



Improving the UKMRIO's Material Footprint

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Abstract

The UK's Multi-Regional Input-Output database (UKMRIO) is used to calculate the UK's material footprint as well as a number of other environmental and economic indicators. The UKMRIO is constructed from National Accounts data from the UK's Office for National Statistics, as well as from international trade data from a global Multi-Regional Input-Output (GMRIO) databases. As research on the UK's carbon and greenhouse gas footprints has recommended switching the GMRIO input data from FIGARO to EXIOBASE, this research aims to understand the impacts of this switch on the material footprint.

This analysis is particularly timely and necessary, as these databases have very different levels of disaggregation of the mining and quarrying sector – a key sector for the material footprint. While EXIOBASE subdivides this into 14 distinct sectors, FIGARO contains only a single mining and quarrying sector. The UK National Accounts, which make up the UK's economic data in the UKMRIO, on the other hand contain 4 sectors for mining and quarrying.

To assess the impact of this switch, this report undertakes two analyses. First, we aim to understand the impact of aggregating mining on the material footprint by calculating the UK's consumption-based material footprint from EXIOBASE with mining and quarrying disaggregated to 1, 4, and 14 sectors. Second, we assess the impact of using FIGARO data in the UKMRIO on the UK's material footprint and provide recommendations for method improvements.

Our findings show that while 4 mining sectors provide a good approximation of 14 mining sectors, having only a single mining sector overestimates the UK's material footprint. We therefore provide a new method which uses EXIOBASE proportions to disaggregate FIGARO's single mining sector into 4 distinct sectors. Using the disaggregated version of the FIGARO dataset provides a practical solution to improve both the material and the carbon footprints.

Keywords: Multi-regional input-output analysis, environmental accounting, materials footprint, carbon footprint

JEL classification: Q56, Q57

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Improving the UKMRIO's Material Footprint

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Summary

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To assess the impact of this switch, this report undertakes two analyses. First, we aim to understand the impact of aggregating mining on the material footprint by calculating the UK's consumption-based material footprint from EXIOBASE with mining and quarrying disaggregated to 1, 4, and 14 sectors. Second, we assess the impact of using FIGARO data in the UKMRIO on the UK's material footprint and provide recommendations for method improvements.

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Introduction

The University of Leeds (UoL) has developed the UK's Multi-Regional Input-Output database (UKMRIO) that is used to calculate the UK's material footprint and a number of other environmental and economic indicators for the UK (see Owen et al., 2023). The model considers the emissions embodied in global trade, to estimate the impact of UK consumption irrespective of where production occurred. This is in contrast to other measures, including territorial and production-based emissions, which estimate emissions by where they occur and who owns the production, respectively (see ONS, 2024).

The 2025 UKMRIO model is constructed using National Accounts data from the Office for National Statistics and global trade data from global Multi-Regional Input-Output (GMRIO) databases. Previous releases of the UKMRIO use EXIOBASE (Stadler et al., 2018) as source data for international trade. However, as research on the UK's carbon and greenhouse gas footprints has recommended using FIGARO (Eurostat, no date) data¹, FIGARO data will be used from the UKMRIO 2025 release. However, the impact of this switch on the material footprint has not yet been assessed.

¹ The UKMRIO 2025 release will use EXIOBASE data for the years 2001-2014 in the timeseries and FIGARO data for the years 2015-2022 in the timeseries.

One key difference between these datasets is level of disaggregation of the mining sectors. While the ONS data disaggregates the UK's mining and quarrying into 4 distinct sectors, EXIOBASE has 14 distinct mining and quarrying subsectors, while FIGARO aggregates all mining and quarrying into a single sector (see Table 1).

As sectoral aggregation can impact consumption-based emission results (Su et al., 2010), we investigate the impact of sectoral aggregation in mining – a key sector for the material footprint – on the consumption-based material footprint of the UK. In this report, we run two analyses. First, we assess the impact of sectoral aggregation of 'Mining and Quarrying' using EXIOBASE. This assesses the extent to which sectoral aggregation of 'Mining and Quarrying' can impact the UK's footprint. Next, we assess whether and how using FIGARO data impacts the UKMRIO's material footprint results and test potential improvements.

Table 1. The disaggregation of 'Mining and Quarrying' in FIGARO, UKMRIO, and EXIOBASE.

FIGARO	UKMRIO	EXIOBASE
1. Mining and Quarrying	1. Mining Of Coal And Lignite	1. Mining of coal and lignite extraction of peat
	2. Extraction Of Crude Petroleum And Natural Gas	2. Extraction of crude petroleum and services related to crude oil extraction, excluding surveying; 3. Extraction of natural gas and services related to natural gas extraction, excluding surveying; Extraction, liquefaction, and regasification of other petroleum and gaseous materials
	3. Mining of Metal Ores	4. Mining of uranium and thorium ores 5. Mining of iron ores 6. Mining of copper ores and concentrates 7. Mining of nickel ores and concentrates 8. Mining of aluminium ores and concentrates 9. Mining of precious metal ores and concentrates 10. Mining of lead, zinc and tin ores and concentrates 11. Mining of other non-ferrous metal ores and concentrates
	4. Other Mining and Quarrying	12. Quarrying of stone 13. Quarrying of sand and clay 14. Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.

Mining sector aggregation in EXIOBASE

1. Aim

In this part of the analysis, we aim to assess the impact of sectoral aggregation of 'Mining and Quarrying' using EXIOBASE, to understand potential limitations of sectoral aggregation in the UKMRIO.

