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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 analyze the wealth composition of the top 501 billionaires and construct a dataset linking each of their assets to emissions. According to our ownership-based emission accounting framework, *every USD million* held by billionaires is associated with more than 65 tCO2e 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 more so, 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 playing a disproportionate role as emission sources. Emission intensity is key: 97% 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%) 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 codes: D31 · D63 · G32 · Q50 · Q54

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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 501 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 socioeconomic 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 (Palagi et al., 2022; Paglialunga 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 mobilize resources, improve progressivity, and target the economic activities most closely associated with emissions (Bastos Neves and Semmler, 2022).

In this work, 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 (Baselgia and Martínez, 2024; Ischinsky and Tisch, 2022; Tisch and Ischinsky, 2023). We combine these data with firm-level emissions from Thomson/Refinitiv and market capitalization data from Yahoo Finance, Financial Times and Market Screener to estimate asset-level emissions for the world's 501 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 our knowledge, the first global assessment of the joint concentration of wealth and ownership-based emissions among the world's richest individuals.

Every Mln$ in the top 501 billionaires' wealth is associated to an yearly amount of more than 65 tCO2e. Focusing on publicly traded assets alone, the emission intensity almost doubles, approaching 130 tCO2e/Mln$, which is 5.4 times higher than the emission intensity of the richest 1% in France. Further, our findings reveal a striking dual concentration, with the top 0.00001% of the world's population owning more than 1% 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 billionaires' carbon footprint almost entirely stems from their investment decisions and not by 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% 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 mobilize revenues on the order of $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 mobilizing substantial fiscal resources for an inclusive and just global decarbonization agenda.

The remainder of the paper is organized as follows. Section 2 reviews the literature on emission accounting and carbon inequality. Section 3 describes the data and methodology used to construct the dataset and implement the tax simulations. Section 4 presents the main empirical findings, while Section 5 reports the results of the tax simulation exercises. Finally, Section 6 concludes and outlines directions for future research.

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 emphasizing 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 consistent 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 et al., 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% in the United States were 40 times higher than those of the top 10% in Nigeria, and more than 500 times higher than those of Nigeria's bottom 10%. At the global level, individuals in the richest 1% are estimated to emit close to 100 times more than members of the poorest 10% (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 only indirectly influence. Yet important determinants of emissions 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

[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

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% 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% accounting for about 40% of privately owned total GHG 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 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 decarbonization 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, infrastructures 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

transport—remain attributed to the final user.

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

pool of individuals and to a broader range of asset classes, our dataset allows us to jointly characterize 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 CO2e emissions associated with each asset (Section 3.2). Third, building on the ownership-based approach 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 Bloomberg Billionaires Index (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 BBI.[4] The index provides a daily ranking of the world's 500 richest individuals, reporting both total net worth and a detailed breakdown of individual asset holdings. Across all reported holdings, 38% are publicly traded companies, 31% privately held companies, 20% cash, 4% residential or commercial real estate, and a residual 7% comprises 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 BBI and Yahoo Finance. In particular, when BBI's methodological notes report an explicit ownership share, we adopt that figure as given. Instead, when 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 capitalization data from Yahoo Finance.[5] Specifically, for these holdings, we retrieve companies' market capitalization as of 24 February 2025.[6] Finally, we compute the ownership shares by dividing the stake value reported in BBI by the companies' total market capitalization expressed in USD.[7]

[4] Our sample includes 501 billionaires: 500 are drawn directly from BBI, to which we add Michael Bloomberg, whose holdings are not disclosed by his own company (Bloomberg LP) and are therefore not reported in 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% 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 2023, a *New York Times* article from April 2024, and a *Simple Flying* article from March 2025) and valued using the same methodology applied to the rest of the sample.

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

[6] Because market capitalization is retrieved on 24 February 2025 while 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 capitalization is reported in a foreign currency, we first convert the value into USD using the prevailing exchange rate from BBI on the corresponding date.

3.1.2 Privately held assets

For non-listed equity, we rely primarily on the asset-level notes from BBI. Whenever 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. 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 Appendix A 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 Appendix A.

For all remaining privately held holdings—including real estate, cash, infrastructure-related assets, luxury items and liabilities—we adopt the valuations reported in 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% of publicly traded assets and approximately 79% of privately held assets; including private assets where the individual is clearly the majority owner brings coverage of private holdings to about 82.6%. To preserve data quality in the empirical analysis, we exclude billionaires for whom more than 50% 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% to about 1.10%.[11]

[8] There is a fourth case in which, for 22 holdings (21 unique entities), 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% 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, BBI reports the value of the billionaire's stake in each holding, and these holdings account for 0.62% 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.

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

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 GHG emission figures through a hierarchical multi-model procedure that prioritizes company-reported values and impute missing observations with model-based estimates. Reported values are collected, quality-checked and standardized 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 Appendix A. 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 prioritize reported emissions over estimated figures and, when multiple estimates are available, 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] 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% of all listed equity holdings in our dataset. Second, for companies for which Thomson/Refinitiv reports only the sum of estimated Scope 1

[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 applying 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.

[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 which, in turn, own stakes in other companies. In practice, most firms in our sample define their GHG organizational 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 Appendix D.

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).

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% 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% of listed holdings. Finally, for the remaining 17.3% 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 value. We adopt the U.S. 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 category, and we consistently adopt the most conservative assumption whenever multiple estimates are available. For non-listed equity, we apply the same U.S. Scope 1 equity-based benchmark intensity from Chancel and Rehm (2025) used for listed equity, corresponding to 59.4 tCO2e per million of USD owned.[17] Infrastructure and business assets are assigned the French Scope 1 business-asset benchmark from the same source (35.53 tCO_2e per million USD), while residential and commercial real estate is matched to the corresponding French

[15] The ICB is a global classification developed by FTSE Russell and distributed via Thomson/Refinitiv. It organizes 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.

