize economic vulnerabilities (e.g. ERECON, 2015).

One important strategy which enables China to outperform its foreign competitors is the double pricing structure on the REE market. The heavy financial subsidization both by the central government and local authorities enables Chinese companies to offer temporarily lower prices than its competitors on the world market (Roskill, 2014; Hayes-Labruto et al., 2013; Massari and Ruberti, 2013). Low labor costs and weak law enforcement in the provinces are additional advantages to keep the Chinese REE production costs low and more competitive (Roskill, 2015; Ebner, 2014). The consequence is that foreign private companies succumb in the price competition against Chinese corporations (Vacuumschmelze, 2015).

China's REE policy goes far beyond differential pricing and is part of a bigger national industrial development strategy. The main agenda is to transform the country into a leading innovation-

[3] Mechanisms which allow the free market to regulate itself, e.g., laws and forces of demand and supply, competition, etc.