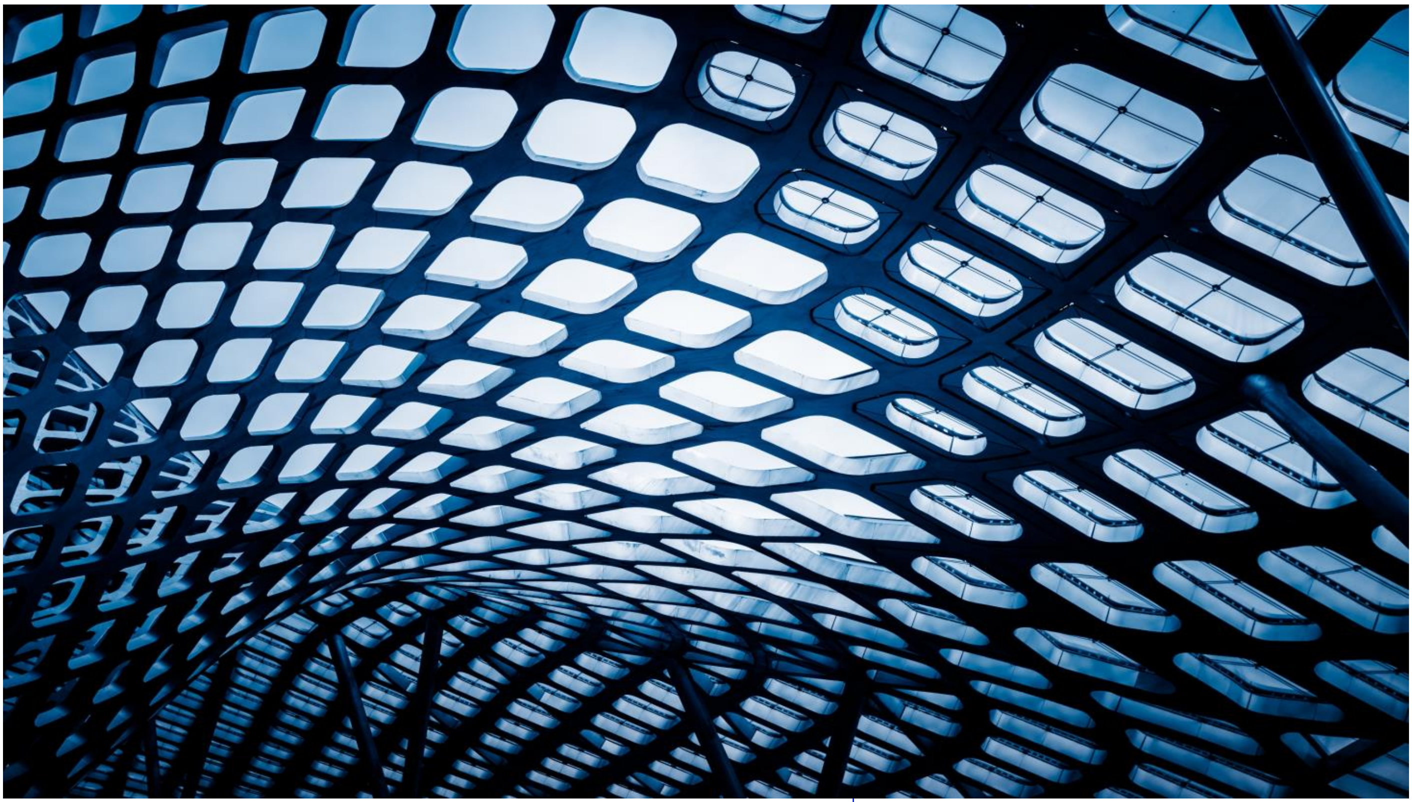

Global Investment Research | Multi-Asset

The digital economy − critical minerals and equity markets

Implications for equity markets of rising demand for critical minerals

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Overview

- **Higher demand for critical minerals:** This trend is driven by the rapid adoption of artificial intelligence, the expansion of data centres and graphic processing units, the rollout of next-generation semiconductors, 5G networks and advanced digital infrastructure. Clean energy technologies, electric vehicles, and the broader economy's shift toward digitisation and automation further increase this need, embedding critical minerals at the core of the modern global economy.
- **Strategic shifts in global supply chains** are reshaping the market and creating new opportunities. Countries and companies are seeking to diversify sources of critical minerals, reducing the reliance on dominant suppliers, and investing in domestic processing capabilities. This trend is prompting shifts in trade policies and new exploration initiatives.
- **Significant market implications:** Equity performance is starting to reflect this evolving landscape. Established producers, like China, may see renewed investment as their reserves grow in strategic importance, while emerging players could introduce new competitive dynamics.
- **Valuation opportunities:** Valuation metrics across Australia, Brazil and India remain compelling, suggesting that these economies are well positioned to capitalise on the convergence of digital growth and their natural resource advantage.
- **Assessing risks:** Investors will need to assess geopolitical risks, supply chain vulnerabilities, the environmental impact, and the potential for technological advancements to redefine demand projections.

