TRADE & INDUSTRIAL POLICY STRATEGIES

THE GLOBAL CLIMATE CHANGE REGIME AND ITS IMPACTS ON SOUTH AFRICA'S TRADE AND COMPETITIVENESS: A DATA NOTE ON SOUTH AFRICA'S EXPORTS

Gaylor Montmasson-Clair

August 2020

info@tips.org.za
+27 12 433 9340
www.tips.org.za

Gaylor Montmasson-Clair
TIPS Senior Economist: Sustainable Growth

TABLE OF CONTENT

LIST OF FIGURES

ABBREVIATIONS

BCAs	Border Carbon Adjustments
CAGR	Compound Annual Growth Rate
EU	European Union
GHG	Greenhouse Gas
PGMs	Platinum Group Metals
SADC	Southern African Development Community
SDGs	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America

1. INTRODUCTION

A global transition to sustainable development is under way and strengthening as a response to multiple socio-environmental crises, including the global impacts of climate change. The Paris Agreement, reached in 2015 under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), and the United Nations Sustainable Development Goals (SDGs), have created a global framework indicating the direction of travel for all economies.

The transition to a sustainable development pathway is an all-encompassing endeavour, cutting across all spheres of government and policy. It is not only an environmental issue but also a socio-economic challenge which has ramifications at all levels of economic development, notably trade and industrial development (Montmasson-Clair 2016).

From a trade and industrial perspective, this transition has implications on the composition and dynamics of entire value chains. This concerns what inputs are accessed, the processes that underlie production, what goods and services are produced, as well as what happens to these products post-consumption. The transition materialises through two complementary streams: the development of new, green industries and the greening of existing, traditional industries.

Dynamics around the transition and the pace at which countries move to low(er)-carbon paths have deep implications on any given country's competitiveness, trade performance and ultimately industrial and economic development. The global transition can bring opportunities as well as generate risks. The opportunities and risks should be understood jointly in order to devise a strategy aimed at managing such trends. Initial work points to significant opportunities that remain unexploited (see, for instance, Montmasson-Clair et al. 2017; Maia et al. 2011; TIPS 2018) as well as risks for South Africa (see Camco and TIPS 2010; Montmasson-Clair 2015; 2012; TIPS, the dti, and IDC 2013a).

With the rise of the international climate change regime, greenhouse gas (GHG) emissions have become a tradable (and traded) commodity. The Kyoto Protocol, under the UNFCCC, gave rise to carbon trading, allowing countries to buy and sell emissions units as well as emissions reductions or removals. Carbon trading has also been implemented at the regional, national and subnational levels, with 31 Emissions Trading Schemes in place worldwide as of May 2020 (World Bank 2020).

More importantly, GHG emissions have become a determining factor of trade and investment. GHG emissions can effectively be traded between countries through the import and export of products and services, when emissions are "embodied" within products. The volume of a country's carbon embodied in exports is *de facto* a function of this country's structure of exports and its carbon intensity.

The impact of the strengthening climate change regime on South Africa's trade remains, however, largely unexplored, despite the implementation of domestic and international climate change response measures being a prime risk factor for South African trade and competitiveness.

The impact of climate change regulation, such as carbon pricing, and shifts in trade patterns away from carbon-intensive products and/or jurisdictions, are important areas of risk for South Africa's international competitiveness and access to markets and finance. Several countries have already initiated a transition away from coal-fired electricity generation, in turn influencing coal exports globally. Green protectionism,[1] through trade-related climate change response measures, such as

[1] Green protectionism refers to the justification of trade protectionist measures under the guise of addressing climate change and environmental goals.

border carbon adjustments (BCAs) or other non-tariff barriers, is also becoming more prevalent internationally (Cosbey and Wooders 2011; Du Plooy and Jooste 2011; Jooste et al. 2009; TIPS, the dti, and IDC 2013a). For example, the President of the European Commission, Ursula von der Leyen, considers the introduction of a BCA to avoid carbon leakage as core to the proposed European Green Deal, which would bind the European Union (EU) to becoming carbon neutral by 2050 (Von der Leyen 2019). The implementation of a BCAs by the EU, at the latest by 1 January 2023, has been included as a component of the Union's recovery package (European Council 2020; European Commission 2020). BCAs have also been endorsed by more than 3 500 American (USA) economists, including 27 Nobel laureates, 15 Chairs of the Council of Economic Advisers, all four former Chairs of the Federal Reserve and two Former Secretaries of the US Department of Treasury in a 2019 statement on carbon dividends (Akerlof et al. 2019).[2]

A number of macroeconomic and policy factors, which underpin the following analysis, make the South African economy particularly vulnerable to trade-related climate change risks. First, South Africa is one of the most carbon- and energy-intensive economies in the world. The economy relies on coal as a feedstock for the quasi-totality of electricity (86% in 2016) as well as about a quarter of liquid fuels production in the country. Second, South Africa's climate change framework remains unambitious by global standards, despite some progress in recent years with the implementation of a carbon tax and carbon budgets (Montmasson-Clair and Chigumira 2020). Third, South Africa is relatively far from its main trading partners, which has implications for transport costs and associated GHG emissions. With an average distance of 7 877 km for exports and 9 106 km for imports, South Africa's geographical distance to its key trade partners is much larger than the respective global averages of 4 715 km and 5 148 km for exports and imports, respectively (based on TradeMap data). Fourth, South Africa has the status of emerging economy and upper-middle-income country. Exemptions at the international level are likely to be granted solely to low-income countries and, to some extent, to lower-middle-income countries (Tamiotti et al. 2009). Given South Africa's international status, it is a likely that the country will not be treated as leniently as low/lower-middle countries.

As a result of these underlying factors, South Africa's vulnerability, which is not diminished by scale or production volumes, appears relatively high compared to most other countries (Cosbey and Wooders 2011; Du Plooy and Jooste 2011; TIPS, the dti, and IDC 2013b; Peters and Hertwich 2008; Montmasson-Clair 2016).

This report aims to shed light on the trade-related risks faced by South Africa as a result of the global transition to a low-carbon economy by delving further these underlying factors and unpacking South Africa's trade patterns from a carbon perspective. Section 2 highlights global trends in the trade of GHG emissions. Section 3 reviews South Africa's exports (of goods). Section 4 unpacks South Africa's exports of embodied carbon per destination while Section 5 details exports at a sectoral level. Section 6 reviews the carbon intensity of South Africa's leading exports, compared to other key exporters. Section 7 concludes.

[2] Despite the US exiting the Paris Agreement under the Trump administration, federal states have continued to further strengthen the climate regime in the country.

2. OVERVIEW OF GLOBAL TRADE AND GREENHOUSE GAS EMISSIONS

A first step in understanding the interplay between climate change risks and trade is to unpack the trade movements of GHG emissions. Like global trade, global GHG emissions embodied in exports (i.e. the indirect export of GHG emissions) are strongly dominated by China (25% in 2015).[3] Other leading carbon exporters were the United States of America (USA) (6%), Russia (5%), India (5%), South Korea (4%), Germany (4%) and Japan (3%). The EU as whole accounted for 8% in 2015.

South Africa accounted for about 2% of global exported GHG emissions in the same year. While this is a relatively small share, it is much larger than South Africa's global export share, which accounts for 0.5% of global exports. Figure 1 and Figure 2 highlight the key countries that export GHG emissions, in volume and shares.

Figure 1: Global GHG emissions embodied in gross exports per country (in $MtCO_2e$)

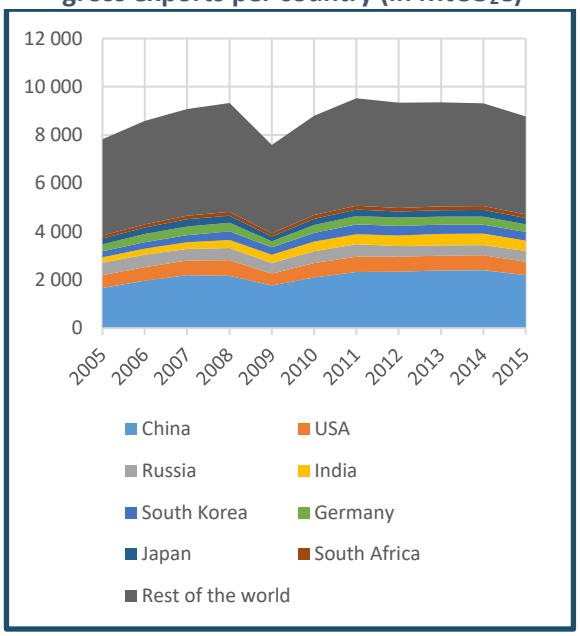
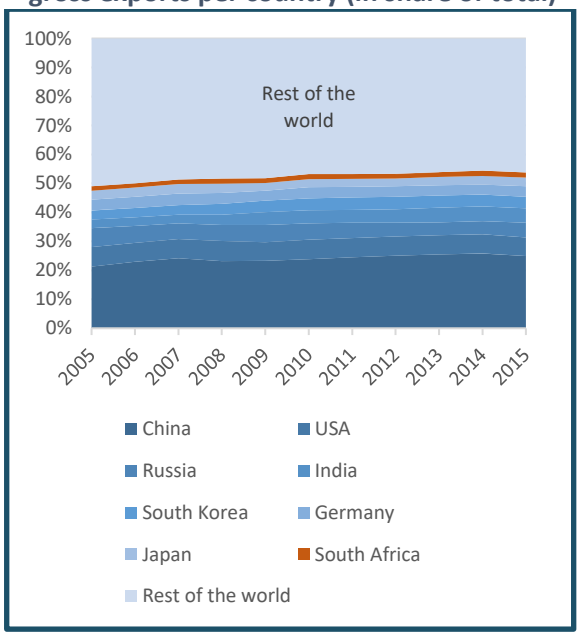


Figure 2: Global GHG emissions embodied in gross exports per country (in share of total)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

GHG emissions can also be indirectly imported from trade partners. Again, this largely follows traditional trade patterns. Figure 3 and Figure 4 indicate that the USA (15%) and China (10%) were by far the largest importers of embedded carbon. Japan and Germany follow (about 5% each). The EU as a whole accounted for 14% of all imports.

South Africa is a marginal importer, with less than 1% of total imports of embodied emissions, although this is larger than the country's share of imported goods (about 0.5% in value).

[3] As of June 2020, data on carbon embodied in trade are only available up to 2015. Data on exported/ imported emissions relate to the latest year (2015) unless otherwise noted.

Figure 3: Global GHG emissions embodied in gross imports per country (in $MtCO_2e$)

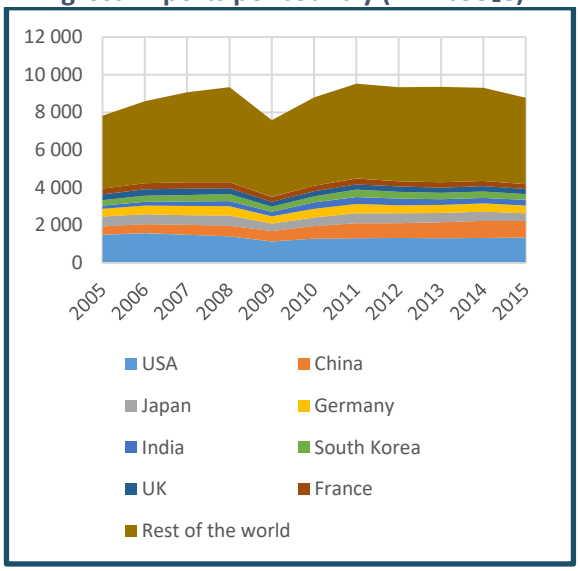
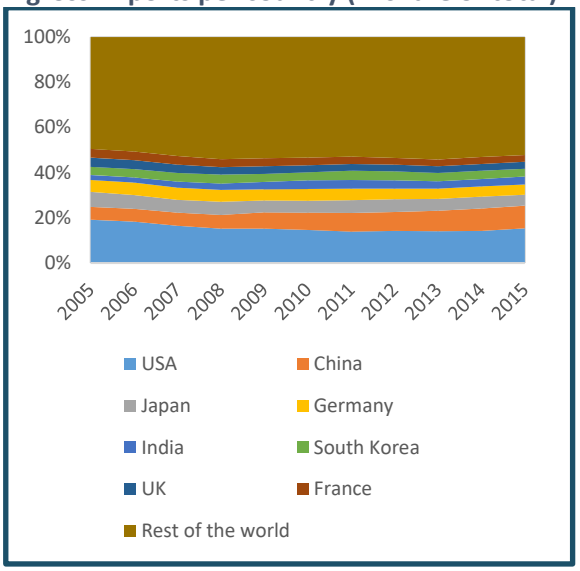


Figure 4: Global GHG emissions embodied in gross imports per country (in share of total)

