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Clean energy industries and rare earth materials: Economic and financial issues

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HIGHLIGHTS

- Clean energy is an industry with a double-digit growth market rate in the last years.
- Rare earth materials are a key component in the development process of this industry.
- Recently REMs' prices have skyrocketed and the clean energy industry is in turmoil.
- We analyze the effect of REMs price on the stock market performances of clean industry.
- We find negative relation between REMs price increase and stock market performances.

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ABSTRACT

In the last few years, rare earth materials (REM) prices have experienced a strong increase due to geopolitical and sustainability issues. Financial markets could already have factored in concerns about shortages of REM supplies into clean energy companies' valuations. We use a multifactor market model for the period January 2006 to September 2012 to analyze the impact of REM price trends – specifically dysprosium and neodymium – on six clean energy indices (NYSE–BNEF) tracking the world's most important companies in the clean energy sector. The results show that during period of price increase, there is a negative relationships between REM price changes and the stock market performance of some clean energy indices. The European clean energy index is also negatively affected, and this effect could be relevant to policy makers, considering that Europe is implementing some relevant policy actions to support the development of the clean energy industry.

1. Introduction

Clean energy is a dynamic and promising industry, with a double-digit growth market rate over the last few years. In clean energy, rare earth materials (REMs hereafter), such as dysprosium, neodymium, terbium and yttrium—are key components in the development process of new technologies.

China accounts for approximately 97% of the global production of REMs, but recently it cut its export, apparently to protect its environment. As a consequence, REM prices have skyrocketed, and the clean energy industry is in turmoil.

The relevance of REMs for the worldwide economy and for diplomacy was outlined by Ting (2010), who made a curious analogy comparing REMs to spices. More than 400 years ago, access and control to spice production regions were causes of disputes and competition among European countries. Certainly, this is not the case with REMs today, but if decision makers do not strongly encourage R&D for substitution and recycling and do not actively encourage diplomacy actions to reduce contrasts in trade activity, then the statement of Chinese President Deng Xiaoping that "if the Middle East has oil, China has the rare earths" could take on a certain relevance. In the future, REMs could be placed on the same level as mineral oil and raw commodities, which during the last century played key roles in shaping global political equilibrium.

The heightened concern about the availability of REMs has stimulated the economies with greatest demand for critical materials, such as the European Union, United States and Japan—to take the first steps toward implementing a mineral policy strategy with the aim of stimulating R&D, new mining activity and diplomacy actions, to reduce dependence on China's supply of REMs.

From a financial perspective, REMs prices can influence green energy stock prices. Financial markets could already have factored in concerns about shortages of REM supplies into the valuation of clean energy companies. Macro- and microeconomic variables determine the fundamental value of firms and, in turn, stock prices. Raw materials, such as REMs, could play a role in

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determining the performance of clean energy firms and, to some degree, in determining investment performance.

As a consequence, understanding the factors that affect the profitability of these firms could be useful for investment decisions and portfolio diversification strategies. Moreover, equity and venture capital investments in alternative energy technologies, other than public expenditures, are important sources of funding for R&D.

Despite the agreed upon future relevance of REMs, there have not been available empirical studies of how REM prices will impact the clean energy industry. Within this framework, the aim of this study is to analyze the impact of REM price trends on the share price value of clean energy companies. Specifically, we focus our analysis on dysprosium and neodymium, which are considered more critical materials than other REMs (DOE, 2010, 2011). As for the share price value of clean energy companies, we use a new family of clean energy indices.

Following the approach of Sadorsky (2001), we use a multi-factor market model, based on the theory of the capital asset pricing model (CAPM). According to the CAPM, stock price returns are associated with the movement of some common factors. To investigate the performance of a security or a portfolio of securities, we apply this model to three clean energy sectors' specific indices and to three regional clean energy indices. These indices are produced by the New York Stock Exchange (NYSE) and by Bloomberg New Energy Finance (BNEF), and they track the world's most important companies in the clean energy industry. Sector-specific indices cover companies involved in wind, solar and smart energy technologies. Regional indices include companies active in the Americas, Europe, the Middle East and Africa, Asia and Oceania. We use daily data from January 2006 to September 2012.