[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.

housing benchmark (0.068 tCO_2e per million USD).

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.

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

[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.

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 only around 0.00001% of the world population, they account for more than 1% 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%.

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 documented in the literature. Average emission intensity is between 2.6 and 5.4 times higher than the corresponding estimates for the top 1% 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% of the total), followed by China, India, Russia, and some European economies. Overall, the top eight countries account for 354 billionaires, corresponding to 73% 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 relative emissions) are associated with 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 BRICS countries and the rest of the world. By contrast, average emissions and emission intensities are highest among billionaires from BRICS countries, and comparatively lower among Western billionaires.

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 internationalized nature of capital ownership and the large net foreign asset positions characterizing several advanced economies (Chancel and Rehm, 2026). This international dimension is also visible in residence patterns. As shown in Appendix Figure B.3, 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.

[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

Table 2: Average per capita emissions (tCO2e) for global wealth groups and for top 500 billionaires, and relative ratios. Values for global wealth groups are from Chancel and Rehm (2026), and refer to 2022.

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

Table 3: Average emission intensities for top 1% wealth groups in selected countries and for top 500 billionaires, and relative ratios. Values for France (2017), United States (2019) and Germany (2017) are from (Chancel and Rehm, 2025). 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/Mln$.

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

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.

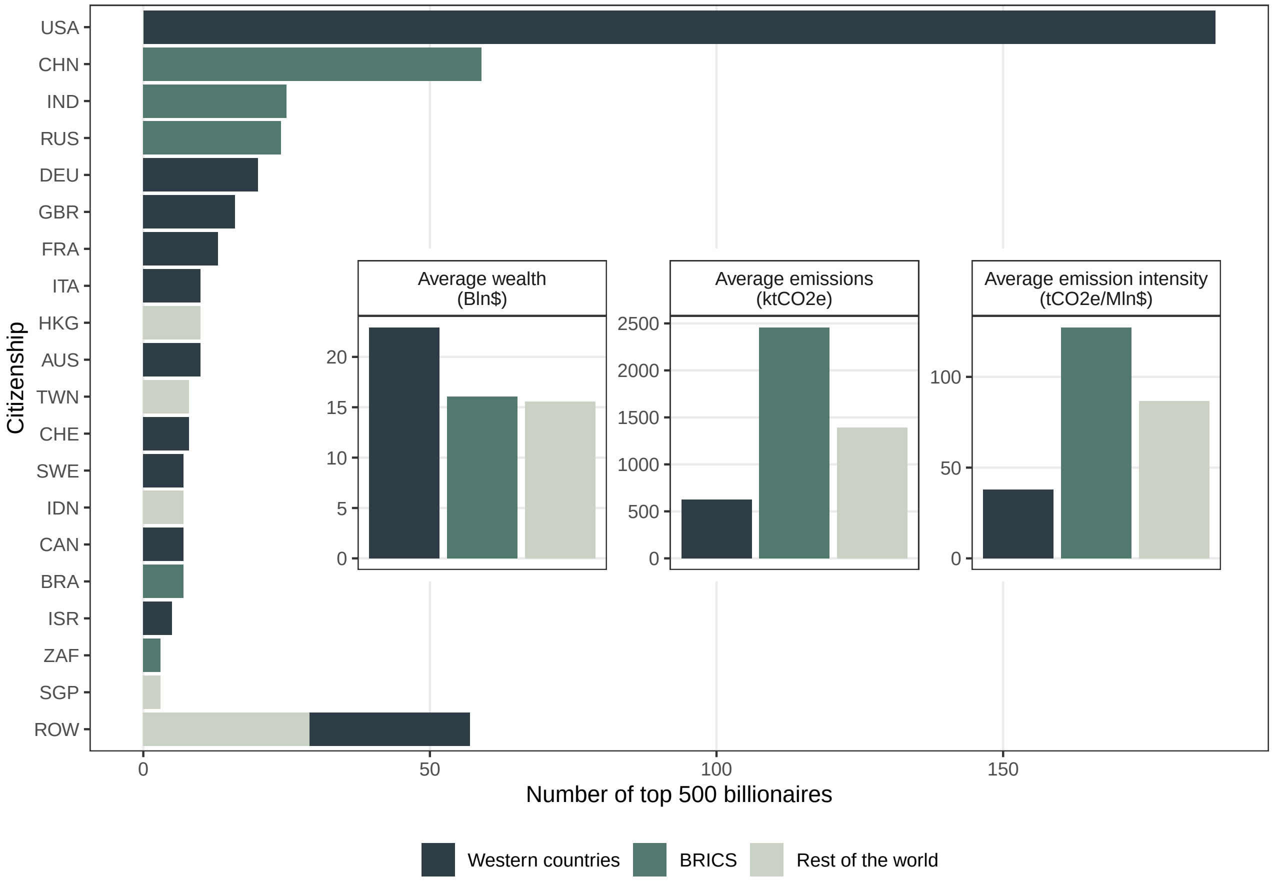
Panel A compares billionaire wealth and ownership-based emissions on a logarithmic scale. Although wealth and emissions are positively correlated, the relationship remains relatively weak, with billionaires holding comparable fortunes often exhibiting dramatically different ownership-based emissions. 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.

Panel 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. Since 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% of the variance in log emissions is associated with intensity differences, whereas wealth explains only around 6%.[21]

assigned based on their country of birth.

[21] The covariance term is slightly negative.

Figure 1: Citizenship of the world's top 500 billionaires. Horizontal bars report the number of billionaires by citizenship, grouped into Western countries, BRICS, 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.