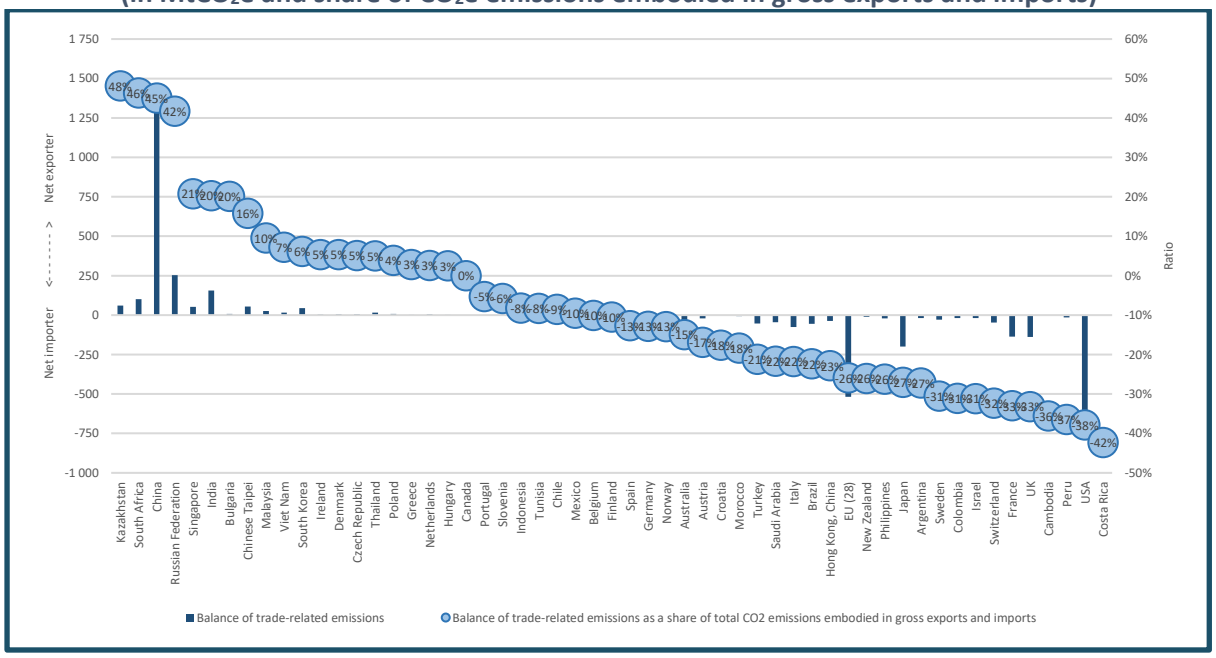


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

Based on the above analysis, from a climate change perspective, the world can be divided into two groups: net exporters and net importers of GHG emissions. Countries' production- and consumption-related emissions generally differ. Countries with production-related emissions higher than their consumption-based emissions are net exporters, and vice versa. The following figures illustrate this dichotomy. Figure 5 ranks countries based on the net volume of exported or imported emissions. While China largely dominates (due to its role in global trade), South Africa features as a leading net exporter of carbon emissions. Figure 6 depicts the proportion of imported or exported emissions for each country, compared to its production-based emissions. Figure 7 compares countries' production- and consumption-related emissions. Countries are ranked based on the share of their imported or exported emissions. As such, in 2015, South Africa exported 24% of its emissions, one of the largest shares worldwide.

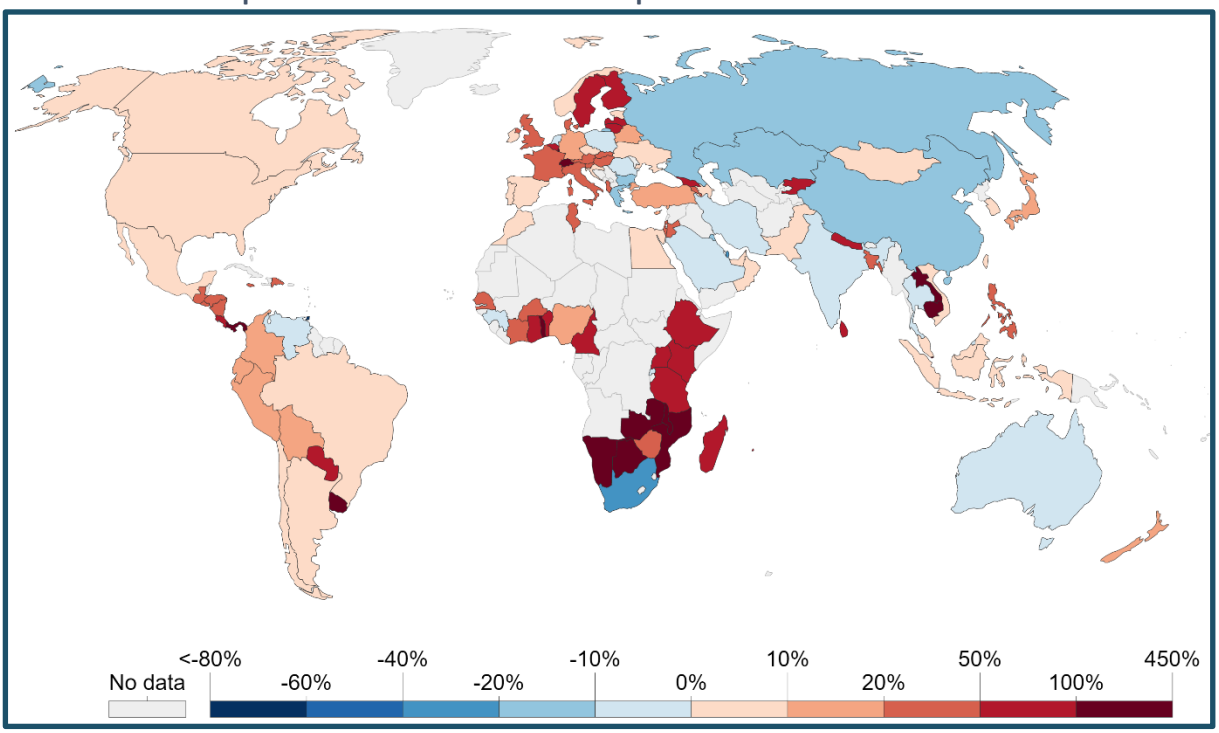
In sum, South Africa displays a relatively peculiar situation. While a small country in terms of overall embodied emissions, South Africa arises as one of the leading exporters of embodied GHG emissions. In addition, exported emissions represent a large share of South Africa's total GHG emissions. This situation is a function of a) the country's high carbon intensity (of production); b) production-related emissions exceeding consumption-based emissions and c) exported emissions surpassing imported emissions. These aspects, considered together, put the country at risk of measures aimed to curbing the trade (and specifically import) of carbon-intensive goods or from carbon-intensive jurisdictions.

Figure 5: CO2 embodied in gross exports, trade-related balance per country, 2013-2015 average (in $MtCO_2e$ and share of CO_2e emissions embodied in gross exports and imports)



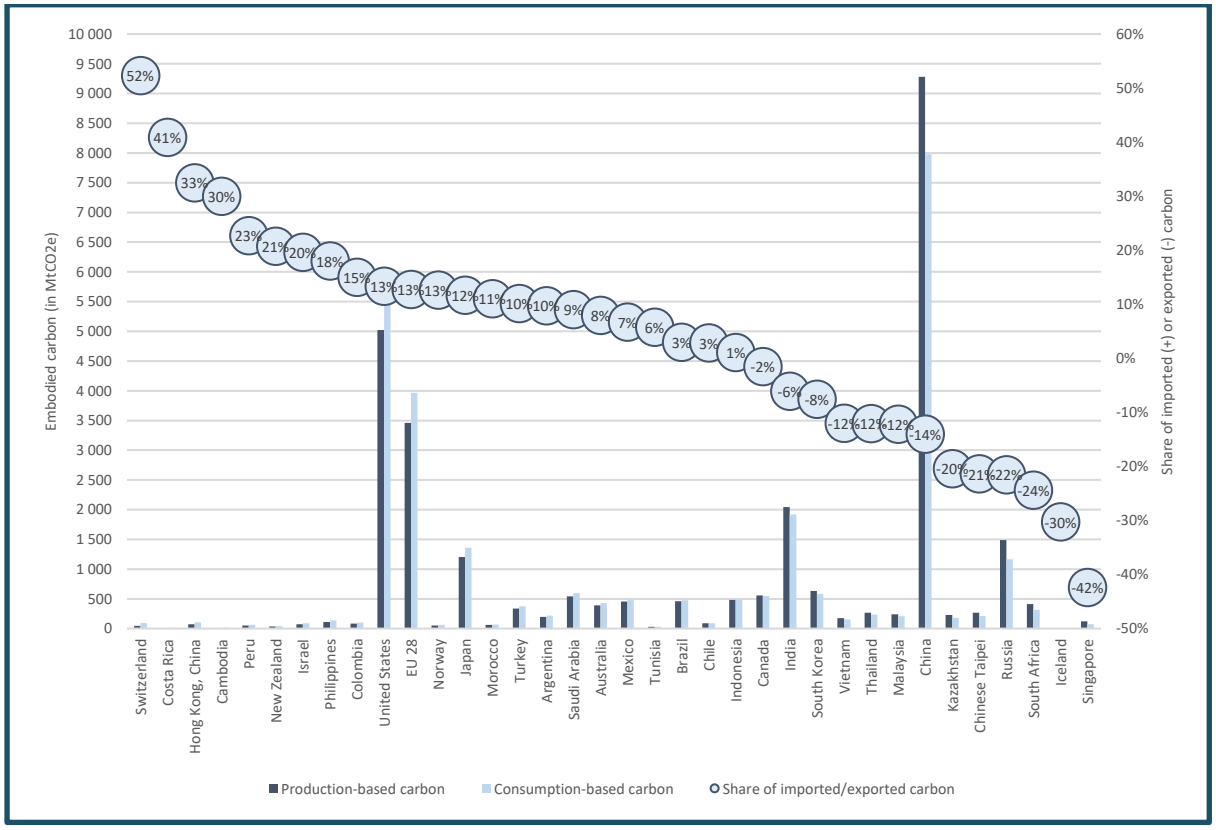
Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

Figure 6: Share of CO_2e emissions embedded in trade in 2015, measured as emissions exported or imported as the share of domestic production-related emissions



Source: Our World in Data (n.d.), based on data from Peters et al. (2011) and Global Carbon Project (2019).
Note: positive values (red) represent net importers of CO_2 (i.e. '20%' would mean a country imported emissions equivalent to 20% of its domestic emissions). Negative values (blue) represent net exporters of CO_2.

Figure 7: Carbon embodied in production and consumption per country in 2015



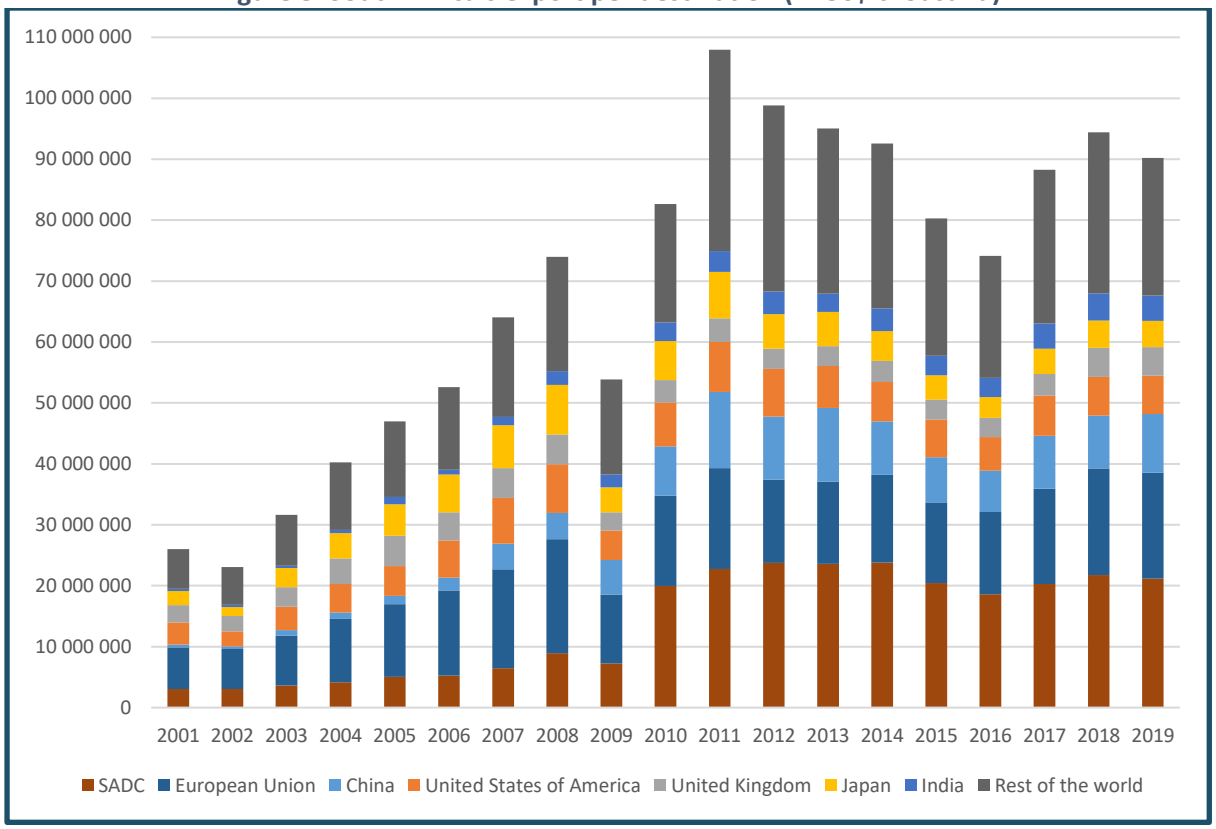
Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020. Note: 'Share of imported/exported carbon' denotes, for net importers, the share of imported carbon in their consumption-based emissions, and for net exporters, the share of exported carbon in their production-based emissions.

3. OVERVIEW OF SOUTH AFRICA'S EXPORTS

South Africa's exports (of goods) are concentrated on a few destinations, as illustrated in Figure 8. The Southern African Development Community (SADC) region was the primary buyer of South Africa's goods (23% in 2019), followed by the EU (19%). China (11%), the USA (7%), the UK (5%), Japan (5%) and India (5%) complete the list of top importers.[4]

From a climate change and trade perspective, these leading countries/regions can be split into two groups. One the one hand, the EU, the USA, the UK and Japan have all embarked on an aggressive shift of their economies towards low-carbon pathways. This group accounted for 36% of South African exports in 2019. In some cases, like the EU and the USA, the shift to a low-carbon development pathway may trigger with the introduction of BCAs to protect domestic economies.[5] As such, carbon-intensive exports to these countries are overall at risk. On the other hand, SADC, China and India have initiated more modest or selective transitions. Risks to South African exports are in these cases more focused on specific products, such as coal exports to India.

