DOI: 10.1111/1475-5890.70035

Fiscal Studies
The Journal of Applied Public Economics
IFS Institute for Fiscal Studies

SYMPOSIUM PAPER

The carbon content of billionaire wealth: composition, concentration and taxation

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Submitted: September 2025

Funding information
ERC FIND project, Grant/Award Number: 101117427;
Italian Ministry of University and Research FIS3 SCI-PET project, Grant/Award Number: CUP J53C25002420001;
Italian Ministry of University and Research FIS3 TRACE project, Grant/Award Number: CUP J53C25002430001

Abstract

How large are billionaires' carbon footprints? While increasing evidence highlights large disparities in emissions between and within countries, detailed individual-level data on emissions portfolios remain scarce. In this paper, we analyse the wealth composition of the top 500 billionaires and construct a dataset linking each of their assets to emissions. According to our ownership-based emission accounting framework, every million US dollars held by billionaires is associated with more than 65 tonnes of CO_2 equivalent per year – about 10 times the annual carbon footprint of the average person. Further, our estimates reveal an extreme concentration of wealth among the super-rich and even greater concentration of emissions. About 50 billionaires account for around three-quarters of total emissions in our sample, with publicly traded equity in Basic Materials, Industrials and Utilities accounting for a disproportionate share of attributed emissions. Emission intensity is key: 97 per cent of the variance in log emissions is explained by intensity differences, suggesting that scale effects play a limited role and carbon footprints are almost entirely driven by investment choices. The highest-emitting billionaires – including some of the wealthiest – derive a substantial share of their emissions (between 44 and 66 per cent) from hard-to-abate sectors. Comparing alternative taxation schemes targeting both extreme wealth and emissions, we show that the introduction of a new progressive carbon wealth tax can potentially achieve three objectives: progressively taxing billionaires to curb inequality, targeting the most polluting activities, and raising substantial resources to finance a sustainable and equitable transition.

KEYWORDS
wealth, emissions, billionaires, ownership, carbon tax, wealth tax, carbon wealth tax

JEL CLASSIFICATION
D31, D63, G32, Q50, Q54

1 | INTRODUCTION

This work bridges the literature on wealth concentration and greenhouse-gas emissions at the individual level. It constructs a novel dataset linking billionaire wealth portfolios to greenhouse-gas emissions attributed through asset ownership. Using detailed information on the asset holdings of the world's 500 richest billionaires, we estimate individual carbon footprints and examine their concentration across assets, sectors and wealth groups. We then assess the revenue potential and the degree of progressivity of a new carbon wealth tax and compare them with traditional wealth and carbon taxation schemes.

Recent evidence has highlighted the extreme concentration of global wealth in the hands of a few individuals (Chancel et al., 2022), raising concerns about its socio-economic implications. At the same time, a growing body of research documents stark inequalities in emissions (Bruckner et al., 2022; Chancel, 2022), with the richest individuals exhibiting disproportionately large carbon footprints. Recent advances in carbon accounting have further shown that a substantial share of these emissions may be linked not only to consumption but also to the ownership of productive assets and investment portfolios (Chancel and Rehm, 2026). Yet, despite growing interest in ownership-based emissions, evidence remains scarce on the specific assets, firms and sectors underlying the carbon footprints of the world's wealthiest individuals.

Beyond unequal contributions, climate impacts themselves are also distributed unequally, with the most vulnerable regions and individuals bearing disproportionate costs (Paglialunga, Coveri and Zanfei, 2022; Palagi et al., 2022; Coronese et al., 2025). Climate policies face a similar challenge: if poorly designed, they may exacerbate existing inequalities (Bettarelli et al., 2024) and undermine political feasibility (Dechezleprêtre et al., 2025). Their implementation also requires substantial financial resources (Stern and Stiglitz, 2023). These concerns have contributed to growing interest in the taxation of extreme wealth and high-emission activities. Discussions of wealth taxation have gained particular prominence in recent international policy debates (see, e.g., Zucman, 2024), in a context where effective tax rates often decline at the top of the income distributions (Saez and Zucman, 2019; Guzzardi et al., 2024). A central question is whether tax instruments can simultaneously mobilise resources, improve progressivity and target the economic activities most closely associated with emissions (Bastos Neves and Semmler, 2025).

In this paper, we focus on a global sample of billionaires for whom detailed information on wealth composition is available from the Bloomberg Billionaires Index (BBI), in line with studies using billionaire rich lists to study the distribution and composition of extreme wealth (Ischinsky and Tisch, 2022; Tisch and Ischinsky, 2023; Baselgia and Martínez, 2024). We combine these data with firm-level emissions from Thomson/Refinitiv and market capitalisation data from Yahoo Finance, *The Financial Times* and Market Screener to estimate asset-level emissions for the world's 500 richest billionaires, adopting the ownership-based accounting framework of Chancel and Rehm (2025). Building on Maitland et al. (2022), we extend the analysis to a larger and globally comparable sample while incorporating a broader range of asset classes. This allows us to provide, to the best of our knowledge, the first global assessment of the joint concentration of wealth and ownership-based emissions among the world's richest individuals.

Every million US dollars (Mln$) held by the top 500 billionaires is associated with more than 65 tonnes of CO_2 equivalent (tCO2e) emissions per year. Focusing on publicly traded assets alone, the emission intensity almost doubles, approaching 130 tCO2e per Mln$, which is 5.4 times higher than the emission intensity of the richest 1 per cent in France. Further, our findings reveal a striking dual concentration, with the top 0.00001 per cent of the world's population owning more than 1 per cent of both global wealth and global emissions. Within this group, emissions are even more unequally distributed than wealth, with around 50 billionaires accounting for around three-quarters of total billionaire emissions. Importantly, this pattern is largely driven by differences in asset-level emission intensities rather than by wealth scale alone, suggesting that the carbon footprint of billionaires almost entirely stems from their investment decisions rather than from the size of their fortune. Indeed, emissions in our sample are primarily linked to equity holdings, especially in publicly traded firms, and are heavily concentrated in hard-to-abate (HTA) sectors. Among the highest-emitting billionaires, between 44 and 66 per cent of portfolio emissions originate from investments in HTA activities, depending on the sector classification adopted.

The pronounced concentration of ownership-based emissions among a small number of individuals, together with the substantial mismatch between wealth and emissions rankings, highlights the importance of considering both dimensions jointly for policy analysis. We therefore compare three taxation approaches targeting wealth, emissions, and their combination. In particular, we benchmark a wealth tax and a carbon tax against a new progressive carbon wealth tax that directly links taxation to both wealth and emissions. By applying differentiated rates across emissions brackets and mapping them onto billionaire portfolios, this instrument combines elements of wealth taxation and carbon pricing. Baseline estimates suggest that such a tax could mobilise revenues on the order of US dollars (USD) 151 billion annually, generating substantially higher revenues than the benchmark wealth and carbon tax schemes considered here, while ensuring progressivity across both wealth and emissions and spreading the tax burden broadly among billionaires. Our results suggest that a progressive carbon wealth tax could potentially contribute to three policy objectives: increasing the tax burden borne by the wealthiest individuals, strengthening incentives to reduce the carbon intensity of investment portfolios, and mobilising substantial fiscal resources for an inclusive and just global decarbonisation agenda.

The remainder of the paper is organised as follows. In Section 2, we review the literature on emission accounting and carbon inequality. In Section 3, we describe the data and methodology used to construct the dataset and implement the tax simulations. In Section 4, we present the main empirical findings, while in Section 5 we report the results of the tax simulation exercises. Finally, we conclude and outline directions for future research in Section 6.

2 | ATTRIBUTING EMISSIONS ACROSS PRODUCTION, CONSUMPTION AND OWNERSHIP

Understanding how greenhouse-gas emissions are distributed across economic actors requires deciding how they should be attributed along complex production chains. Among the approaches most commonly used for this purpose are production-based, consumption-based and ownership-based accounting frameworks, each emphasising different aspects of the economic process.

Production-based accounting provides the most direct attribution rule, assigning emissions to the entities and territories where they are physically generated. As the foundation of national greenhouse-gas inventories and international reporting frameworks, it has highlighted substantial cross-country differences in emissions and remains the dominant approach for monitoring emissions and assessing progress toward mitigation targets (Franzen and Mader, 2018). Yet, attributing emissions exclusively to producers may provide only a partial view of increasingly transnational production systems (Hertwich and Peters, 2009; Parsons, 2023). As production chains have become more fragmented across countries, a substantial share of emissions is generated in one location to satisfy demand elsewhere. Early estimates suggested that roughly one-quarter of global CO_2 emissions from fossil-fuel combustion were embodied in internationally traded goods (Davis and Caldeira, 2010).

Consumption-based accounting emerged in part to address these limitations (Tukker, Pollitt and Henkemans, 2020). By combining emissions inventories with input–output frameworks that trace emissions along global supply chains, it provides a bridge between economy-wide emissions and micro-level consumption data (Afionis et al., 2017). This allows one to move beyond purely territorial or sectoral perspectives and examine how emissions are distributed across households and income groups. A recurring finding is that emissions rise steeply with income, resulting in a pronounced concentration of emissions among high-income individuals and households (Golley and Meng, 2012; Ivanova and Wood, 2020; Chancel, 2022).[1] The magnitude of these differences can be substantial. For example, Bruckner et al. (2022) show that the carbon footprints of the top 10 per cent in the United States were 40 times higher than those of the top 10 per cent in Nigeria, and more than 500 times higher than those of Nigeria's bottom 10 per cent. At the global level, individuals in the richest 1 per cent are estimated to emit close to 100 times more than members of the poorest 10 per cent (Chancel and Piketty, 2015). Consistent with these patterns, increasing emissions among high-income groups have been identified as a major driver of the growth in global emissions over recent decades (Kartha et al., 2020). Yet, by attributing emissions to final demand, consumption-based accounts implicitly place primary emphasis on consumer choices. These choices, however, are made within production systems, technological constraints and infrastructure networks that consumers may influence only indirectly. Important determinants of emissions therefore lie upstream of consumption itself. Through ownership and investment decisions, economic actors influence the activities of firms and sectors, shaping not only current emissions but also future production and technological trajectories.