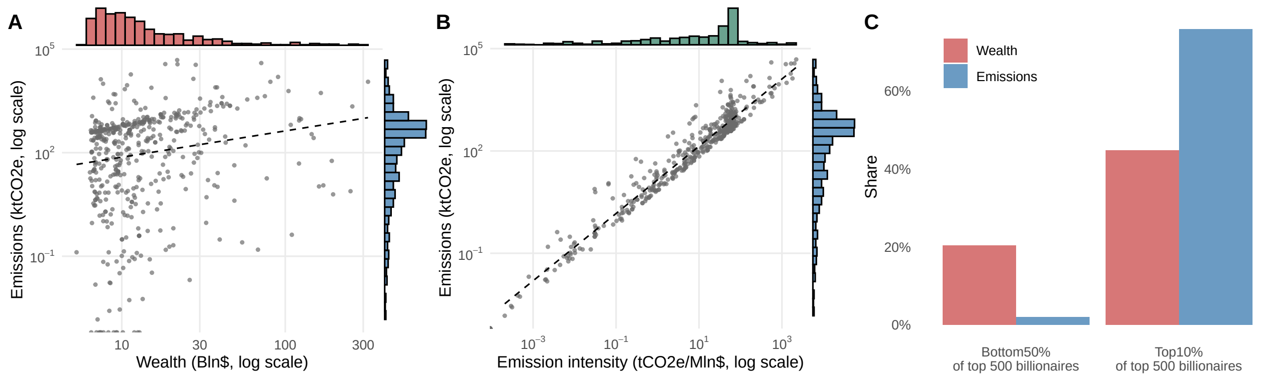
Panel C further highlights the extreme concentration of emissions within the billionaire population. Billionaires in the bottom 50% of the emissions distribution account for only around 2% of total billionaire emissions, while the top 10% account for approximately 76%. By contrast, wealth is less concentrated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

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. Figure 3 illustrates this heterogeneity. Panel A shows how wealth composition, in terms of asset categories, varies across the billionaire wealth distribution. Up to the

Figure 2: Panel A: Scatterplot of individual billionaire wealth *vs.* emissions, with marginal distributions shown along the axes. The dashed line indicates the OLS fitted trend. Panel B: Same as Panel A, but replacing wealth with emission intensity. Emissions are reported in tCO2e/Mln$, which is equivalent to emissions in ktCO2e/Bln$. Panel C: Shares of total wealth and total emissions accounted for by the bottom 50% and the top 1% of billionaires in the sample.



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 is characterized by a disproportionately large concentration of its wealth portfolio in equity—particularly publicly traded equity—holding on average more than $80 billion in listed equity alone. 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% 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.

Panel 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). Panel 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]

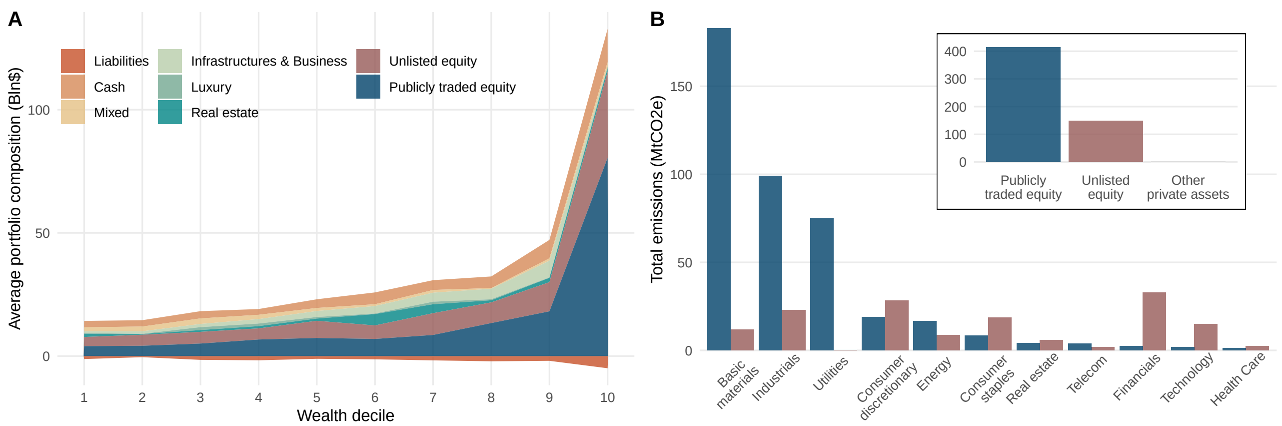
To further characterize this pattern, we explicitly examine the extent to which billionaires' wealth and emissions portfolios reflect exposure to HTA sectors. Figure 4 reports the average share of emissions attributable to HTA sectors across both the emissions and wealth distributions, under alternative classification assumptions.[23]

[22] Basic Materials comprises subsectors such as aluminium, chemicals, iron and steel, paper, and fertilizers, most of which are HTA sectors. Within Industrials, the highest-emitting subsectors are cement, aerospace & defense 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); 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 & Defense, Glass, and Plastics. Less stringent classifications expand this definition to include (i) fossil fuels

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% under the strict definition and more than 65% when including fossil fuels and mildly HTA sectors. This suggests that the highest-emitting billionaires are disproportionately exposed to sectors where decarbonization 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 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% HTA emissions, we find a marked concentration in the upper tail of both distributions: 50% 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).

Figure 3: Panel A: Average value (billion $) of each asset category by wealth decile, shown by asset type. Liabilities are reported as negative values. Panel 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 & business, luxury, and real estate). Liabilities, cash, and mixed asset types are assigned zero emissions (see Section 3.2).