Figure 8: South Africa's export per destination (in US$ thousand)



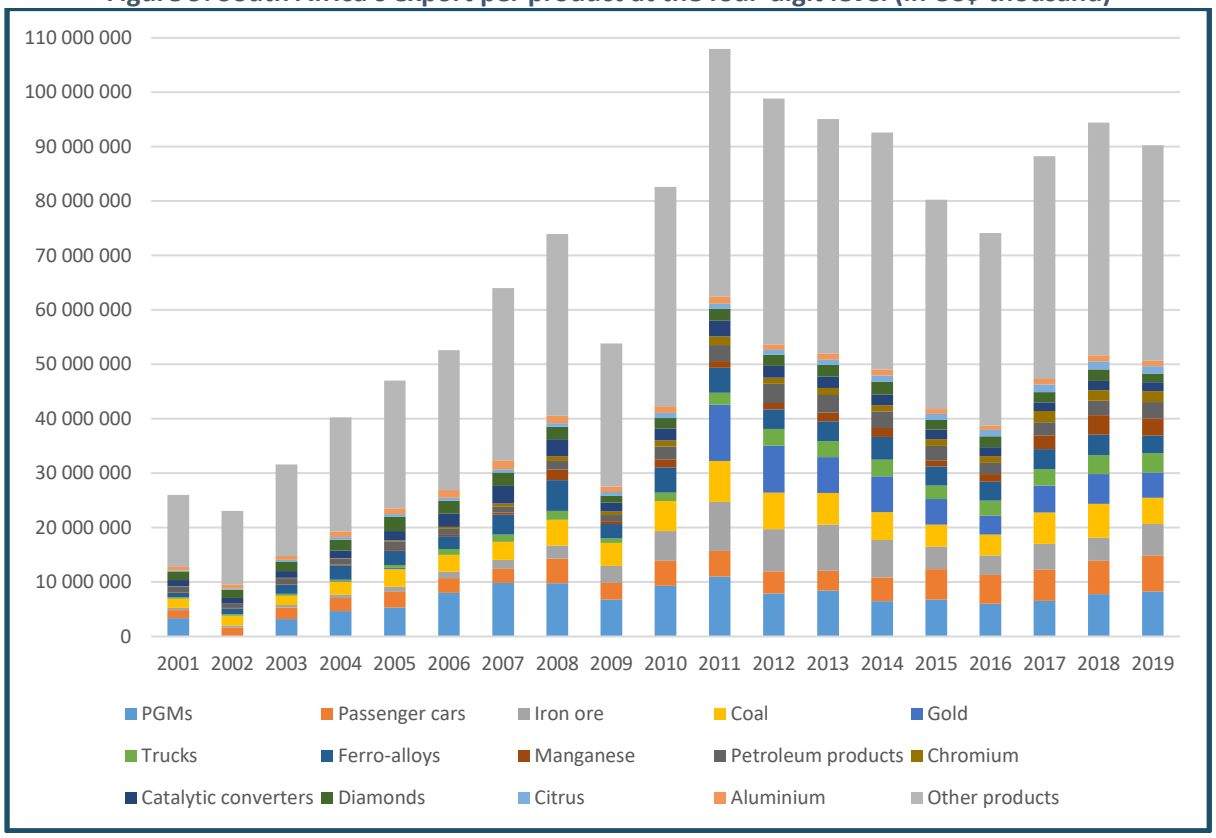
Source: Author, based on data from Quantec.

A similar picture emerges when considering South African exports at the four-digit level (see Figure *9*). The country's exports are heavily concentrated around a few value chains, some of which may face significant changes as a result of the transition to a low-carbon economy. Automotive-related exports, i.e. passenger cars, trucks, catalytic converters and Platinum Group Metals (PGMs) feature among the top South African exports. These four product categories represented 22% of the country's exports in 2019. Overall, automotive-related exports and PGMs respectively accounted for 15.5% and 9.1% in 2019. Fossil fuels, namely coal and petroleum products, also account for substantial export shares.

[4] On a country basis, China is the largest importer, followed by Germany and the USA.
[5] As raised in the introduction, a BCA is planned from 2023 in the EU.

Coal is the single largest export product at a six-digit level. Other key exports rely on the country's mineral resources and are exported in raw (iron ore, gold, manganese, chromium, diamonds) or beneficiated form (ferro-alloys). Such exports are less at risk and may, under certain circumstances, even benefit from the transition to a low-carbon world (World Bank 2017; Hund et al. 2020; Montmasson-Clair forthcoming)). The case of aluminium is peculiar in this respect, as South Africa does not host deposits of bauxite (imported from Australia). Aluminium production, which requires a large amount of reliable, cheap electricity, is historically linked to a coal beneficiation strategy which is no longer valid (Monaisa and Montmasson-Clair forthcoming).

Figure 9: South Africa's export per product at the four-digit level (in US$ thousand)

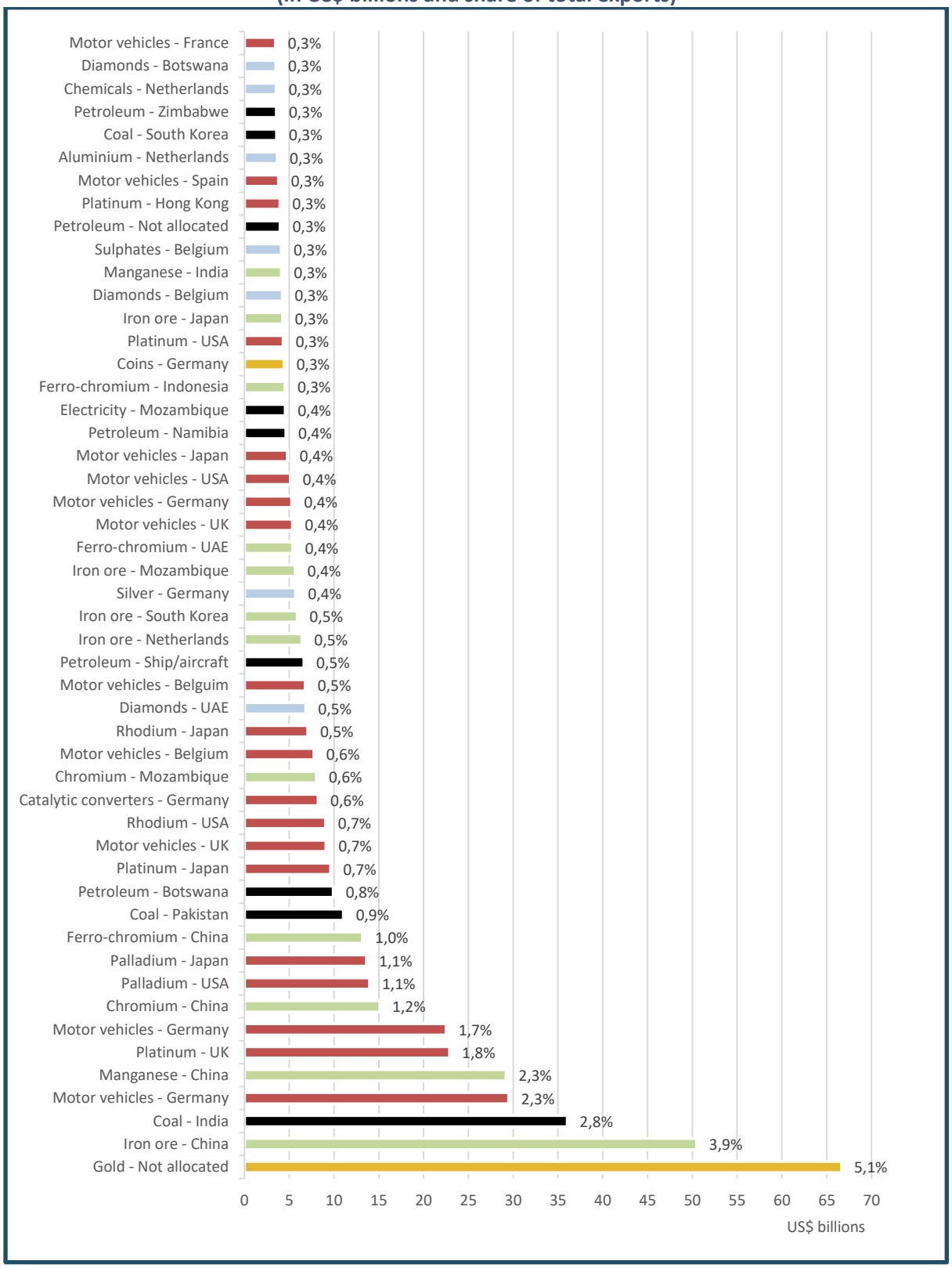


Source: Author, based on data from Quantec.

South Africa's exports by leading pairs of product-country (Figure 10) confirms these diagnostics at the geographical and product levels.

Besides unallocated gold, South Africa's exports are largely dominated by: minerals to China; motor vehicles to Europe and the US; PGMs to Europe, Japan and the USA; coal to India, Pakistan and South Korea; and petroleum products to SADC countries.

Figure 10: South Africa's main export per product-country pair in 2019 (in US$ billions and share of total exports)



Source: Author, based on data from Quantec. Note: gold is depicted in yellow; fossil fuels in black; automotive-related products in red; metals and minerals (non-automotive-related) in green; other products in light blue.

4. SOUTH AFRICA'S EXPORTED GHG EMISSIONS PER DESTINATION

South Africa's exports of GHG emissions match the country's trade profile. China captures the largest share of South Africa's exported GHG emissions, followed by the EU, India, the USA and Japan.[6] China's imports (in carbon terms) furthermore increased rapidly over the 2005-2015 period, compensating for a material decline in the EU's absolute and relative share.

Overall, the volume of exported GHG emissions grew progressively over the 2005-2015 period, although somewhat slower than the growth of exports. South African exports in US$ terms grew by a compounded annual growth rate of 5.5% while GHG emissions increased by 2.5% per annum, indicating a relative decoupling of GHG emissions with exports.

Figure 11: Carbon embodied in South Africa's gross export per destination (in $MtCO_2e$)

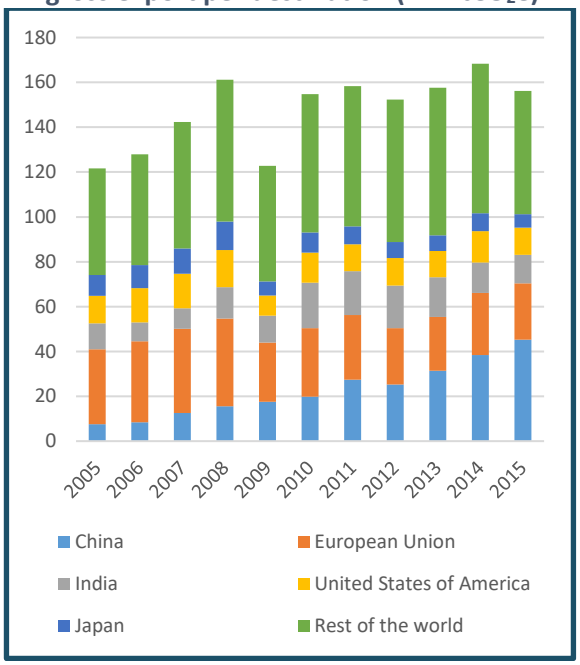
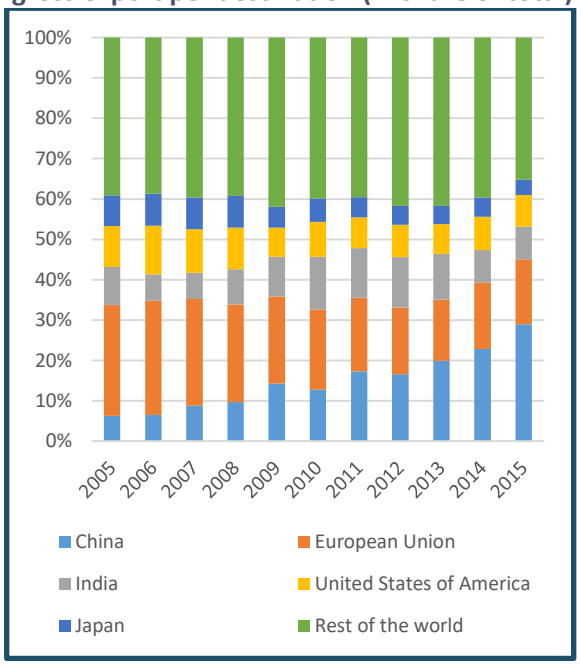


Figure 12: Carbon embodied in South Africa's gross export per destination (in share of total)



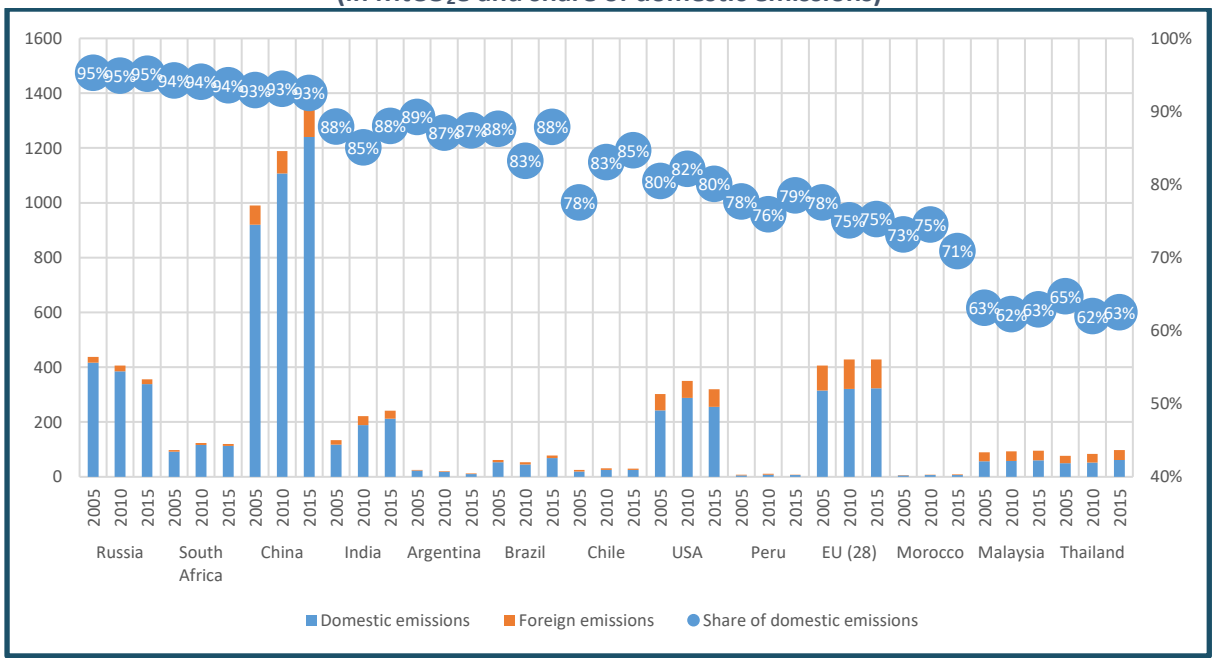
Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020. Disaggregated data for SADC countries are not available.

