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Critical Materials

Present Danger to U.S. Manufacturing

RICHARD SILBERGLITT, JAMES T. BARTIS,
BRIAN G. CHOW, DAVID L. AN, KYLE BRADY

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Summary

Critical Materials: The Problem

The U.S. economy, and especially its manufacturing sector, is dependent on the supply of raw and semi-finished materials used to make products. While the United States has extensive mineral resources and is a leading global materials producer, a high percentage of many materials critical to U.S. manufacturing are imported, sometimes from a country that has the dominant share of a material's global production and export. In this situation, U.S. manufacturers are vulnerable to export restrictions that limit their access to these materials and that can result in two-tier pricing, under which domestic manufacturers in the producing country have access to materials at lower prices than those charged for exports, thereby hindering the international competitiveness of U.S. manufacturers and creating pressure to move manufacturing away from the U.S. and into the producing country.

Several reports over the past four years have analyzed the economic importance and supply risks of a large number of materials from various perspectives, with substantial overlap and agreement. Starting from this base, we focus our analysis on a subset of materials for which production is concentrated in one or a few countries and for which the following conditions apply:

- The dominant producer is outside the United States.
- The United States has appreciable net imports.
- The dominant producers have shortfalls in their quality of governance, as measured by the Worldwide Governance Indicators (WGI) published by the World Bank.

We find that one country, China, is in a unique position in that it is the only country that satisfies the above conditions and produces more than 50 percent of the global production of more than one material critical to U.S. manufacturing. In fact, China produces more than 50 percent of 11 of these materials, nine of which were

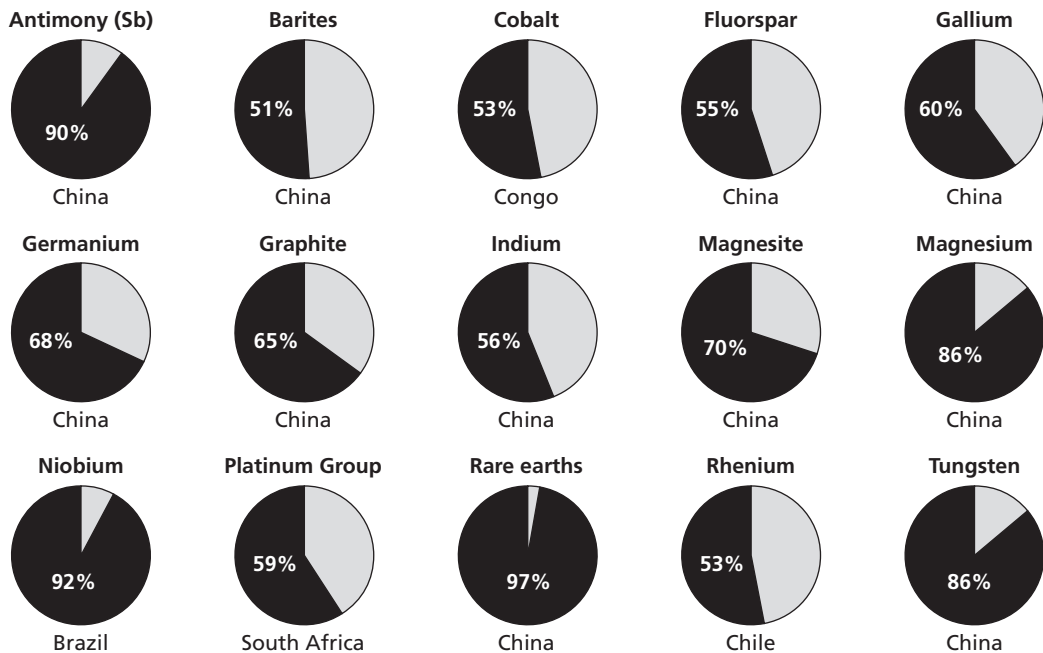
identified in one or more of the previous reports as having high economic importance and high supply risk (see Figure S.1).

Three of these materials (rare earths [REs], antimony, and tungsten) are difficult to substitute without significantly increasing the cost or decreasing the performance of the products they are used to make. REs are used in lasers and many components of electronic devices and defense systems, antimony is critical to flame retardant plastics and textiles, and tungsten is used to produce cemented carbides for cutting tools used in many industries. Moreover, the United States is heavily dependent on imports for all three of these materials; virtually 100 percent of REs and 90 percent of antimony are imported.