This perspective underpins the development of ownership-based accounting, which allocates emissions according to the ownership of productive capital. Instead of following emissions downstream to final consumers, the ownership perspective traces them upstream to the individuals and institutions holding claims on the firms responsible for production (Chancel and Rehm, 2025; Coronese, 2026). For example, emissions generated in the production of cement would be attributed to the owners of the cement company rather than to the households ultimately purchasing the homes built with it.[2] Applying this framework to France, Germany and the United States, Chancel and Rehm (2025) show that ownership-based accounting reveals substantially higher levels of carbon inequality than consumption-based accounting. While both approaches point to a strong concentration of emissions at the top of the distribution, ownership-based accounting attributes a considerably larger share of emissions to top wealth groups. For example, the share assigned to the top 10 per cent roughly doubles when emissions are allocated through ownership rather than consumption. Extending the analysis to the global scale, Chancel and Rehm (2026) show that these patterns are not confined to a handful of advanced economies. Ownership-based emissions remain highly concentrated at the top of the global wealth distribution, with the richest 1 per cent accounting for about 40 per cent of privately owned total greenhouse-gas emissions. Importantly, this concentration reflects not only differences in the amount of wealth held but also differences in portfolio composition, as wealthier individuals tend to hold more carbon-intensive assets. The global framework also highlights the growing importance of cross-border ownership as a distinct channel through which emissions are redistributed internationally, beyond trade alone. A non-negligible share of emissions generated in one country is ultimately attributed to asset owners residing elsewhere, implying that ownership-based accounts can differ substantially

[1] Chancel (2022) relies on hybrid accounting frameworks that extend beyond pure consumption-based accounting.

[2] As in consumption-based accounting, direct household emissions – such as those associated with residential energy use or private transport – remain attributed to the final user.

from production-based ones, particularly in high-income economies with large foreign asset holdings.

The ownership perspective is particularly appealing when studying billionaires or, more generally, ultra-wealthy individuals, whose economic influence is exercised primarily through the ownership of productive assets rather than through consumption alone. Moreover, as major providers of capital, they can influence the allocation of investment across firms, sectors and technologies, thereby shaping not only current emissions but also future production and decarbonisation pathways. Billionaires also offer a unique empirical setting for studying ownership-based emissions. Unlike studies that allocate ownership emissions using information on wealth distributions and portfolio structures, analyses of billionaire wealth can leverage detailed information on assets held by a relatively small number of highly visible individuals. This makes it possible to link ownership stakes directly to the firms generating the associated emissions. Recent contributions have begun to explore this approach by combining billionaire wealth data with firm-level emissions information to estimate the carbon footprint of billionaire portfolios (Maitland et al., 2022). This emerging literature provides a useful framework for examining the relationship between extreme wealth concentration and ownership-based emissions.

3 | EMISSIONS IN WEALTH: DATA AND METHODOLOGY

In this section, we describe our dataset and the methodology used to estimate billionaires' ownership shares and their related carbon footprints. The resulting cross-sectional dataset maps the portfolios and carbon footprints of 501 billionaires, covering 1,983 holdings across 1,703 unique entities[3] and spanning publicly listed equity, privately held companies, real estate, luxury items, infrastructure and business assets, debt and cash holdings. We improve upon recent efforts such as Maitland et al. (2022), who map the carbon content of the portfolios of 220 billionaires while focusing exclusively on publicly traded companies. By extending coverage to a larger pool of individuals and to a broader range of asset classes, our dataset allows us to jointly characterise the distribution of wealth and emissions within this group of ultra-high-net-worth individuals in Section 4, and supports the comparative tax-simulation exercise developed in Section 5.

Our methodology proceeds in three steps. First, we estimate each billionaire's ownership share in every asset of their portfolio (Section 3.1). Second, we compute the total CO_2 equivalent (CO2e) emissions associated with each asset (Section 3.2). Third, building on the ownership-based accounting framework (Chancel and Rehm, 2025), we attribute to each billionaire a fraction of these emissions in proportion to their ownership share (Section 3.3).

3.1 | Ownership shares

We reconstruct the investment portfolios of the world's wealthiest individuals by combining data from the BBI, Forbes Billionaires' Data and Yahoo Finance. The core of the analysis is based on asset-level information for the top 500 billionaires as of 10 February 2025, retrieved from the BBI.[4] The index provides a daily ranking of the world's 500 richest individuals, reporting both total net worth

[3] The gap reflects entities co-held by more than one billionaire.

[4] Our initial sample includes 501 billionaires: 500 are drawn directly from the BBI, to which we add Michael Bloomberg, whose holdings are not disclosed by his own company (Bloomberg LP) and are therefore not reported in the BBI. We reconstruct his portfolio using data from Forbes Billionaires' Data (as of 16 June 2025), supplemented by publicly available sources. Forbes Billionaires' Data reports that Michael Bloomberg owns 88 per cent of the media company Bloomberg LP; we estimate the company's value using a peer-valuation method based on enterprise value-to-revenue ratios of comparable listed peers (Morningstar and Thomson Reuters), retrieved from Yahoo Finance. Other components of his portfolio, such as real estate and luxury assets, are identified through public records – a *Vanity Fair* article from February 2020 (Jones, 2020), a *New York Post* article from April 2024 (Thaler, 2024) and a *Simple Flying* article from March 2025 (Memon, 2025) – and valued using the same

and a detailed breakdown of individual asset holdings. Of all reported holdings, 38 per cent consist of publicly traded companies, 31 per cent of privately held companies, 20 per cent of cash, 4 per cent of residential or commercial real estate; the remaining 7 per cent consists of luxury items, infrastructure and business assets, debt, and non-classifiable holdings. Ownership shares are estimated as follows.

3.1.1 | Publicly traded assets

For publicly traded assets, we compute ownership shares by combining information from the BBI and Yahoo Finance. In particular, when the BBI's methodological notes report an explicit ownership share, we adopt that figure as given. When, instead, the BBI reports only the monetary value of each billionaire's stake in publicly traded companies without specifying the ownership share, we estimate the share using market capitalisation data from Yahoo Finance.[5] Specifically, for these holdings, we retrieve companies' market capitalisation as of 24 February 2025.[6] Finally, we compute the ownership shares by dividing the stake value reported in the BBI by the companies' total market capitalisation expressed in USD.[7]

3.1.2 | Privately held assets

For non-listed equity, we rely primarily on the asset-level notes from the BBI. Whenever the BBI specifies a billionaire's ownership share, we take that value as reported. When the ownership percentage is not reported, we estimate it through a peer comparison approach consistent with Bloomberg's own valuation methodology. The procedure computes the value of a private company by applying a valuation ratio (e.g., price-to-book, price-to-sales, enterprise value-to-revenue, enterprise value-to-employment) derived from comparable publicly listed firms (the so-called peers) to the relevant financial metric of the private company. The BBI's methodological notes typically specify both the valuation metric and the relevant peers. We retrieve the required financial data from Yahoo Finance and estimate ownership share as the ratio between the reported stake value and the estimated total company value. When no suitable peer data or financial metrics are available, the ownership share is treated as missing.[8] Tables A.2 and A.3 in online Appendix A.2 report the list of companies valued using the peer comparison approach, along with additional information about the common financial ratios applied, the average peer ratio retrieved from Yahoo Finance, the number of peers considered and the resulting estimated enterprise value. Further details on the choice of valuation multiples and on the timing of peer metrics are reported in online Appendix A.2.

methodology applied to the rest of the sample. Further, due to data quality, the sample is sometimes restricted to 486 individuals; see Section 3.1 for further details.

[5] In 28 cases where market capitalisation is not available on Yahoo Finance, we supplement with market capitalisation data from *The Financial Times* and Market Screener. Table A.1 in online Appendix A.1 reports the full list of companies for which market capitalisation data are obtained from sources other than Yahoo Finance.

[6] Because market capitalisation is retrieved on 24 February 2025 while the BBI's stake values refer to 10 February 2025, minor biases may arise in our share estimates due to share-price movements over this two-week interval.

[7] For companies listed outside the United States, where market capitalisation is reported in a foreign currency, we first convert the value into USD using the prevailing exchange rate from the BBI on the corresponding date.

[8] There is a fourth case in which, for 22 holdings (21 unique entities), the BBI provides only a qualitative indication of majority ownership in its methodological notes. In these cases, we refrain from assigning a specific ownership share and therefore neither assume a 50 per cent ownership stake nor apply the peer-comparison approach to infer the total value of the underlying company and, indirectly, the billionaire's ownership share. As a result, the total carbon footprint of these 21 entities is not estimated. However, the BBI reports the value of the billionaire's stake in each holding, and these holdings account for 0.62 per cent of the total wealth owned by the billionaires in our sample. We therefore estimate attributed emissions directly at the billionaire level by multiplying the reported value of the stake by the emission intensity for non-listed equity reported in Section 3.2.2. Consequently, for these holdings, billionaire-level attributed emissions can be estimated even though the carbon footprint of the underlying entities is unavailable, and the attribution rule described in Section 3.3 is not applied.