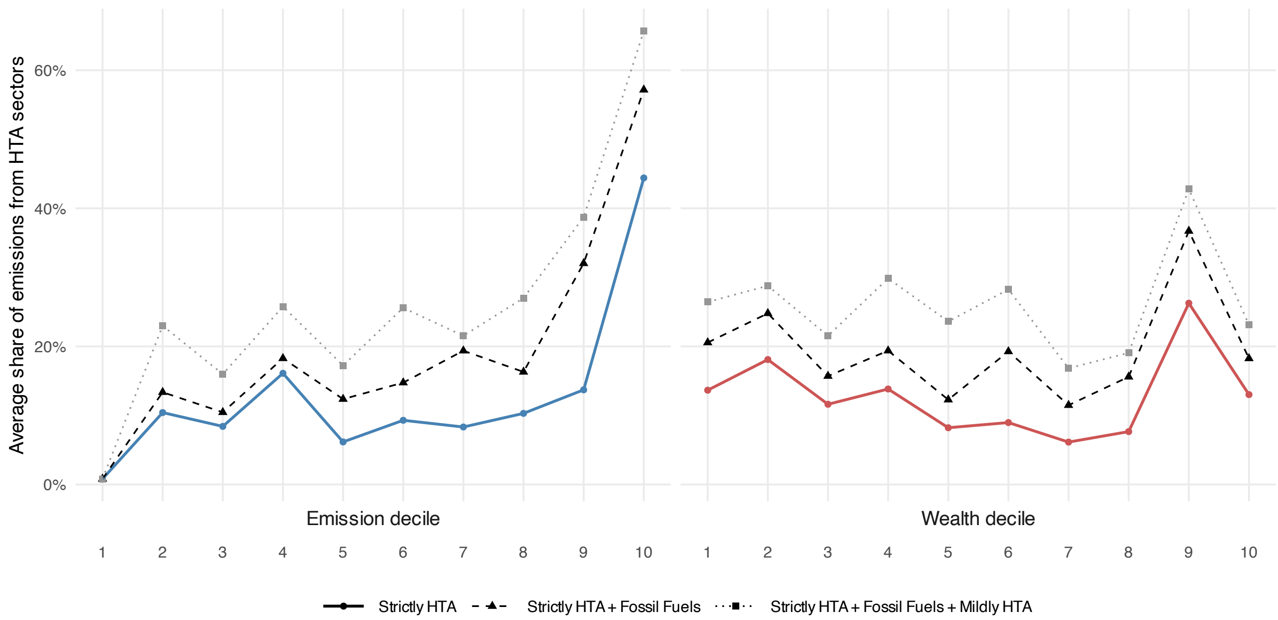


The concentration of billionaire emissions in HTA sectors also points to a potentially important mechanism of climate-policy resistance (Chancel et al., 2025). Decarbonizing these sectors typically requires policies that are capital-intensive, disruptive to existing production processes, and likely to 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

(Strictly HTA + Fossil Fuels) and (ii) mildly HTA sectors (Strictly HTA + Fossil Fuels + Mildly HTA), primarily within the automotive and waste sectors.

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

Figure 4: Average share of emissions from HTA sectors in billionaires' emissions portfolios. 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, Strictly HTA + Fossil Fuels + Mildly HTA).



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 decarbonization 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 (e.g., Piketty et al., 2018; Saez and Zucman, 2019, 2020; Advani et al., 2023; Bruil, 2023; Bozio et al., 2024; 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 (Zucman, 2024; Dalle Luche et al., 2024), including wealth taxation, with the aim to gather resources needed to fund climate policies (Chancel et al., 2024; Guzzardi et al., 2023). 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 et al., 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, 2022). 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 decarbonization. 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 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 (à la 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 stylized emissions distribution with the 50th and 90th percentiles set at 50 and 150, respectively, defining three illustrative tax brackets. A rate of $\tau = 1\%$ is applied to emissions below the 50th percentile, $\tau = 2\%$ to emissions between the 50th and 90th percentiles, and $\tau = 3\%$ 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% of emissions below the 50th percentile and 50% above it; therefore, 50% of their wealth is taxed at $\tau = 1\%$ and 50% at $\tau = 2\%$. Billionaire B, with higher emissions, has 25% below the 50th percentile, 50% between the 50th and 90th percentiles, and 25% above the 90th percentile. Consequently, 25% of their wealth is taxed at $\tau = 1\%$, 50% at $\tau = 2\%$, and 25% at $\tau = 3\%$. Under this scheme, tax revenues from billionaire A equal 3, while revenues from billionaire B equal 4. The 1%, 2% and 3% rates are in line with other proposals focusing on wealth taxation only (Landais et al., 2020).[25]

We apply the progressive carbon-wealth tax, the wealth tax and the carbon tax to our sample of billionaires.

[25] Although in our baseline specification taxation is based on total emissions, 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 5: Schematic illustration of a carbon wealth tax. 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%, 2%, and 3%, respectively.