Figure 13 and Figure 14further disaggregate the carbon embodied in exports based on the origin of GHG emissions, i.e. domestic vs foreign GHG emissions. Domestic emissions are the result of local inputs and production while foreign emissions represent emissions embodied in inputs imported from other countries. This makes it possible to separate the origin of exported emissions into local factors (such as electricity supply) or imported emissions through intermediate products and inputs. Irrespective of the absolute level of exported GHG emissions (which China largely dominates), South Africa has a relatively high share of exported emissions which originate from domestic factors. This is particularly so for the export of intermediate products. For intermediate products, about 94% of South Africa's exported GHG emissions came from domestic sources in 2015. This is materially higher than most countries and largely a function of South Africa's coal-based electricity supply. Such a large share

[6] Disaggregated data for SADC countries are not available. SADC countries fall in the "Rest of the world' categories. While it is unlikely that any individual country would feature as a top importer of South African GHG emissions, the region as a whole would still account for a material share.

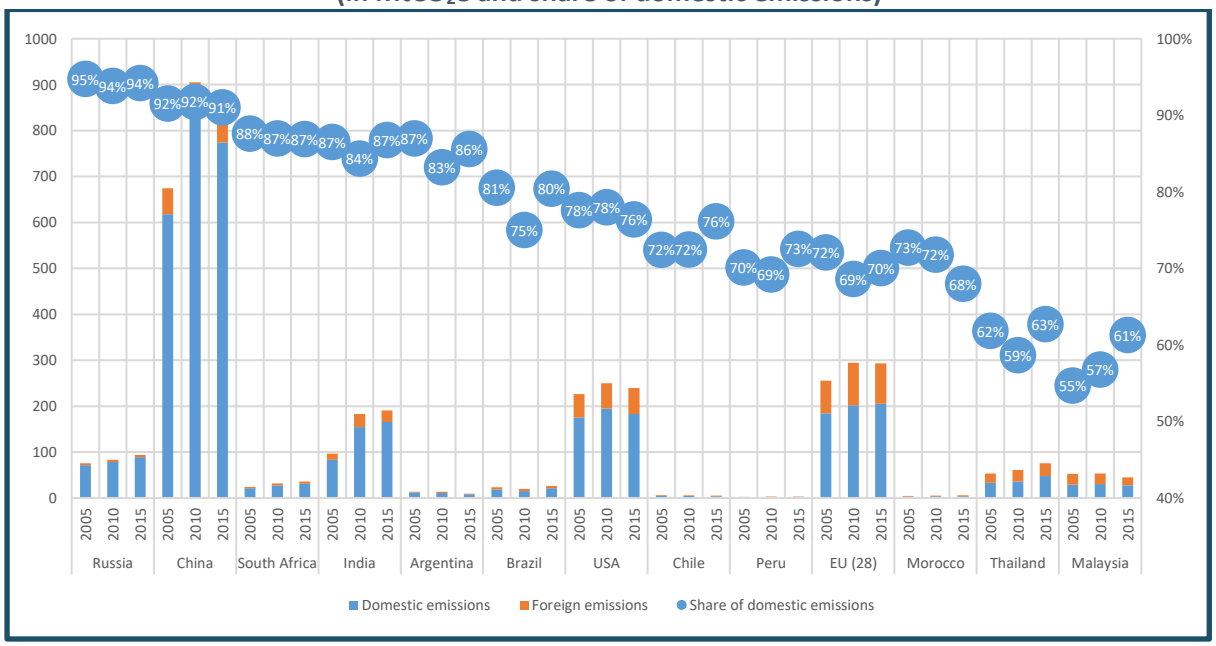
of domestic GHG emissions reduces the ability of South Africa to improve its resilience by shifting the origin of its inputs and puts the onus squarely on local factors.

Figure 13: Carbon embodied in South Africa's export of intermediate products (in $MtCO_2e$ and share of domestic emissions)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

Figure 14: Carbon embodied in South Africa's export of final products (in $MtCO_2e$ and share of domestic emissions)

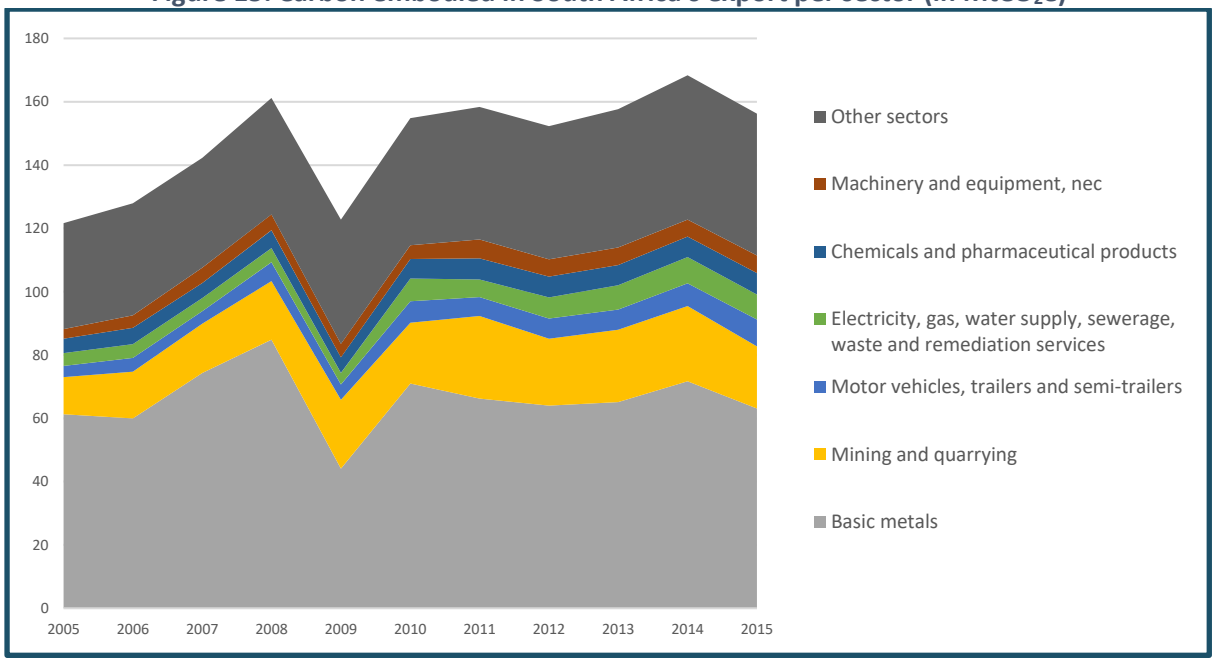


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

5. SOUTH AFRICA'S EXPORTED GREENHOUSE GAS EMISSIONS PER SECTOR

At a sectoral level, South Africa's exported GHG emissions are concentrated on mining value chain exports. Basic metals, mining and quarrying products accounted for more than half of exported GHG emissions (53%) in 2015. Motor vehicles, utility services, chemicals and chemical products, and machinery and equipment followed.

Figure 15: Carbon embodied in South Africa's export per sector (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

Exports (of embodied emissions) to the EU show a strong downward trend. On a Compound Annual Growth Rate (CAGR) basis, exports of embodied emissions declined by 2.8% per annum over the 2005-2015 period, and by 4.9% from the peak of 2008 until 2015. Exports in carbon terms are still dominated by basic metals despite a massive decline (in volume) by two-thirds over the 10-year period. Exported carbon embodied in mining and quarrying products (including coal) also decreased by more than half, over the same period.

Japan's imports of South African carbon have followed a similar trajectory to the EU's imports. From the 2008 peak to 2015, carbon embodied in South Africa's exports to Japan decreased by two-thirds. This decline was primarily driven by a decrease in basic metals, which account for the lion's share of Japanese imports (79% at the peak in 2008).

Figure 16: Carbon embodied in South Africa's export to the European Union (28) per sector (in $MtCO_2e$)

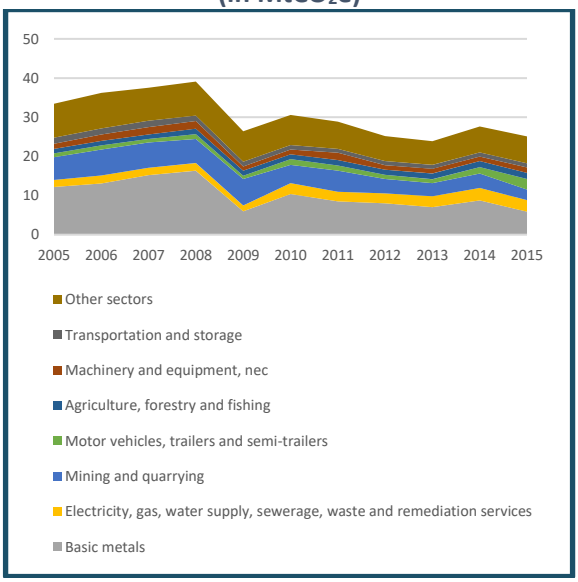
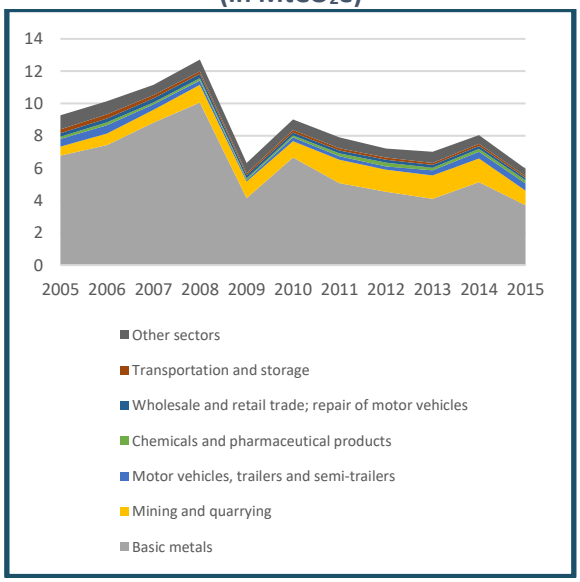


Figure 17: Carbon embodied in South Africa's export to Japan per sector (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

The Chinese picture dramatically contrasts with the EU and Japanese trade patterns. China's import of South African carbon has spiked six-fold over the 2005-2015 period (see Figure 18). Basic metals, followed by mining and quarrying products, account for the bulk (84%) of imported South African carbon by China.

US imports of South African embodied carbon display a third pattern (see Figure 19). While maintaining similar levels in 2005 and 2015 (around 12.3 $MtCO_2e$), US imports of South African embodied carbon have been relatively volatile over the period, fluctuating between 8.9 and 16.6 $MtCO_2e$.