Contents

The digital economy – introducing the elements

The expanding digital economy is fuelling a surge in demand for critical minerals. These are unique for their magnetic qualities and are indispensable components of AI technology, semiconductor manufacturing and energy storage solutions. As AI applications become more integrated across industries, the need for efficient computing, advanced battery technologies and sustainable energy sources is accelerating the extraction, processing, and commercialisation of these key materials.

Critical mineral is a broad term used to define the important elements, notably rare earth elements (REEs), which are essentials to the modern economic infrastructure (Table 1).

Table 1: Critical elements defined

Category	Definition	Examples	Key Uses	Notes / Differences
Critical Metals	A broad term for metals deemed **essential for economic and national security,** often with **supply risk**	Lithium, cobalt, nickel, tungsten, bauxite, germanium, gallium, REEs, graphite, antimony, tellurium, platinum group metals	EV batteries, wind/solar tech, aerospace, defence, AI servers, electronics	Umbrella term. **Includes rare earths** as a subset and byproduct from processing and refining. Defined differently by each country (e.g., US, EU, Japan)
Rare Earth Minerals	**Naturally occurring ores** containing rare earth elements in **mineral form**	Monazite, bastnäsite, xenotime, ion-adsorption clays	Mining and extraction − these are the **source materials** for REEs	Not the REEs themselves, but host **rocks** or **mineral deposits** from which REEs are extracted
Rare Earth Metals	**Pure metallic forms** of the 17 rare earth elements (REEs) after processing & refining	Neodymium, praseodymium, dysprosium, terbium, yttrium, europium	Permanent magnets, lasers, EV motors, wind turbines, high-performance electronics, phosphors	These are the **usable refined forms**. Must be separated, purified, and alloyed from rare earth minerals. Distinct from mineral form due to complex metallurgy involved

Source: US Geological Survey.

New alliances to redefine market dynamics

The growing importance of critical metals over the last decade has revealed a significant geographic concentration in mining and production, especially in China. To mitigate these dependencies, a new wave of cross-border partnerships is reshaping supply chains. These collaborations increasingly link resource-rich nations with countries that have refining capacity and serve as downstream consumers.

Taking graphite as an example, African countries such as Madagascar, Mozambique, and Tanzania hold approximately a quarter of global graphite reserves. Meanwhile, Germany, Japan, South Korea, and the United States are investing in the production of graphite anode materials, essential components of lithium-ion batteries used in electric vehicles and grid storage systems. Similarly, while rare earth elements are mined in countries like Australia, Brazil, and Vietnam, processing capacity is expanding in Europe, Malaysia, and the US, reflecting a broader push for diversified and resilient supply ecosystems[1].

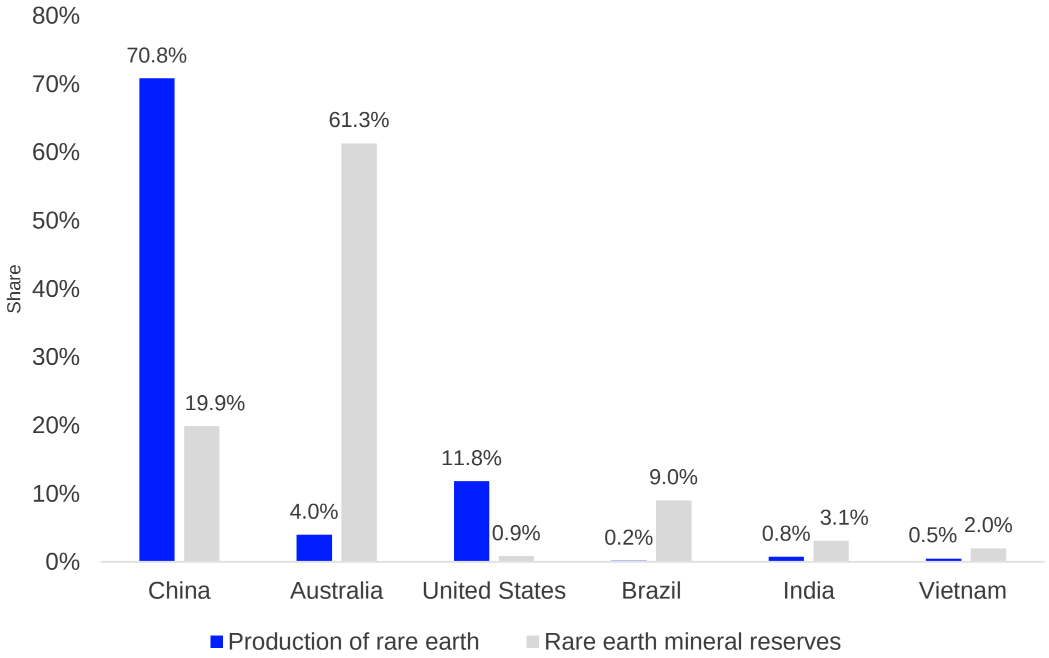
[1] Global Critical Minerals Outlook 2025, Source: IEA. International Energy Agency Website: www.iea.org.

Rare Earth Elements (REEs) producers

It is no coincidence that many of the top rare earth producers are also major players in other industrial commodities. This reflects their existing extraction capabilities and infrastructure. As Chart 1 shows, China leads the production of rate earth elements, accounting for 71% of output, but holds only 20% of known reserves. Beyond extraction, China's dominance also extends to refining, where it controls about 50% of the global market. This concentration has raised supply chain vulnerabilities and highlights the importance of developing substitute markets.

