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Navigating the green transition: insights for the G7

Pia Andres and Penny Mealy

Policy insight

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Green Transition Navigator

To view the interactive Green Transition Navigator website, which visualises metrics of green competitiveness and green competitiveness potential for 231 countries and territories over the time period 1995–2019, and to which this paper refers, visit www.green-transition-navigator.org.

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This policy paper is intended to inform decision-makers in the public, private and third sectors. It has been reviewed by internal and external referees before publication.

Contents

1. Introduction and summary

Analysing countries' green competitiveness using a new online tool

Climate change and the transition to net-zero emissions have risen to the top of the policy agenda in many countries in recent years and are expected to be important topics for discussion by the G7 during 2021.

Ahead of the G7 Leaders' Summit in June 2021, this report uses a new data-driven online tool, the *Green Transition Navigator*,[1] to analyse the green competitiveness of the seven individual G7 member states and invited countries (Australia, India, South Africa and South Korea). The report also includes China, due to its recent rise to prominence in producing and exporting many green technologies and products.

Background: competitiveness in the green economy

The transition to the green economy is transforming the landscape of global competitiveness. With the number of countries with net-zero emissions commitments steadily increasing, demand for renewable energy technologies, such as wind turbines, solar panels and lithium-ion batteries, is burgeoning. Growing worldwide recognition of the importance of achieving greater prosperity without harming the planet is also driving unprecedented growth opportunities in a wide range of products with environmental benefits, from water conservation to waste-management to air-pollution monitoring. At the same time, fossil-fuel-based production is increasingly perceived as risky and time-limited, and investors are starting to shift capital out of carbon-intensive assets.

Economic success in the green economy will largely depend on the capacities of countries to respond to this shift. Countries that cultivate the capabilities to competitively produce green products and technologies are likely to thrive in the green transition. Other countries that are slow or fail to diversify away from fossil-fuel-based products or other polluting modes of production risk falling behind in their global competitiveness (e.g. falling demand for their exports) and future growth and development prospects.

What is the Green Transition Navigator and what does it tell us?

The Green Transition Navigator is designed to help map and manage the shifting landscape of green competitiveness for different countries. It is underpinned by recent peer-reviewed research by Mealy and Teytelboym (2020), and draws on over 20 years of detailed data to showcase new metrics of green competitiveness and future green diversification potential across 231 countries and territories. It also enables the exploration and comparison of countries' competitive strengths in specific green products, and the identification of new green industrial growth opportunities that align with countries' existing productive capabilities.

Our analysis shows that Germany has consistently held its position as a 'green leader', followed by Italy and the United States. These countries currently have productive capabilities that allow them to competitively export a wide range of 'complex' (or technologically sophisticated) green products. While competitiveness in green products allows countries to take advantage of the green transition, competitiveness in products with higher complexity is also important, as it has been shown to enhance countries' overall economic growth and diversification prospects (Hidalgo and Hausmann, 2009; Hausmann et al., 2014). **China** has rapidly increased its competitiveness in green products over the past 20 years and is now the world leader in exporting solar photovoltaic cells, fuel cells and electric soil heating apparatus, among other products. **Australia**, on the other hand, has seen a significant decline in its green production capabilities over the past two decades and now lags behind many countries in terms of its capacity to competitively export products relevant to the green economy.

Many countries that currently export a diverse range of green, technologically sophisticated products are also well placed to expand into new green industries in the future. Our analysis suggests that of the 12 countries considered, **Italy** and **China** stand out as having the most future potential to develop

[1] https://green-transition-navigator.org/

competitiveness into further green products and technologies. While the landscape of future green growth opportunities may not be as rich for other countries, the Green Transition Navigator aims to provide a starting point for policymakers, researchers and businesses to identify possible industrial growth opportunities that align with countries' existing competitive strengths, and which are likely to be in greater demand as the world transitions to a greener economy.

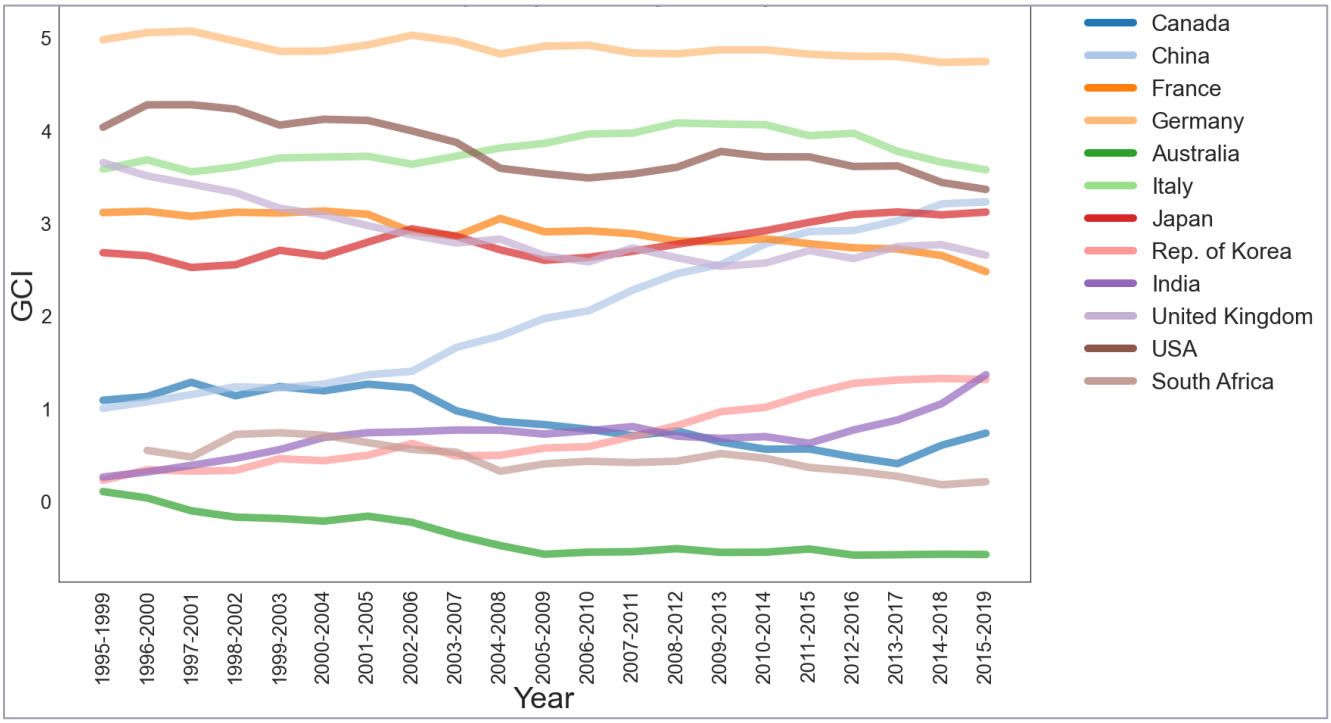
2. Green competitiveness and future green growth potential across G7 members and invited countries

Measuring strengths: green competitiveness and the Green Complexity Index

One way to assess a country's green competitiveness would be simply to sum up all the green products it is able to export competitively (where 'competitively' means it is able to export a greater share of a given product than the global average). However, research has shown that achieving higher growth and development outcomes depends not only on the number of different products countries are able to export, but also on the complexity or technological sophistication of those products (Mealy et al., 2019; Hausmann et al., 2007; Lall et al., 2006).

As such, this report analyses green competitiveness by drawing on the Green Complexity Index (GCI), which incorporates both the number and the complexity of green products that countries are able to export competitively (see section 4 on Methods for more detail). In addition to having the productive capabilities that are likely to place them in good stead to thrive in the transition to the green economy, countries that rank highly on the GCI have been shown to have higher rates of environmental patenting, lower CO_2 emissions and more stringent environmental policies (Mealy and Teytelboym, 2020).

Figure 1. Green Complexity Index (GCI) over time (1995–99 to 2015–19) for selected countries



Note: Calculated based on rolling five-year averages in trade values from 1995–99 to 2015–19.

Germany has ranked highest on the GCI globally throughout the period. The United States ranked second globally on the GCI until it was overtaken by Italy in 2004–08. China ranks fourth globally, a considerable rise from 24th in 1995–99, followed by Japan (fifth, up from tenth in 1995–99). The UK experienced a small decline over the same period, originally ranking third in 1995–99 and ranking eighth in 2015–19.