2. Method

To test the impact of the mining sector aggregation and disaggregation on the UK's consumption-based material footprint, we run two analyses. First, we use EXIOBASE to calculate the UK's material footprint at the 3 levels of sectoral aggregation (1, 4, and 14 sectors, as shown in Table 1). To be able to compare these outputs, we keep other products and industries as closely aligned to their UKMRIO

aggregation as possible (see Appendix A). We assess results for the total material footprint, the biomass, fossil fuels, non-metallic minerals, and ore footprints.

Consumption-based material footprints are calculated using input-output analysis. The Leontief input-output model reports the economic interrelationships between industries throughout the global supply chain (Wood et al., 2019; Miller and Blair, 2022). The fundamental Leontief equation, $\mathbf{d} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$, indicates the inter-industry requirements of each sector to deliver a unit of output ($\mathbf{x}$) to final demand ($\mathbf{y}$), where $\mathbf{A} = \mathbf{Z}\mathbf{x}^{-1}$, and $\mathbf{I}$ is the identity matrix with the same dimensions as the input-output matrix ($\mathbf{Z}$). To calculate embedded consumption-based emissions ($\mathbf{p}$), direct industry material footprints ($\mathbf{s}$) are added into the equation (Equation 1).

Equation 1.

$$\mathbf{p} = \mathbf{s}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}}$$

3. Results

As shown in Figure 1, the materials footprint varies with different levels of ‘Mining and Quarrying’ product and industry aggregation². Until the year 2005, using 4 sectors results in a higher material footprint than using 1 or 14 sectors. However, after the year 2006, results from using 4 and 14 sectors appear to be more similar to each other than to aggregating mining to a single sector. Thus, for current results, having 4 subsectors for mining and quarrying appears to provide an estimate close to disaggregating mining into 14 subsectors. Aggregating mining to a single sector, on the other hand, appears to inflate the UK’s material footprint.

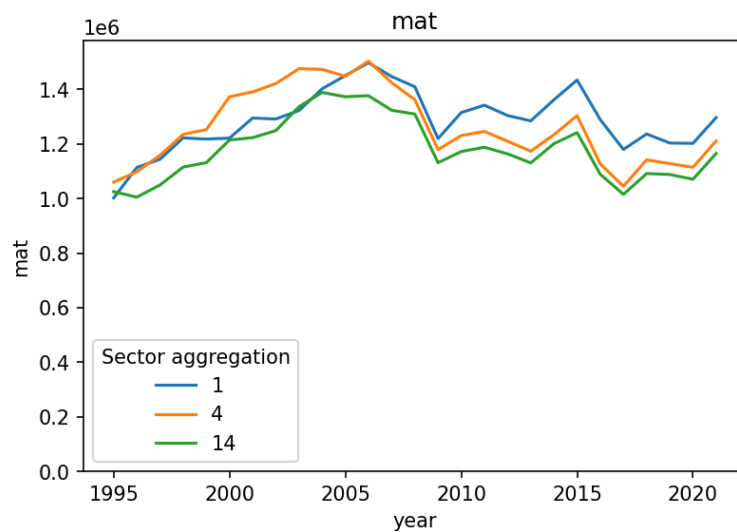


Figure 1. The UK's total material footprint from EXIOBASE.

These results are further mirrored in Figure 2, which shows the UK’s material footprint for different materials. While biomass does not seem to be impacted by this aggregation, we find noticeable differences in the UK’s consumption-based footprint by level of mining sector aggregation for fossil

² A test for the carbon and greenhouse gas footprints shows that these are not impacted by mining sector aggregation (see Appendix B). This was done to ensure other official footprints are not impacted by these potential changes to the UKMRIO model.

fuels, non-metallic minerals, and ore. Particularly for fossil fuels and ore, we find greater alignment in results from having 4 and 14 sectors, than from having only a single mining sector throughout the timeseries. As for total materials, non-metallic minerals show higher similarity from the 4 and 14 sector method only after the year 2006. Despite this shift in results over time, these findings suggest that for current years, having only a single mining sector may reduce the reliability of the material footprint.



Figure 2. The UK's material footprint from EXIOBASE for biomass (top left), fossil fuels (top right), non-metallic minerals (bottom left) and ore (bottom right).

These findings indicate that using FIGARO as international trade source data in the UKMRIO model may impact the UK's material footprint. To assess this impact, we investigate the impact of mining sector aggregation and disaggregation on the UKMRIO directly.

The impact on UKMRIO results

1. Aim

The 2025 version of the UKMRIO uses FIGARO as source data for international trade. To align FIGARO sectors to those in the UK's National Accounts data from ONS, FIGARO sectors are aggregated or disaggregated using ONS data proportions. Thus, where FIGARO sectors need to be split to align the UK sectors, we assume that non-UK subsector distributions are in line with the UK's relative subsector sizes. As FIGARO currently only has a single mining sector, the UKMRIO would split this into four subsectors using UK mining subsector proportions (see Table 1).

As established in the EXIOBASE part of this analysis, this kind of aggregation of the mining sector can strongly impact the material footprint. As a result, we test the impact of splitting the rest of the world

mining sectors using the UK's proportion, compared to using country-specific proportions from EXIOBASE.