The US ranks second in REE production but holds just about 1% of known reserves, indicating significant dependence on external supply chains. By contrast, Australia has 61% of global reserves, yet contributes to only 4% of the production, underscoring the significant disparity between its geological resources and industrial output.

Chart 1: Selected key countries with leading production and global reserves of rare earth metals (see definition below)



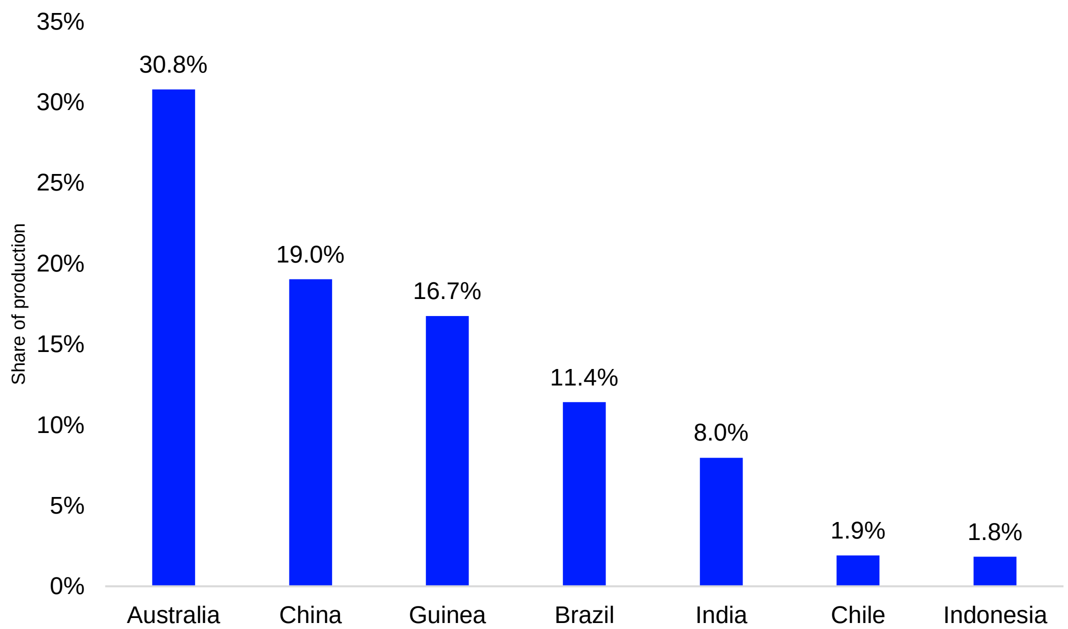
Source: US Geology Survey, 2024. **Production of rate earth** includes three elements: Rare Earth Elements (Neodymium, Praseodymium, Dysprosium). **Rare earth reserves**: data include 17 rare earth elements (REEs), which are chemically similar metals critical to modern technologies. These are typically grouped into three main categories, based on their geological occurrence and applications — even though the data includes all 17 elements individually. The three main groupings are: 1. Light Rare Earth Elements (LREEs) (lanthanum, cerium, praseodymium, neodymium, etc), more abundant, typically used in magnets, batteries, glass polishing, and automotive catalysts. 2. Heavy Rare Earth Elements (HREEs), which includes dysprosium, terbium, europium, gadolinium, etc. These are Less abundant, often critical in high-temperature magnets, phosphors for displays and military tech. 3. Other / Ion-Adsorption Clays or Process Categories. Some data sources group REEs based on how they are mined or processed, such as ion adsorption clays (main source of HREEs in southern China), by-product categories (e.g., REEs extracted from monazite sands or as a by-product of other mining). This category is more about economic and process classification, not chemistry.

Elsewhere, several emerging market entrants are actively developing strategies for mining and processing critical minerals. For instance, the African Minerals Development Centre (AMDC) is developing the African Green Minerals Strategy[2], designed to guide African countries as they consider how to exploit their raw materials. While Canada is an established producer, it has implemented more recently a framework to support extraction and refinement.

Beyond REEs, conventional and critical metals

Alongside rare earth elements, a wider group of critical metals forms the industrial backbone of the technological age. Critical metals like bauxite, cobalt, nickel, copper and lithium are essential for powering the physical infrastructure behind chips, wiring, processing units, 5G networks, modern telecommunications, semiconductor production and advanced clean energy systems. Chart 2 shows an aggregated view of global production, with Australia leading at 31%, followed by China (19%) and Guinea (17%). Together with Brazil, India, Chile and Indonesia, these countries account for approximately 90% of the global supply, highlighting the concentration of the critical minerals market.

Chart 2: Leading critical metal producers of bauxite, cobalt, nickel, copper and lithium



Source: LSEG, 2025.