Figure 18: Carbon embodied in South Africa's export to China per sector (in $MtCO_2e$)

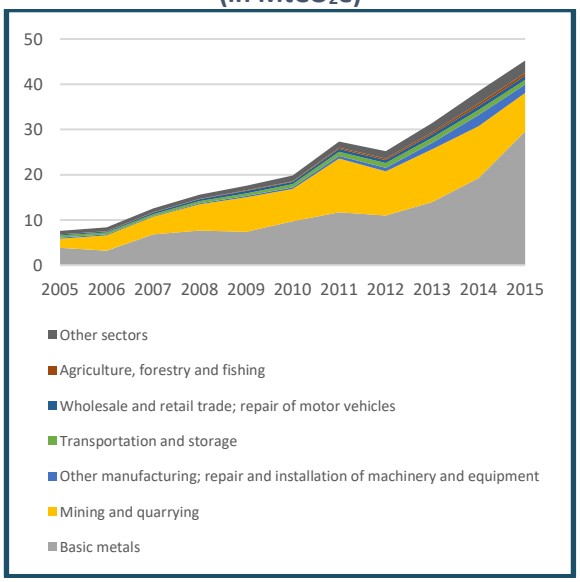
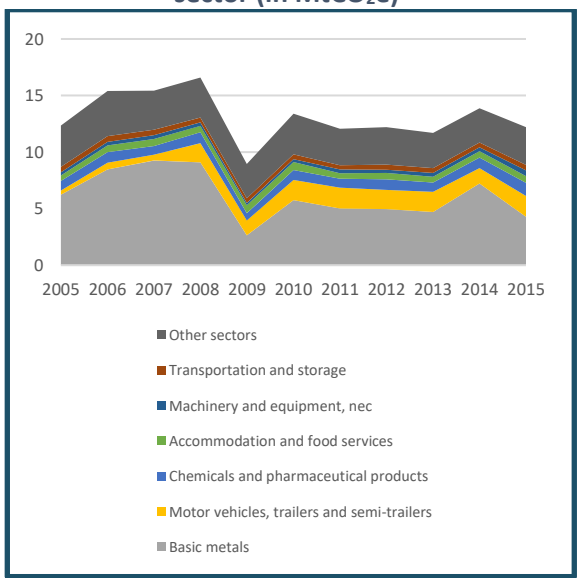


Figure 19: Carbon embodied in South Africa's export to the United States of America per sector (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020

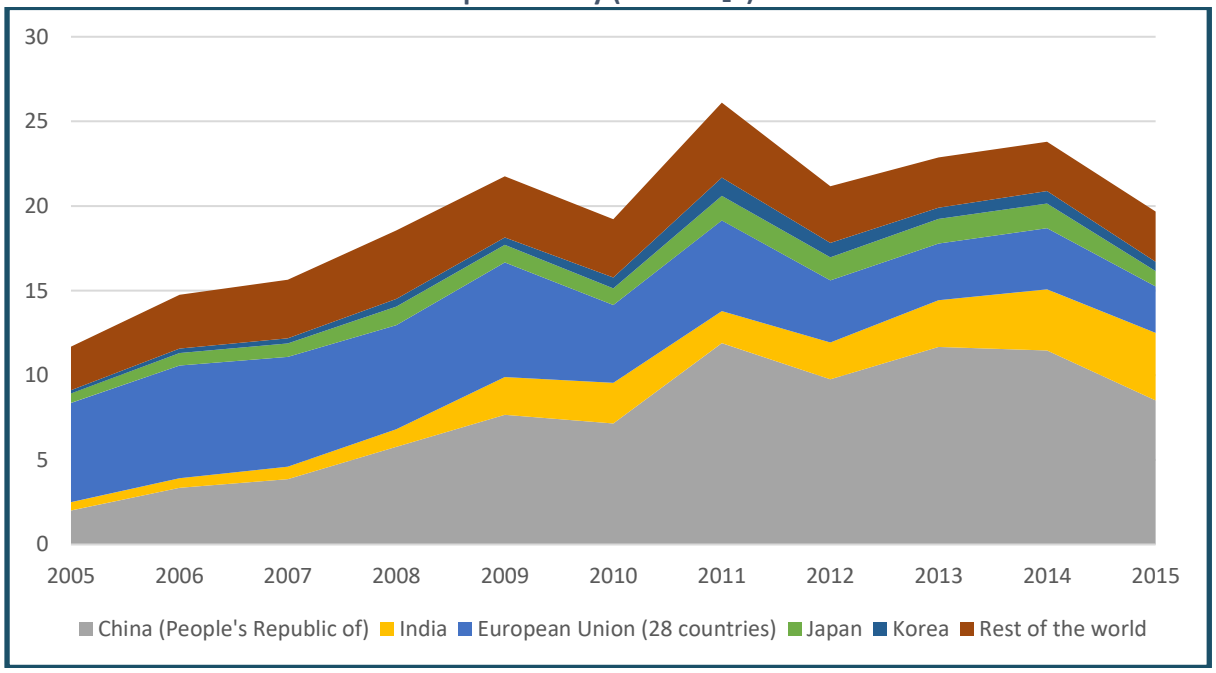
6. COMPARATIVE ANALYSIS AT A SECTORAL LEVEL

To fully grasp South Africa's trade vulnerability to climate change response measures, it is paramount to understand the destination of key exports and to examine the carbon intensity of South African exports relative to other countries.

6.1. Mining and quarrying

South Africa's mining and quarrying exports, in GHG emission terms, predominantly go to China, which attracted about half of such exports in 2015. Other key destinations have been India, which has also been growing steadily and the EU, which saw a material decline over the 2005-2015 period.

Figure 20: Carbon embodied in South Africa's mining and quarrying export per country (in $MtCO_2e$)

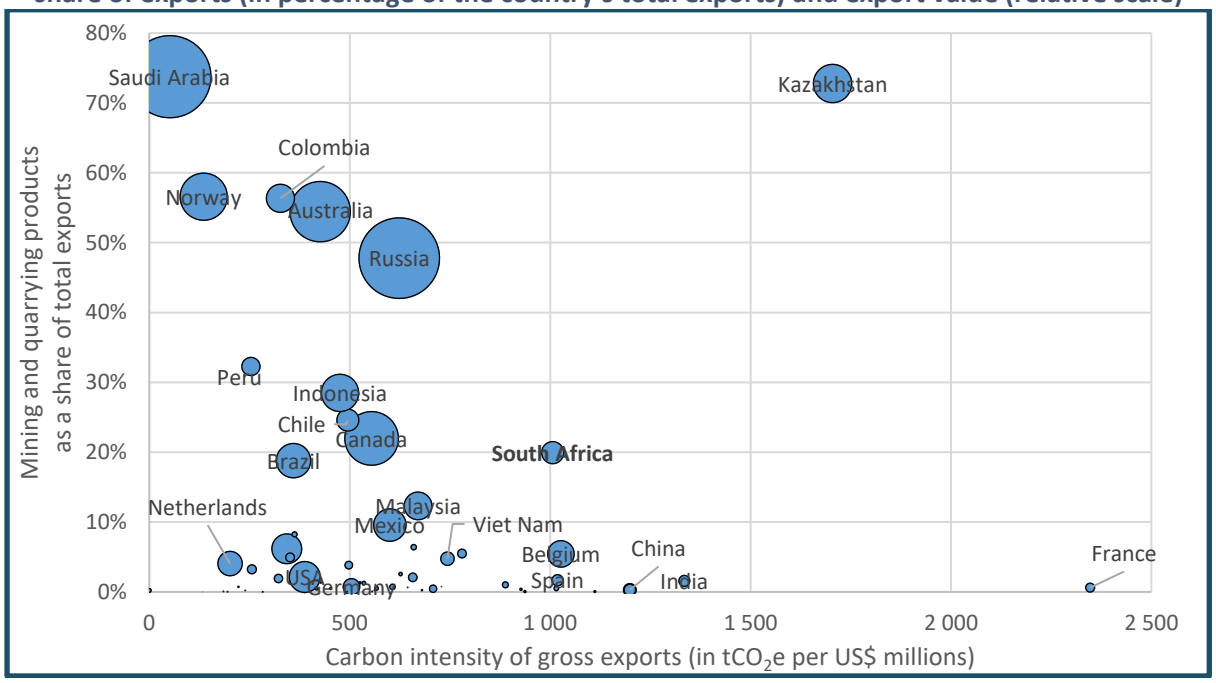


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020

Comparatively, South Africa's mining and quarrying exports are relatively carbon intensive (Figure 21), when measured in tCO_2e per US$ million. While not an outlier (like France and Kazakhstan), South Africa forms part of a group of high carbon-intensity countries, with India, China, Belgium, Vietnam, Japan and Spain. Within this group, only South Africa and Belgium have sizeable (in US$ terms) exports of mining and quarrying products.

South Africa also has the highest share of mining and quarrying exports (about 20%) in the country range. Large exporters, such as Saudi Arabia, Russia, Australia, Canada and Norway, all have much lower carbon intensity. In addition, South Africa is a large exporter of coal. With an increasing number of countries moving away from coal-fired electricity generation, the future of South Africa's coal exports (dominated by exports to India, Pakistan and South Korea) appears very uncertain (see Patel forthcoming for more details on coal-related dynamics).

Figure 21: Mining and quarrying export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)

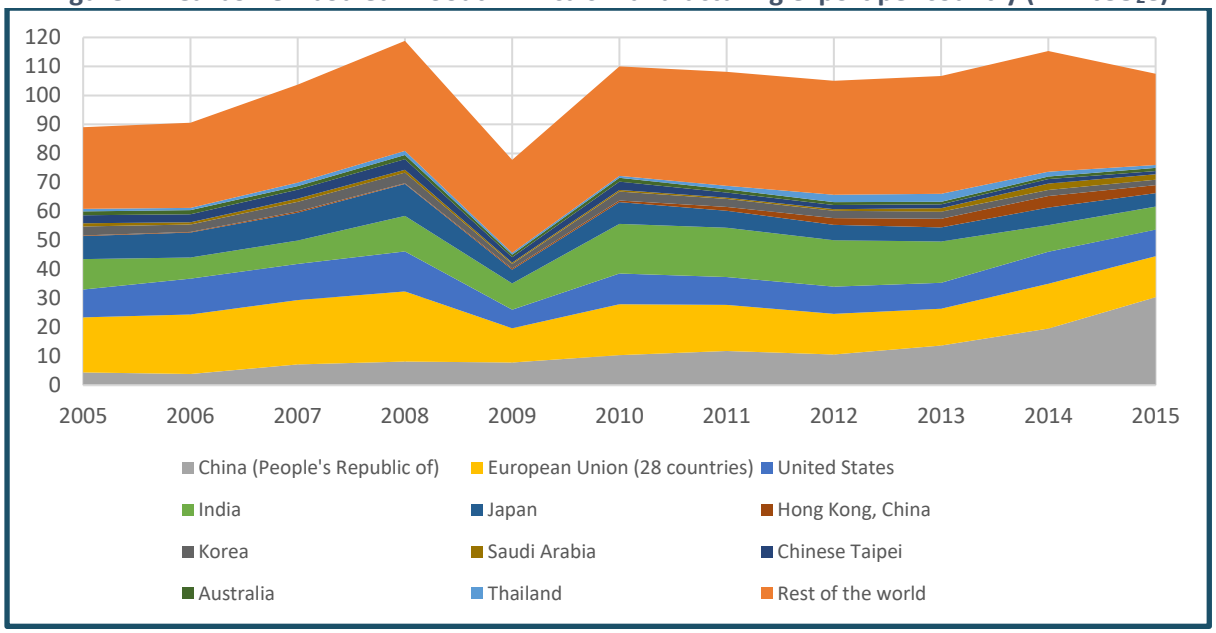


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020

6.2. Manufacturing

Manufacturing exports, in terms of embodied carbon, are primarily directed to China, which overtook the EU in 2013. The USA, India and Japan follow. Overall, GHG emissions embodied in manufacturing exports grew progressively from 2005 to 2015 at a CAGR of 1.9% per annum. This growth was driven by a significant increase in Chinese imports, while European, Japanese and Indian imports declined. Despite some fluctuation between years, imports from the USA remained largely stable over the period.

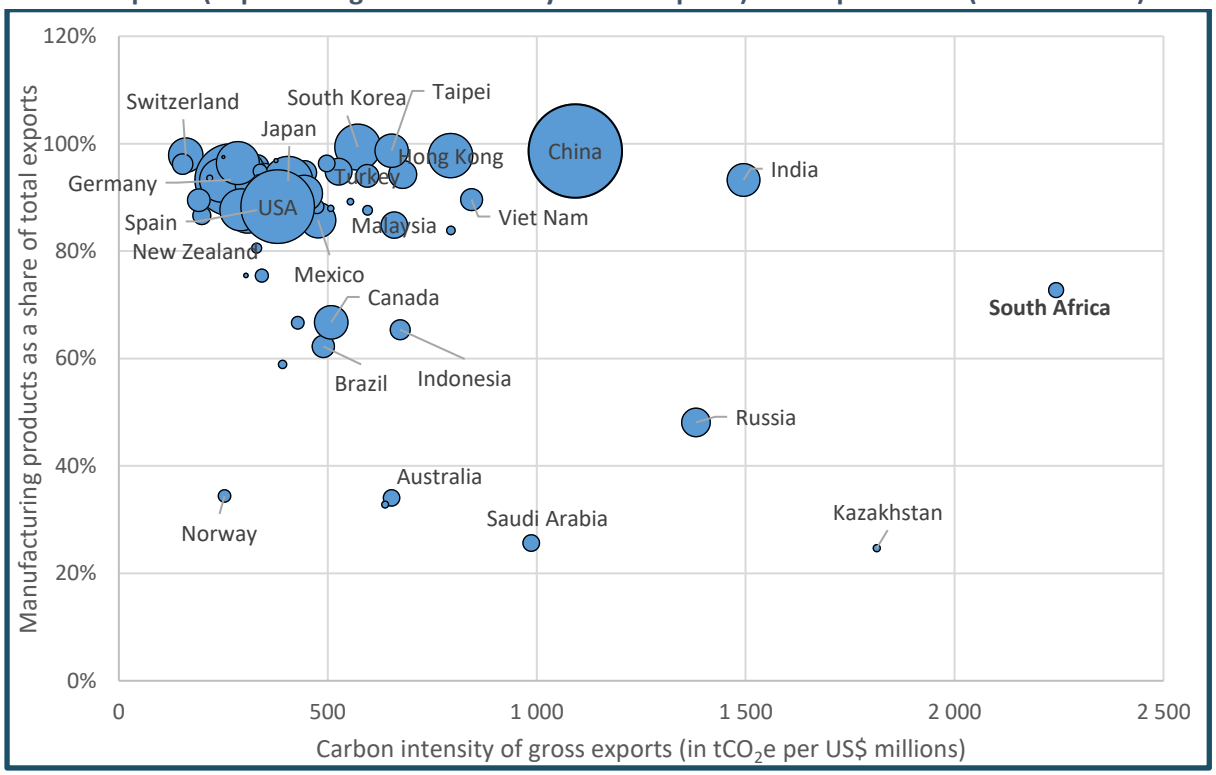
Figure 22: Carbon embodied in South Africa's manufacturing export per country (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020

In terms of carbon intensity, South Africa's manufacturing exports are extremely at risk. As shown in Figure 23, South Africa is an outlier compared to other countries. With 2 243 tCO_2e per US$ million, South Africa is the only country with a carbon intensity over 2 000 tCO_2e per US$ million. This can largely be explained by the high carbon-intensity of South Africa's energy supply (electricity and fuels), combined with a poor (although improving) performance in energy efficiency (Montmasson-Clair and Chigumira 2020). Even other outliers, such as Kazakhstan (1 814), India (1 495) and Russia (1 381) do much better. The bulk of the countries are spread from about 300 to 1 100 tCO_2e per US$ million. While important at the domestic level, South Africa's manufacturing exports are furthermore marginal at the global level, increasing their vulnerability to shifts in trade patterns.