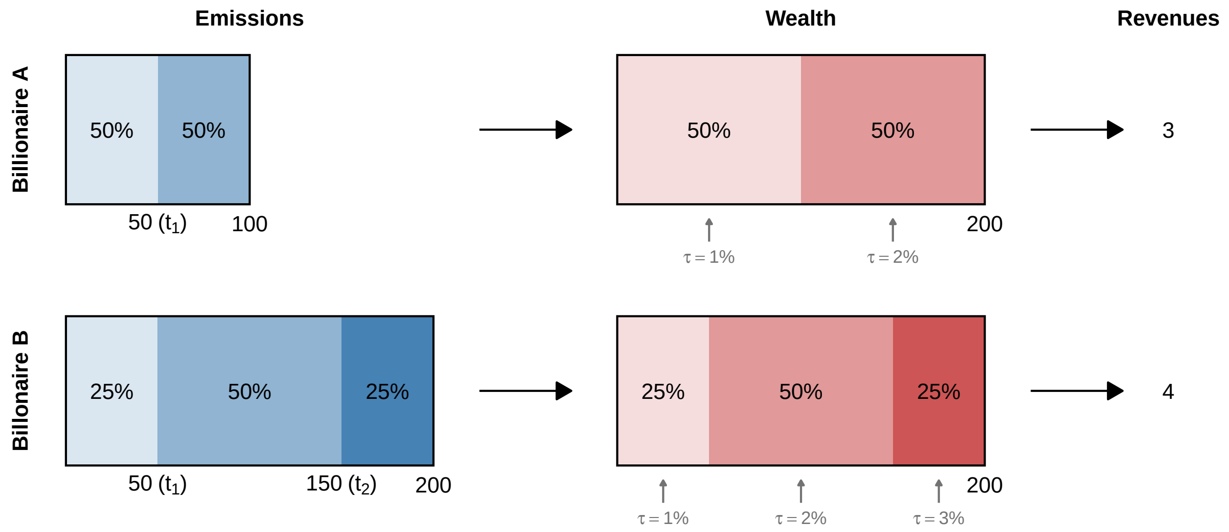


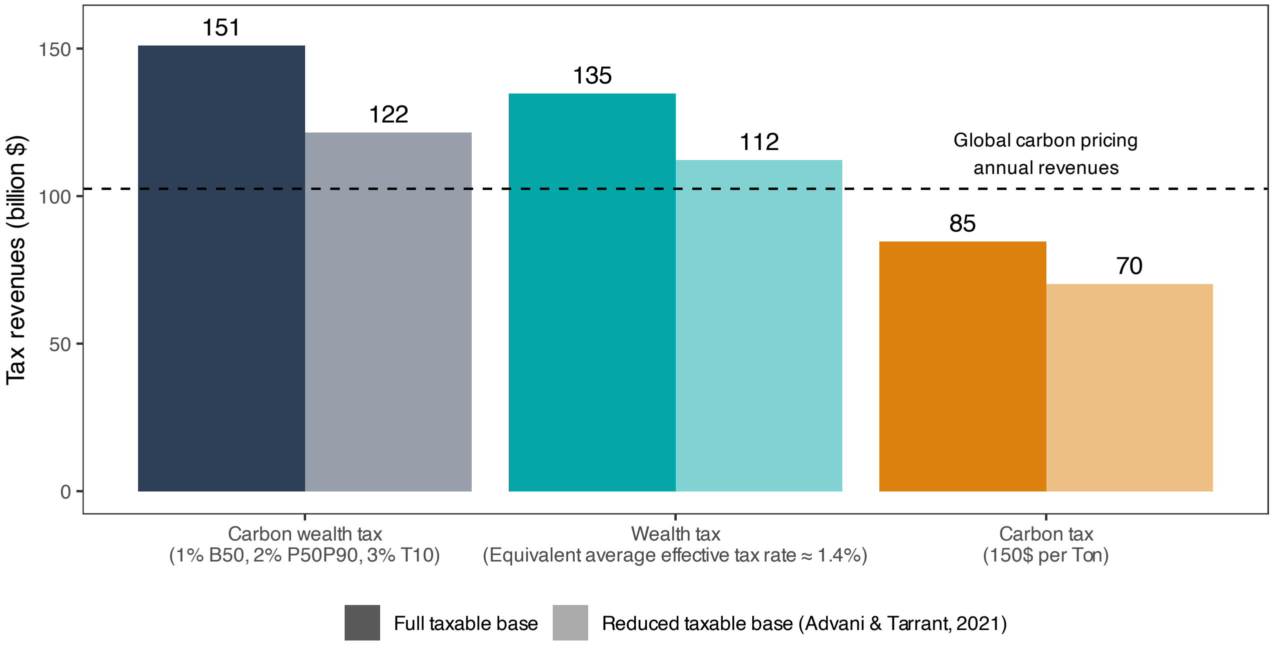
Figure 6 shows that imposing a progressive carbon-wealth tax on the world's top billionaires would generate $151 billion per year. This exceeds the revenue from both a standard wealth tax with a comparable average effective tax rate of 1.4%, which would raise $135 billion, and a carbon tax of $150 per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

If billionaires strategically reallocate their portfolios to reduce tax liabilities, revenues would decline. Assuming a 17% reduction in wealth and associated emissions due to behavioral responses, in line with Advani and Tarrant (2021), and holding portfolio emissions intensity constant, revenues would fall to $122 billion, $112 billion, and $70 billion 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% is required to reach a minimum effective taxation of 2%, given that billionaires currently pay on average 0.3% of their wealth in income taxes. Under this specification, the carbon wealth tax would generate $188 billion in revenues. An alternative approach—combining a wealth tax of 1.7% (raising $169 billion) with an emission top-up (Chancel et al., 2022) imposing an additional 1% on top 10% emitters—would raise $191 billion. 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,

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

Figure 6: Carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at $150 per ton of CO2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes.



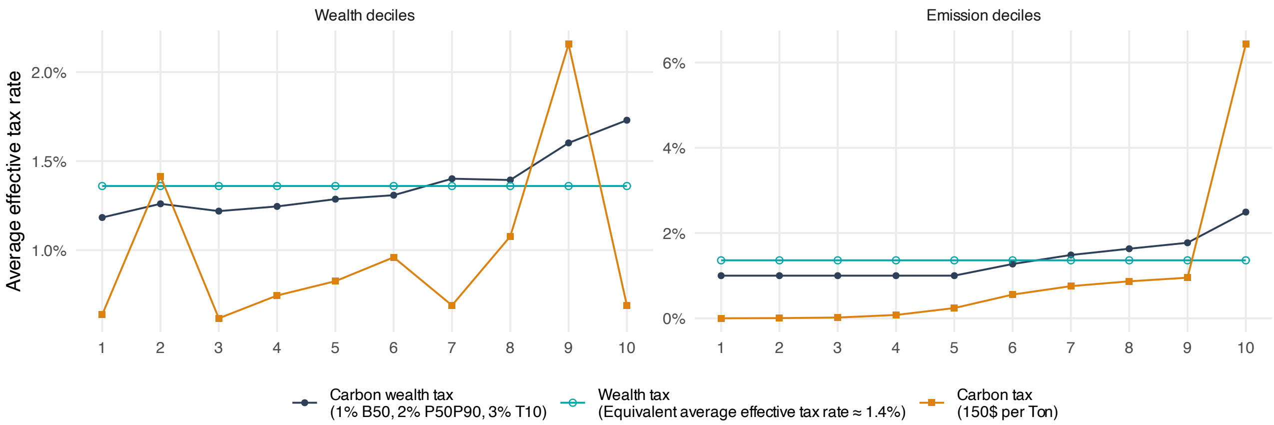
revenues decline; however, the carbon-wealth tax would still generate $86 billion in the absence of behavioral responses. Taken together, these exercises highlight the substantial revenue potential of combining wealth- and emissions-based taxation. Such revenues could cover a large share of adaptation financing needs in developing countries, estimated at $459 billion (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 characterized 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% to 1.7% on average. By contrast, the carbon tax exhibits peaks at the second and ninth deciles (1.4 and 2.2%, 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% of emitters facing effective tax rates exceeding 6%. At the same time, effective tax rates for the bottom 50% 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