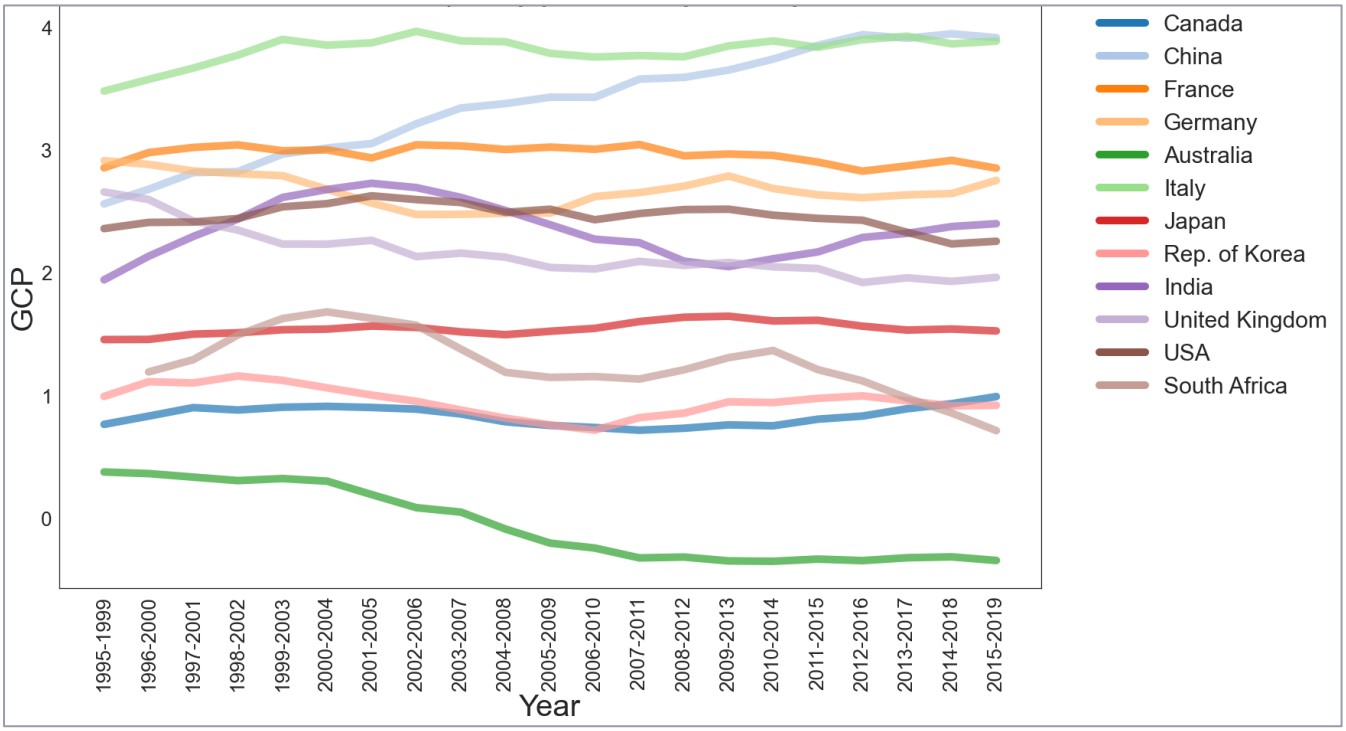
India, which overtook South Korea in the last period, ranked 20th in 2015–19, up from 44th in the world at the start of the period. South Korea ranked 23rd in 2015–19, up from 46th. In contrast, Canada, South Africa and Australia have experienced falls in the GCI over the past two decades, with Canada ranking 33rd, South Africa 45th and Australia 96th in 2015–19.

Measuring opportunities: countries' potential for future growth in green competitiveness and the Green Complexity Potential

A key concern for policymakers is not just current competitiveness in the green economy, but also countries' future development trajectories and ability to become more competitive in new green products and technologies. A rich body of literature has shown that it is generally easier for countries and regions to transition into new products or industries that involve capabilities (e.g. skills, know-how, factors of production) that are similar (or proximate) to those they already possess (Hidalgo et al., 2007; Neffke et al., 2011; Hidalgo et al., 2018). Germany, for example, has developed competitiveness in wind turbines in part due to its existing capabilities in high-precision machining (Huberty et al., 2011; Fankhauser et al., 2013).

To capture countries' potential to transition into green products that involve similar capabilities to those they already have, this report draws on the Green Complexity Potential (GCP) measure. The GCP captures the average proximity (a proxy measure for the similarity in capabilities) between a country and all the green products in which it is not currently competitive (see section 4 on Methods for more detail). Countries with high GCP have many new complex, green export possibilities that could be unlocked relatively easily. The GCP has been shown to be a significant predictor of future GCI and growth in green trade (Mealy and Teytelboym, 2020).

Figure 2. Green Complexity Potential (GCP) over time (1995–99 to 2015–19) for selected countries



Note: Calculated based on rolling five-year averages in trade values from 1995–99 to 2015–19.

While Italy consistently has had very high GCP over the past few decades, China has recently risen to new heights and in 2015–19 ranked first, neck and neck with Italy. France has had consistently high GCP throughout the period, and ranked fourth in 2015–19, while Germany, which ranked second in 1995–99, has seen a slight decline in GCP and ranked fifth in 2015–19. South Africa and Australia both have lagged behind and saw decreases in their GCP throughout the period.

3. Country-level analysis: green competitive strengths and new growth opportunities

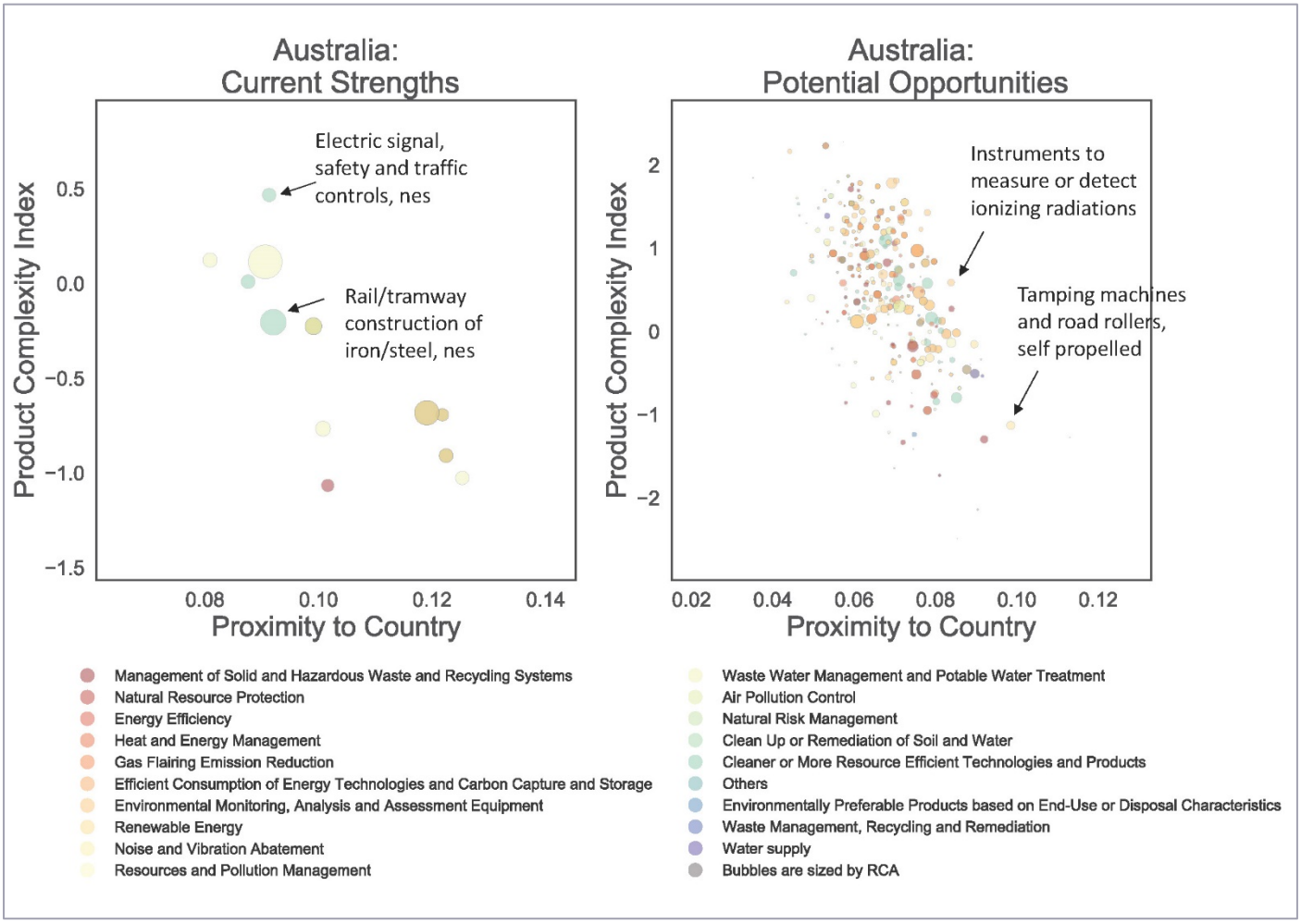
While the GCI and GCP measures allow for cross-country comparisons at an aggregate level, it is also useful for policymakers to visualise and pinpoint specific green products in which a country is currently competitive, as well as potential green product development opportunities. In this section we map current green competitive strengths and potential opportunities for each country.