2. Method

For this part of the analysis we generate three versions of the UKMRIO model. The first one (UKMRIO-EXIOBASE) uses the 2024 method for UKMRIO construction (see Owen et al., 2023; Owen and Kilian, 2024). This means, ONS and EXIOBASE data are used in its construction. The second version of the UKMRIO model (UKMRIO-FIGARO) is constructed from ONS data and FIGARO, using methods from previous UMRIO releases. For the third version, we use data from ONS, Figaro and EXIOBASE. Instead of assuming the UK's economic structure to disaggregate FIGARO's mining sector from a single to the 4 UKMRIO sectors, we use proportions from EXIOBASE. This allows us to maintain totals from FIGARO, while having country-specific mining sector disaggregation. This UKMRIO-Stretch method, is visualised in Figure 3.

We, again, calculate consumption-based material footprints using Equation 1.

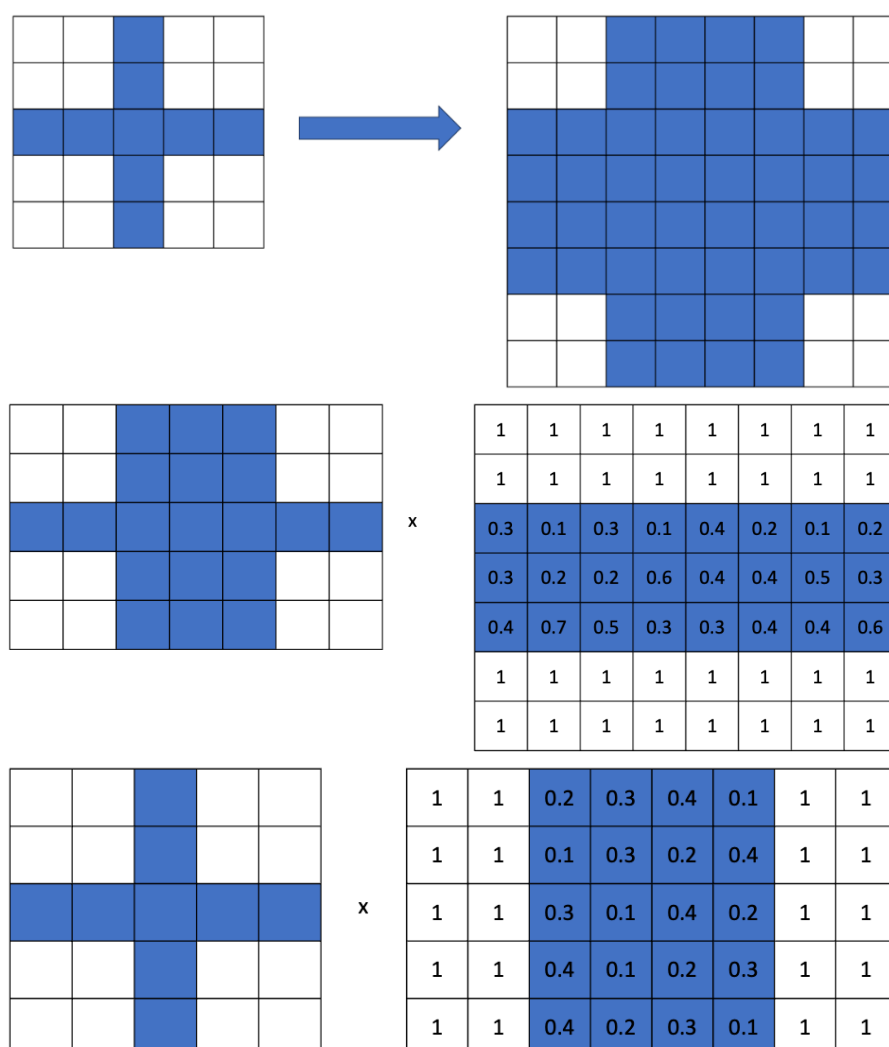


Figure 3. Method for UKMRIO-Stretch, showing the method's aim (top), row-wise split (middle) and column-wise split (bottom).

3. Results

The results show strong differences in the UK's material footprint³ between the UKMRIO-EXIOBASE, UKMRIO-FIGARO and UKMRIO-Stretch methods. As shown in Figure 4, UKMRIO-FIGARO estimates a noticeably higher material footprint than the other two methods, with this difference increasing in 2022. Similarly, when investigating individual materials (Figure 5), we find strong differences in results between the methods for all materials except fossil fuels. For the UK, biomass footprint differences appear to stem from disagreement between EXIOBASE and FIGARO data, as UKMRIO-FIGARO and UKMRIO-Stretch are more similar than UKMRIO-EXIOBASE. Results for ore, on the other hand, are more similar to total material footprint differences, with more similarity between UKMRIO-EXIOBASE and UKMRIO-Stretch. Finally, both ore and non-metallic minerals show a high increase in the footprint after 2020, which is likely due to data issues, as post-2020 footprints far exceed those before 2020.