For all remaining privately held holdings, including real estate, cash, infrastructure-related assets, luxury items and liabilities, we adopt the valuations reported in the BBI's methodological notes and assume full ownership.[9] For 13 holdings, no asset classification is available, either because the BBI reports the asset with vague labels (e.g., 'Other Assets' or 'Personal Assets') or because it combines categories that cannot be disentangled (e.g., items reporting 'Real Estate *and* Yachts'); in these cases, we also assume full ownership.[10]

Overall, our methodology recovers ownership shares for 99.6 per cent of publicly traded assets and approximately 79 per cent of privately held assets; including private assets for which the individual is clearly the majority owner brings coverage of private holdings to about 82.6 per cent. To preserve data quality in the empirical analysis, we exclude billionaires for whom more than 50 per cent of reported net worth corresponds to assets with missing ownership information. This filter removes 15 individuals, reducing the working sample from 501 to 486 billionaires and lowering the share of unobserved billionaire wealth from 2.42 per cent to about 1.10 per cent.[11]

3.2 | Emissions

We estimate the CO2e emissions associated with each asset by combining company-level emissions data from Thomson/Refinitiv, emission intensities from Chancel and Rehm (2025) and investment-related emissions per unit from Alestig et al. (2024).

In particular, Thomson/Refinitiv constructs greenhouse-gas emission figures through a hierarchical multi-model procedure that prioritises company-reported values and imputes missing observations with model-based estimates. Reported values are collected, quality-checked and standardised by combining firms' public disclosures with responses to the annual surveys of the Carbon Disclosure Project. Further details on the model-based procedures used by Thomson/Refinitiv to impute missing observations are provided in online Appendix A.3. For holdings not covered by Thomson/Refinitiv, we draw on two complementary sources. Chancel and Rehm (2025) provide emission intensities derived from distributional environmental accounts, which link industry-level direct emissions to capital stocks and national balance sheets, and then map these emissions to asset classes held by investors. For luxury transport assets, we rely on the investment-related emission estimates reported by Alestig et al. (2024).[12]

Whenever possible, we prioritise reported emissions over estimated figures, and when multiple estimates are available, we consistently adopt the most conservative value. Consistent with the ownership-based framework of Chancel and Rehm (2025), we focus on Scope 1 emissions, defined as direct emissions from sources owned or controlled by the reporting entity: the company for corporate holdings, or the asset itself for non-corporate items such as private jets, yachts and real estate. Scope 2 emissions, which include indirect emissions from the consumption of purchased electricity, heat or steam, are used only to recover Scope 1 figures when these are not directly reported (see below).[13]

[9] Except for two infrastructure-related assets: Woodfibre LNG (an export terminal, 50 per cent owned by Sukanto Tanoto) and Seaspan Ferries (a fleet of seven ferries operating in the Vancouver area, 25 per cent owned by Dennis Washington).

[10] Two holdings lack any ownership share estimate: 'Employee Loans' and 'Accumulated Earnings', belonging to Wang Chuan-Fu and Ray Dalio, respectively.

[11] The excluded billionaires are Sukanto Tanoto (rank 109), Theo Albrecht Jr (129), Ray Dalio (142), Tilman Fertitta (146), Charles Butt and family (157), George Kaiser (159), Renata Kellnerova (169), Robert Smith (251), John Grayken (290), Eric Smidt (318), Tatyana Kim (353), Daniel Kretinsky (412), Frederik Paulsen (447), Odd Reitan (491) and David Green (499).

[12] Alestig et al. (2024) combines publicly available information such as media reports and photographs with technical specifications on vehicle and vessel size and engine power, and applies average emission factors for the relevant transport modes.

[13] While restricting the analysis to Scope 1 emissions avoids double counting and is consistent with the ownership-based framework, the bottom-up nature of our dataset may also open the possibility of extending the analysis to broader emission boundaries. Because we observe the portfolios of a relatively small number of billionaires, potential double counting arising from Scope 2 emissions could, in principle, be explicitly identified and corrected. Such an extension may prove particularly relevant for electricity-intensive sectors, such as ICT, where Scope 2 emissions often exceed direct operational emissions (see Table 1).

TABLE 1 Average Scope 2 to Scope 1 ratios by ICB industry.

ICB industry	Average Scope 2/Scope 1
Basic materials	1.27
Consumer discretionary	7.45
Consumer staples	1.64
Energy	1.28
Financials	9.45
Health care	5.08
Industrials	1.24
Real estate	9.40
Technology	35.90
Telecommunications	19.20
Utilities	5.12

Note: Due to extreme Scope 2/Scope 1 values relative to industry peers, a small number of outliers are excluded from the computation of the ICB Industry-average Scope 2/Scope 1 ratios, namely Tata Teleservices (Telecommunications), Ares Management (Financials), and Frasers Centrepoint Trust (Real Estate).

Scope 3 emissions, which cover value-chain emissions, are excluded by construction, as they cannot be unambiguously attributed to individual asset holders under an ownership-based approach.[14] The following subsections describe how asset-level emissions are estimated from each of the underlying data sources

3.2.1 | Publicly traded assets

Emissions for publicly listed equity are computed through a multi-step procedure. First, we use reported Scope 1 emissions from Thomson/Refinitiv whenever available; this covers 68.2 per cent of all listed equity holdings in our dataset. Second, for companies for which Thomson/Refinitiv reports only the sum of estimated Scope 1 and Scope 2 emissions, we recover Scope 1 using industry-specific Scope 2/Scope 1 ratios. To this end, we classify all listed firms in our sample according to the Industry Classification Benchmark (ICB) provided by Thomson/Refinitiv,[15] retain those firms for which both Scope 1 and Scope 2 emissions are distinctly reported, compute the Scope 2/Scope 1 ratio for each firm, and then average these ratios within each of the 11 ICB industries represented in the sample. The resulting industry-specific ratios are reported in Table 1, and are then applied to disaggregate the available Scope 1 + Scope 2 totals. This industry-ratio approach is used for 14.2 per cent of listed equity holdings. Third, for companies where Thomson/Refinitiv provides the total (Scope 1 + Scope 2) and only one of the two components, we recover the missing component residually by subtraction; this concerns 0.3 per cent of listed holdings. Finally, for the remaining 17.3 per cent of listed equity holdings, for which no emission data are available from Thomson/Refinitiv, we impute emissions by multiplying the USD value of each stake by the 2019 equity-based Scope 1 emission intensity benchmark from Chancel and Rehm (2025), expressed in tCO2e per million USD of asset

[14] While this focus on Scope 1 is consistent with our ownership-based approach, it does not, by itself, resolve the issue of indirect ownership in the case of corporate holdings; that is, the possibility that billionaires hold equity in firms that, in turn, own stakes in other companies. In practice, most firms in our sample define their greenhouse-gas organisational boundary through the financial or operational control approach, so that the emissions of controlled subsidiaries are already consolidated within the parent's Scope 1. A detailed discussion of how our framework accounts for indirect ownership, together with the residual sources of underestimation specific to financial firms, is provided in online Appendix D.

[15] The ICB is a global classification developed by FTSE Russell and distributed via Thomson/Refinitiv. It organises companies in a four-tier hierarchy – Industry, Supersector, Sector and Subsector – based on their primary source of revenue, allowing for consistent cross-company and cross-sectoral comparisons.

value. We adopt the US benchmark of 74.9 tCO2e per million 2019 USD, as the most conservative figure across the countries reported by the authors.[16]

3.2.2 | Privately held assets

For privately held assets (excluding cash holdings and debt items), emission estimates vary by asset class, and we consistently adopt the most conservative assumption whenever multiple estimates are available. For non-listed equity, we apply the same US Scope 1 equity-based benchmark intensity from Chancel and Rehm (2025) used for listed equity, corresponding to 59.4 tCO2e per million USD owned. Infrastructure and business assets are assigned the French Scope 1 business-asset benchmark from the same source (35.53 tCO2e per million USD), while residential and commercial real estate is matched to the corresponding French housing benchmark (0.068 tCO2e per million USD).[17]

Luxury assets are treated separately, given the substantial heterogeneity in emission profiles across asset types. Whenever possible, we distinguish between private jets, helicopters and superyachts, and apply the per-unit annual emission estimates from Alestig et al. (2024): 2,074 tCO2e per private jet and 5,672 tCO2e per yacht. This disaggregated approach is feasible because Bloomberg's methodological notes frequently report the exact number of jets or yachts owned by each billionaire. For luxury holdings reported in aggregate form, without sufficient detail to disentangle the number of jets, helicopters or yachts, we adopt the more conservative housing-based benchmark of 0.068 tCO2e per million 2025 USD.[18]

For all remaining asset types – in particular, cash and debt instruments – we assign zero emissions. Unknown or miscellaneous assets and artworks are also classified as luxury assets. Depending on the information available, they are either assigned zero emissions or the conservative housing-based benchmark.[19]

3.3 | Attribution

The final step of our methodology combines ownership shares and asset-level emissions into individual carbon footprints. Following the ownership-based approach of Chancel and Rehm (2025), we attribute the emissions of each asset to its holders in proportion to their ownership stake. Formally, let $s_{ij} \in [0, 1]$ denote the ownership share of billionaire i in asset j, and let E_j denote the total Scope 1 emissions of asset j. The carbon footprint of billionaire i is then defined as

$$F_i = \sum_{j \in \mathcal{J}_i} s_{ij} \cdot E_j, \tag{1}$$

where $\mathcal{J}_i$ denotes the set of holdings in the portfolio of billionaire i. An immediate implication of equation (1) is that when the same entity is co-held by more than one billionaire in our sample, share-weighting ensures that emissions are not double-counted across individual footprints: each billionaire is assigned only the fraction of the entity's emissions corresponding to their own stake.

[16] Such figures have been rescaled to a 2025 USD base using the Bureau of Labor Statistics CPI inflation factor of 1.26 between 2019 and 2025, obtaining an adjusted intensity of 59.4 tCO2e per million 2025 USD.

[17] All benchmark intensities are expressed in 2025 USD. We apply the BLS CPI inflation factor; when original values are reported in EUR, we convert them using an EUR/USD exchange rate of 1.13 from the ECB Data Warehouse.

[18] We apply the housing-based benchmark to Michael Bloomberg's helicopters, Enrique Razon's aircraft, helicopters and yacht, and the vehicles and aircraft of Roman Abramovich.