[2] Africa's Green Minerals Strategy, AMDC, African Union, 44539-doc-AGMS_Final_doc.pdf

As with rare earth elements, China also dominates the production of these conventional critical metals, thanks to its extensive processing capacity and advanced manufacturing infrastructure, as mentioned earlier. Despite the Democratic Republic of the Congo being the leading cobalt producer, China refines about 80% of the global supply. It also accounts for about 65% of refined lithium, 44% of refined copper and 27% of refined nickel[3]. According to the International Energy Agency (IEA), China controls 60% of rare earth mining production and an estimated 90% of processing and refining, reinforcing its outsized influence on global supply chains.

Other critical elements

While rare earths often draw headlines, the US and EU among others have classified a wider set of elements as critical minerals, emphasising their economic significance and risk of supply disruptions, rather than geological rarity. Table 2 highlights five such elements − gallium, germanium, hafnium, indium, and niobium − each essential to core technologies:

Table 2: The five elements essential to core technologies

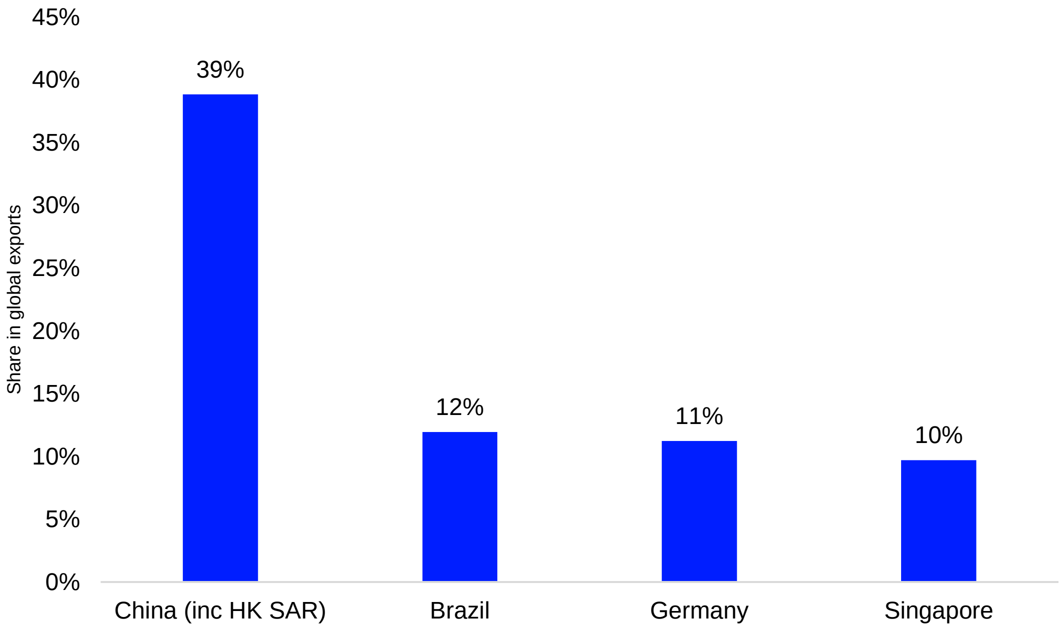
Element	Type	Main Uses	Why It Matters
Gallium (Ga)	Post-transition metal	Semiconductors (GaAs), LEDs, solar cells, 5G chips	Key for **compound semiconductors** in **telecoms and AI hardware**
Germanium (Ge)	Metalloid	Fiber optics, infrared optics, solar panels, semiconductors	Crucial in **infrared tech**, **military night vision**, and high-efficiency PVs
Hafnium (Hf)	Transition metal	Nuclear control rods, superalloys, high-k dielectrics in microchips	Used in **aerospace engines**, and **advanced semiconductors** (e.g., Intel FinFET chips)
Indium (In)	Post-transition metal	Indium tin oxide (ITO) for touchscreens, solar panels, LCDs, solder	Enables **transparent electronics − touchscreens, displays, flexible tech**
Niobium (Nb)	Transition metal	Superconducting magnets, steel-strengthening alloys, aerospace components	Enhances **high-strength alloys** for **jet engines, rockets, and particle accelerators**

Source: European Commission, NATO.

The complex nature of the supply chain for these metals results in a highly concentrated export market, with main countries leading global trade. China (including Hong Kong SAR) holds the dominant position, representing 39% of global exports. With Brazil, Germany and Singapore, these four countries collectively represent some 70% of total exports, highlighting the limited distribution of supply.

[3]Business Insider article The new battlegrounds for AI supremacy: 3 things to know about the trade in rare earth minerals and Barclays Research.

Chart 3: Top four leading exporters of gallium, germanium, hafnium, indium and Niobium



Source: OECD.

Industry spotlight: critical minerals in semiconductors and chip manufacturing

Critical minerals such as copper, lithium, nickel, cobalt and rare earth elements are essential components of modern energy technologies, driving advancements in wind turbines, electricity grids and electric vehicles[4].These materials are indispensable for the production of semiconductors (and the equipment to manufacture them).

Below is the list of essential critical minerals and their respective use in semiconductor technology.

[4] Critical Minerals – Topics – IEA.