Figure 23: Manufacturing export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)



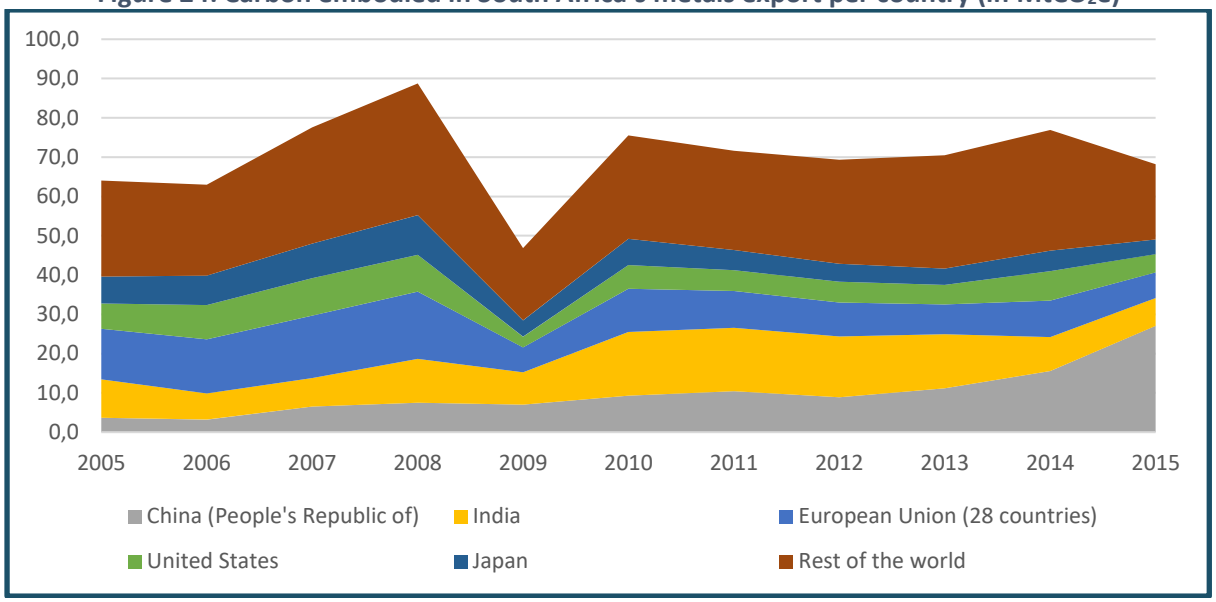
Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

6.3. Metals

South Africa's metals exports, calculated in terms of GHG emissions embodied in trade, were relatively stable over the 2005-2015 period.

Strong growth from Chinese imports (seven-fold increase over the period) has been compensated by a progressive but continual decline in all other major trade partners. This indicates a clear shift in trade patterns to China (see Figure 24).

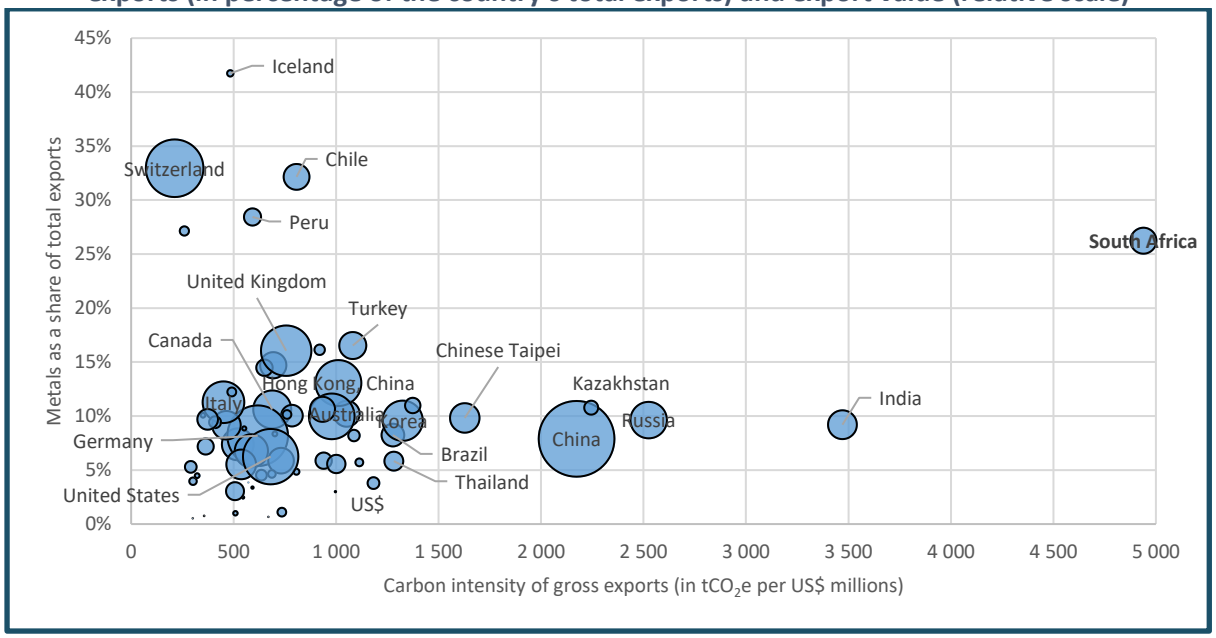
Figure 24: Carbon embodied in South Africa's metals export per country (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

In terms of carbon intensity, metals exports out of South Africa face a dire challenge. The country is an extreme outlier, with a carbon intensity of about 5 000 tCO_2e per US$ million, far from the second outlier, India, with about 3 500 tCO_2e per US$ million. China, the leading exporter, has an intensity of about 2 200 tCO_2e per US$ million. Russia features closely with about 2 500 tCO_2e per US$ million. All other countries, including key exporters, such as Switzerland, the USA, the UK, Australia, Italy and Canada, as well as South African competitors, like South Korea, Brazil, Thailand or Turkey, oscillate between 200 and 1 400 tCO_2e per US$ million. Again, South Africa's coal-based electricity supply, associated with a relatively energy inefficiency, largely explains the position of the domestic metals industry, which relies primarily on coal and electricity to fire foundries, smelters and (metal) refineries (Lowitt 2020).

Figure 25: Metals export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)

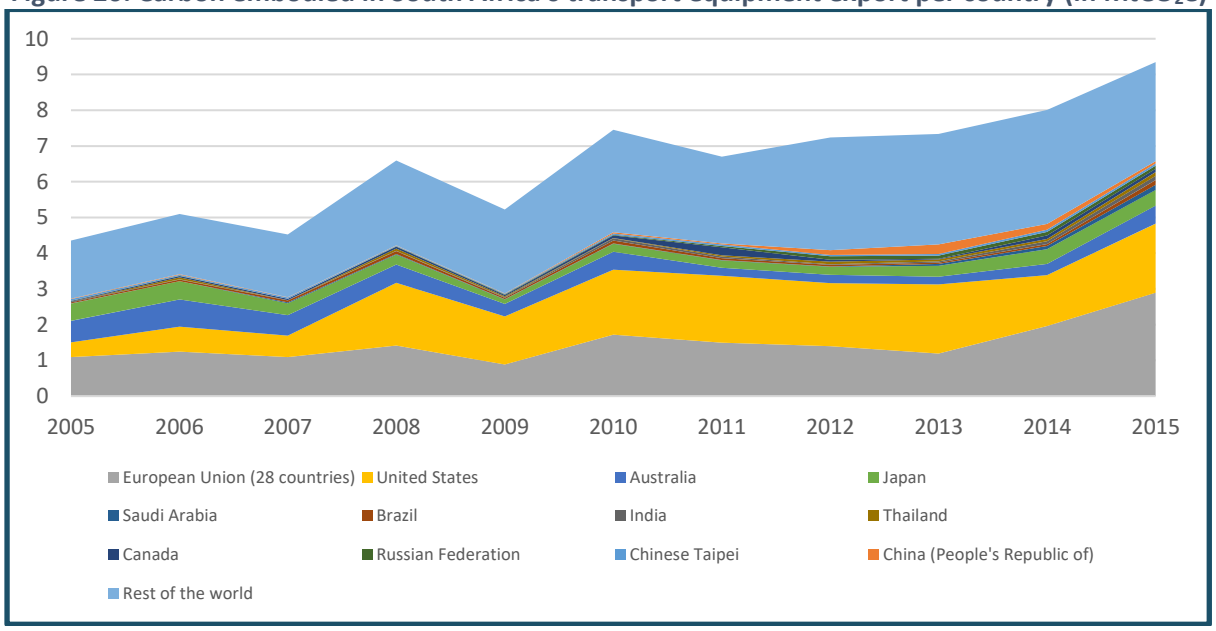


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

6.4. Transport equipment

GHG emissions originating from the export of transport equipment, which are dominated by the automotive value chain, are essentially directed to the EU and the USA. These two destinations accounted for more than half of exported GHG emissions in 2015. Overall, exports progressed upwards over the 2005-2015 period, led by growth in both the EU and the USA.

Figure 26: Carbon embodied in South Africa's transport equipment export per country (in $MtCO_2e$)

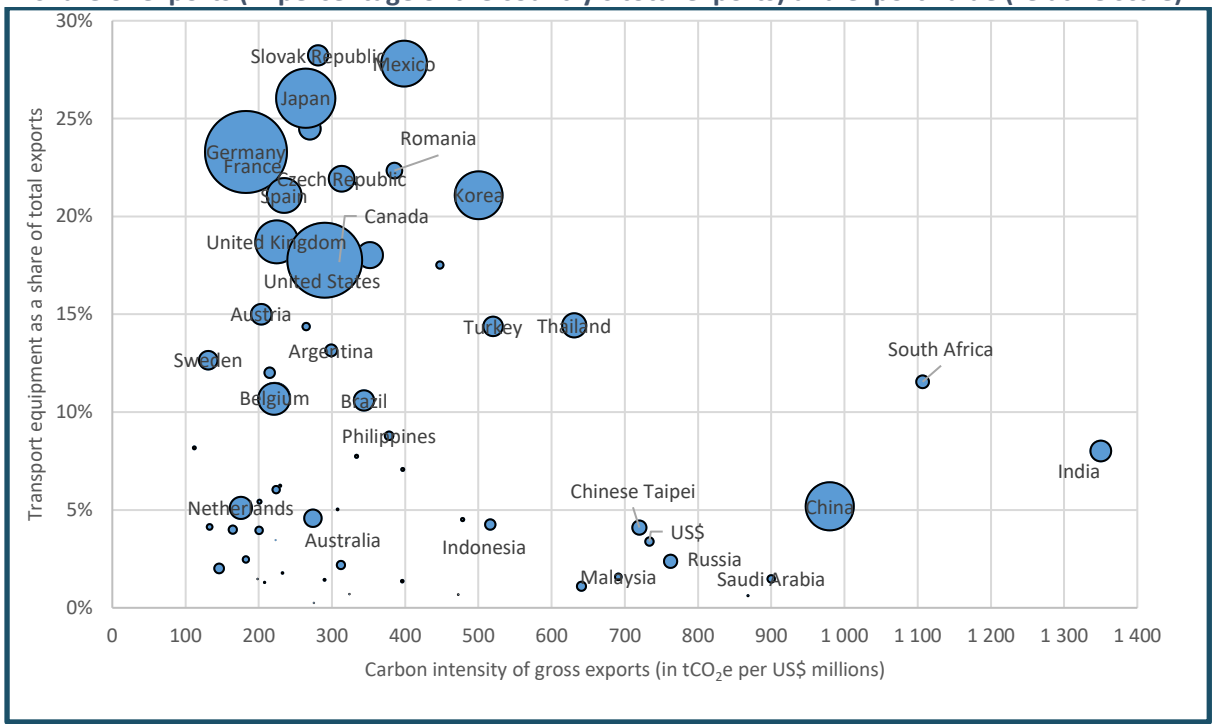


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020

Once again, South Africa is an outlier in terms of carbon intensity (see Figure 27). While not at the level of India (1 350), South Africa is an outlier with a carbon intensity of 1 100 tCO_2e per US$ million. China is also an outlier with about 1 000 tCO_2e per US$ million. Most countries, including leading exporters like Germany, the USA, the UK, France, Japan and South Korea, range from 150 to 500 tCO_2e per US$ million.

This outlying situation, combined with leading destinations being the EU and USA, puts South Africa's exports at risk. However, the main climate change-related risk to South African exports of transport equipment does not originate from their relative carbon intensity. Vulnerability stems primarily from the underlying shift in the transport sector to e-mobility. The EU and the USA are two markets which are aggressively shifting to electric vehicles. Yet South Africa's export of transport equipment are heavily linked to petroleum-based vehicles. This will require the domestic industry to find new markets for its products and/or shift production towards electric vehicles (Montmasson-Clair, Dane, and Moshikaro 2020; Dane, Wright, and Montmasson-Clair 2019).