[19] The use of the housing-based benchmark applies to Len Blavatnik, for whom we are unable to distinguish between his art collection and personal assets, including homes in New York City and London.

The carbon footprints $\{F_i\}$ defined in equation (1), together with the wealth underlying the ownership shares s_{ij}, are the central objects of the empirical analysis that follows.

4 | MAPPING BILLIONAIRE WEALTH AND EMISSIONS

This section presents the core empirical evidence derived from our newly constructed dataset, which brings together detailed information on billionaire wealth, portfolio composition and associated emissions. We begin by placing billionaire wealth and emissions in a broader comparative perspective, benchmarking them against the general population and other top wealth groups (Section 4.1). We then examine how wealth and ownership-based emissions are distributed within the billionaire population, highlighting their concentration at the very top (Section 4.2). Finally, we investigate the composition of billionaire portfolios and carbon footprints across asset classes and sectors to identify the economic activities underlying this concentration (Section 4.3).

4.1 | Billionaires in comparative perspective

The top billionaires occupy a unique position in the global distribution of wealth and emissions. Although the individuals in our sample represent less than 0.00001 per cent of the world population, they account for more than 1 per cent of both global wealth and global emissions. Average ownership-based emissions exceed 1.1 million tCO2e per billionaire per year, corresponding to more than 181,000 times the emissions of the average global citizen (Table 2). These differences remain striking even relative to already affluent groups: the average billionaire in our sample emits more than 5,000 times as much as an individual belonging to the global richest 1 per cent.

The concentration of billionaire emissions is not explained by wealth size alone. Table 3 shows that billionaire portfolios are also substantially more carbon-intensive than those of other top wealth groups

TABLE 2 Average per capita emissions (tCO2e) for global wealth groups and for top 500 billionaires, and relative ratios.

Group	Per capita emissions (tCO2e)	Billionaires-to-group ratio
Total population	6.4	181,409
Bottom 50 per cent	1.2	967,516
Middle 40 per cent	5.0	232,204
Top 10 per cent	43.6	26,629
Top 1 per cent	209.5	5,542
Top 500 billionaires	1,161,019.3	1

Note: Values for global wealth groups are from Chancel and Rehm (2026), and refer to 2022.

TABLE 3 Average emission intensities for top 1 per cent wealth groups in selected countries and for top 500 billionaires, and relative ratios.

Group	Emission intensity (tCO2e per Mln$)	Billionaires-to-group ratio
Top 1 per cent France	24	5.4
Top 1 per cent United States	37	3.5
Top 1 per cent Germany	51	2.6
Top 500 billionaires	129	1

Note: Average emission intensity for top 500 billionaires is computed only on publicly traded assets, as we relied on average intensities from Chancel and Rehm (2025) for non-publicly traded assets. Including all assets in our dataset would yield an average emission intensity of 65.33 tCO2e per million USD. *Source*: Values for France (2017), United States (2019) and Germany (2017) are from Chancel and Rehm (2025).

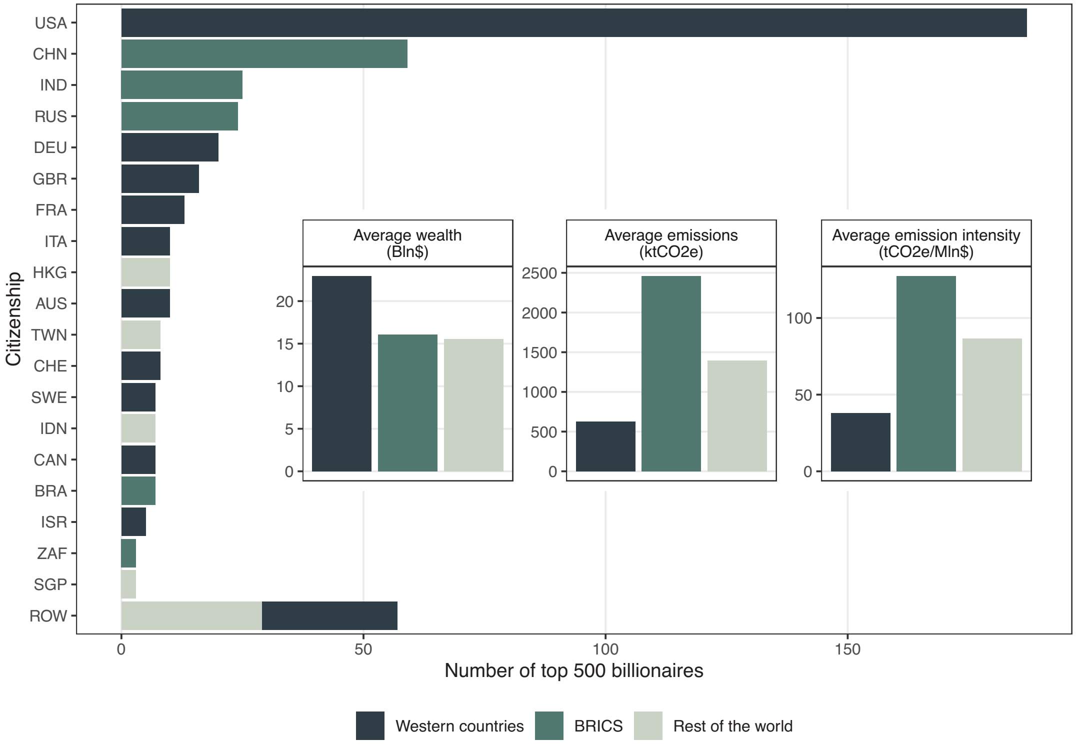

FIGURE 1 Citizenship of the world's top 500 billionaires. *Note*: Horizontal bars report the number of billionaires by citizenship, grouped into Western countries, BRICS countries and the rest of the world. Countries with fewer than four billionaires are aggregated under rest of the world (ROW). The inset compares the average wealth, ownership-based emissions and emission intensity of billionaires across the three country groups. [Colour figure can be viewed at wileyonlinelibrary.com]

documented in the literature. Average emission intensity is between 2.6 and 5.4 times higher than the corresponding estimates for the top 1 per cent wealth holders in France, Germany and the United States reported by Chancel and Rehm (2025). This points to an important compositional dimension: billionaire emissions reflect not only exceptionally large fortunes, but also the specific carbon intensity of the assets they hold (see also Sections 4.2 and 4.3).

Figure 1 further shows that billionaire wealth and associated emissions are geographically concentrated in a relatively small number of countries. In terms of citizenship, the United States accounts for the largest share of billionaires in the sample (186 individuals, corresponding to 38 per cent of the total), followed by China, India, Russia and some European economies. Overall, the top eight countries account for 354 billionaires, corresponding to 73 per cent of the sample. Although Figure 1 refers to billionaires' citizenship[20] – rather than to the geographical location of their investments – the observed concentration nevertheless highlights the extent to which large fortunes and their associated emissions are concentrated in a relatively limited number of capital hubs. As shown in the inset of Figure 1, billionaires from Western economies hold on average larger fortunes than those from Brazil, Russia, India, China and South Africa (BRICS countries) and the rest of the world. By contrast, average emissions and emission intensities are highest among billionaires from the BRICS countries, and comparatively lower among Western billionaires.

[20] Citizenship information is retrieved from each billionaire's Wikipedia page. In our dataset, 43 billionaires hold multiple citizenships. In these cases, the selected citizenship corresponds to the country of residence reported in the Forbes Billionaires' Data. Among them, 11 billionaires reside in a country for which they do not hold citizenship; for these individuals, nationality is assigned based on their country of birth.

These differences should, however, be read in light of the strong concentration of billionaires in Western economies, which still account for the largest share of individuals in the sample. Moreover, billionaire citizenship only imperfectly maps into the geography of the underlying assets and emissions, given the increasingly internationalised nature of capital ownership and the large net foreign asset positions characterising several advanced economies (Chancel and Rehm, 2026). This international dimension is also visible in residence patterns. As shown in Figure B.3 in the online Appendix, billionaires whose country of residence differs from their citizenship tend to relocate toward a relatively small number of major financial centres and global wealth hubs, further reinforcing the geographical concentration of billionaire wealth.

4.2 | Wealth, emissions and portfolio intensity among billionaires

Figure 2 shows that billionaire emissions are highly heterogeneous even within this extremely narrow segment of the global wealth distribution. While all individuals in the sample belong to the global economic elite, large differences emerge both in the scale of wealth holdings and in the carbon intensity of the underlying assets.

Figure 2(a) compares billionaire wealth and ownership-based emissions on a logarithmic scale. Although wealth and emissions are positively correlated, the relationship remains relatively weak, with billionaires holding comparable fortunes often exhibiting dramatically different ownership-based emissions. Several individuals outside the very top of the wealth distribution display emission levels comparable to – or even exceeding – those of much wealthier billionaires. This suggests that portfolio composition plays a central role in shaping ownership-based emissions.

Figure 2(b) investigates this mechanism more directly by relating emissions to emission intensity. The relationship is close to linear on the logarithmic scale, and substantially tighter than the one observed between wealth and emissions, indicating that differences in billionaire emissions are driven primarily by the carbon intensity of owned assets rather than by wealth size alone. This result is further confirmed by a variance decomposition exercise. Because emissions are mechanically given by the product of wealth and emission intensity, variation in billionaire emissions can reflect either differences in wealth levels or differences in the carbon intensity of portfolios. In our sample, however, almost all the variation in emissions is accounted for by differences in emission intensity: approximately 97 per cent of the variance in log emissions is associated with intensity differences, whereas wealth explains only around 6 per cent.[21]

Figure 2(c) further highlights the extreme concentration of emissions within the billionaire population. Billionaires in the bottom 50 per cent of the emissions distribution account for only around 2 per cent of total billionaire emissions, while the top 10 per cent account for approximately 76 per cent. By contrast, wealth is less concentrated within the sample: the bottom 50 per cent of the wealth distribution hold around 20 per cent of total billionaire wealth, whereas the top 10 per cent account for roughly 45 per cent.