Table 2: Essential critical minerals and their respective use in semiconductor technology

Mineral/Commodity	Use
Silicon	Main substrate for semiconductors; essential for all chips.
Gallium	Used in GaN/GaAs chips for 5G and AI; high-frequency, high-efficiency semiconductors.
Rare Earth Elements (Neodymium, Praseodymium, Dysprosium)	Crucial for permanent magnets in AI hardware, robotics, and 5G base stations.
Cobalt	Key stabiliser in lithium-ion batteries powering AI servers and telecoms.
Lithium	Core component of energy storage (batteries) for data centres and edge computing.
Copper	Primary conductor in AI server wiring, 5G infrastructure, and thermal management.
Neon	Enables EUV lithography for advanced semiconductor manufacturing.
Nickel	Used in battery cathodes for high-performance computing and telecom backup systems.
Graphite	Primary anode material in lithium-ion batteries for AI systems.
Phosphorus	Used in doping processes in silicon wafers for semiconductors.
Gold	Used in high-reliability chip contacts and precision electronics.
Silver	Excellent conductor used in AI chips, sensors, and interconnects.

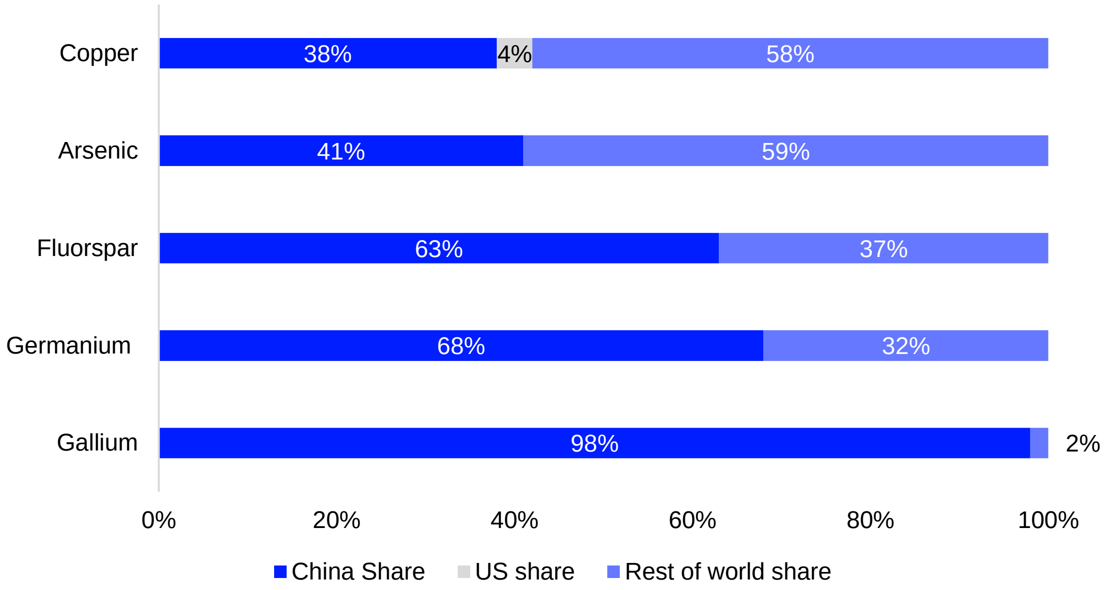
Source: FTSE Russell, GIR Research.

Different technologies rely on distinct mineral resources. Lithium, nickel, cobalt, manganese and graphite are critical for battery performance, while rare earth elements play a key role in the permanent magnets used in wind turbines and electric vehicle motors. Electricity networks require substantial amounts of aluminium and copper, with the latter being fundamental to all electricity-based technologies.

For semiconductor manufacturing, the primary challenge lies in processing and refining rather than raw supply. Gallium, germanium, and arsenic are produced as byproducts of other mineral refining processes. Although the absolute volume needed for chip manufacturing is relatively low, modest supply fluctuations can significantly impact the broader ecosystem.

Brazil holds approximately 22% of the global graphite reserves and 17% of the rare earth element reserves, both essential for chipmaking equipment, including specialised lithography lasers. Meanwhile, China leads in the production of technology-critical minerals, accounting for 98% of gallium and 68% of germanium output (Chart 4).

Chart 4: Primary production of raw minerals by country/region in 2021



Source: U.S. Geological Service (USGS), Mineral Commodity Summaries 2024 (Reston, VS:USGS, January 2024, Mineral Commodity Summaries 2024.

Impact of rising demand for critical minerals on equity market and valuation

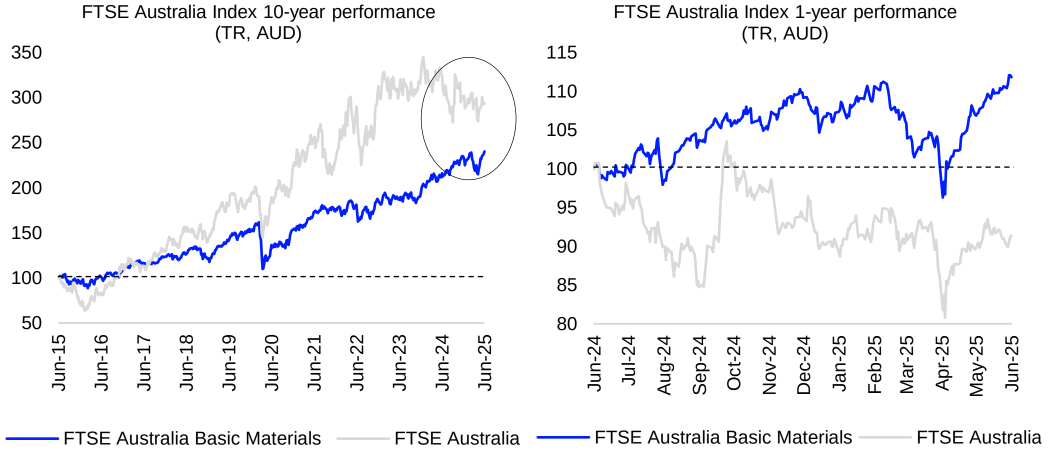
As demand for critical minerals accelerates, their influence on equity market performance has become increasingly significant. This analysis looks at the 10-year and 12-month equity trends of four countries, selected for their substantial mineral reserves, leading roles in critical metal production and potential to emerge as key beneficiaries of the digital age.