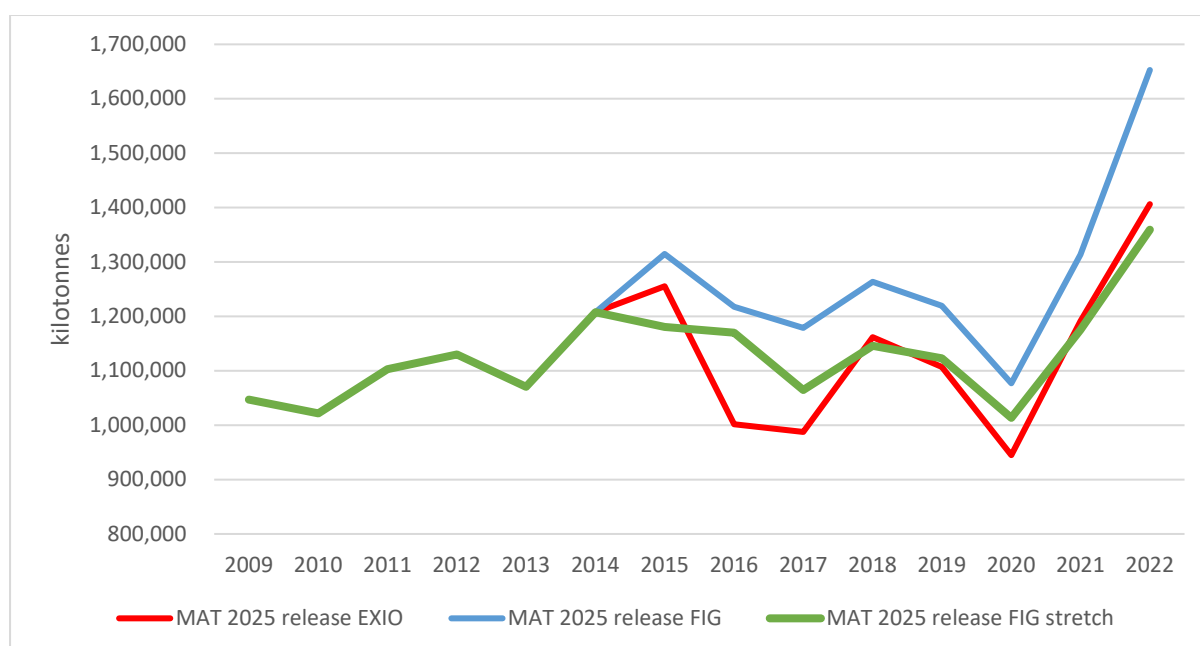


Figure 4. The UK's consumption-based material footprint using the UKMRIO-EXIOBASE method (red), the UKMRIO-FIGARO method (blue) and the UKMRIO-Stretch method (green).

³ A test for the carbon and greenhouse gas footprints shows that these are not impacted by using the UKMRIO-Stretch method for the UKMRIO construction (see Appendix B). This was done to ensure other official footprints are not impacted by these potential changes to the UKMRIO model.

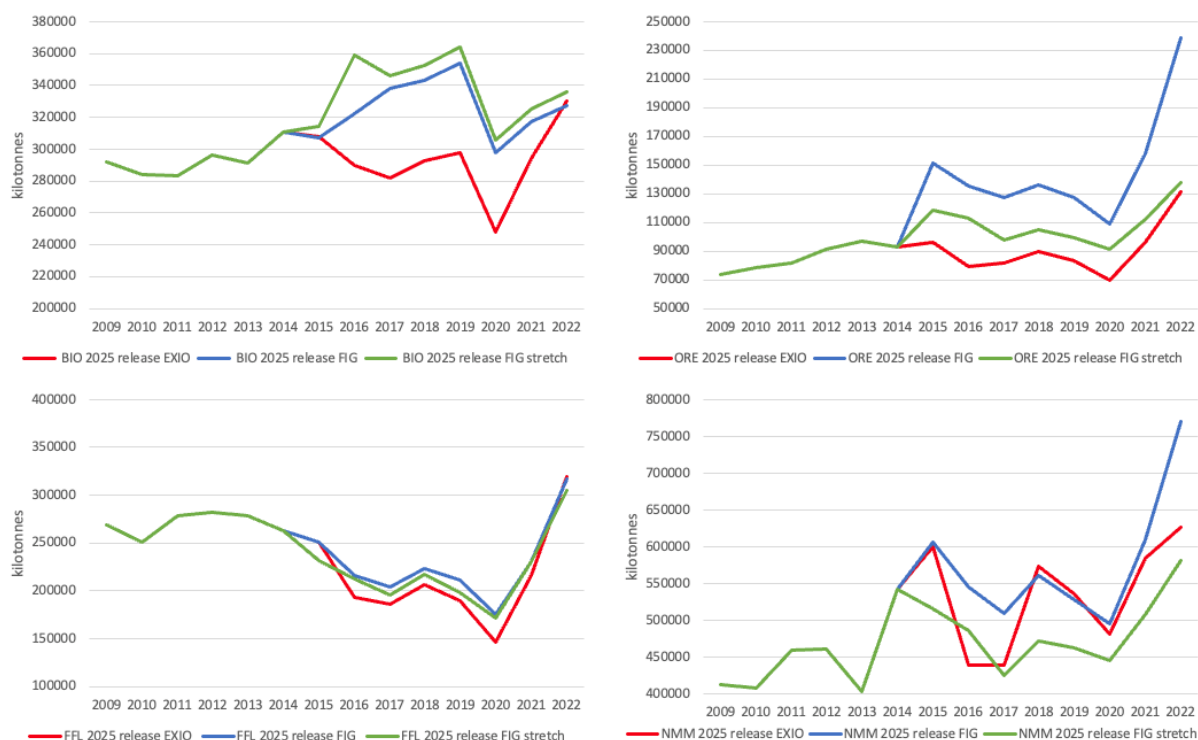


Figure 5. The UK's consumption-based biomass (top left), ore (top right), fossil fuels (bottom left) and non-metallic minerals (bottom right) footprints using the UKMRIO-EXIOBASE method (red), the UKMRIO-FIGRAO method (blue) and the UKMRIO-Stretch method (green).