Taken together, these results indicate that billionaire ownership-based emissions are substantially more concentrated than wealth itself, and that differences in portfolio composition play a much larger role than wealth size in explaining variation in emissions across billionaires.

4.3 | Going more granular: evidence on portfolio composition and sectors

The large disparities across billionaires' emissions and emission intensities documented in the previous sections are largely driven by differences in portfolio composition. Billionaires differ substantially both in the types of assets they hold and in the sectors in which they invest.

[21] The covariance term is slightly negative.

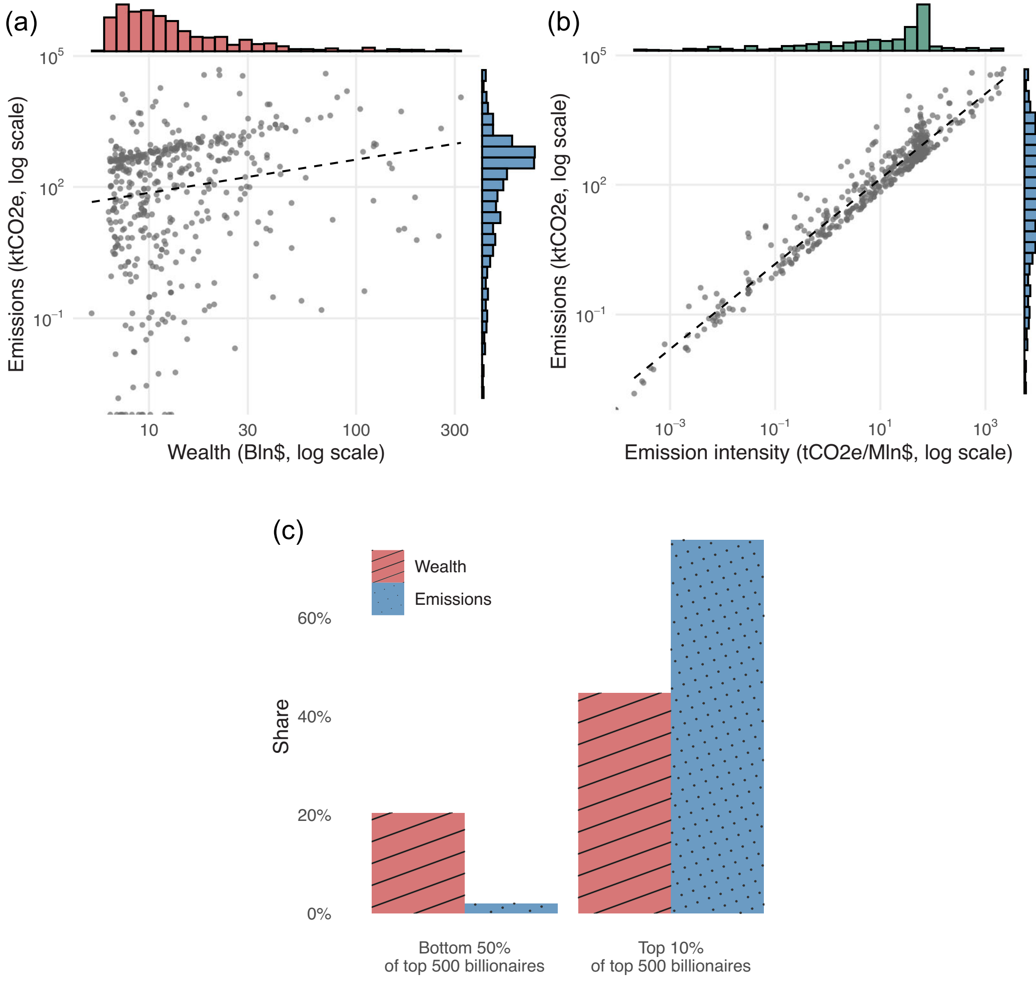

FIGURE 2 (a) Scatterplot of individual billionaire wealth versus emissions, with marginal distributions shown along the axes. The dashed line indicates the OLS fitted trend. (b) Same as panel (a) but replacing wealth with emission intensity. Emissions are reported in tCO2e per million USD (Mln$), which is equivalent to emissions in ktCO2e per billion USD (Bln$). (c) Shares of total wealth and total emissions accounted for by the bottom 50 per cent and the top 10 per cent of billionaires in the sample. [Colour figure can be viewed at wileyonlinelibrary.com]

Figure 3 illustrates this heterogeneity. Figure 3(a) shows how wealth composition, in terms of asset categories, varies across the billionaire wealth distribution. Up to the ninth decile, portfolios are relatively diversified, with wealth allocated across cash, infrastructure and business assets, unlisted equity, and publicly traded equity in broadly comparable proportions, while luxury goods, real estate and mixed assets play a more limited role. By contrast, the top decile holds a disproportionately large share of its wealth in equity – particularly publicly traded equity – with average listed-equity holdings exceeding USD 80 billion. This likely reflects both large ownership stakes in some of the world's largest corporations and the role of stock market valuations in amplifying the wealth of the ultra-rich. Liabilities remain relatively modest across the distribution, although they become somewhat more pronounced among the top 10 per cent of billionaires. Given this sharp asymmetry in portfolio composition between the top decile and the rest of the distribution, it is natural to ask how these differences translate into heterogeneous emission profiles.

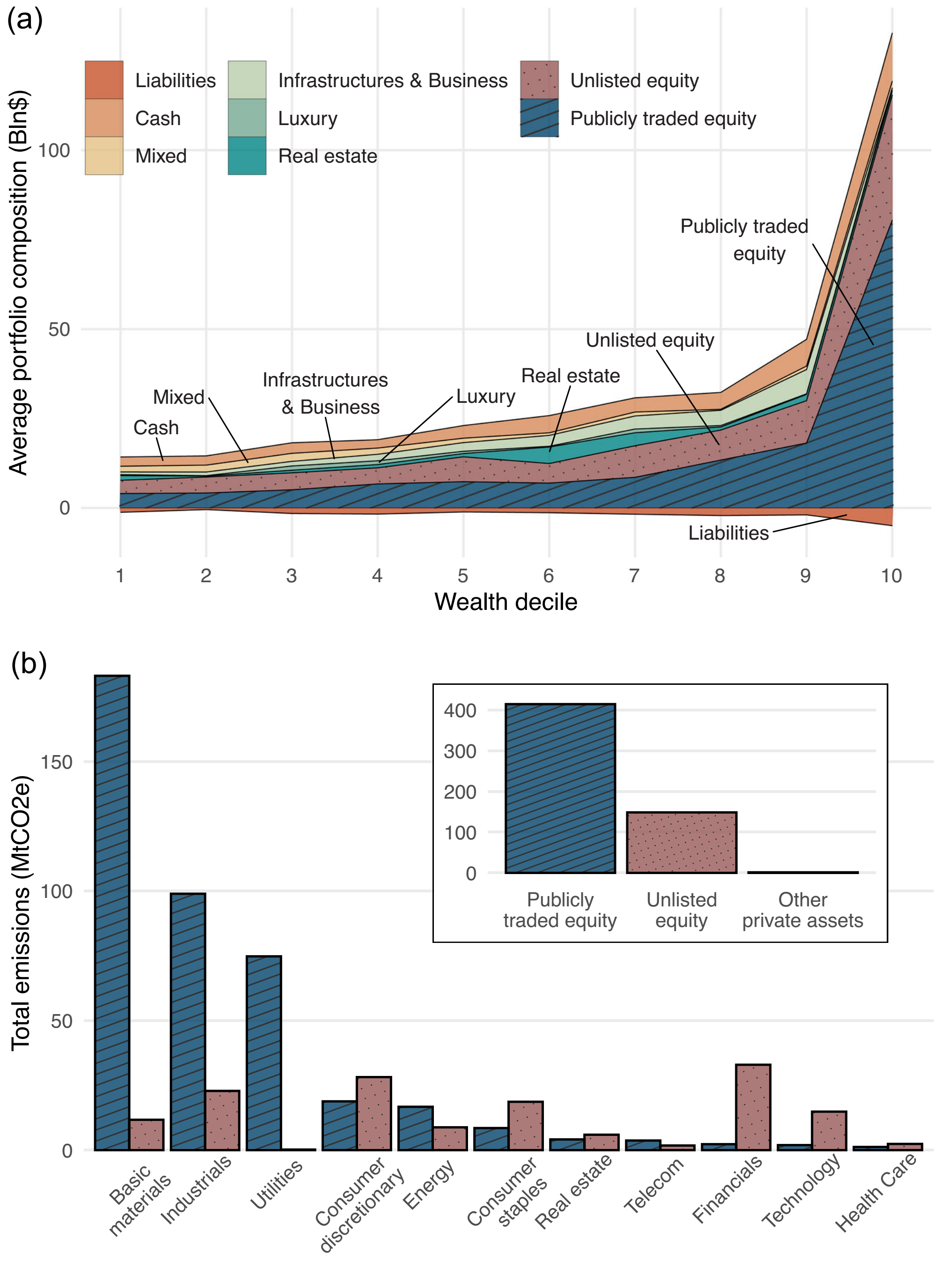

FIGURE 3 (a) Average value (billion USD) of each asset category by wealth decile, shown by asset type. Liabilities are reported as negative values. (b) Total emissions (million tonnes of CO2e) from publicly traded and unlisted equity assets held by the top billionaires, broken down by ICB industry. The inset reports totals for publicly traded assets, unlisted equity, and 'other private assets' (comprising infrastructures and business, luxury, and real estate). Liabilities, cash and mixed asset types are assigned zero emissions (see Section 3.2). [Colour figure can be viewed at wileyonlinelibrary.com]