In the figures that follow:

- The left-hand plot shows green products in which a country is currently competitive. These are products of which the country currently exports more than the global average and are thus considered a *competitive strength*.
- The right-hand plot shows green products in which a country is not yet competitive. These products represent *potential opportunities*.
- The y-axis shows each product's complexity as measured by the Product Complexity Index (PCI). Products with higher PCI tend to be more technologically sophisticated and have been shown to be associated with more favourable economic growth outcomes (Hidalgo and Hausmann, 2009; Hausmann et al., 2014).
- The x-axis shows the proximity between each product and the country, and is more relevant to the right-hand plot showing potential opportunities. The higher the proximity, the more likely a country will develop competitiveness in it in the future (Hidalgo et al., 2007; Neffke et al., 2011; Hidalgo et al., 2018).
- Products (represented as bubbles) are coloured by their broader environmental category and sized by a country's revealed comparative advantage (RCA) in the product (see section 4 on Methods for more detail).

Australia

- GCI rank: 96
- GCP rank: 96
- No. of green strengths: 12
- No. of green opportunities: 283

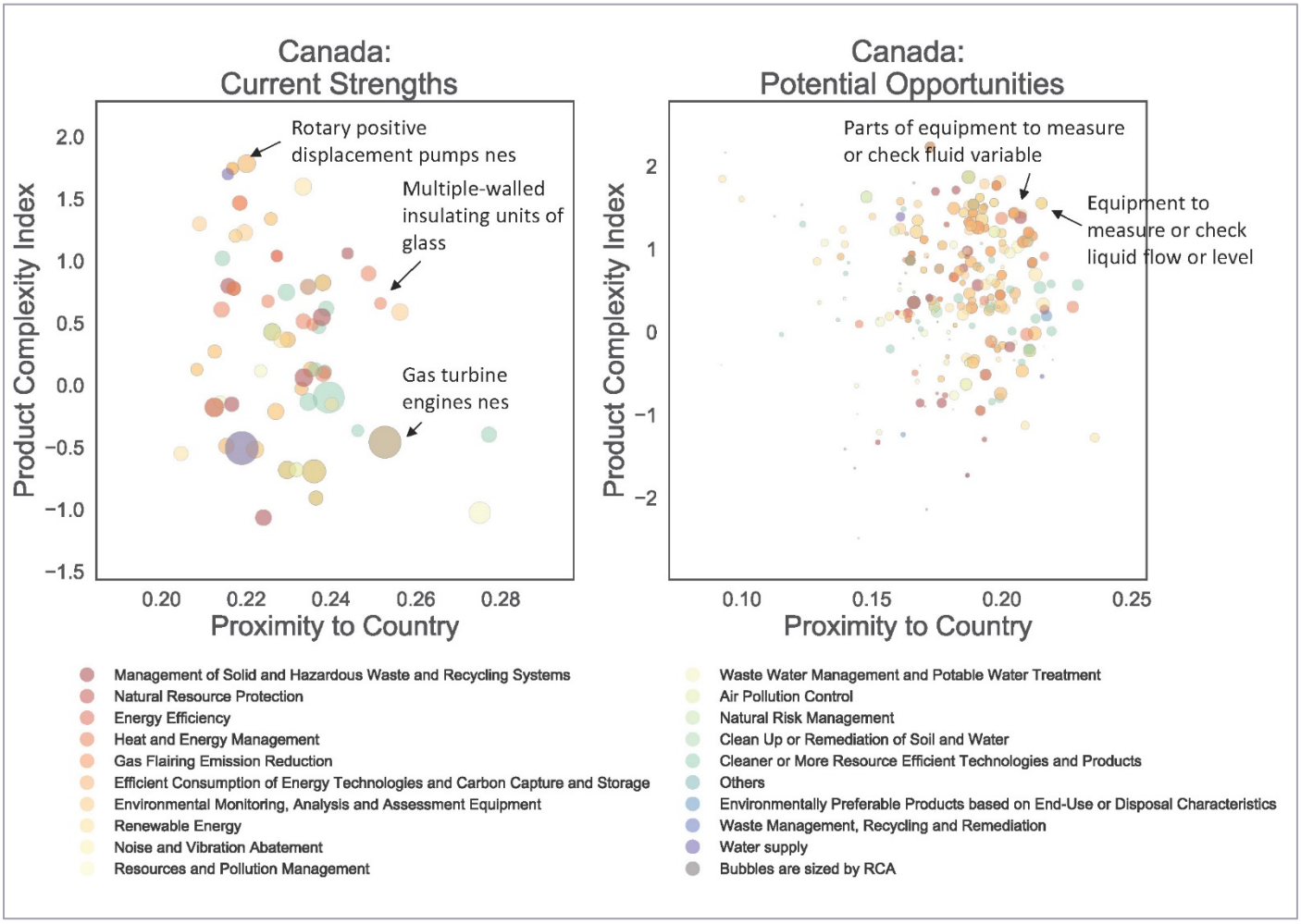


Of the countries considered, Australia appears to be in the least favourable starting position to competitively export products with environmental benefits. Some existing green competitive strengths include electric signal, safety and traffic controls and rail/tramway construction materials, which are likely to be in greater demand as greater investments are made in cleaner modes of public transport.

When it comes to green potential opportunities, Australia has comparably low proximity to most of the green products used in this analysis. Some relatively proximate opportunities include tamping machines and road rollers, which are used in recycling and solid waste treatment processes. However, it is important to note that the underlying data do not yet capture the 'greenness' of countries' production processes. For example, Australia's strong potential to capture products such as 'green' steel, which is made from hydrogen rather than coal (Allen and Honeyands, 2021), is not yet accounted for. As more detailed data on emissions and environmental qualities associated with production inputs become available, future work can seek to address these limitations.

Canada

- GCI rank: 33
- GCP rank: 33
- No. of green strengths: 59
- No. of green opportunities: 236



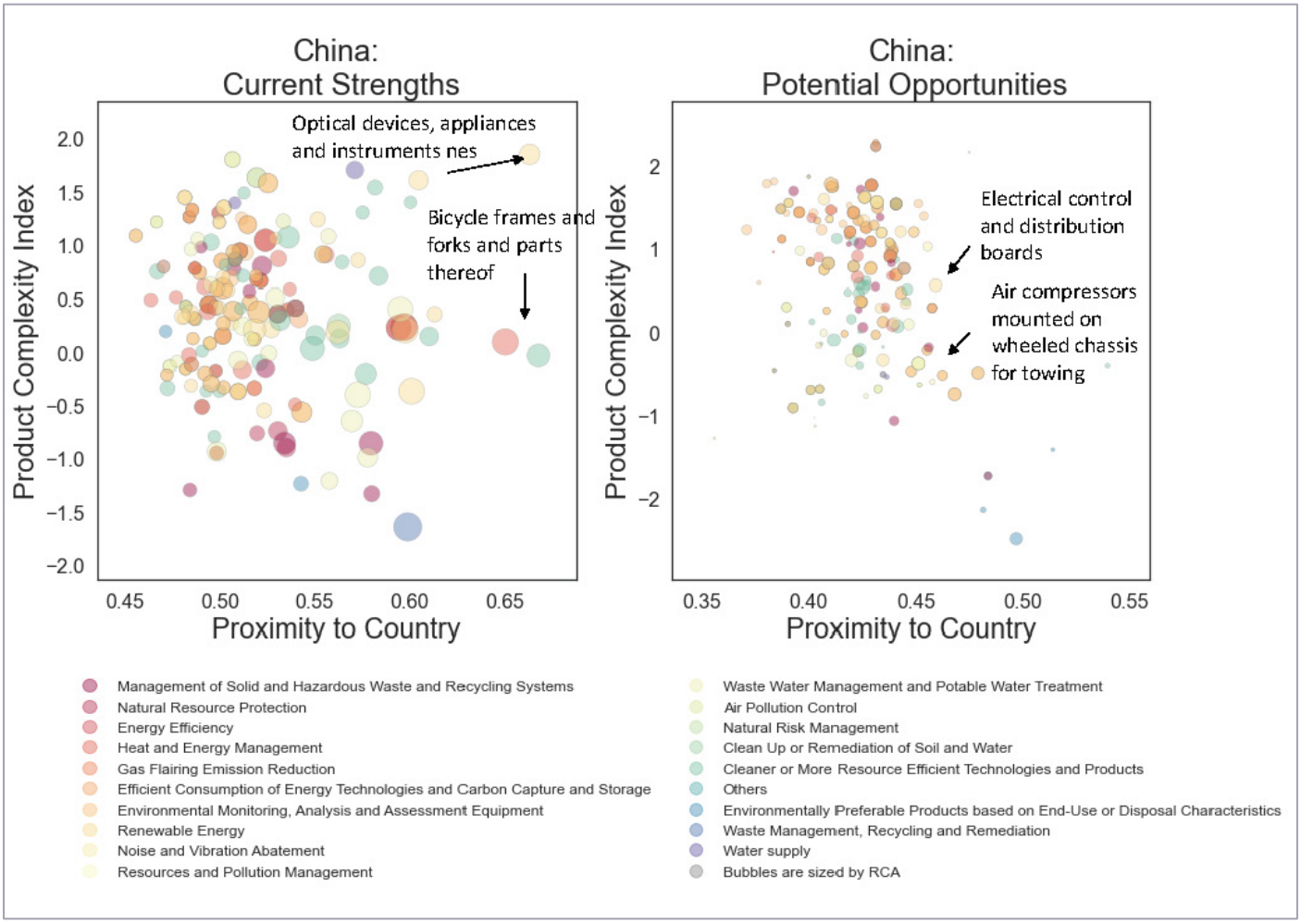
Canada is competitive in a number of green products, including rotary displacement pumps, which are used to manage wastewater, multiple-walled insulating units of glass, which can improve energy efficiency, and gas turbines, which can be used to generate power from recovered landfill gas, coal mine vent gas or biogas.