[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.

Figure 7: Average effective tax rates by billionaire wealth deciles (left panel) and CO2e emission deciles (right panel), under alternative taxation schemes. Taxation schemes considered (as Figure 6) are: a carbon wealth tax (see Figure 5) with rates $\tau = 1$, 2, and 3%; a wealth tax calibrated so that the average effective tax rate equals that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO2e.



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 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%, 4%, and 6%) and increasing the carbon tax by a factor of 3.5, implying a carbon price above \$500 per tonne of CO_2e. Figure B.2 in 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 features stand out. First, the top 10% emitters face effective tax rates above 20%, far exceeding the average annual rate of return on wealth of 7.5% (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 \$300 billion revenue target, it implies progressive effective tax rates ranging from around 2% for low-emitting billionaires to approximately 5% 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

[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).

measured progressivity at the top in standard tax incidence frameworks (Saez and Zucman, 2019; Bruil et al., 2022; Guzzardi et al., 2024; Bozio 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 501 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% 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% 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 tCO2e per million of USD, which is 5.4 times that of the top 1% in France. The sectoral composition of wealth also reveals that the highest-emitting billionaires derive 44–66% 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%, 2%, and 3% to the bottom 50%, middle 40%, and top 10% of the emissions distribution, respectively. These progressive rates are then mapped onto wealth, based on the share of each billionaire's emissions that falls within the corresponding emissions brackets.

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 $151 billion more than comparable alternatives while relying on relatively modest tax rates. Moreover, the carbon-wealth tax delivers effective rates that are progressive both across 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

[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 need 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.

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%, compared to an average rate of return on wealth of 7.5%. 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 incentivize greener portfolios, and mobilizing significant resources to finance an inclusive decarbonization 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 subsidized, 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 of emissions' concentration in billionaires' wealth stocks and underscores the potential for their role in wealth taxation, our research can be improved along different complementary avenues. 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 et al., 2019; Advani and Tarrant, 2021; Brülhart et al., 2022). Better accounting for behavioral responses would allow us to examine how carbon-intensive 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.

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Appendices

A Details on data construction

Supplementary market capitalization data

When market capitalization figures are unavailable from Yahoo Finance, we supplement the missing information using alternative financial sources, namely the Financial Times and Market Screener. The list of companies using these alternative sources is provided below.

Table A.1: Supplementary sources for market capitalization data

Financial Times (23 companies)	**Market Screener (5 companies)**
Aditya Birla Capital Ltd	Aros Bostadsutveckling AB
AllDay Marts Inc	CP Tower Leasehold Real Estate Investment Trust
AllHome Corp	Lulu Retail Holdings PLC
Apex Mining Co Inc	Orascom Financial Holding S.A.E.
Coloplast A/S	Orascom Telecom Media and Technology Holding S.A.E.
Dangote Cement PLC	
Dangote Sugar Refinery PLC	
Distribuidora Internacional de Alimentación SA	
Global Health Ltd	
Golden MV Holdings Inc	
ISS A/S	
Kontron AG	
NASCON Allied Industries PLC	
Nilfisk Holding A/S	
PolyPeptide Group AG	
Reinet Investments S.C.A.	
Roche Holding AG	
Shree Cement Ltd	
Sichuan Biokin Pharmaceutical Co Ltd	
Turkcell Iletisim Hizmetleri AS	
United Bank for Africa PLC	
Vista Land & Lifescapes Inc	
Vistamalls Inc	

Peer comparison approach

Under our peer comparison approach, the value of a private company (non-listed equity) is inferred by applying a valuation ratio from comparable publicly listed firms to the relevant financial metric of the private firm. Bloomberg's methodological notes generally identify both the metrics used for the valuation and the set of comparable peers. Based on this information, we collect peer data from Bloomberg LP and Yahoo Finance and estimate the company's total value accordingly.

Two caveats are worth mentioning. First, we were unable to retrieve reliable Yahoo Finance data for all the valuation metrics employed by Bloomberg and therefore had to rely on a single multiple in some cases. For example, Bloomberg estimates the value of Guardian Industries using both Enterprise Value-to-EBITDA and Enterprise Value-to-Sales multiples, whereas our valuation relies solely on Enterprise Value-to-EBITDA.

Second, Bloomberg's methodological notes specify the reference dates of the peer financial metrics used in each valuation. We sought to retrieve comparable data as close as possible to February 2025, the reference date of the Bloomberg valuations used in our main analysis. However, owing to data availability constraints in Yahoo Finance, this was not always feasible. Consequently, peer financial metrics were collected at different points in time depending on the company being valued.[30]

Taken together, these differences in valuation inputs may lead to minor discrepancies between our estimates and Bloomberg's reported valuations. Table A.2 reports, for each private company valued through this approach, the financial metric used and the number of peers considered, while Table A.3 reports the value of the selected metric, the mean peer ratio, and the resulting company valuation. All values are expressed in USD.