Our paper offers three main contributions. First, the paper provides an overview of a topic that has not been empirically investigated but that will be of utmost importance in the future. Second, it provides the first econometric analysis of the effects of REMs on clean energy corporate value, using a multifactor market model. Lastly, the paper leverages the NYSE–BNEF clean energy indices in an academic context for the first time, encouraging their use in future investigations.

The paper is organized as follows: Section 2 reviews existing research about REMs, Section 3 focuses on the multifactor market model, Section 4 presents the data and the empirical model, Section 5 reports the results, and Section 6 discusses the main conclusions.

2. Clean energy and REMs

To address climate change, to increase energy supply safety and to foster the sustainability and competitiveness of the economy, many countries have instituted regulatory frameworks to increase the diffusion of clean energy. In recent years, the installed capacity of renewable technologies has skyrocketed. Between 2006 and 2011, the average annual growth rate of solar photovoltaic (PV) energy was 58%, followed by concentrating solar thermal power (37%) and by wind power (26%) (REN21, 2012).

In 2011, almost half of the new electricity capacity installed worldwide was renewable. In the power sector, wind and solar photovoltaic accounted, respectively, for almost 40% and 30% of the new renewable capacity installed in 2011, followed by hydropower with approximately 25% (REN21, 2012).

On the worldwide level, investment in renewable energy increased to 257.5 billion dollars in 2011 from 39.5 billion in 2004 (UNEP, 2012). Economic policies supporting renewable energies, together with increasing investment, have, in turn, prompted interest in the market of the input materials used in clean energy technology. According to a GSI (2010) study, the Organization for Economic Co-operation and Development (OECD) estimated the market for input material as accounting for 27 billion US dollars in renewable energy (excluding hydroelectricity) and for 20 billion US dollars in biofuels.

Among the different input materials used in low-carbon technologies, REMs are considered the most critical because they play key roles in clean energy industries, and their supply is at risk (DOE, 2010).

The rare earth materials includes 17 metals, eight of which are classified as light (LREMs) and the other nine as heavy (HREMs). According to the International Union of Pure and Applied Chemistry, the LREMs are scandium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium and europium. The HREMs are yttrium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

Specifically, some REMs play important roles in many clean energy technologies. For example, REMs are necessary for permanent magnets, which are used in wind turbines and electric drive vehicles, for batteries, which are used in vehicles with electric drive trains, for thin films, which are used in photovoltaic (PV) cells, and for phosphors, which are used in fluorescent lighting. REMs are also heavily employed in a wide range of technologies, and they are critical inputs for several applications, such as computer hard drives, cell phones, fiber optics, lasers and various defense applications (such as control systems and global positioning systems).

It is very likely that due to the expected growth of clean energy industries, demand for REMs will experience a spectacular increase in the near future. However, negative geopolitical events could affect the industry, threatening its growth.

The US Geological Survey (USGS, 2012) reported the current world mine reserves of REM oxides at approximately 114 million tons, with China holding 48.3% and the United States holding 11.4% (Table 1). Canada has significant REM potential as well, and reserves can also be found in Australia, Brazil, India, Russia, Malaysia and Malawi. Despite the large amount of worldwide reserves, environmental problems related to mining and separation processes greatly limit extraction. China is the largest worldwide producer, and approximately 97% of the REM oxides produced worldwide derive from China's mines.

From the 1940s to the middle of the 1980s, the United States was the leading producer of REMs, providing the majority of these minerals to the rest of the world. From 2002, US mines (Mountain Pass California) stopped extraction, and only in the last few years has mining activity finally resumed.

From an import viewpoint, the major importers are Japan (66% of global value), the United States (7%), Europe, namely Germany and France, (11%), Hong Kong (4%) and South Korea (3%) (CRS, 2012).

To regulate the production of REMs and to stabilize their prices, China recently introduced and implemented several policies concerning mining. Some of these policies are oriented toward increasing internal control and modifying the overall industrial policy program. Others are more oriented toward influencing global supply and prices. Officially praising environmental issues related to mining activity and internal demand concerns, China has introduced several restrictions and has reduced exports of REMs, setting separate quotas on the amounts that can be exported from domestic rare-earth producers and from Sino-foreign joint-venture rare-earth producers (Fig. 1). In particular Sino-foreign joint-venture production companies are allowed to export their own products under a licensing system.

Over the last few years, China has gradually reduced its export quota. In 2005, the Chinese Ministry of Commerce (MOC), which is responsible for the issuance and distribution of export licenses,