Green opportunities that are both relatively complex and proximate to Canada's existing capabilities are equipment to measure or check liquid flow level, and parts of equipment to measure or check fluid variables. These types of equipment have various applications in environmental monitoring, as well as in water and waste treatment plants, air pollution control systems and hydroelectric facilities.

Canada's proximity to green technology is lower across the board than for most of the G7, indicating that maintaining and/or developing an advantage in the green economy could be more difficult for Canada. However, the recent uptick in GCI observed in recent years suggests a positive trend.

China

- GCI rank: 4
- GCP rank: 1
- No. of green strengths: 153
- No. of green opportunities: 142

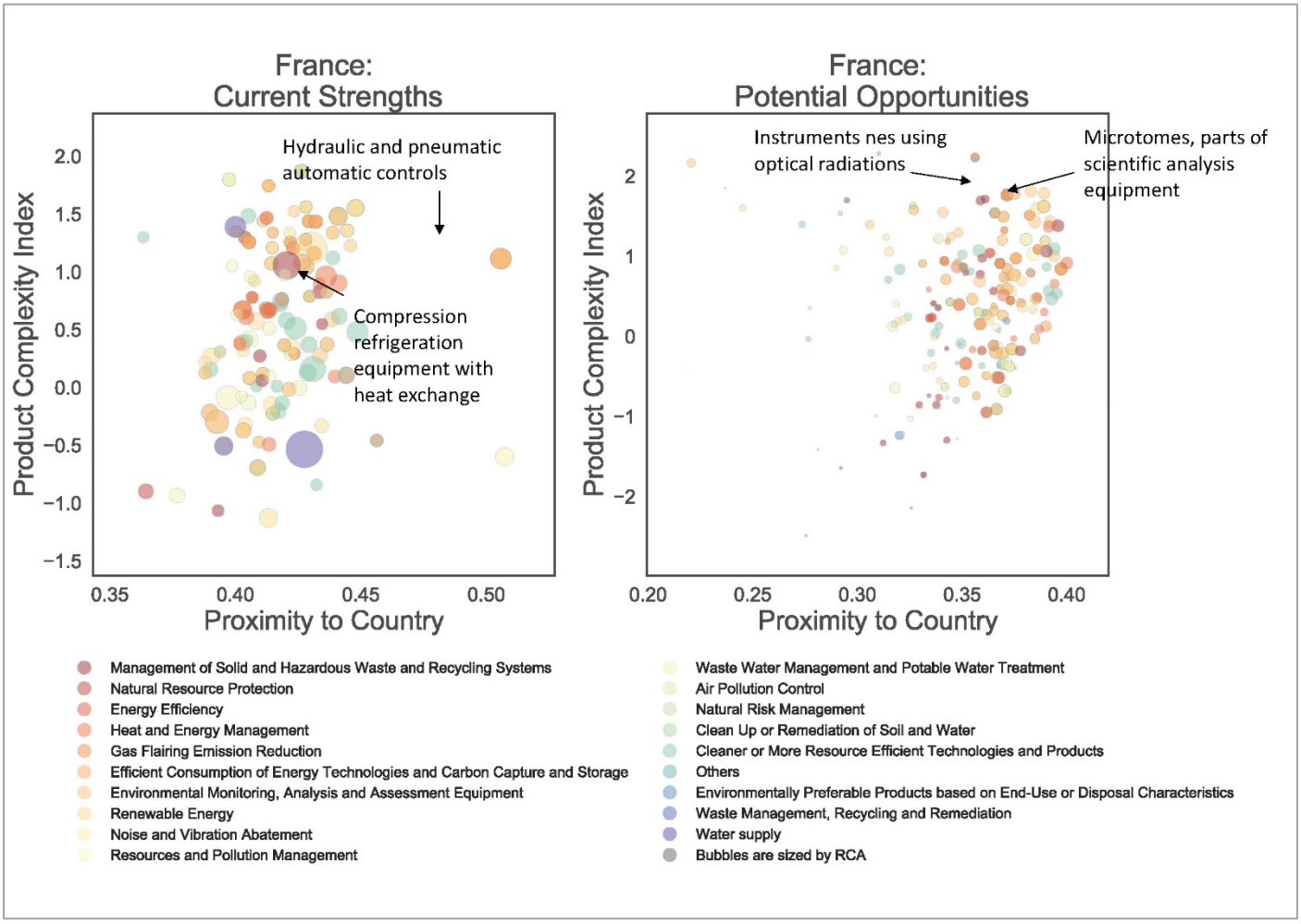


Owing to its strong manufacturing capabilities, China has numerous competitive strengths in green products and also high potential to develop further competitiveness in green products in the future.

China's existing green competitive strengths include quite complex products such as optical devices like heliostats to orient mirrors in concentrated solar power systems to reflect sunlight onto a concentrated solar power (CSP) receiver, as well as less complex products such as bicycle frames and forks. Possible green product opportunities to which China could easily transition in the future include electrical control and distribution boards, which are used to control the functioning of photovoltaic systems, and air compressors, which are used to transport or extract polluted air.

France

- GCI rank: 9
- GCP rank: 4
- No. of green strengths: 117
- No. of green opportunities: 178

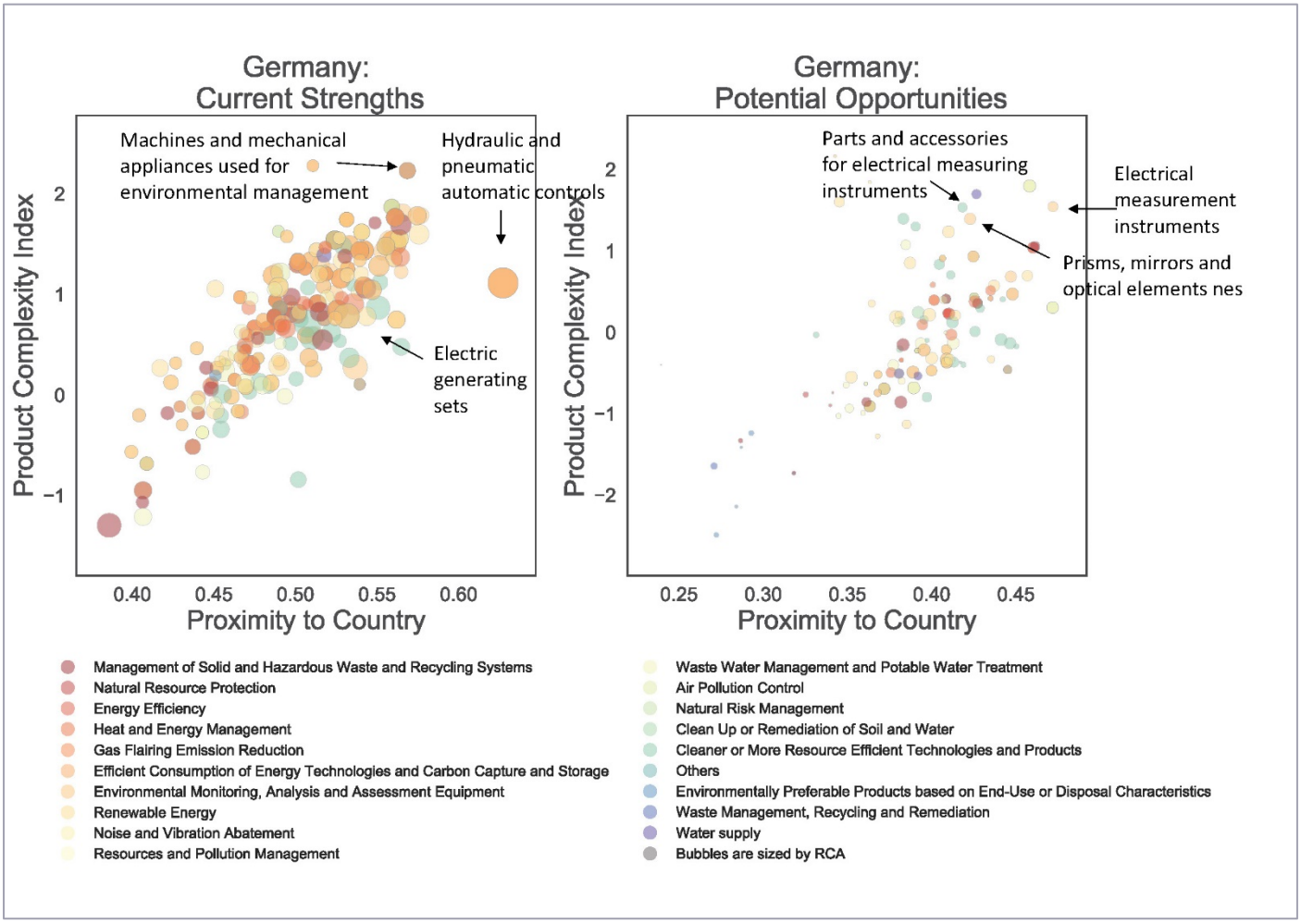


France is competitive in a number of complex green products such as hydraulic and pneumatic automatic controls, which are used in water treatment and air pollution control, and compression refrigeration equipment, which is used in geothermal heat pump systems.