Figure 27: Transport equipment export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)

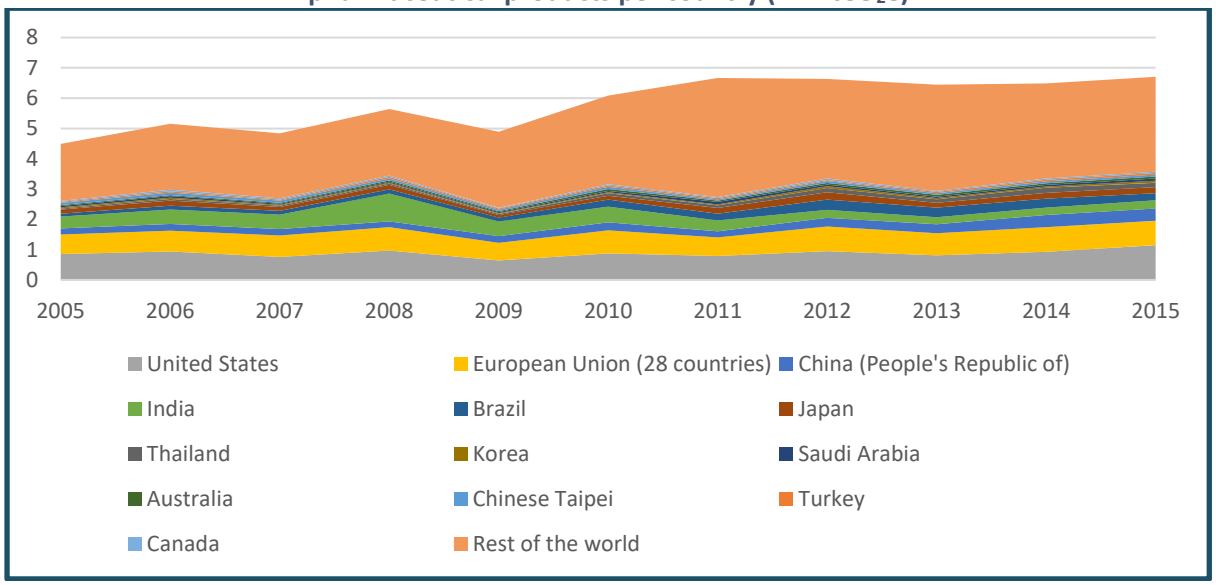


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020 Note: bubbles indicate the relative value of countries' export of transport equipment in US$.

6.5. Chemicals and chemical products

South Africa's export of carbon embodied in chemicals and pharmaceutical products rose steadily from 2005 to 2015, at a CAGR of 4.1%. Geographically, they are spread across a large number of countries. Primary destinations over the period were the USA (17%) and the EU (12%), followed by China (6%), India (4%) and Brazil (3%).

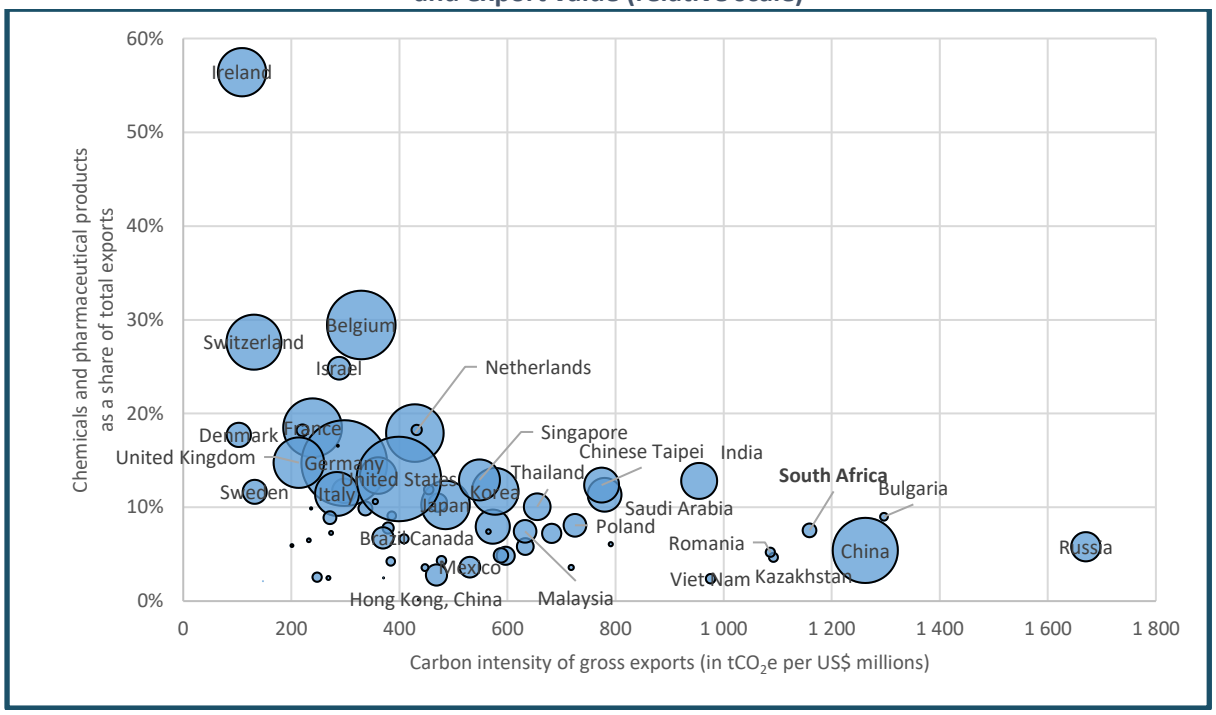
Figure 28: Carbon embodied in South Africa's export of chemicals and pharmaceutical products per country (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

In terms of carbon intensity, South Africa's exports of chemicals and pharmaceutical products are more carbon-intensive than most other countries. Russia is the most carbon-intensive exporter and an outlier at 1 670 tCO_2e per US$ million. South Africa, at 1 159 tCO_2e per US$ million, is part of a group of carbon-intensive exporters including China. Most countries are located between 200 and 800 tCO_2e per US$ million.

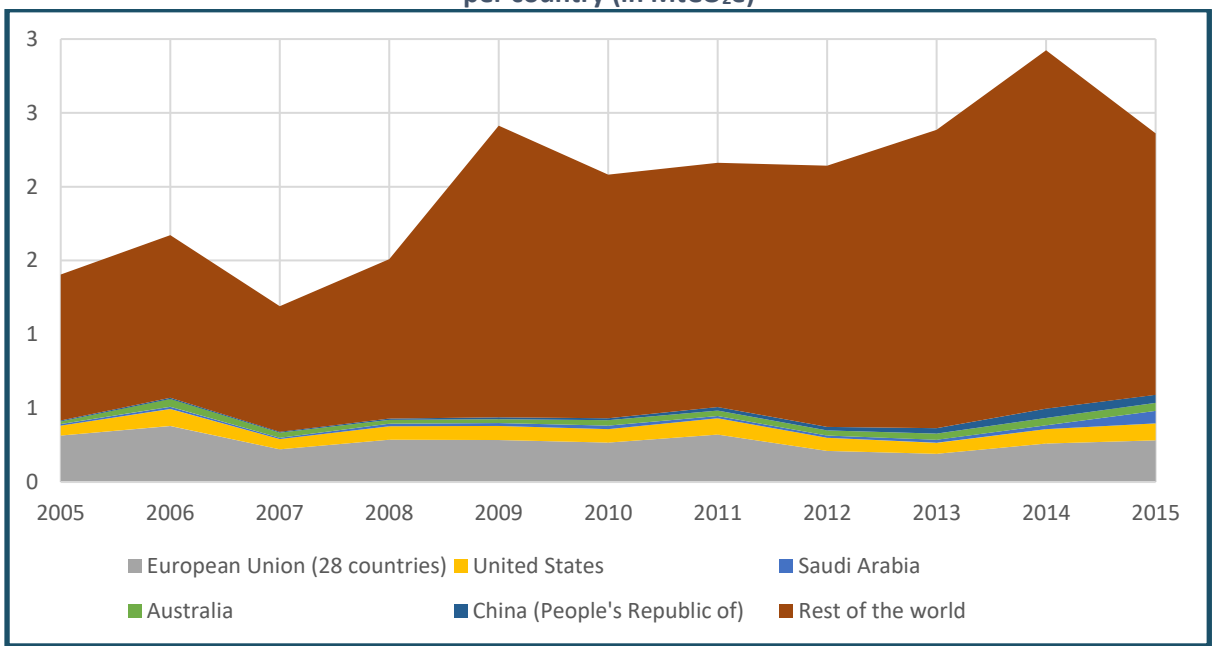
Figure 29: Export of chemicals and pharmaceutical products per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.
Note: bubbles indicate the relative value of countries' export of chemicals and pharmaceutical products in US$.

Turning to the export of carbon embodied in rubber and plastic products, a similar picture emerges. Exported embodied carbon has been growing strongly at a CAGR of 5.3%. The EU (12% in 2015) followed by the USA (5%) and Saudi Arabia (4%), dominate a list of geographically spread importers.

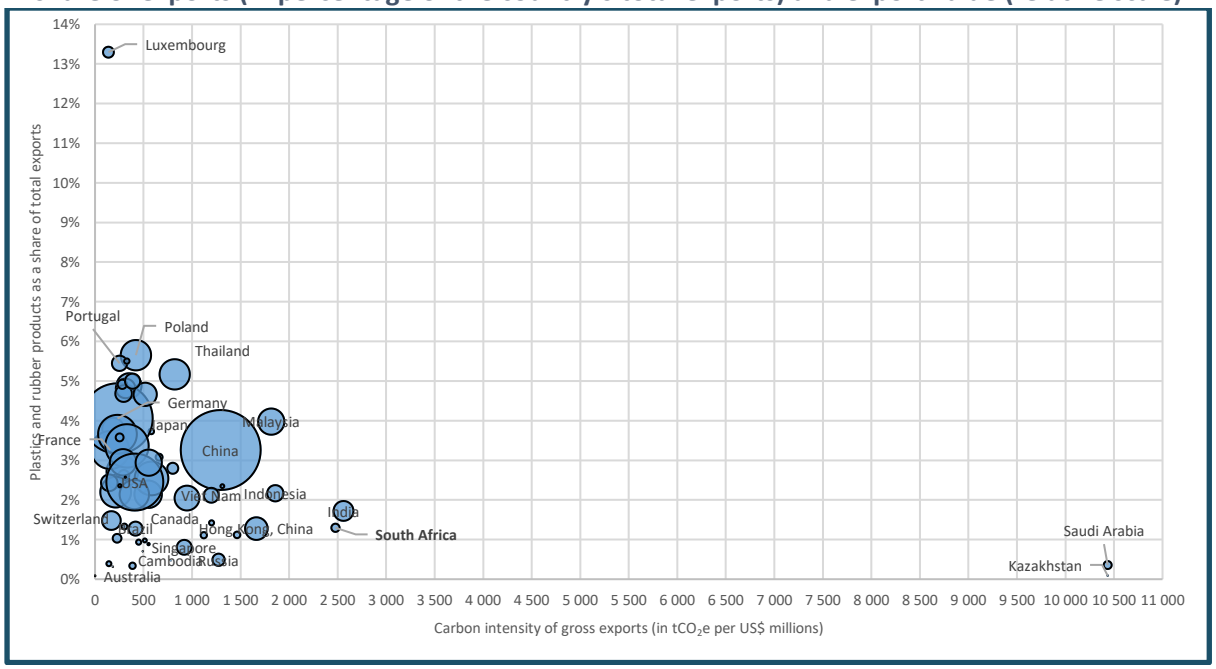
Figure 30: Carbon embodied in South Africa's export of rubber and plastic products per country (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

The carbon intensity of South Africa's export of rubber and plastics products is once again relatively high, largely due to the country's coal-based electricity and Sasol's coal-to-liquid process. While nowhere near Saudi Arabia and Kazakhstan, two extreme outliers, South Africa still has carbon-intensive rubber and plastic exports. At around 2 500 tCO_2e per US$ million, South Africa's exports are much more carbon intensive than China (at about 1 300 tCO_2e per US$ million) and the bulk of countries (between 150 and 600 tCO_2e per US$ million).

Figure 31: Plastics and rubber export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)

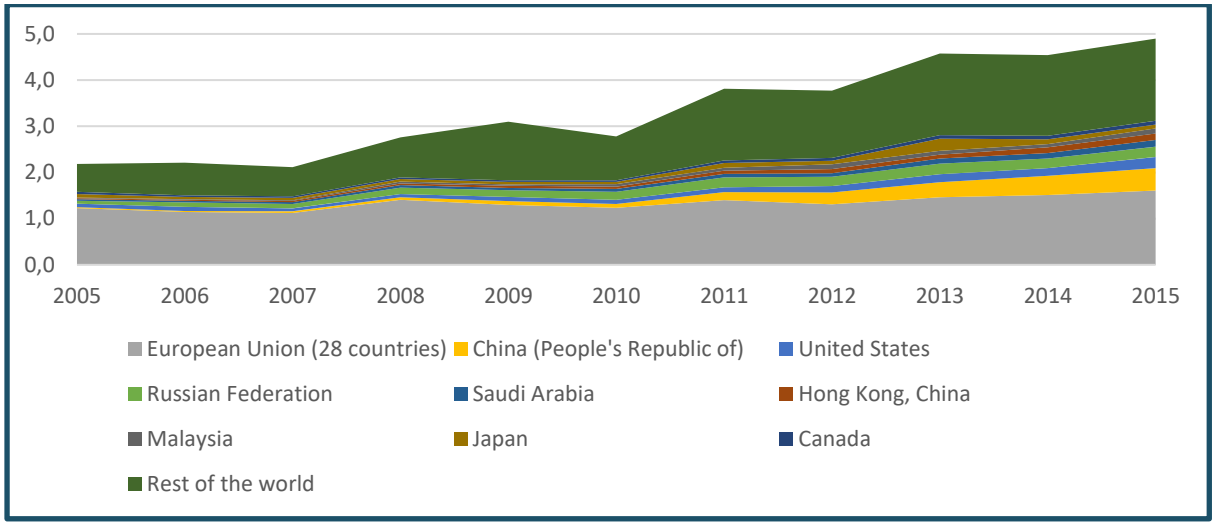


Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020 Note: bubbles indicate the relative value of countries' export of plastics and rubber products equipment in US$.