[30] For instance, peer metrics were retrieved in June 2025 for Bloomberg's own valuation; March 2025 for Kaufland, Lidl, and PreZero; December 2024 for Cook Group and C&S Wholesale Grocers; September 2024 for Safra National Bank of New York and Banco Safra S.A.

Table A.2: Valuation of privately held companies using Peer Comparison Approach I

Company	**Ratio type**	**N. of peers**
Advance Publications	Value to sales/revenues	3
Apical	Value to revenues	3
April Group	Value to sales/revenues	5
Arvest Bank Group	Price-to-book value	2
Aviation Partners	Enterprise value-to-sales	3
Banco Safra SA	Average price-to-book value	5
Bloomberg LP	Enterprise value-to-revenues	2
C&S Wholesale Grocers	Enterprise value-to-sales/revenues	4
Conde Nast	Enterprise value-to-sales/revenues	2
Cook Group	Value-to-sales/revenues	2
Cox Automotive	Enterprise value to sales/revenues	3
Cox Communications	Enterprise value to sales/revenues	3
Dyson	Enterprise value-to-sales/revenues	3
Ferrero SpA	Enterprise value-to-Ebitda	3
Flint Hills Resources, LLC	Enterprise value-to-sales	3
Georgia-Pacific	Enterprise value-to-Ebitda	3
GoAirlines India	Price-to-sales	2
Guardian Industries	Enterprise value-to-Ebitda	2
Infor Global Solutions	Enterprise value-to-Ebitda	2
Inmuebles Carso	Price-to-book value	3
Invista	Enterprise value-to-Ebitda	3
Kaufland	Enterprise value-to-sales	2
Lee Kum Kee	Price-to-earnings	5
Lidl	Enterprise value-to-sales	3
Menarini	Enterprise value-to-sales/revenues	4
Molex	Enterprise value-to-Ebitda	5
New Hope Property Developer	Price-to-book value	3
Nowcom Corporation	Enterprise value-to-sales	3
Phoenix Pharmahandel	Enterprise value-to-sales	2
Pratt Industries	Enterprise value-to-sales	2
PreZero	Enterprise value-to-sales	4
Safra National Bank of New York	Price-to-book	3
Skoda Transportation	Enterprise value-to-sales	2
Viessmann	Enterprise value-to-sales	3
Wuerth Group	Enterprise value-to-Ebit	4

Table A.3: Valuation of privately held companies using Peer Comparison Approach II

Company	**Metric (value)**	**Mean peer ratio**	**Company value**
Advance Publications	2,000,000,000	1.843	3,686,666,667
Apical	7,300,000,000	0.877	6,399,666,667
April Group	1,400,000,000	0.862	1,206,800,000
Arvest Bank Group	1,735,470,000	1.540	2,672,623,800
Aviation Partners	614,000,000	1.477	906,673,333
Banco Safra SA	3,400,000,000	1.414	4,807,600,000
Bloomberg LP	13,000,000,000	8.975	116,675,000,000
C&S Wholesale Grocers	20,400,000,000	0.315	6,426,000,000
Conde Nast	1,800,000,000	1.890	3,402,000,000
Cook Group	2,600,000,000	6.475	16,835,000,000
Cox Automotive	9,000,000,000	0.933	8,400,000,000
Cox Communications	13,300,000,000	3.007	39,988,666,667
Dyson	9,000,000,000	1.450	13,050,000,000
Ferrero SpA	18,200,000,000	15.673	285,254,666,667
Flint Hills Resources, LLC	38,000,000,000	0.433	16,466,666,667
Georgia-Pacific	3,500,000,000	11.083	38,791,666,667
GoAirlines India	588,000,000	0.415	244,020,000
Guardian Industries	3,700,000,000	15.795	58,441,500,000
Infor Global Solutions	740,000,000	24.370	18,033,800,000
Inmuebles Carso	4,434,772,000	2.553	11,323,451,173
Invista	1,500,000,000	11.050	16,575,000,000
Kaufland	181,000,000,000	0.260	47,060,000,000
Lee Kum Kee	2,300,000,000	30.236	69,542,800,000
Lidl	181,000,000,000	0.343	62,143,333,333
Menarini	4,800,000,000	3.353	16,092,000,000
Molex	7,100,000,000	12.288	87,244,800,000
New Hope Property Developer	4,800,000,000	0.347	1,664,000,000
Nowcom Corporation	190,000,000	13.773	2,616,933,333
Phoenix Pharmahandel	47,000,000,000	0.175	8,225,000,000
Pratt Industries	4,700,000,000	2.090	9,823,000,000
PreZero	181,000,000,000	0.925	167,425,000,000
Safra National Bank of New York	1,300,000,000	1.087	1,412,666,667
Skoda Transportation	1,215,500,000	0.585	711,067,500
Viessmann	1,000,000,000	1.970	1,970,000,000
Wuerth Group	22,100,000,000	1.783	39,393,250,000

Construction of GHG emission figures in Thomson/Refinitiv

Thomson/Refinitiv constructs company-level emission figures by combining firm-level disclosures, collected through its own data-gathering process and complemented with responses to the annual surveys of the Carbon Disclosure Project, with a hierarchical imputation procedure that fills the gaps left by direct reporting. We provide here additional details on the imputation procedure, building on the brief description in Section 3.2.

Missing observations are first imputed by extrapolating the last available emission intensity for up to two years, under the assumption that firm-level intensities are constant in the short run, and rescaling it using current-year activity proxies such as revenues. Sector-specific production models are then applied to energy-related firms, using disclosed production data and standard emission factors and incorporating systematic outlier filtering. Any residual gap is completed via a "carbon ensemble" best estimate that combines multiple statistical approaches — including sector-median benchmarks and input-output models — trained on quality-checked reported observations.