Ranked fourth in the world in terms of GCP, France also has productive capabilities that enable it to diversify more easily into a wide range of green, complex products. These include microtomes and parts of scientific analysis equipment, which are used to measure, record, analyse and assess environmental samples or environmental influences, and instruments using optical radiations, which are used for the chemical analysis of water samples.

Germany

- GCI rank: 1
- GCP rank: 5
- No. of green strengths: 187
- No. of green opportunities: 108

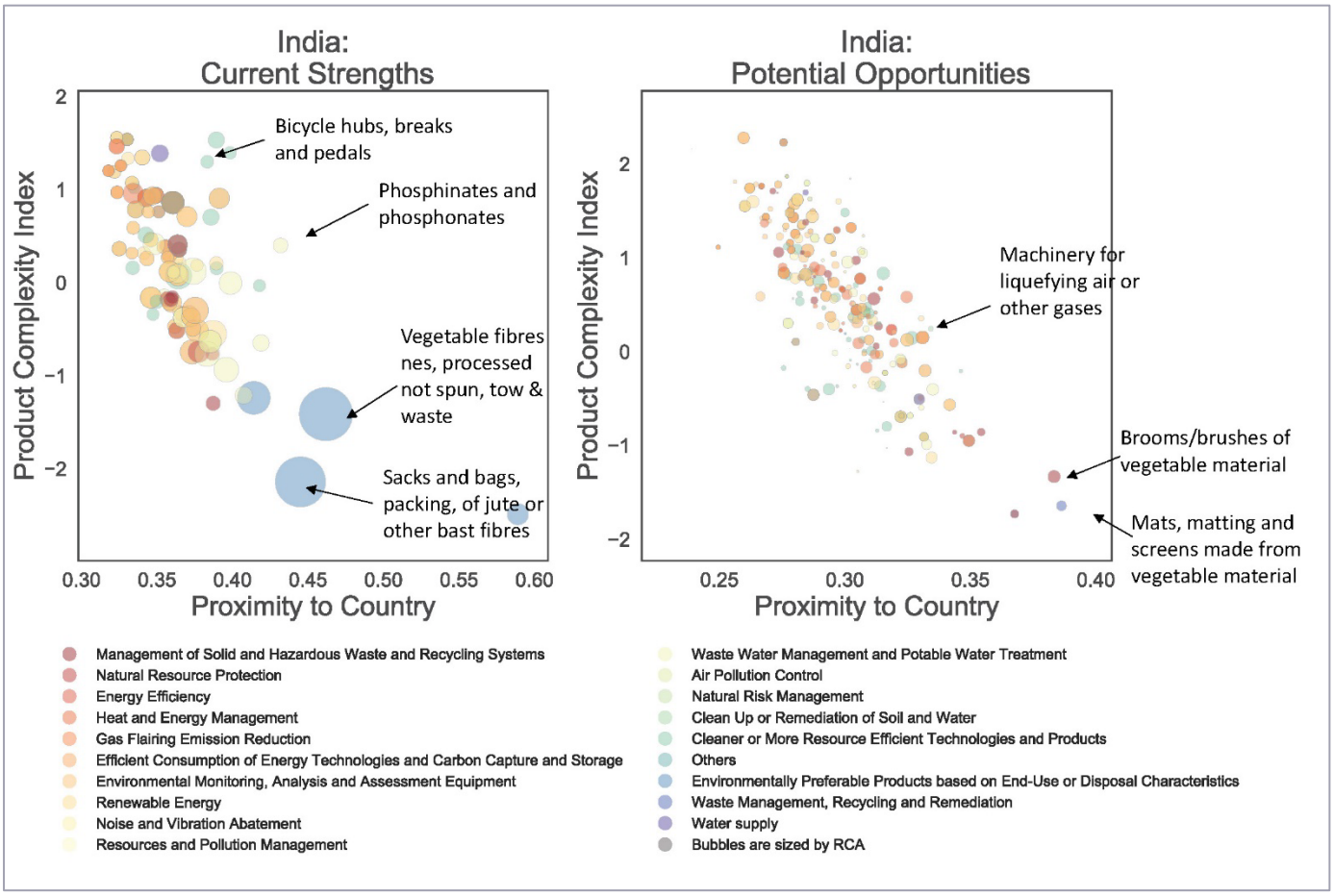


Having consistently held the highest GCI ranking over the entire period covered by the data, Germany stands out as a strong leader in the production of green, complex products. Some of Germany's competitive strengths include machines and mechanical appliances used for environmental management, electric generating sets, and, like France, it is also competitive in hydraulic and pneumatic automatic controls.

Germany also has promising prospects to develop further competitiveness in green, complex products. For example, electrical measurement instruments and their associated parts and accessories could represent a key growth area. Another area relates to prisms, mirrors and optical elements, which are used in concentrated solar systems.

India

- GCI rank: 20
- GCP rank: 8
- No. of green strengths: 88
- No. of green opportunities: 207

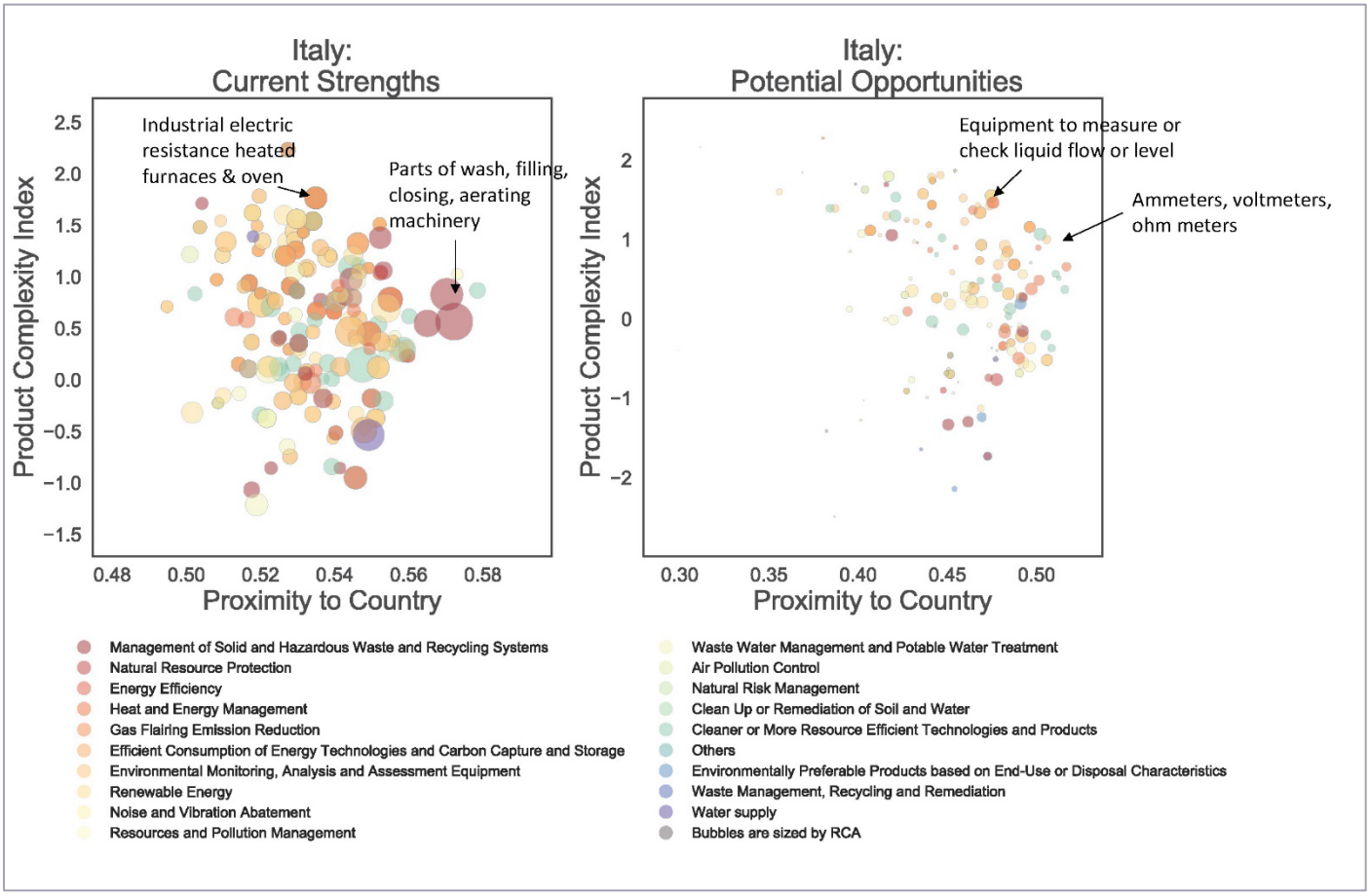


India has quite strong competitiveness in vegetable fibres and the production of sacks, bags and packing made from jute and other bast fibres. These products are likely to be in higher demand as the world transitions to a green economy because they are more biodegradable than other synthetic fibre alternatives and are also made from renewable resources. Other green competitive strengths include phosphinates and phosphonates, which are used in chemical recovery systems for wastewater management, and bicycle hubs, breaks and pedals, respectively.