6.6. Agricultural products

GHG emissions linked to the export of South African agricultural products mainly go to the EU, for about a third (in 2015). China (10% in 2015), the USA (5%) and Russia (5%) follow. Despite some energy efficiency improvement, exported carbon from agricultural products grew by more than 200% from 2005 to 2015, due to growing demand from most markets.

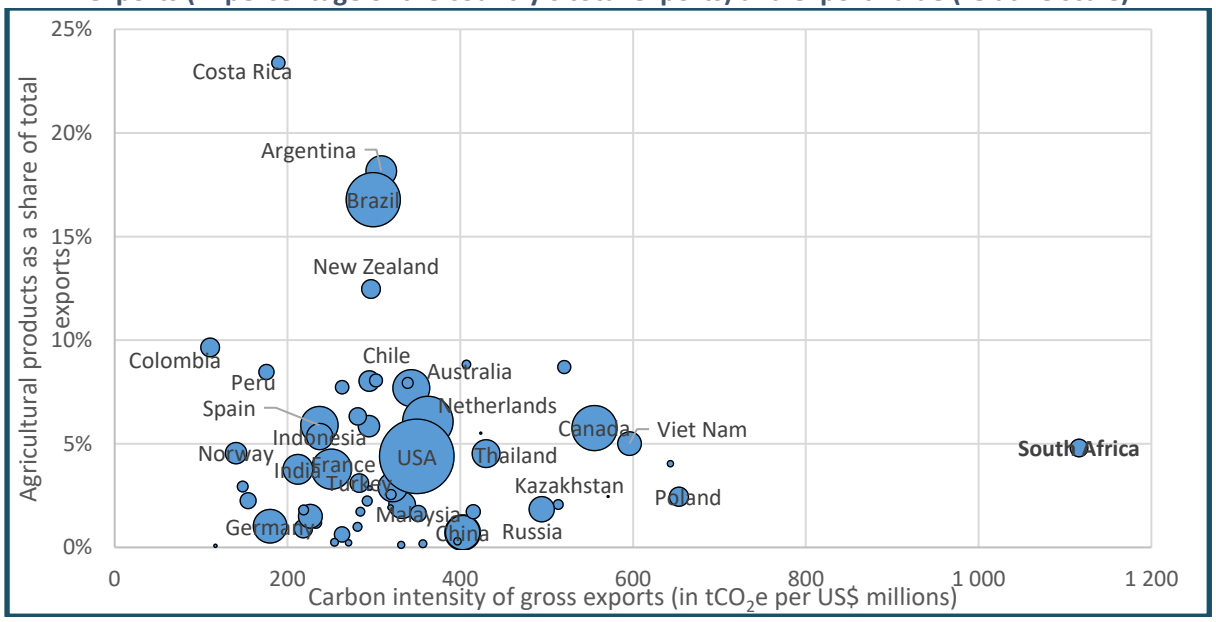
Figure 32: Carbon embodied in South Africa's agricultural export per country (in $MtCO_2e$)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020.

South Africa's agricultural exports are, like for metals, extreme outliers at the global level in carbon intensity. With an intensity of more than 1 100 tCO_2e per US$ million, South Africa is almost twice as carbon intensive than the second country, Poland (650). Most countries have an intensity between 100 and 500 tCO_2e per US$ million. The leading exporter in GHG emissions, the USA, stands at 350 tCO_2e per US$ million.

Figure 33: Agricultural export per country per carbon intensity (in tCO_2e per US$ million), share of exports (in percentage of the country's total exports) and export value (relative scale)



Source: Author, based on data from the OECD, dataset on carbon dioxide emissions embodied in international trade, downloaded from https://stats.oecd.org in March 2020 Note: bubbles indicate the relative value of countries' export of agricultural products in US$.

7. CONCLUSION

Overall, the rise of the global climate change regime, as part of a broader transition to sustainable development, has deep implications for South Africa's industrial development. This is evident in the case of South Africa's exports, which are at risk of measures aimed at curbing the trade of carbon-intensive goods as well as imports from carbon-intensive jurisdictions. With the rise of the international climate change regime, GHG emissions have emerged as a new commodity. Embodied carbon is effectively traded through the import and export of products and services.

South Africa's export (of goods) are focused on a few destinations (SADC, EU, China, USA, UK, Japan and India). The country's exports are also heavily concentrated around a limited number of value chains (i.e. the minerals, automotive, petroleum and agricultural value chains). Combined, these two dimensions make South Africa particularly vulnerable to changes in trade patterns arising from measures aimed at transiting to low-carbon pathways.

From a climate risk perspective, a material share of importers (such as the EU, the USA, UK and Japan) are rapidly moving away from carbon-intensive activities and may introduce BCAs in the near future. Already, South Africa's exported GHG emissions have shifted over the past two decades. China's imports (in carbon terms) have increased rapidly, compensating a material decline in the EU's and Japan's absolute and relative share.

Comparatively, South Africa's exports are moreover relatively carbon intensive. The country is a global outlier for numerous products, such as metals, transport equipment and agricultural products. In other cases, South Africa forms part of a group of high carbon-intensity countries (mining and quarrying, chemicals and pharmaceutical products, rubber and plastics products).

In addition, South Africa is a large exporter of fossil fuels (coal but also petroleum products) as well as petroleum-based transport equipment, which are set to experience dramatic shifts in the coming years.

While a small country in overall embodied emissions, South Africa is one of the leading exporters of embodied GHG emissions. In fact, exported emissions represent a large share of South Africa's total GHG emissions (about a quarter in 2015). South Africa also has a relatively high share of exported emissions originating domestically, highlighting once more the role of domestic factors, such as energy supply and use.

This situation is largely a function of: a) the country's carbon-intensive energy system; b) a poor (although improving) energy efficiency performance; and c) the key role played by energy-intensive industries in the South Africa's economy. The country's vulnerability is also reinforced by the absence of an ambitious climate change framework, South Africa's relatively long distance to its trading partners and the status of emerging economy. Encouragingly, South African exports have nevertheless increased faster in US$ terms than in embodied carbon terms, indicating a relative decoupling of GHG emissions with exports over the 2005-2015 period.

Looking ahead, this situation calls for decisive action to reduce the carbon intensity of the South African economy as well as diversify the structure of exports to low(er)-carbon products. This is essential to maintain South Africa's competitiveness and market access going forward. Despite some progress (for instance, in grid decarbonisation and energy efficiency efforts), much more is required to reduce South Africa's vulnerability to climate change regulations and set the country on a sustainable pathway.

REFERENCES

Akerlof, George, Alan Greenspan, Eric Maskin, William Sharpe, Robert Aumann, Lars Peter Hansen, and Daniel McFadden. 2019. "Economists' Statement on Carbon Dividends." *Wall Street Journal*, January 17, 2019. https://www.clcouncil.org/economists-statement/.

Camco, and TIPS. 2010. "Climate Change: Risks and Opportunities for the South African Economy – An Assessment of Mitigation Response Measures." Johannesburg: Camco.

Cosbey, Aaron, and Peter Wooders. 2011. "Border Carbon Adjustments: What Risk for South African Exporters?" Winnipeg: International Institute for Sustainable Development.

Dane, Anthony, Dave Wright, and Gaylor Montmasson-Clair. 2019. "Exploring the Policy Impacts of a Transition to Electric Vehicles in South Africa." Pretoria: Trade & Industrial Policy Strategies.

Du Plooy, Peet, and Meagan Jooste. 2011. "Trade and Climate Change: Policy and Economic Implications for South Africa." Pretoria: Trade and Industrial Policy Strategies.

European Commission. 2020. "Europe's Moment: Repair and Prepare for the Next Generation." Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0456&from=EN.

European Council. 2020. "Special Meeting of the European Council (17, 18, 19, 20 and 21 July 2020) – Conclusions." Brussels: European Council. https://www.consilium.europa.eu/media/45109/210720-euco-final-conclusions-en.pdf.

Global Carbon Project. 2019. "Supplemental data of Global Carbon Budget 2019." (Version 1.0) [Data set]. Global Carbon Project.

Hund, Kirsten, Daniele La Porta, Thao P. Fabregas, Tim Laing, and John Drexhage. 2020. "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition." Washington, D.C.: World Bank.

Jooste, Meagan, Harald Winkler, Dirk van Seventer, and Truong P. Truong. 2009. "The Effect of Response Measures to Climate Change on South Africa's Economy and Trade. Final Report to the Department of Environmental Affairs." Cape Town: Energy Research Centre at the University of Cape Town.

Lowitt, Sandy. 2020. "An Economic Input into the Decision-Making Process Regarding the National Foundry Technology Network." Pretoria: Trade & Industrial Policy Strategies.

Maia, Jorge, Thierry Giordano, Nico Kelder, Ganief Bardien, Moleboge Bodibe, Peet du Plooy, and Xoliswa Jafta. 2011. "Green Jobs: An Estimate of the Direct Employment Potential of a Greening South African Economy." Johannesburg and Pretoria: Industrial Development Corporation, Development Bank of Southern Africa and Trade and Insdustrial Policy Strategies.

Monaisa, Lerato, and Gaylor Montmasson-Clair. forthcoming. "South Africa's Aluminium Value Chain and Climate Change." Pretoria: Trade & Industrial Policy Strategies.

Montmasson-Clair, Gaylor. forthcoming. "South Africa's Metals Value Chains in a Climate-Compatible World: A Just Transition Approach." Pretoria: Trade & Industrial Policy Strategies.

———. 2012. "Harnessing Public Trade Finance to Foster a Green Economy in Developing Countries: Current State of Play and Way Forward." In *Le Méridien*, Mauritius.

———. 2015. "The Interplay between Mining and Green Economy in South Africa: An Energy Lens." Grenoble: Pierre Mendès-France University.

———. 2016. "Designing Policy Frameworks for a Climate-Compatible Industrial Development Transition in South Africa." Pretoria: Trade & Industrial Policy Strategies and the Department of Trade and Industry.

Montmasson-Clair, Gaylor, and Gillian Chigumira. 2020. “Green Economy Policy Review of South Africa’s Industrial Policy Framework.” Geneva and Pretoria: United Nations Environment Programme, Department of Environment, Forestries and Fisheries, Department of Trade, Industry and Competition, and Department of Science and Innovation.

Montmasson-Clair, Gaylor, Anthony Dane, and Lesego Moshikaro. 2020. “Harnessing Electric Vehicles for Industrial Development in South Africa.” Pretoria: Trade & Industrial Policy Strategies, Department of Trade, Industry and Competition, and National Association of Automobile Manufacturers of South Africa.

Montmasson-Clair, Gaylor, Christopher Wood, Shakespear Mudombi, and Bhavna Deonarain. 2017. “A Green Economy Industry and Trade Analysis: Assessing South Africa’s Potential.” Pretoria: Department of Environmental Affairs, Department of Trade and Industry, Department of Science and Technology, United Nations Environment Programme and United Nations Industrial Development Organization.

Our World in Data. n.d. “CO_2 emissions embedded in trade, 2017. https://ourworldindata.org/grapher/share-co2-embedded-in-trade

Patel, Muhammed. forthcoming. “South Africa’s Coal Value Chain.” Pretoria: Trade & Industrial Policy Strategies.

Peters, Glen P., and Edgar G. Hertwich. 2008. “CO2 Embodied in International Trade with Implications for Global Climate Policy.” *Environmental Science and Technology* 42 (5): 1401–7.

Peters, Glen P., Jan C. Minx, Christopher L. Weber, and Ottmar Edenhofer. (2011). “Growth in emission transfers via international trade from 1990 to 2008.” Proceedings of the National Academy of Sciences of the United States of America (PNAS).

Tamiotti, Ludivine, Robert Teh, Vesile Kulaçoğlu, Anne Olhoff, Benjamin Simmons, and Hussein Abaza. 2009. “Trade and Climate Change.” Geneva: World Trade Organisation and United Nations Environment Programme.

TIPS. 2018. “Unlocking Green Jobs in South Africa: A Catalytic Intervention. Synthesis Report.” Pretoria: Trade & Industrial Policy Strategies, WWF Nedbank Green Trust, Agence Française de Développement.

TIPS, the dti, and IDC. 2013a. “Trade and Climate Change: Exploring the Impact on South African Business.” Summary of Roundtable Discussion. Pretoria and Johannesburg: Trade and Industrial Policy Strategies. Department of Trade and Industry and Industrial Development Corporation.

———. 2013b. “Trade and Climate Change: Exploring the Impact on South African Business.” Summary of Roundtable Discussion. Pretoria and Johannesburg: Trade and Industrial Policy Strategies. Department of Trade and Industry and Industrial Development Corporation.

Von der Leyen, Ursula. 2019. “A Union That Strives for More. My Agenda for Europe. Political Guidelines for the next European Commission 2019-2024.” Brussels: European Commission. https://www.europarl.europa.eu/resources/library/media/20190716RES57231/20190716RES57231.pdf.

World Bank. 2017. “The Growing Role of Minerals and Metals for a Low Carbon Future.” Washington, D.C.: World Bank Group.

———. 2020. “State and Trends of Carbon Pricing 2020.” Washington, D.C.: World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/33809/9781464815867.pdf?sequence=4&isAllowed=y.