Australia

Australia is a prominent global supplier of critical minerals, playing an important role in the energy transition and strengthening its economy through the development and processing of these resources. The country boasts abundant reserves of lithium, cobalt, rare earths elements and nickel, with government initiatives focused on enhancing supply chains and increasing resource value through processing.

The performance of the FTSE Australia Basic Materials has been strong over the last 10 years but has underperformed the broader FTSE Australia universe during that period. However, the performance over the last year (RHS Chart 5) tells a different story, with basic materials outperforming the broader market, led by the strong momentum in the precious metals and mining sector.

Chart 5: Shifts in performance from Australia's Basic Materials



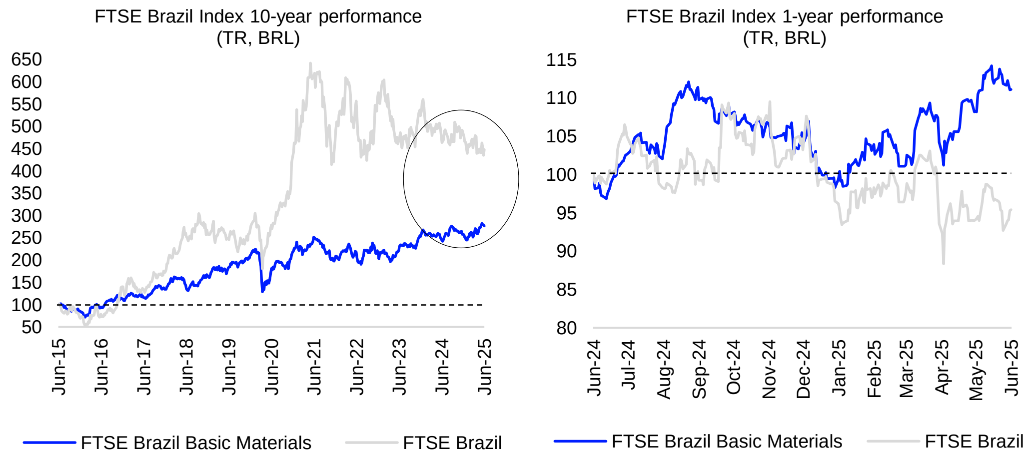
Source: FTSE Russell/LSEG, June 6, 2025. Total returns in Australian dollar. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

Brazil

Brazil holds substantial reserves of minerals essential for renewable energy technologies and electric vehicles, including lithium, nickel, graphite, rare earth elements and niobium. While its production levels have yet to fully reflect this resource potential, Brazil is actively developing these minerals and emerging as a leading exporter, particularly in lithium.

Similarly to Australia, the FTSE Brazil Basic Materials has underperformed the Brazilian equity market over 10 years. However, in the last year, a combination of REE embargoes from China and increased defence and infrastructure spending has increased focus on the sector, driving basic materials to significantly outperform FTSE Brazil (see RHS Chart 6).

Chart 6: Increased focus on critical minerals boosts Brazil's Basic Materials sector



Source: FTSE Russell/LSEG, June 2025. Total returns, in Brazilian real. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

China

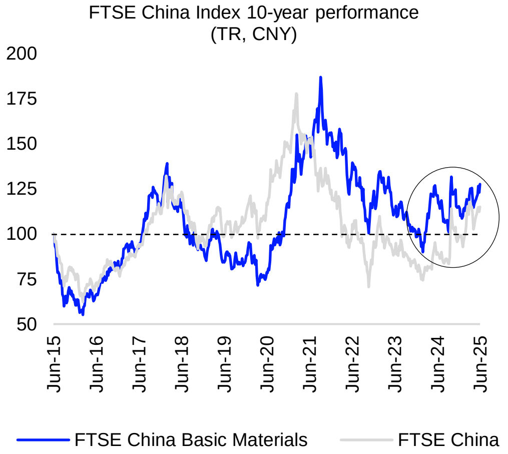
China is rich in natural resources, with 90% concentrated in coal and rare earth metals. Years of government-backed investment have given the country significant influence over the global market, from refined battery metals to unprocessed rare earths. These metals are essential components for the energy transition due to their use in electrification, clean energy generation and battery production.