As a less technologically advanced country than others discussed in this paper, many of India's most proximate green opportunities are also less complex. They include matting and screens made from vegetable material, which are used to prevent soil erosion, and brooms and brushes also made from vegetable material, which are used for waste collection. Given the benefits of technological upgrading, it may be advantageous for India to aim to develop competitiveness in products that are slightly less proximate but more complex, such as machinery for liquefying air or other gases, which is used in air pollution control.

Italy

- GCI rank: 2
- GCP rank: 2
- No. of green strengths: 156
- No. of green opportunities: 139

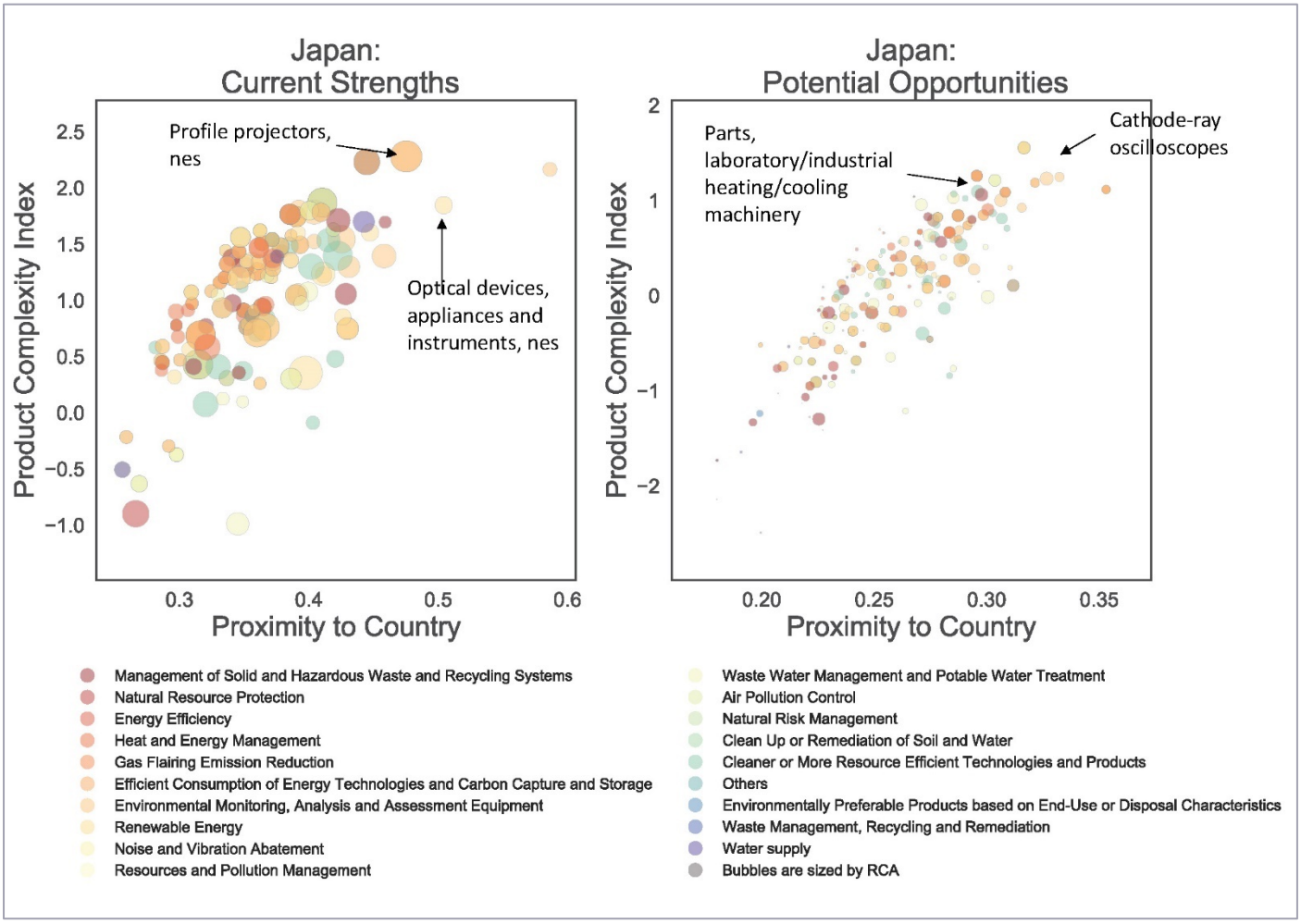


Italy is ranked second in GCI and GCP, suggesting it has a high number of green competitive strengths as well as proximate opportunities in green products. Some areas of competitiveness include industrial electric resistance heated furnaces and ovens, which are used to destroy solid and hazardous waste, and parts of wash, filling, closing and aerating machinery, which are used to recycle and reuse bottles.

The landscape of new green opportunities in which Italy could potentially develop future competitiveness is rich and varied. Some key opportunities include ammeters, voltmeters and ohm meters, which are used for measuring electrical flow and to identify electrical problems in equipment, and equipment to measure and check gas/liquid flow or level, which is used in air pollution control systems and wastewater treatment plants.

Japan

- GCI rank: 5
- GCP rank: 23
- No. of green strengths: 121
- No. of green opportunities: 174

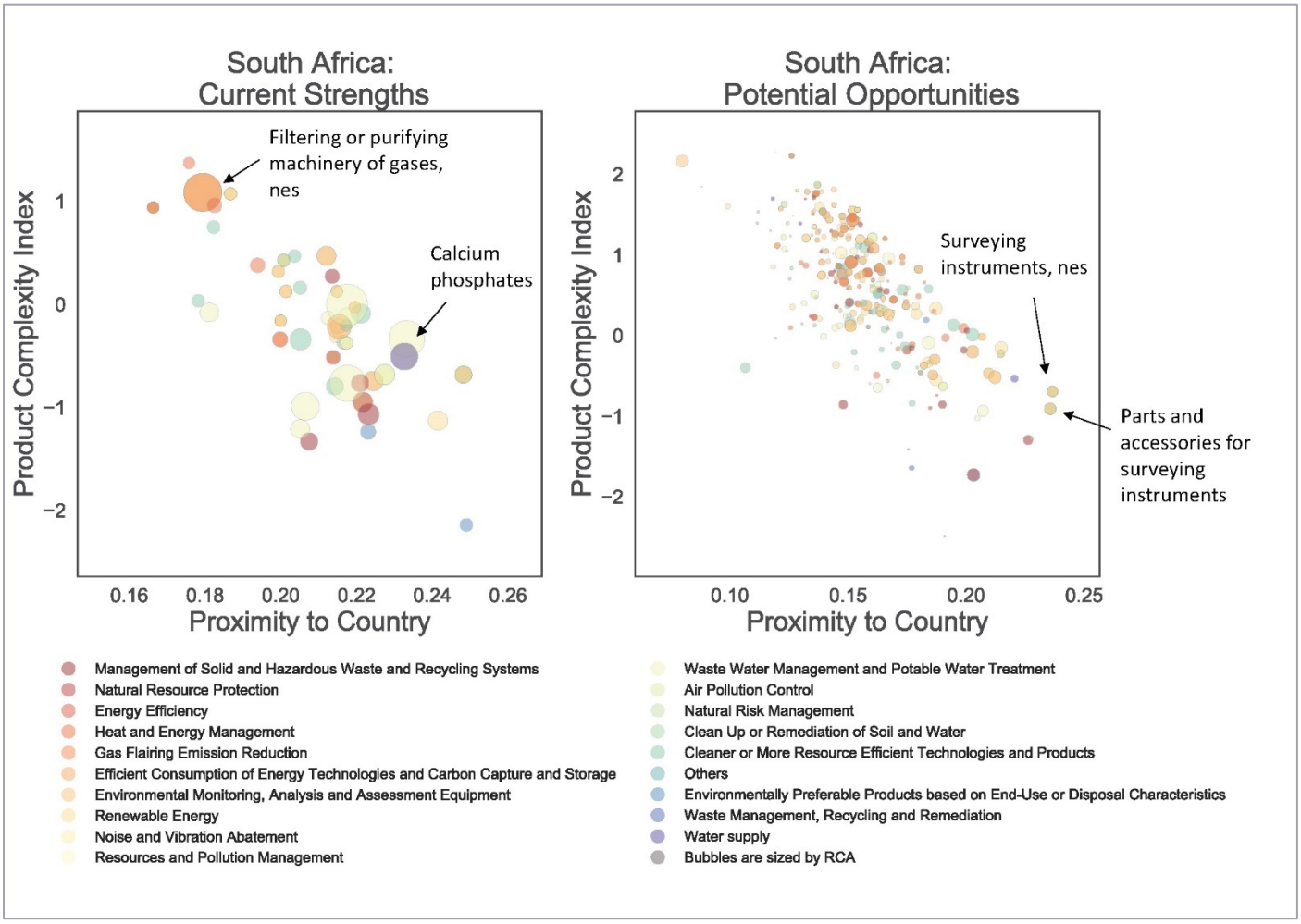


Japan has a mix of existing strengths and opportunities in the green economy. Green areas of competitiveness include products such as profile projectors, which are used to measure, record and analyse environmental impacts, and optical devices, which include solar heliostats (used to orient mirrors in concentrated solar power systems to reflect sunlight on to a CSP receiver).