Trends in China's Role

China's market share of the global production of critical materials has grown dramatically over the past two decades from a strong position to an overwhelmingly dominant one. For example, China's share of tungsten and antimony production, already 60 percent in 1990, is now over 80 percent for tungsten and about 90 percent for antimony. As China's market share and domestic consumption have grown, its mate-

Figure S.1
Percentage of Global Production (Mining) of Key Materials Within a Single Country



SOURCE: U.S. Geological Survey, *Minerals Commodity Summaries*, Pittsburgh, Penn.: U.S. Government Printing Office, 2012; International Organizing Committee for the World Mining Congresses, *World Mining Data*, Vol. 26, 2011.

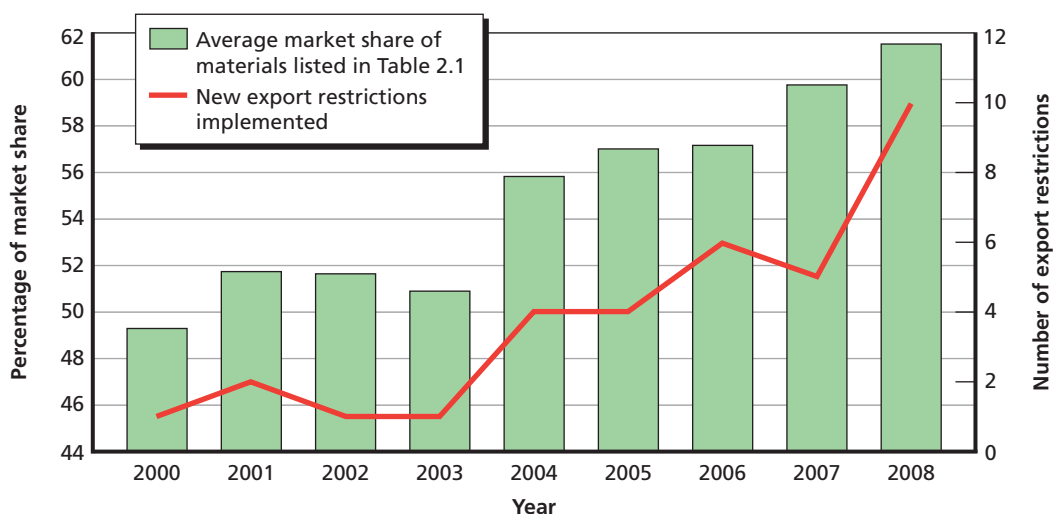
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rials export policies have moved in a direction that has created concern among its customers. In particular, China has instituted a combination of production controls, export restrictions (e.g., quotas and tariffs; see Figure S.2), mine closings, and company consolidation.

The increases in export restrictions illustrated in Figure S.2 initially focused almost solely on REs and tungsten, but in 2007 and 2008 broadened to include other materials. The combined effect of export restrictions and worldwide demand for these materials has contributed to significant increases in their price and, in some cases, volatility on the world market. For example, the price of rare earth metals doubled from 2010 to 2011, while prices of some elements, such as lanthanum and cerium (both REs), reportedly rose as much as 900 percent. Prices of antimony and tungsten more than doubled over this same period.

The export restrictions have resulted in a two-tier pricing system for certain materials of which China is the dominant producer, including its rare earth metals, allowing China's domestic manufacturers to pay a lower price than the export price. By undercutting the market price, China's actions have both discouraged the continuation of manufacturing in the United States and provided motivation for moving U.S. manufacturing operations specifically to China.

Figure S.2
Concurrent Rise in China's Market Share of Key Materials and the Number of Export Restrictions Applying to Them



SOURCES: U.S. Geological Survey, *Minerals Commodity Summaries*, 2003–2010; Jane Korinek and Jeonghoi Kim, "Export Restrictions on Strategic Raw Materials and Their Impact on Trade and the Global Supply," *OECD Trade Policy Papers*, No. 95, Paris: OECD Publishing, 2010; Strategic Metal Investments, Ltd., *China's Growing Role in the Production and Supply of Minor Metals: Part II*, May 10, 2010.

Attempts to Counter China's Actions

In response to these actions, two separate complaints were brought against China at the World Trade Organization (WTO) over the past three years. In 2009, the United States, followed by the European Union (EU), and later Mexico, brought a complaint against China's trade restrictions on various forms of bauxite, coke, fluorspar, magnesium, manganese, silicon carbide, silicon metal, yellow phosphorus, and zinc. The WTO ruled in 2011 that China's export duties and export quotas on these materials were in violation of WTO rules. This ruling was upheld after appeal in January 2012 and, at the time of this writing, China's compliance actions were not yet defined. In March 2012, the United States, EU, and Japan brought a new WTO complaint against China's trade restrictions on REs, tungsten, and molybdenum. At the heart of both of these complaints, as stated by U.S. and European trade representatives, are China's export restrictions, leading to the two-tier pricing structure and its effect on the competitiveness of U.S. and European firms.