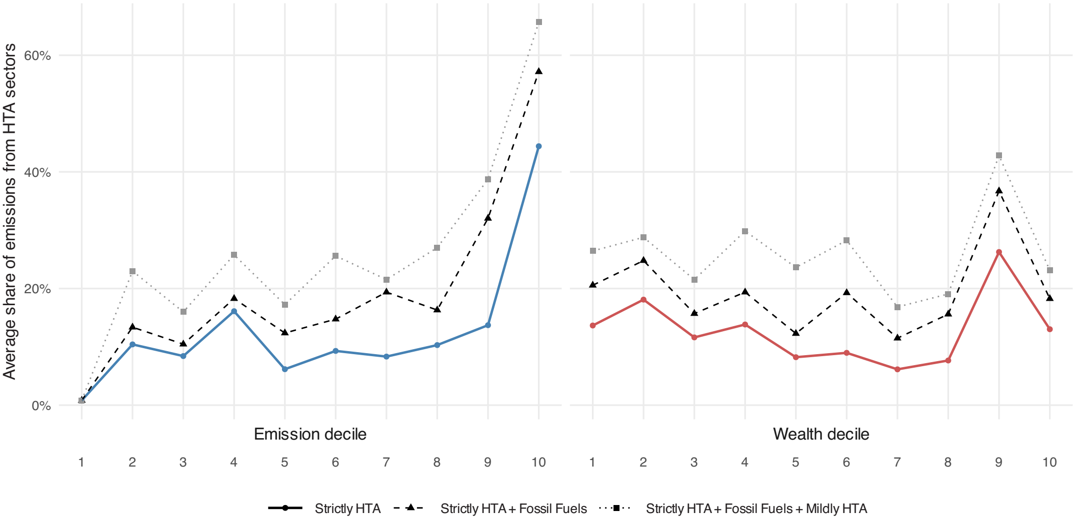

FIGURE 4 Average share of emissions from HTA sectors in billionaires' emissions portfolios. *Note*: Billionaires are ranked according to total emissions (emission decile, left panel) or to total net wealth (wealth decile, right panel). The figure shows HTA emission shares for three definitions of HTA: Strictly HTA; Strictly HTA + Fossil Fuels; and Strictly HTA + Fossil Fuels + Mildly HTA. [Colour figure can be viewed at wileyonlinelibrary.com]

Figure 3(b) addresses this question by showing the distribution of total emissions across major asset categories and economic sectors. Publicly traded equity is associated with by far the largest emissions (414 million tonnes in total), followed by private equity (148 million tonnes), while other private assets contribute only marginally (1.4 million tonnes). Figure 3(b) further decomposes these emissions by sector within publicly traded and privately held equity. In the case of unlisted equity, emissions are more concentrated in Financials and Consumer Discretionary. Differently, among listed assets, the largest contributions come from Basic Materials, Industrials and Utilities, all sectors with structurally high carbon intensities.[22]

To further characterise this pattern, we explicitly examine the extent to which billionaires' wealth and emissions portfolios reflect exposure to HTA sectors. Figure 4 reports the average share of emissions attributable to HTA sectors across both the emissions and wealth distributions, under alternative classification assumptions.[23] The left panel ranks billionaires by their total emissions, while the right panel ranks them by wealth. Across specifications, the share of emissions associated with HTA sectors increases markedly at the top of the emissions distribution, exceeding 40 per cent under the strict definition and more than 65 per cent when including fossil fuels and mildly HTA sectors. This suggests that the highest-emitting billionaires are disproportionately exposed to sectors where decarbonisation is technologically and economically more challenging. A less monotonic pattern emerges across the wealth distribution. While HTA exposure remains substantial throughout, it peaks in the ninth decile.[24] The combination of the highest HTA portfolio shares in the top emissions decile

[22] Basic Materials comprises subsectors such as aluminium, chemicals, iron and steel, paper and fertilisers, most of which are HTA sectors. Within Industrials, the highest-emitting subsectors are cement, aerospace and defence, and marine transportation. Utilities include conventional electricity, waste and multi-utilities.

[23] The most stringent classification of HTA ICB subsectors (Strictly HTA), following Paltsev et al. (2021), International Energy Agency (2022) and International Renewable Energy Agency (2024), includes only the following sectors: Aerospace, Airlines, Aluminum, Cement, Chemicals and Synthetic Fibers, Diversified Chemicals, Iron and Steel, Marine Transportation, Pharmaceuticals, Specialty Chemicals, Nonferrous Metals, Metal Fabricating, General Mining, Gold Mining, Paints and Coatings, Copper, Semiconductors, Paper, Aerospace and Defense, Glass, and Plastics. Less stringent classifications expand this definition to include (i) fossil fuels (Strictly HTA + Fossil Fuels) and (ii) mildly HTA sectors (Strictly HTA + Fossil Fuels + Mildly HTA), primarily within the automotive and waste sectors.

[24] Figure B.1 shows a similar pattern when considering the share of HTA in wealth portfolios rather than emissions portfolios.

and the ninth wealth decile points to a group of billionaires who, while not belonging to the very top of the billionaire wealth distribution or being the most publicly visible, are nonetheless extremely wealthy, among the highest emitters, and particularly concentrated in HTA sectors. Indeed, focusing on individuals whose emissions portfolios are composed of at least 90 per cent HTA emissions, we find a marked concentration in the upper tail of both distributions: 50 per cent of these individuals are located in either the ninth or tenth decile of the wealth or emissions distributions, indicating that ultra-high-wealth and ultra-high-emissions billionaires disproportionately invest in HTA sectors (Table B.2).

The concentration of billionaire emissions in HTA sectors also points to a potentially important mechanism of climate-policy resistance (Chancel et al., 2025). Decarbonising these sectors typically requires policies that are capital-intensive, disruptive to existing production processes, and likely to reprice carbon-intensive assets. When ownership of such assets is concentrated among a small number of very wealthy individuals, the expected private losses from ambitious mitigation policies are correspondingly concentrated as well (Semieniuk et al., 2022; Chancel et al., 2025). This creates strong incentives for these actors to defend the value of incumbent technologies and business models, including through lobbying, public communication, litigation, campaign finance, influence over corporate strategy, as well as via increasing reliance on carbon removals to balance emissions out. Thus, the relevance of billionaire emissions extends beyond their direct carbon footprint: concentrated ownership of HTA assets may also amplify political and institutional barriers to certain decarbonisation pathways (Goss, 2016; Mercure et al., 2021). The patterns documented in Figure 4 therefore suggest that the upper tail of the emissions distribution is not merely a site of exceptional responsibility, but also a locus of potential resistance to climate policy.

5 | TAXING BILLIONAIRES: A COMPARISON OF THREE APPROACHES

We now compare alternative taxation approaches targeting billionaires: primarily a minimum wealth tax, a carbon tax and a novel carbon wealth tax. The rationale for considering wealth and carbon taxation stems from both the regressivity of tax systems at the top and the strong concentration of emissions, as well as from the empirical patterns on billionaires documented in Section 4. A growing literature documents the regressivity of tax systems at the top of the income distribution when all taxes are considered jointly – see, for example, Piketty, Saez and Zucman (2018), Saez and Zucman (2019, 2020), Advani, Hughson and Summers (2023), Bruil (2023), Bozio et al. (2024) and Guzzardi et al. (2024) – highlighting the inability of current tax systems to effectively tax ultra-high-net-worth individuals. This has prompted increasing discussion of policy instruments aimed at closing this regressivity gap (Dalle Luche et al., 2024; Zucman, 2024), including wealth taxation, with the aim to gather resources needed to fund climate policies (Guzzardi et al., 2023; Chancel, Bothe and Voituriez, 2024). In parallel, carbon pricing remains a benchmark climate policy instrument (Metcalf and Stock, 2020), although its effectiveness depends critically on policy design and distributional acceptability (Best, Burke and Jotzo, 2020). At the same time, emissions – and particularly ownership-based emissions – have been shown to be even more concentrated than wealth (Chancel and Rehm, 2025), while recent work has begun to explore policy instruments targeting polluting capital directly (Bastos Neves and Semmler, 2025). More broadly, policy instruments that target high emitters and discourage carbon-intensive investments are likely to form part of the broader policy mix required for deep decarbonisation. This motivates comparing instruments that target related but distinct dimensions of concentration: wealth, emissions and their intersection.

Building on the empirical evidence in Section 4, three facts regarding top billionaires are particularly relevant for the comparative exercise conducted in this section. First, emissions are highly concentrated at the top of the billionaire emissions distribution – even more so than wealth. Second, this extreme concentration is largely due to assets' emission intensities rather than wealth scale

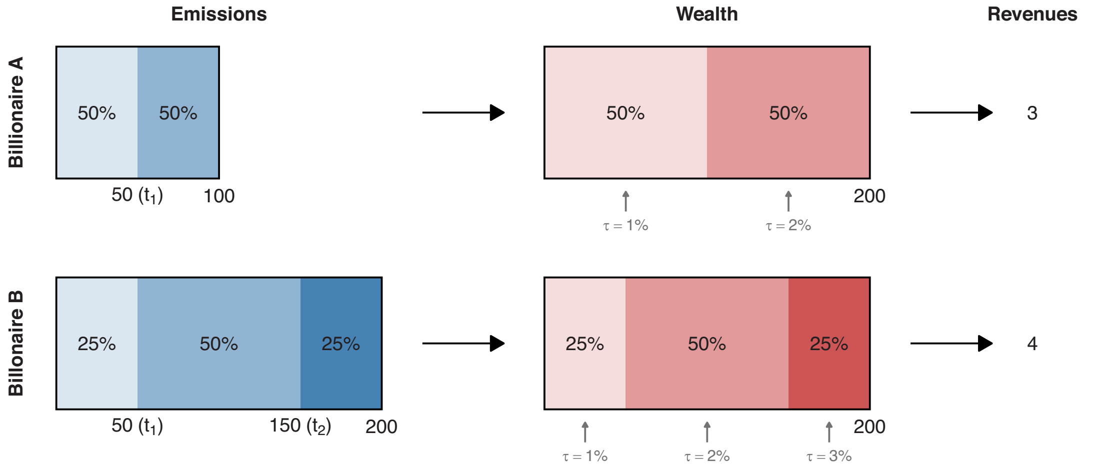

FIGURE 5 Schematic illustration of a carbon wealth tax. *Note*: Two billionaires with identical wealth but different emission compositions face different tax liabilities. Thresholds t_1 and t_2 define emission brackets – set in this manuscript at the 50th and 90th percentiles of the pooled billionaire emission distribution – associated with progressively increasing wealth tax rates τ_1, τ_2 and τ_3, which are set in the baseline exercise at 1 per cent, 2 per cent and 3 per cent, respectively. [Colour figure can be viewed at wileyonlinelibrary.com]

effects. Third, and relatedly, wealth and emissions are only mildly positively associated, rather than tightly aligned: the wealthiest individuals are not always the highest emitters, and some of the highest emitters are not among the very wealthiest. Taken together, these findings suggest that wealth taxes and emissions-based taxes target related but distinct dimensions of concentration. A policy relying exclusively on one instrument may therefore miss part of the relevant distribution, motivating the comparative exercise developed in this section.