New complex green products in which Japan may consider developing future competitiveness include parts for laboratory/industrial heating/cooling machinery, which are used in the maintenance and repair of solar water heaters, and cathode-ray oscilloscopes, which have a number of applications in environmental monitoring.

South Africa

- GCI rank: 45
- GCP rank: 43
- No. of green strengths: 48
- No. of green opportunities: 247

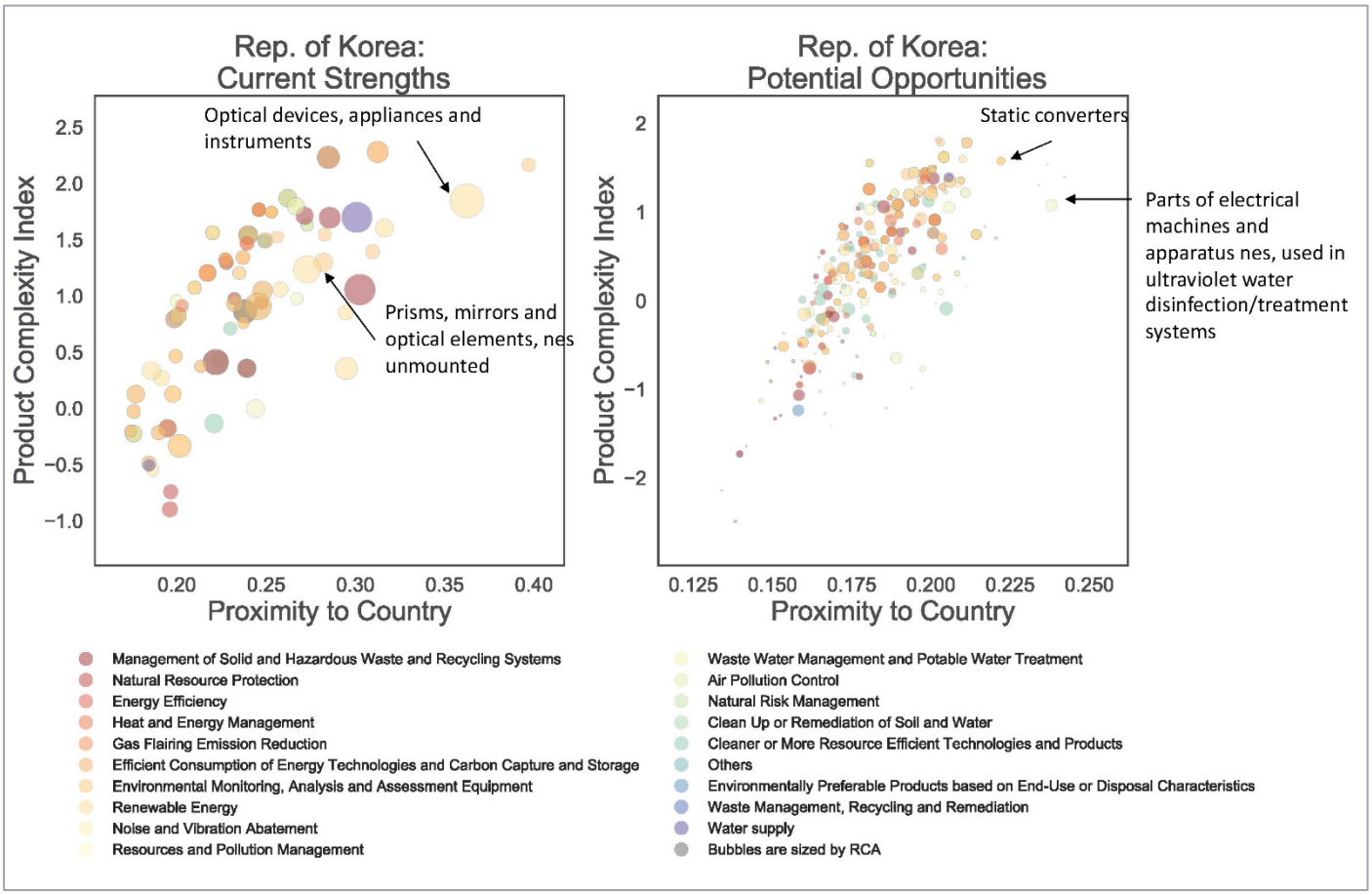


While South Africa's green competitive strengths are not quite as developed as some of the G7 countries', it exports a relatively large volume of filtering and purifying machinery, which has numerous environmental applications for gases and water. South Africa is also particularly competitive in the export of calcium phosphates, which are used in chemical recovery systems for wastewater management.

Some of South Africa's most proximate green opportunities include surveying instruments and parts and accessories for surveying instruments. These are used to measure the ozone layer and to monitor and assist planning for natural risks such as earthquakes, cyclones and tsunamis.

South Korea

- GCI rank: 23
- GCP rank: 35
- No. of green strengths: 68
- No. of green opportunities: 227

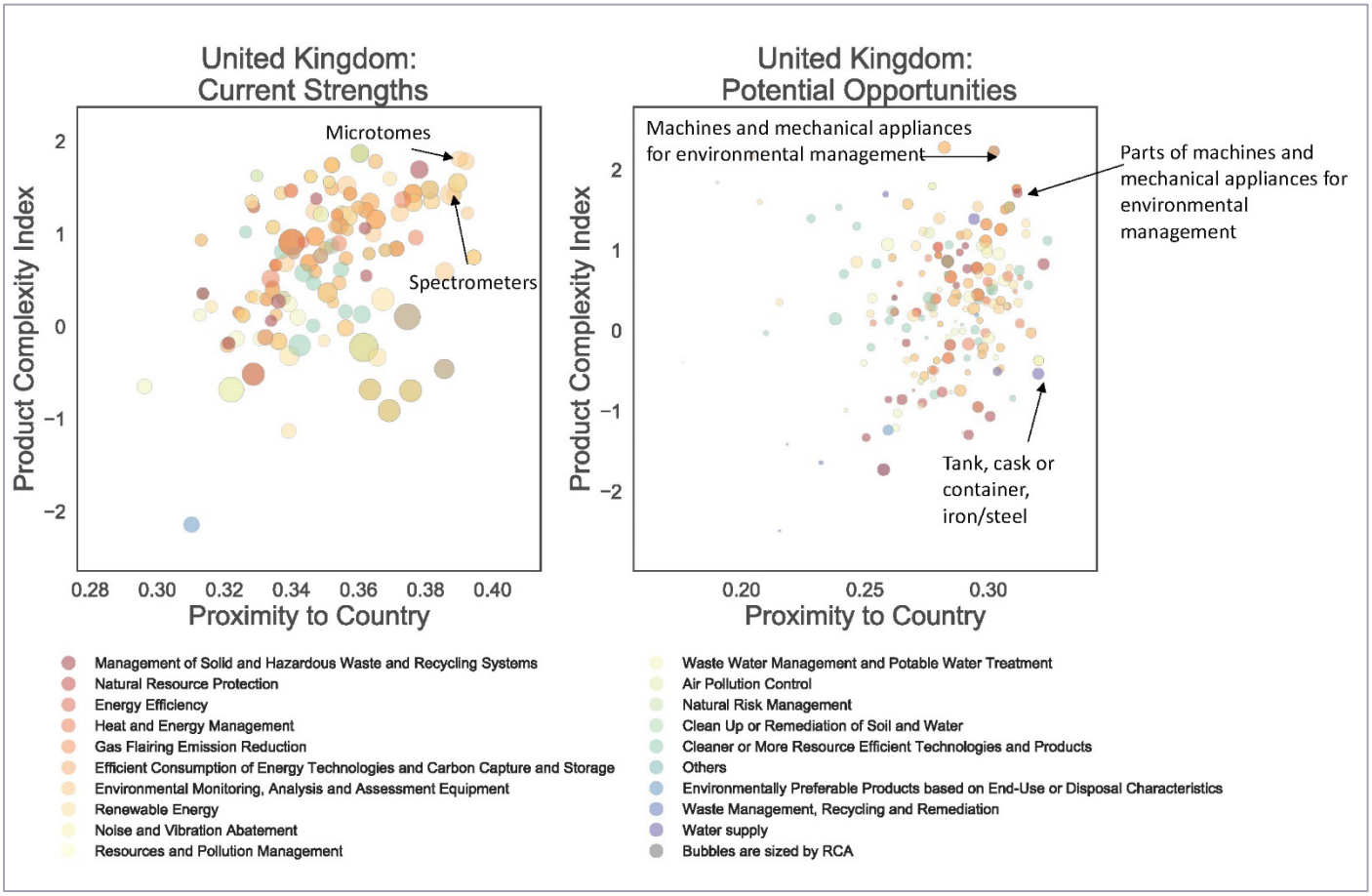


South Korea has several existing green competitive strengths in renewable energy technology, such as optical devices, appliances and instruments, and prisms, mirrors and optical elements. These products are all used in concentrated solar power.