Discussion and Conclusion

This analysis investigates the impact of the level and method of disaggregation of 'Mining and Quarrying' products and industries on the UK's consumption-based material footprint. When assessing the impact of this aggregation using only EXIOBASE data, we find the having 4 'Mining and Quarrying' sectors provides a good approximation of having 14 sectors. Having only a single sector, however, likely overestimates the UK's material footprint. Similarly, UKMRIO results reveal a large increase in the estimated material footprint when using only FIGARO and ONS data. This means that using proportions from the UK's mining sector to disaggregate rest of world mining sectors likely overestimates the UK's material footprint significantly. Thus, more detailed, country-level data is needed. To address this issue, we propose using the UKMRIO-Stretch method to construct the UKMRIO 2025 model. This method uses proportions from EXIOBASE to disaggregate FIGARO's single mining and quarrying sector into the 4 mining subsectors from the UK's ONS data. This method reduces uncertainty and errors in footprint results by providing information on country-specific economic structures, while still using totals from FIGARO. As FIGARO data is closer to National Accounts than EXIOBASE data, and has shown improvements in the UKMRIO's greenhouse gas and carbon footprints, this method provides a practical solution to improving both the UK's material and carbon footprints, while maintaining a single version of the UKMRIO.

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Appendix A

Table 2. The aggregation of EXIOBASE non-‘Mining and Quarrying’ products.

Product aggregation in analysis	EXIOBASE Products ⁴
Products of agriculture, hunting and related services	Paddy rice; Wheat; Cereal grains nec; Vegetables, fruit, nuts; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops nec; Cattle; Pigs; Poultry; Meat animals nec; Animal products nec; Raw milk; Wool, silk-worm cocoons; Manure (conventional treatment); Manure (biogas treatment);
Products of forestry, logging and related services	Products of forestry, logging and related services (02)
Fish and other fishing products; aquaculture products; support services to fishing	Fish and other fishing products; services incidental of fishing (05)
Preserved meat and meat products	Products of meat cattle; Products of meat pigs; Products of meat poultry; Meat products nec;
Vegetable and animal oils and fats	products of Vegetable oils and fats
Dairy products	Dairy products
Grain mill products, starches and starch products	Processed rice
Food products nec	Sugar; Food products nec;
Beverages	Beverages
Processed and preserved fish, crustaceans, molluscs, fruit and vegetables	Fish products
Tobacco products	Tobacco products (16)
Textiles	Textiles (17)
Wearing apparel	Wearing apparel; furs (18)
Leather and related products	Leather and leather products (19)
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials (20); Wood material for treatment, Re-processing of secondary wood material into new wood material;

⁴ Using label names, including spelling, from EXIOBASE.

Paper and paper products	Pulp; Secondary paper for treatment, Re-processing of secondary paper into new pulp; Paper and paper products;
Printing and recording services	Printed matter and recorded media (22)
Coke and refined petroleum products	Coke Oven Coke; Gas Coke; Coal Tar; Motor Gasoline; Aviation Gasoline; Gasoline Type Jet Fuel; Kerosene Type Jet Fuel; Kerosene; Gas/Diesel Oil; Heavy Fuel Oil; Refinery Gas; Liquefied Petroleum Gases (LPG); Refinery Feedstocks; Ethane; Naphtha; White Spirit & SBP; Lubricants; Bitumen; Paraffin Waxes; Petroleum Coke; Non-specified Petroleum Products; Nuclear fuel;
Paints, soaps, dyestuff, chemicals	Plastics, basic; Secondary plastic for treatment, Re-processing of secondary plastic into new plastic; N-fertiliser; P- and other fertiliser; Chemicals nec; Charcoal; Additives/Blending Components; Biogasoline; Biodiesels; Other Liquid Biofuels;
Rubber and plastic products	Rubber and plastic products (25)
Glass, refractory, clay, other porcelain and ceramic, stone and abrasive products - 23.1-4/7-9	Glass and glass products; Secondary glass for treatment, Re-processing of secondary glass into new glass; Ceramic goods; Bricks, tiles and construction products, in baked clay; Ash for treatment, Re-processing of ash into clinker; Other non-metallic mineral products;
Cement, lime, plaster and articles of concrete, cement and plaster	Cement, lime and plaster
Basic iron and steel ; Other basic metals and casting	Basic iron and steel and of ferro-alloys and first products thereof; Secondary steel for treatment, Re-processing of secondary steel into new steel; Precious metals; Secondary precious metals for treatment, Re-processing of secondary precious metals into new precious metals; Aluminium and aluminium products; Secondary aluminium for treatment, Re-processing of secondary aluminium into new aluminium; Lead, zinc and tin and products thereof; Secondary lead for treatment, Re-processing of secondary lead into new lead; Copper products; Secondary copper for treatment, Re-processing of secondary copper into new copper; Other non-ferrous metal products; Secondary other non-ferrous metals for treatment, Re-processing of secondary other non-ferrous metals into new other non-ferrous metals; Foundry work services;
Fabricated metal products, except machinery and equipment	Fabricated metal products, except machinery and equipment (28)
Machinery and equipment n.e.c.	Machinery and equipment n.e.c. (29)
Computer, electronic and optical products	Office machinery and computers (30); Radio, television and communication equipment and apparatus (32); Medical, precision and optical instruments, watches and clocks (33);
Electrical equipment	Electrical machinery and apparatus n.e.c. (31)
Motor vehicles, trailers and semi-trailers	Motor vehicles, trailers and semi-trailers (34)
Other transport equipment	Other transport equipment (35)
Furniture; other manufactured goods n.e.c.	Furniture; other manufactured goods n.e.c. (36); Secondary raw materials; Bottles for treatment, Recycling of bottles by direct reuse;
Electricity, transmission and distribution	Electricity by coal; Electricity by gas; Electricity by nuclear; Electricity by hydro; Electricity by wind; Electricity by petroleum and other oil derivatives; Electricity by biomass and waste; Electricity by solar photovoltaic; Electricity by solar thermal; Electricity by tide, wave, ocean; Electricity by Geothermal; Electricity nec; Transmission services of electricity; Distribution and trade services of electricity;
Gas; distribution of gaseous fuels through mains; steam and air conditioning supply	Coke oven gas; Blast Furnace Gas; Oxygen Steel Furnace Gas; Gas Works Gas; Biogas; Distribution services of gaseous fuels through mains; Steam and hot water supply services;
Natural water; water treatment and supply services	Collected and purified water, distribution services of water (41)
Construction	Construction work (45); Secondary construction material for treatment, Re-processing of secondary construction material into aggregates;
Wholesale and retail trade and repair services of motor vehicles and motorcycles	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories
Wholesale trade services, except of motor vehicles and motorcycles	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)

Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	Retail trade services of motor fuel; Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52);
Hotel and restaurant services	Hotel and restaurant services (55)
Rail transport services	Railway transportation services
Land transport services and transport services via pipelines, excluding rail transport	Other land transportation services; Transportation services via pipelines;
Water transport services	Sea and coastal water transportation services; Inland water transportation services;
Air transport services	Air transport services (62)
Warehousing and support services for transportation	Supporting and auxiliary transport services; travel agency services (63)
Post and telecommunication services	Post and telecommunication services (64)
Financial services, except insurance and pension funding	Financial intermediation services, except insurance and pension funding services (65)
Insurance and pension funding services, except compulsory social security services	Insurance and pension funding services, except compulsory social security services (66)
Services auxiliary to financial services and insurance services	Services auxiliary to financial intermediation (67)
Real estate services	Real estate services (70)
Rental and leasing services	Renting services of machinery and equipment without operator and of personal and household goods (71)
Computer and related services	Computer and related services (72)
Scientific research and development services	Research and development services (73)
Other business services	Other business services (74)
Public administration and defence services; compulsory social security services	Public administration and defence services; compulsory social security services (75)
Education services	Education services (80)
Health and social work services	Health and social work services (85)
Sewerage, waste, remediation	Food waste for treatment: incineration; Paper waste for treatment: incineration; Plastic waste for treatment: incineration; Intert/metal waste for treatment: incineration; Textiles waste for treatment: incineration; Wood waste for treatment: incineration; Oil/hazardous waste for treatment: incineration; Food waste for treatment: biogasification and land application; Paper waste for treatment: biogasification and land application; Sewage sludge for treatment: biogasification and land application; Food waste for treatment: composting and land application; Paper and wood waste for treatment: composting and land application; Food waste for treatment: waste water treatment; Other waste for treatment: waste water treatment; Food waste for treatment: landfill; Paper for treatment: landfill; Plastic waste for treatment: landfill; Inert/metal/hazardous waste for treatment: landfill; Textiles waste for treatment: landfill; Wood waste for treatment: landfill;
Services furnished by membership organisations	Membership organisation services n.e.c. (91)
Recreational, cultural and sporting services	Recreational, cultural and sporting services (92)
Services of households as employers of domestic personnel	Private households with employed persons (95)
Other services	Other services (93); Extra-territorial organizations and bodies;

Table 3. The aggregation of EXIOBASE non-‘Mining and Quarrying’ industries.

Industry aggregation in analysis	EXIOBASE Industries
Crop And Animal Production, Hunting And Related Service Activities	Cultivation of paddy rice; Cultivation of wheat; Cultivation of cereal grains nec; Cultivation of vegetables, fruit, nuts; Cultivation of oil seeds; Cultivation of sugar cane, sugar beet; Cultivation of plant-based fibers; Cultivation of crops nec; Cattle farming; Pigs farming; Poultry farming; Meat animals nec; Animal products nec; Raw milk; Wool, silk-worm cocoons; Manure treatment (conventional), storage and land application; Manure treatment (biogas), storage and land application;
Forestry And Logging	Forestry, logging and related service activities (02)