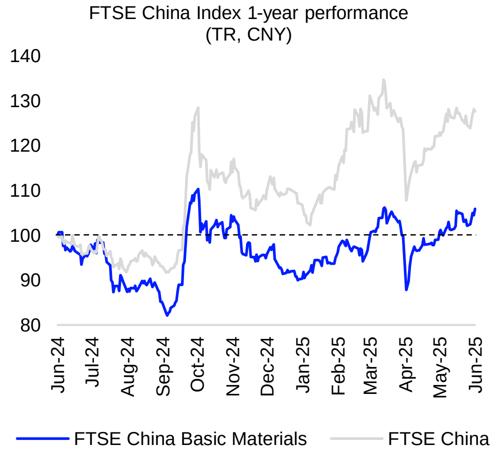
China's decision in April 2025 to suspend the exports of a wide range of rare earths and related magnets has upended the supply chains central to the automotive, aerospace and semiconductor industries worldwide, affecting global trade and equity markets.

China's first rare earths embargo was in 2010, when it restricted exports to Japan following a fishing dispute. Between 2023 and 2025, the country progressively tightened restrictions on strategic materials to the US. More recently, it also extended its export restrictions to include seven heavy rare earth metals and related magnets, including samarium, gadolinium, terbium, dysprosium, lutetium, scandium and yttrium.

Given China's leadership in critical minerals, it is perhaps not surprising that the FTSE China Basic Materials sector has outperformed FTSE China since 2015. However, this trend has softened in the last year. Despite the higher performance over the long term, disruptions in supply chains have changed some investment strategies and investors are increasingly looking to alternative markets, which are expected to benefit from shifts in global trade.

Chart 7: China's Basic Materials performance softened, as investors consider other markets to benefit from changes in global trade





Source: FTSE Russell/LSEG, June 2025. Total return in Chinese renminbi. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

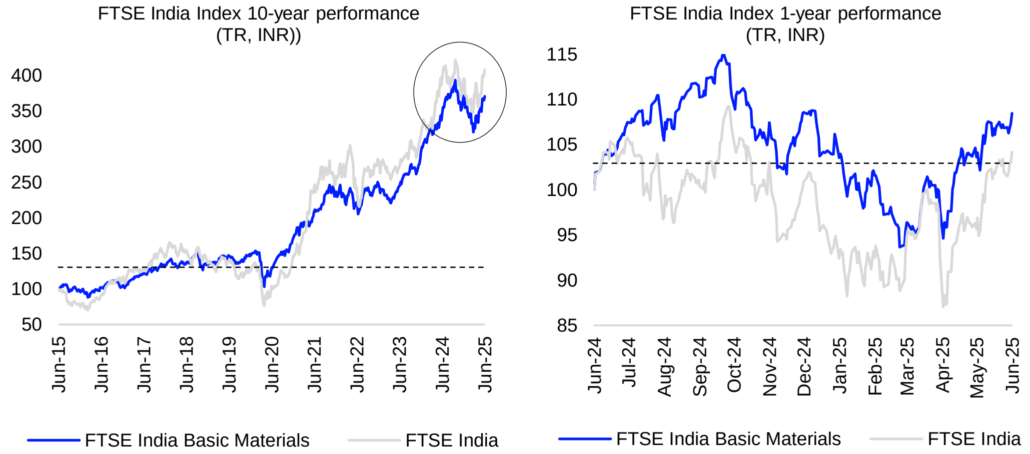
India

India is a producer of copper and graphite, but it remains largely dependent on imports for lithium, cobalt, nickel and others. With ambitious climate targets, demand for these minerals is projected to increase significantly, according to the Institute for Energy Economics and Financial analysis.

To address this challenge, India's Ministry of Mines has launched initiatives to expand its domestic production and exploration, including the development of a National Critical Mineral Strategy (NCMS). In addition, India is pursuing international partnerships to strengthen supply chains and promote recycling and domestic processing of critical minerals.

The FTSE India Basic Materials industry has closely tracked the performance of the FTSE India in the last 10 years but has lagged the broader returns of the FTSE India. However, the last twelve months have seen a marked shift, with the industry strongly outperforming the market, as reflected in Chart 8 (RHS).

Chart 8: India is another market with Basic Materials outperforming the market recently



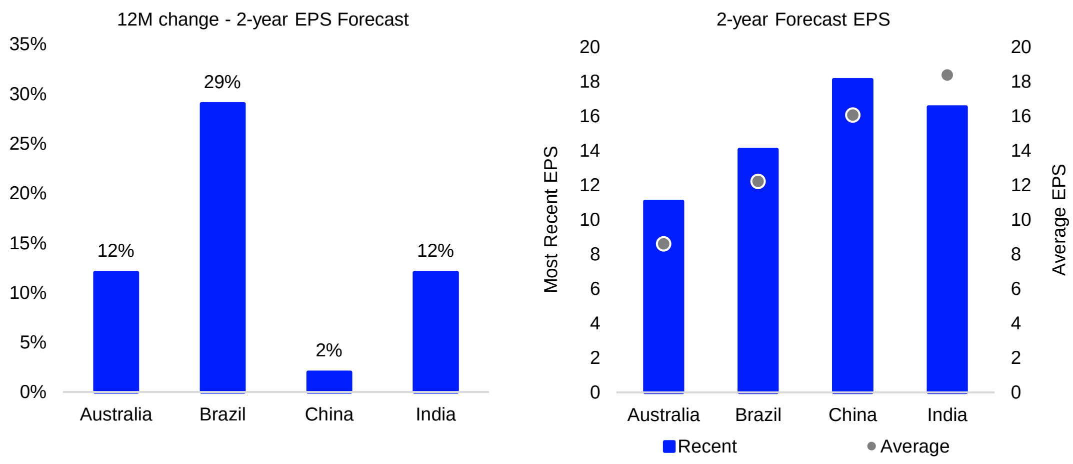
Source: FTSE Russell/LSEG, June 2025. Total return in Indian rupee. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