As evidenced by the dates given in the previous paragraph, actions at the WTO can take several years. Opening new mines outside China, including the necessary permitting and compliance with regulations and standards, can also take several years and can require hundreds of millions, or even billions, of dollars in a market that is uncertain because of the market power held by a dominant producer. Yet the impacts on manufacturers dependent on imported materials occur much more rapidly. A 2011 global survey of manufacturers¹ found that a majority believe that supply risks will rise significantly over the next decade and that the impact will be felt throughout the supply chain. In some industries (renewable energy, automotive, and energy and utilities), responses suggested that supply instability is currently being experienced.

A Case Study: Tungsten

As an example, we studied the supply situation for tungsten, a critical raw material and one for which U.S. manufacturers depend on imports. China is the controlling producer of tungsten, with more than 80 percent of 2010 world production and estimated 2011 world production. The leading use of tungsten today is for cemented carbides, composite materials that are used worldwide for drilling, cutting, and machining. These materials are critical to every industrial application that involves cutting or component wear—mining; construction; oil and gas exploration; tools and dies; and the cutting of wood, plastics, and metals. Tungsten is thus a basic commodity underpinning the global manufacturing sector.

¹ Price Waterhouse Coopers, *Minerals and Metals Scarcity in Manufacturing: The Ticking Timebomb: Sustainable Materials Management*, December 2011.

We found that China is the dominant exporter of both raw tungsten and the intermediate tungsten products that are essential inputs to manufacturing. As a result of China's export policies and growing domestic demand for tungsten, analysts both inside and outside of China project a tight supply situation to continue for the next several years. The lack of access to tungsten materials by manufacturers outside of China presents a threat to the manufacturing sector elsewhere in the world and creates pressure on manufacturers to move operations to China. U.S. manufacturers have responded to this threat by increasing secondary production from waste and scrap, reducing their dependence on imports by about one-third. They are also taking steps to reduce the amount of tungsten used in products and to find alternative materials. However, it is not clear how much more secondary production can be increased, and reduction and substitution measures that do not affect product performance require concerted effort. In the meantime, difficult access to supply increases pressure to move manufacturing from the United States to China. Moreover, prolonged disruption in the supply chain for tungsten and other critical raw materials could jeopardize the U.S. science and technology base for these materials and, consequently, U.S. innovation and competitiveness in new products manufactured from them.

Conclusion: Concentration of Supply and Effective Response

We conclude from the data and analyses described in the text of this report that the critical issues associated with the supply of minerals are less about the minerals themselves than they are about where the raw and semi-finished materials that are derived from these minerals and that underpin economies are produced and processed. One clear conclusion is that countries commanding a large market share of a material's production can distort mineral commodity markets through production controls and export restrictions. Thus it is the concentration of supply, in particular the concentration among producing countries that either have weak governance or that control production at the governmental level, or both, that can increase the potential for supply disruptions.

China is the dominant producer and exporter of many critical materials. Its strategic material policies include (1) trying to gain control of production outside of China (i.e., by obtaining controlling interests in mines outside of China that produce materials such as antimony and REs, of which it is already an overwhelmingly controlling producer) and (2) establishing production quotas and export restrictions. These policies have contributed to large price increases, some price volatility, and tight markets, as well as uncertainty that can hinder the financing of new mining projects. Moreover, China's policies contrast with those of other countries with high market shares, such as Chile (with 53 percent of rhenium) and Australia (with 51 percent of zirconium),

which do not implement export restrictions, instead allowing market forces to largely determine the supply and demand of the minerals they produce.

The impact of these policies on the global manufacturing sector suggests the need for two types of actions: (1) those that can increase resiliency to supply disruptions or market distortions and (2) those that can provide early warning of developing problems resulting from the concentration of production. Actions to increase resiliency should be aimed at the diversification of production and processing, as well as the development of new methods of extraction, processing, and manufacturing that will improve the efficiency of material use and increase the recovery of materials from waste and scrap. Actions to provide early warning could be based on benchmarking market activity with diversified commodity markets and international coordination and cooperation that could potentially prevent the situation from reaching the level requiring action at the WTO. The goal of such coordination and cooperation should be to smooth market distortions while allowing for the natural economic development of producing countries.