While South Korea's GCP rank is lower than that of many of the G7 countries, it does have the advantage that its most proximate green opportunities are relatively complex. Some of these include parts of electrical machines and apparatus, which are used in ultraviolet water disinfection/treatment systems, and static converters, which are used in solar cells.

United Kingdom

- GCI rank: 8
- GCP rank: 15
- No. of green strengths: 118
- No. of green opportunities: 177

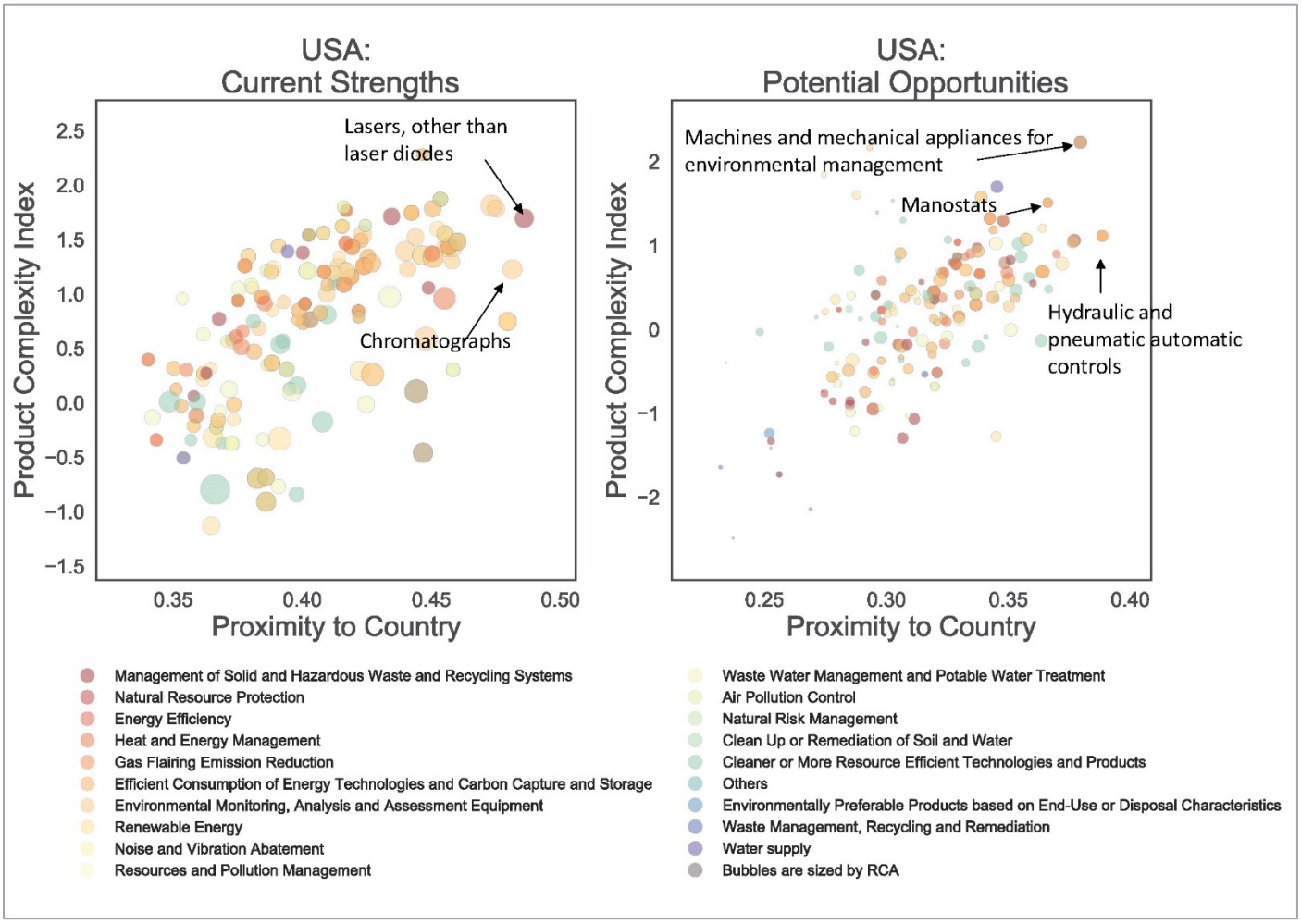


The UK has a competitive advantage in a number of complex green products, including microtomes, which are used to measure, record and analyse environmental influences, and spectrometers, which are used to identify and characterise unknown chemicals or trace contaminants.

The UK also has productive capabilities that are reasonably proximate to a range of green products. Many of these are quite complex, such as machines and mechanical appliances for environmental management and their associated parts. These machines and appliances have a range of applications in the management of waste, wastewater, drinking water production and soil remediation. Other, less complex, green opportunities include products such as tanks, casks and containers, which are important in the management of liquid and solid waste.

United States

- GCI rank: 3
- GCP rank: 12
- No. of green strengths: 140
- No. of green opportunities: 155



Ranked third in GCI, the US is competitive in a diverse range of green, complex products. These include lasers, which are used for hazardous waste storage and treatment equipment, and chromatographs, which are used to monitor air pollution emissions and water quality.

One of the most proximate green opportunities for the US is hydraulic and pneumatic automatic controls (used in water treatment and air pollution control), in which Germany is currently competitive. Other complex and proximate green opportunities include machines and mechanical appliances for environmental management, and manostats, which are used to measure and monitor pressure in wastewater treatment processes.

4. Methodology

The Green Transition Navigator and the analysis presented in this report are based on previous research by Mealy and Teytelboym (2020), which developed a quantitative methodology for measuring countries' current green production capabilities, identifying new green export opportunities, and predicting future green export growth.

Data

The dataset of green products and technologies referred to in this report are based on a compilation of green goods classifications from the Asia-Pacific Economic Cooperation (APEC), the Organisation for Economic Co-operation and Development (OECD) and the World Trade Organization (WTO). Note that the definition of a `green good' can sometimes include products that can be used for both environmentally beneficial and more conventional, polluting practices. Nevertheless, these products are essential to the green economy, and policies aiming to reduce the environmental harm arising from our economic activities are bound to increase demand for them. For the purposes of our analysis, this `dual-use' problem is therefore not an issue.

Country-level trade data are sourced from the CEPII's BACI database[2] (Gaulier and Zignago, 2010). To avoid measurements being skewed by short-term fluctuations in trade, the analysis is based on annual averages in trade values for rolling five-year periods from 1995–99 to 2015–19. (Where no time range is shown, the data are based on the most recent period, i.e. 2015–19.)

Measures

Revealed Comparative Advantage (RCA)

A country's RCA in a product is calculated using the Balassa index (Balassa and Noland, 1989). It is calculated as share of product p in country c's exports, divided by the share of product p in global exports.

Product Complexity Index (PCI)

The PCI is often used as a proxy for the technological sophistication of a product. For more information on how this measure is calculated, see Mealy et al. (2019) and Hidalgo (2021).

Product-to-product proximity

The proximity between two products p and p' is based on the conditional probability that a country is competitive in product p given it is competitive in product p'. For more information on how this measure is calculated see Hidalgo et al. (2007) and Mealy and Teytelboym (2020).

Country-to-product proximity

The proximity between a product p and a country c is calculated as the average product-to-product proximity between product p and all the products the country currently exports competitively. For more information on how this measure is calculated see Hidalgo et al. (2007) and Mealy and Teytelboym (2020).

Green Complexity Index (GCI)

The GCI measures countries' green competitiveness based on the number and complexity of green products in which it is competitive. For more information on how this measure is calculated, see Mealy and Teytelboym (2020).

Green Complexity Potential (GCP)

The GCP measures how much future potential a country has to diversify into complex green products, based on the proximity and complexity of products in which it is not yet competitive. For more information on how this measure is calculated, see Mealy and Teytelboym (2020).

[2] http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=37

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