Impact on valuations

Improvements in the two year earnings per share (EPS) forecasts over the last year highlight the strong potential for commodity-led equity markets. Brazil has seen its 2-year EPS forecast rise by 29%, and Australia and India by 12%. In contrast, China's EPS growth has been more modest, increasing by just 2% (Chart 9).

While these projections reflect the broader market trends, these economies stand out for being well positioned to benefit from both the expanding digital economy and their natural resource wealth. The 2-year EPS forecasts in Australia, Brazil and China are already starting to reflect some of these dynamics, with current levels rising above their 25-year averages.

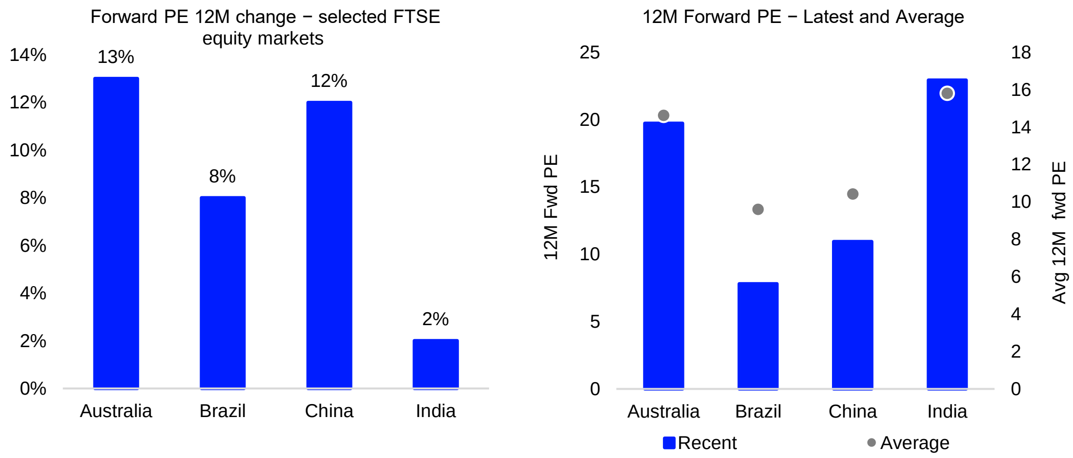
Chart 9: Rising EPS forecasts over the last 12M bode well for commodity-led markets



Source: FTSE Russell/LSEG, May 2000-2025. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

Consistent with rising EPS forecasts, price-to-earnings (PE) ratios have also increased over the last twelve months. Even so, valuations in Australia, Brazil, China and India still have PE ratios trading at, or below, their long-term averages, suggesting interesting valuation opportunities remain for investors, as illustrated in Chart 10 (RHS).

Chart 10: 12M PE ratios are at, or below, their 25-year averages



Source: FTSE Russell/LSEG, data May 2020-2025. FTSE All World Index series. Past performance is no guarantee of future results. For professional investors only.

Conclusion: rising demand, strategic shifts and market implications

The demand for critical minerals is set to accelerate, driven by the rapid adoption of artificial intelligence into the wider economy, clean energy technologies, the evolution of next-generation semiconductors and advanced digital infrastructure. According to the International Energy Agency (IEA)[5], the global semiconductor industry is expected to reach U$1 trillion annually by 2030. If nations fully implement the energy and climate pledges, demand for mineral for clean energy technologies could more than double by 2030[6].

Given the current supply concentration, especially China's dominance, international collaboration is expected to intensify to mitigate supply chain risks. In 2023, mineral exploration spending rose by 15%, with Canada and Australia registering the largest increases, closely followed by African nations. This upward trend is likely to continue as critical mineral strategies unlock further investment in exploration, refining and processing.

From an equity market perspective, an analysis of Australia, Brazil, China and India reveals contrasting trends. Over the last decade, the basic materials sectors in Australia, Brazil and India have generally underperformed their broader markets. However, the performance has reversed in the last twelve months, with Basic Materials outperforming the market universe. In contrast, China's basic materials sector, which has strongly outperformed over the last 10 years, has lagged in the last year, reflecting shifting investor sentiment and possible supply chain adjustments.

Valuation metrics across Australia, Brazil and India remain compelling, suggesting that these economies are well positioned to capitalise on the convergence of the digital growth and their natural resource advantages. However, investors will need to be mindful of geopolitical risks, the environmental impact and supply chain vulnerabilities.

[5] Market review – Global Critical Minerals Outlook 2024 – Analysis – IEA.
[6] International Energy Agency, Critical Minerals – Topics – IEA.

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