Fishing And Aquaculture	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05)
Processing and preserving of meat and production of meat products	Processing of meat cattle; Processing of meat pigs; Processing of meat poultry; Production of meat products nec;
Manufacture of vegetable and animal oils and fats	Processing vegetable oils and fats
Manufacture of dairy products	Processing of dairy products
Manufacture of grain mill products, starches and starch products	Processed rice
Processing of Food products nec	Sugar refining; Processing of Food products nec; Manufacture of beverages;
Processing and preserving of fish, crustaceans, molluscs, fruit and vegetables	Manufacture of fish products
Manufacture Of Tobacco Products	Manufacture of tobacco products (16)
Manufacture Of Textiles	Manufacture of textiles (17)
Manufacture Of Wearing Apparel	Manufacture of wearing apparel; dressing and dyeing of fur (18)
Manufacture Of Leather And Related Products	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)
Manufacture Of Wood & Products Of Wood & Cork, Except Furniture; Manuf. Of Articles Of Straw	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20); Re-processing of secondary wood material into new wood material;
Manufacture Of Paper And Paper Products	Pulp; Re-processing of secondary paper into new pulp; Paper;
Printing And Reproduction Of Recorded Media	Publishing, printing and reproduction of recorded media (22)
Manufacture Of Coke And Refined Petroleum Products	Manufacture of coke oven products; Petroleum Refinery; Processing of nuclear fuel;
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	Plastics, basic; Re-processing of secondary plastic into new plastic; N-fertiliser; P- and other fertiliser; Chemicals nec;
Manufacture Of Rubber And Plastic Products	Manufacture of rubber and plastic products (25)
Manufacture of glass, refractory, clay, porcelain, ceramic, stone products - 23.1-4/7-9	Manufacture of glass and glass products; Re-processing of secondary glass into new glass; Manufacture of ceramic goods; Manufacture of bricks, tiles and construction products, in baked clay; Re-processing of ash into clinker; Manufacture of other non-metallic mineral products n.e.c.;
Manufacture of cement, lime, plaster and articles of concrete, cement and plaster	Manufacture of cement, lime and plaster
Casting of metals	Manufacture of basic iron and steel and of ferro-alloys and first products thereof; Re-processing of secondary steel into new steel; Precious metals production; Re-processing of secondary precious metals into new precious metals; Aluminium production; Re-processing of secondary aluminium into new aluminium; Lead, zinc and tin production; Re-processing of secondary lead into new lead, zinc and tin; Copper production; Re-processing of secondary copper into new copper; Other non-ferrous metal production; Re-processing of secondary other non-ferrous metals into new other non-ferrous metals; Casting of metals;
Manufacture of fabricated metal products, except machinery and equipment	Manufacture of fabricated metal products, except machinery and equipment (28)
Manufacture Of Machinery And Equipment N.E.C.	Manufacture of machinery and equipment n.e.c. (29)
Manufacture Of Computer, Electronic And Optical Products	Manufacture of office machinery and computers (30); Manufacture of radio, television and communication equipment and apparatus (32); Manufacture of medical, precision and optical instruments, watches and clocks (33);
Manufacture Of Electrical Equipment	Manufacture of electrical machinery and apparatus n.e.c. (31)
Manufacture Of Motor Vehicles, Trailers And Semi-Trailers	Manufacture of motor vehicles, trailers and semi-trailers (34)
Manufacture of other transport equipment	Manufacture of other transport equipment (35)

Manufacture of furniture; manufacturing n.e.c.	Manufacture of furniture; manufacturing n.e.c. (36); Recycling of waste and scrap; Recycling of bottles by direct reuse;
Electric power generation, transmission and distribution	Production of electricity by coal; Production of electricity by gas; Production of electricity by nuclear; Production of electricity by hydro; Production of electricity by wind; Production of electricity by petroleum and other oil derivatives; Production of electricity by biomass and waste; Production of electricity by solar photovoltaic; Production of electricity by solar thermal; Production of electricity by tide, wave, ocean; Production of electricity by Geothermal; Production of electricity nec; Transmission of electricity; Distribution and trade of electricity;
Manufacture of gas; distribution of gaseous fuels through mains; steam and aircon supply	Manufacture of gas; distribution of gaseous fuels through mains; Steam and hot water supply;
Water Collection, Treatment And Supply	Collection, purification and distribution of water (41)
Construction	Construction (45); Re-processing of secondary construction material into aggregates;
Wholesale And Retail Trade And Repair Of Motor Vehicles And Motorcycles	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories
Wholesale Trade, Except Of Motor Vehicles And Motorcycles	Wholesale trade and commission trade, except of motor vehicles and motorcycles (51)
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	Retail sale of automotive fuel; Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52);
Hotels and restaurants	Hotels and restaurants (55)
Rail transport	Transport via railways
Land transport services and transport services via pipelines, excluding rail transport	Other land transport; Transport via pipelines;
Water Transport	Sea and coastal water transport; Inland water transport;
Air Transport	Air transport (62)
Warehousing And Support Activities For Transportation	Supporting and auxiliary transport activities; activities of travel agencies (63)
Post and telecommunications	Post and telecommunications (64)
Financial Service Activities, Except Insurance And Pension Funding	Financial intermediation, except insurance and pension funding (65)
Insurance and pension funding, except compulsory social security	Insurance and pension funding, except compulsory social security (66)
Activities Auxiliary To Financial Services And Insurance Activities	Activities auxiliary to financial intermediation (67)
Real estate activities	Real estate activities (70)
Rental And Leasing Activities	Renting of machinery and equipment without operator and of personal and household goods (71)
Computer and related activities	Computer and related activities (72)
Scientific Research And Development	Research and development (73)
Other business activities	Other business activities (74)
Public Administration And Defence; Compulsory Social Security	Public administration and defence; compulsory social security (75)
Education	Education (80)
Health and social work	Health and social work (85)
Sewerage; waste; remediation	Incineration of waste: Food; Incineration of waste: Paper; Incineration of waste: Plastic; Incineration of waste: Metals and Inert materials; Incineration of waste: Textiles; Incineration of waste: Wood; Incineration of waste: Oil/Hazardous waste; Biogasification of food waste, incl. land application; Biogasification of paper, incl. land application; Biogasification of sewage slugde, incl. land application; Composting of food waste, incl. land application; Composting of paper and wood, incl. land application; Waste water treatment, food; Waste water treatment, other; Landfill of waste: Food; Landfill of waste: Paper; Landfill of waste:

	Plastic; Landfill of waste: Inert/metal/hazardous; Landfill of waste: Textiles; Landfill of waste: Wood;
Activities Of Membership Organisations	Activities of membership organisation n.e.c. (91)
Recreational, cultural and sporting activities	Recreational, cultural and sporting activities (92)
Activities Of Households As Employers Of Domestic Personnel	Private households with employed persons (95)
Other service activities	Other service activities (93); Extra-territorial organizations and bodies;

Appendix B

To ensure the greenhouse gas and carbon dioxide consumption-based footprints are not impacted by the mining sector aggregation, we also calculate these footprints with 1, 4, and 14 mining and quarrying sectors. As shown in Figure 3, the impact on these footprints is negligible. Moreover, the UK's GHG footprint is not significantly impacted by using the UKMRIO-Stretch method (Figure 5). Thus improvements to the material footprint through disaggregation of the mining sector do not appear to significantly impact the carbon and greenhouse gas footprints.

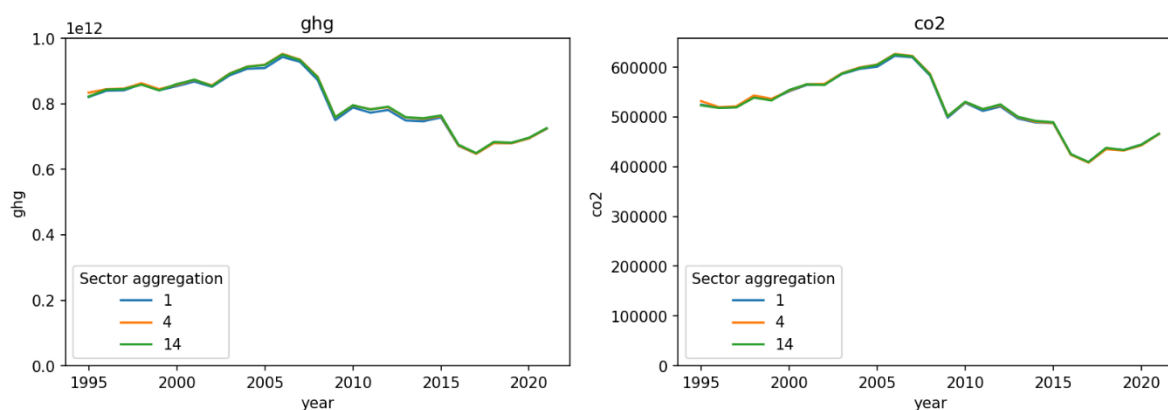


Figure 6. The UK's consumption-based greenhouse gas (left) and carbon (right) footprints from EXIOBASE with 1, 4, or 14 Mining and Quarrying sectors.

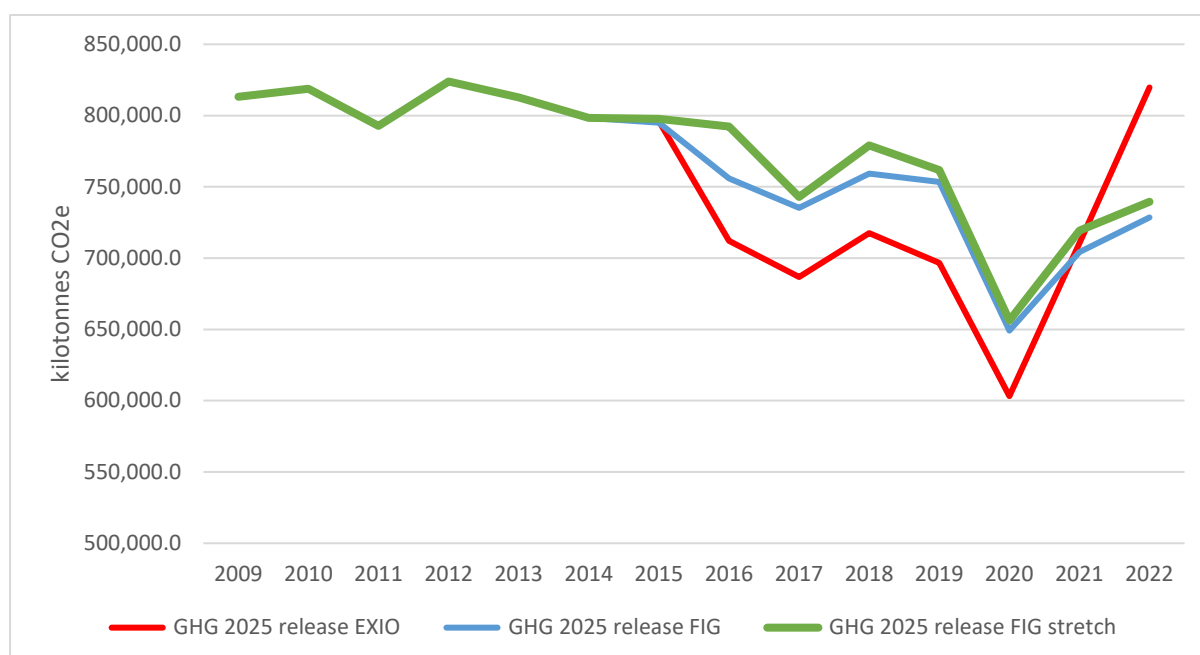


Figure 7. The UK's consumption-based greenhouse footprint using the 2024 method (red), the UKMRIO-FIGRAO method (blue) and the UKMRIO-Stretch method (green).