We compare a minimum wealth tax (according to Zucman, 2024), a carbon tax (in line with Chancel and Rehm, 2025) and a novel progressive carbon wealth tax in terms of revenue potential, progressivity across the wealth and emissions distributions, and selected dimensions of political feasibility. The design of the novel carbon wealth tax is illustrated in Figure 5, which presents a stylised emissions distribution with the 50th and 90th percentiles set at 50 and 150, respectively, defining three illustrative tax brackets. A rate of $\tau = 1$ per cent is applied to emissions below the 50th percentile, $\tau = 2$ per cent to emissions between the 50th and 90th percentiles, and $\tau = 3$ per cent to emissions above the 90th percentile, analogously to a standard progressive income tax. In the example, there are two toy billionaires: billionaire A emits 100 units and owns 200 units of wealth, while billionaire B emits 200 units and also owns 200 units of wealth. The carbon wealth tax requires identifying the proportion of emissions that fall below and above the specified percentiles. Billionaire A has 50 per cent of emissions below the 50th percentile and 50 per cent above it; therefore, 50 per cent of their wealth is taxed at $\tau = 1$ per cent and 50 per cent at $\tau = 2$ per cent. Billionaire B, with higher emissions, has 25 per cent below the 50th percentile, 50 per cent between the 50th and 90th percentiles and 25 per cent above the 90th percentile. Consequently, 25 per cent of their wealth is taxed at $\tau = 1$ per cent, 50 per cent at $\tau = 2$ per cent and 25 per cent at $\tau = 3$ per cent. Under this scheme, tax revenues from billionaire A equal 3, while revenues from billionaire B equal 4. The 1 per cent, 2 per cent and 3 per cent rates are in line with other proposals focusing on wealth taxation only (Landais, Saez and Zucman, 2020).[25]

[25] Although, in our baseline specification, taxation is based on total emissions, online Appendix C (Figures C.7 and C.8) reports results for an alternative design in which tax rates increase progressively with the emissions intensity of billionaires' portfolios. This type of progressive environmental taxation is not without precedent: related policy designs include vehicle taxes linked to weight and emissions, congestion pricing calibrated to marginal social damages, and proposed progressive frequent-flyer levies aimed at disproportionately high emitters.

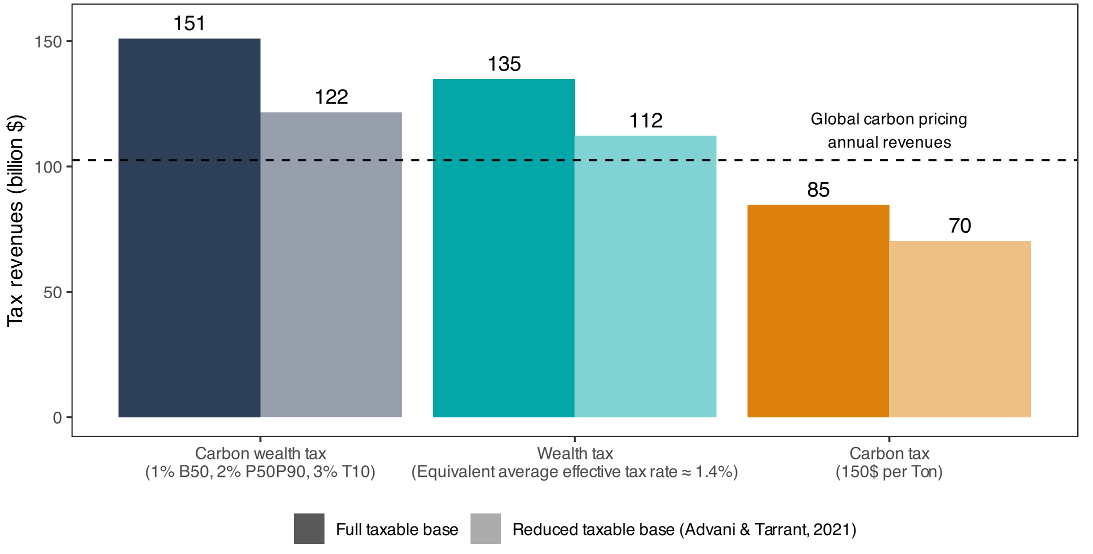

FIGURE 6 Carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2 and 3 per cent, a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx$ 1.4 per cent), and a carbon tax at \$150 per tonne of CO2e. *Note*: Shaded bars indicate revenues under tax-elusion behaviour, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes. [Colour figure can be viewed at wileyonlinelibrary.com]

We apply the progressive carbon wealth tax, the wealth tax and the carbon tax to our sample of billionaires. Figure 6 shows that imposing a progressive carbon wealth tax on the world's top billionaires would generate USD 151 billion per year. This exceeds the revenue from both a standard wealth tax with a comparable average effective tax rate of 1.4 per cent, which would raise 135 billion USD, and a carbon tax of \$150 per tonne of CO2e emissions – the upper bound considered by Chancel and Rehm (2025) – which would generate 85 billion USD. Notably, revenues from the carbon wealth tax also substantially exceed current revenues from global carbon pricing instruments, which amount to 102 billion USD (World Bank, 2025).

If billionaires strategically reallocate their portfolios to reduce tax liabilities, revenues would decline. Assuming a 17 per cent reduction in wealth and associated emissions due to behavioural responses, in line with Advani and Tarrant (2021), and holding portfolio emissions intensity constant, revenues would fall to 122, 112 and 70 billion USD under the carbon wealth tax, wealth tax and carbon tax scenarios, respectively.[26]

Figure C.1 shows that the results remain robust under alternative assumptions for emission imputation. Furthermore, Figure C.3 reports revenue estimates under alternative tax designs. Following Zucman (2024), an average effective tax rate of 1.7 per cent is required to reach a minimum effective taxation of 2 per cent, given that billionaires currently pay on average 0.3 per cent of their wealth in income taxes. Under this specification, the carbon wealth tax would generate 188 billion USD in revenues. An alternative approach – combining a wealth tax of 1.7 per cent (raising 169 billion USD) with an emission top-up (Chancel et al., 2022) imposing an additional 1 per cent on the top 10 per cent emitters – would raise 191 billion USD. Figure C.5 further restricts the analysis to publicly traded equity, the asset class in our sample associated with the highest emissions and for which both ownership and emissions are most readily observable, thereby improving feasibility from an administrative and political perspective. As expected, revenues decline; however, the carbon wealth

[26] Although this paper presents only a stylised treatment of behavioural responses, future work could distinguish more explicitly between relocation to tax havens, portfolio reallocation toward greener assets, and the purchase of carbon credits.

FIGURE 7 Average effective tax rates by billionaire wealth deciles (left panel) and CO2e emission deciles (right panel), under alternative taxation schemes. *Note*: Taxation schemes considered (as in Figure 6) are: a carbon wealth tax (see Figure 5) with rates $\tau = 1$, 2 and 3 per cent, a wealth tax calibrated so that the average effective tax rate equals that of the carbon wealth tax ($\approx$ 1.4 per cent) and a carbon tax at \$150 per tonne of CO2e. [Colour figure can be viewed at wileyonlinelibrary.com]

tax would still generate 86 billion USD in the absence of behavioural responses. Taken together, these exercises highlight the substantial revenue potential of combining wealth- and emissions-based taxation. Such revenues could cover a large share of adaptation financing needs in developing countries, estimated at 459 billion USD (United Nations Environment Programme, 2024).

To what extent do the three taxation approaches in Figure 6 differentially affect the richest and highest-emitting billionaires?[27] Figure 7 illustrates the degree of progressivity of the carbon wealth tax, wealth tax and carbon tax along the distributions of billionaire wealth and emissions. As expected, the wealth tax is characterised by flat effective tax rates across both distributions. Distinctive patterns, however, emerge when comparing the carbon wealth tax to the carbon tax. With respect to billionaire wealth, the carbon wealth tax achieves clear progressivity: effective tax rates rise consistently across wealth deciles in our sample, ranging from 1.2 per cent to 1.7 per cent on average. By contrast, the carbon tax exhibits peaks at the second and ninth deciles (1.4 and 2.2 per cent, respectively), reflecting billionaires with particularly carbon-intensive portfolios, while the first and tenth deciles face similar close-to-zero rates.

The carbon tax displays strong progressivity at the top end of the emissions distribution, with the top 10 per cent of emitters facing effective tax rates exceeding 6 per cent. At the same time, effective tax rates for the bottom 50 per cent of billionaires in the emissions distribution are close to zero. By contrast, the carbon wealth tax exhibits more gradual variation across emissions deciles, with non-negligible tax rates throughout the distribution, while still placing a greater burden on top emitters, albeit at lower levels than under the carbon tax.[28]

To better compare the two emissions-based instruments, we scale them to generate 300 billion USD annually, in line with the COP29 financing target intended to contribute to developing countries' adaptation and mitigation needs. This requires approximately doubling tax rates in the carbon wealth tax scenario (to roughly 2 per cent, 4 per cent and 6 per cent) and increasing the carbon tax by a factor of 3.5, implying a carbon price above \$500 per tonne of CO2e. Figure B.2 in the online Appendix reports the resulting effective tax rates across billionaire emissions deciles. Under the carbon tax scenario, effective tax rates rise sharply between the ninth and tenth emissions deciles. Three

[27] Although this paper focuses on the direct distributional implications of alternative tax instruments, the ultimate incidence of carbon and wealth taxation is subject to uncertainty, as part of the tax burden may be shifted away from wealth holders through adjustments in prices, wages and asset valuations. A more comprehensive analysis of tax incidence is therefore left for future research.

[28] Results remain broadly robust under alternative assumptions, including the use of a different imputation methodology for missing emissions related to publicly traded equity (Figure C.2), comparisons between the carbon wealth tax with additional alternative tax schemes (Figure C.4) and a specification in which taxation is applied only to publicly traded equity (Figure C.6).

features stand out. First, the top 10 per cent emitters face effective tax rates above 20 per cent, far exceeding the average annual rate of return on wealth of 7.5 per cent (Zucman, 2024). As a recurring annual tax, such rates would gradually erode wealth stocks, raising concerns about political feasibility. Second, roughly half of the world's top billionaires face near-zero effective tax rates, indicating that a substantial share of ultra-high-net-worth individuals in the lower part of the emissions distribution bear negligible tax liability, a pattern relevant for the literature on top-end progressivity (Zucman, 2024). Third, the most polluting billionaires are disproportionately exposed to HTA sectors (see Section 4.3), where low-carbon substitutes remain technologically limited, making rapid portfolio greening challenging.

The foregoing issues are mitigated under the carbon wealth scenario. When scaled to achieve the same revenue target of 300 billion USD, it implies progressive effective tax rates ranging from around 2 per cent for low-emitting billionaires to approximately 5 per cent for the most polluting – still below the average return on wealth (Figure B.2). All ultra-high-net-worth individuals face positive tax rates, with incidence jointly determined by wealth and emissions exposure, resulting in a smoother gradient across emissions deciles than under the carbon tax. This increases the tax burden among ultra-high-net-worth wealth holders, a mechanical feature associated with higher measured progressivity at the top in standard tax incidence frameworks (Saez and Zucman, 2019; Bruil et al., 2022; Bozio et al., 2024; Guzzardi et al., 2024), while preserving higher incidence on more emission-intensive portfolios.[29]

6 | CONCLUSIONS AND FURTHER RESEARCH

In this work, we construct a novel dataset with fine-grained, asset-level information on the wealth and emissions portfolios of the top 500 billionaires by combining data from the BBI, Thomson/Refinitiv and Yahoo Finance. This dataset enables us to examine the distribution of wealth, emissions and emission intensity across both assets and individuals.

The results show that among top billionaires, emissions are even more concentrated than wealth: around 50 individuals account for 76 per cent of total emissions in our sample. Ownership of business corporations is the key determinant of billionaires' emissions accounts: publicly traded equity emerges as the largest source, followed by unlisted equity, while other private assets (e.g. luxury) play only a minor role in emissions portfolios. The strong concentration of emissions among billionaires is driven primarily by differences in the emission intensities of their assets rather than by wealth scale alone. Indeed, differences in portfolio emission intensity explain 97 per cent of the variance in log emissions. However, in comparison with other wealth groups, emission intensities remain extremely high at the top: the average emission intensity of the top 500 billionaires' publicly traded assets reaches 129 tCO_2e per million USD, which is 5.4 times that of the top 1 per cent in France. The sectoral composition of wealth also reveals that the highest-emitting billionaires derive 44–66 per cent of their emissions portfolios from HTA sectors. Hence, the extreme concentration of emissions at the top reflects not only how much wealth is held, but also the carbon content and sectoral allocation of that wealth.

Such evidence motivated a comparison of policy designs that address wealth and emissions concentration. To this end, we compare a wealth tax, a carbon tax and a new progressive carbon wealth tax, which jointly targets wealth and emissions. Our progressive carbon wealth tax assigns a larger tax burden at the top of the emissions distribution by applying rates of 1 per cent, 2 per cent and 3 per cent to the bottom 50 per cent, middle 40 per cent and top 10 per cent of the emissions distribution, respectively. These progressive rates are then mapped on to wealth, based on the share of each billionaire's emissions that falls within the corresponding emissions brackets.

[29] Note that our taxation exercises should be interpreted as a comparative simulation of alternative approaches, rather than as a full welfare or optimal-tax analysis. Future research needs to better address the possible issues of portfolio reallocation, wealth mobility, international coordination and pass-through effects to assess the overall distributional implications of the different tax instruments.

We find that the revenue potential of the carbon wealth tax is higher than traditional wealth and carbon taxation schemes. Our baseline estimates show that the carbon wealth tax could raise about USD 151 billion more than comparable alternatives while relying on relatively modest tax rates. Moreover, the carbon wealth tax delivers effective rates that are progressive across both billionaire wealth deciles and emissions deciles. While a simple carbon tax produces stronger progressivity along the emissions distribution, it imposes extremely high effective rates on the 50 most polluting individuals, raising potential concerns for political feasibility. When scaled to meet a revenue target consistent with the COP29 financing goals for adaptation and mitigation in developing countries, the implied top effective tax rates exceed 20 per cent, compared to an average rate of return on wealth of 7.5 per cent. On the contrary, the carbon wealth tax assigns positive tax rates to all billionaires while avoiding an extreme concentration of the burden on HTA sectors.

Overall, the carbon wealth tax could potentially achieve a triple objective: imposing a higher tax burden on the super-rich to address the regressivity of current tax systems and curb inequality, taxing emissions more heavily to incentivise greener portfolios, and mobilising significant resources to finance an inclusive decarbonisation pathway. Relevantly, the policy implications of these findings should be interpreted in the context of existing energy, environmental and fiscal instruments. Some emissions embodied in billionaire portfolios may already be subject to carbon pricing or taxation; however, an emissions-progressive wealth tax would operate on a distinct tax base, targeting ownership of highly emitting assets rather than emissions at the point of production or consumption. Its role would therefore be complementary, especially in a policy landscape where many fossil-fuel and HTA activities remain unevenly regulated or subsidised, and where additional instruments may help reduce reliance on carbon prices whose costs can be passed through to consumers.

While the paper provides *prima facie* evidence that emissions are highly concentrated in billionaire wealth portfolios and highlights the potential role of these emissions in the design of wealth taxation, the analysis could be extended along several complementary dimensions. First, we plan to substantially expand the dataset by constructing a panel of billionaires' wealth, portfolio composition and associated emissions. The sample could also be broadened by incorporating additional sources, such as Forbes Billionaires' Data. Second, we will further refine the simulation of tax scenarios by explicitly distinguishing between tax evasion and tax avoidance through portfolio reallocation, drawing on existing evidence on wealth elasticities (Duran-Cabré, Esteller-Moré and Mas-Montserrat, 2019; Advani and Tarrant, 2021; Brülhart et al., 2022). Better accounting for behavioural responses would allow us to examine how carbon-adjusted wealth taxes may induce shifts in portfolio composition, including divestment from carbon-intensive assets, cross-border wealth mobility and changes in ownership structures. Future work could also explore how these responses depend on the geographical scope of taxation, comparing nationally implemented schemes with more coordinated international approaches. Third, further research should examine the incidence of carbon wealth taxes and the extent to which their burden may be shifted away from wealth holders through adjustments in prices, wages and asset valuations, in order to fully assess the distributional and environmental consequences of such policies. Finally, future analyses could examine whether carbon wealth taxation creates incentives for billionaires to reallocate investments toward greener firms and negative-emissions technologies, or whether it primarily results in the transfer of carbon-intensive assets to less wealthy investors, with potentially limited effects on firms' abatement incentives and aggregate emissions.

ACKNOWLEDGEMENTS

The authors wish to thank Lucas Chancel, Andrea Coronese, Demetrio Guzzardi, Yannic Rehm, the FIND research group, and the participants of LISIT 2025 (Svolvaer, Norway), the 37th EAEPE Annual Conference (Athens, Greece), the 66th SIE Annual Scientific Meeting (Naples, Italy), the 14th IAERE Annual Conference (Trento, Italy), the Sant'Anna Inequality Workshop (Pisa, Italy) and the 3rd World Inequality Conference (Paris, France) for the fruitful comments and suggestions. This work has received funding from the European Research Council (ERC) FIND project (Finance and Innovation to couple Negative emissions and sustainable Development) under the Horizon Europe research and innovation programme (grant agreement No 101117427), the FIS3 project 'SCI-PET', funded by the Italian Ministry of University and Research (CUP J53C25002420001) and the FIS3 project 'TRACE', funded by the Italian Ministry of University and Research (CUP J53C25002430001). Naturally, all usual disclaimers apply.

Open access publishing facilitated by Scuola Superiore Sant'Anna, as part of the Wiley - CRUI-CARE agreement.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The full code to replicate our analysis is available at https://github.com/CoMoS-SA/billionaires-emissions. As the underlying data are proprietary, we provide a synthetic dataset with a limited number of observations to enable replication of the analysis pipeline.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Bua, K., Coronese, M., Lamperti, F., Marino, C., Palagi, E., & Roventini, A. (2026). The carbon content of billionaire wealth: composition, concentration and taxation. *Fiscal Studies*, 1–24. https://doi.org/10.1111/1475-5890.70035