Two implications follow for our analysis. First, a non-negligible share of the emission figures we use is ultimately derived from model-based imputation rather than direct corporate disclosure, and therefore inherits the assumptions embedded in the underlying estimation procedures. Second, even the reported portion of the data is subject to potential self-reporting bias, since firms with more developed environmental management systems tend to disclose more systematically and accurately than firms with weaker reporting practices. Our decision to prioritize reported Scope 1 values, and to rely on model-based estimates only when reported data are unavailable, is intended to minimize the weight of these limitations in the baseline results.

B Additional figures tables

Table B.1: List of top 15 billionaires ranked by total emissions and by emission intensity.

Top 15 billionaires by total emission			Top 15 billionaires by emission intensity		
Rank	Name	Total emissions (ktCO2e)	Rank	Name	Emission intensity (tC02e/Mln$)
1	Lakshmi Mittal	48,203	1	Lakshmi Mittal	2,210
2	Gautam Adani	39,497	2	Kumar Birla	2,001
3	Kumar Birla	36,917	3	Benu Bangur	1,797
4	Zhang Bo	36,455	4	Zhang Bo	1,664
5	Savitri Jindal	35,097	5	Ludwig Merckle	1,630
6	Ludwig Merckle	18,518	6	Li Shuirong	1,295
7	Mukesh Ambani	15,671	7	Savitri Jindal	1,238
8	Aliko Dangote	13,778	8	Dang Yanbao	836
9	Benu Bangur	13,375	9	Michael Kadoorie	664
10	Elon Musk	11,332	10	Ronald McAulay	585
11	Carlos Slim	11,318	11	Thomas Schmidheiny	558
12	Li Shuirong	9,950	12	Gautam Adani	554
13	Dang Yanbao	9,001	13	Nassef Sawiris	535
14	Klaus-Michael Kuehne	7,808	14	Aliko Dangote	503
15	Shapoor Mistry	7,800	15	Paolo Rocca & family	502

Figure B.1: Average share of wealth from HTA sectors in billionaires' wealth portfolios. Billionaires are ranked according to total emissions (Emission decile - left panel) or to total net wealth (Wealth decile - right panel). The figure shows HTA wealth shares for three definitions of HTA (Strictly HTA, Strictly HTA + Fossil Fuels, Strictly HTA + Fossil Fuels + Mildly HTA).

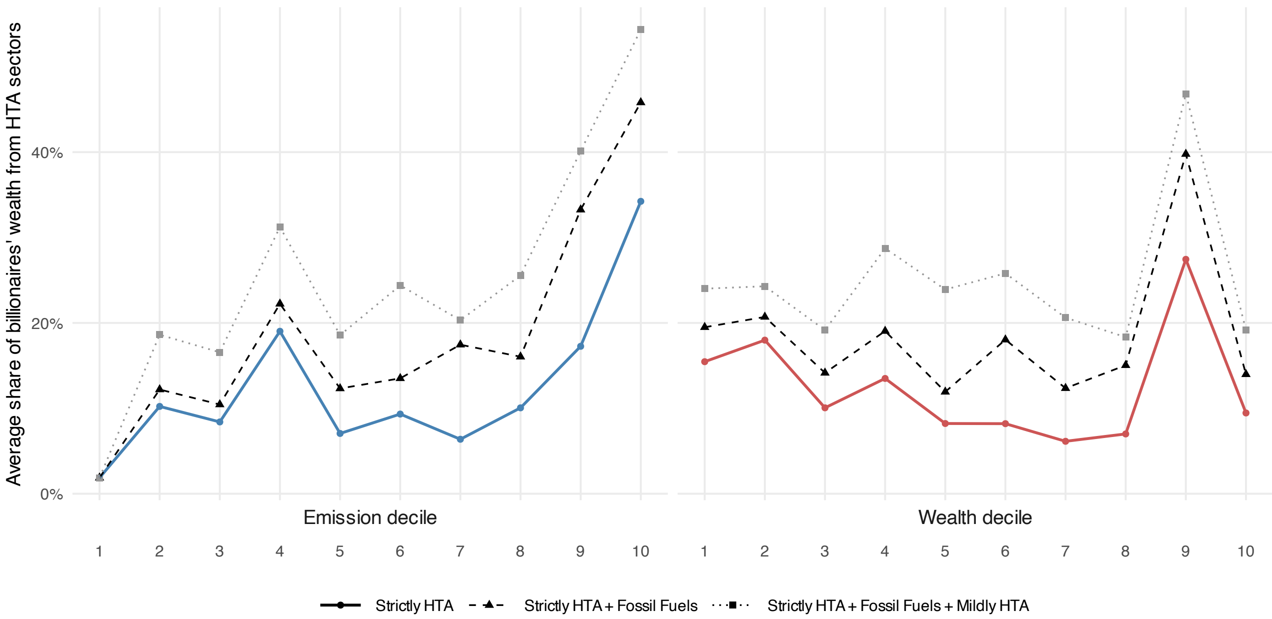


Table B.2: List of billionaires with shares of emissions from HTA sectors exceeding 90%

Name	Net wealth	Wealth decile	Total emissions	Emission decile	ICB Subsector
Jensen Huang	109.7	10	0.4	2	Semiconductors
Klaus-Michael Kuehne	38.2	10	7807.9	10	Airlines
Mukesh Ambani	90.4	10	15671.4	10	Paper
Dilip Shanghvi	26.5	9	25.0	3	Pharmaceuticals
Ernesto Bertarelli & family	27.6	9	51.6	4	Pharmaceuticals
German Larrea	34.9	9	2934.0	10	Nonferrous Metals
Idan Ofer	28.7	9	1795.7	10	Marine Transportation
Lakshmi Mittal	21.8	9	48202.6	10	Iron and Steel
Rodolphe Saade & family	27.8	9	1428.5	9	Marine Transportation
Zhang Bo	21.9	9	36454.9	10	Aluminum
Gina Rinehart	21.0	8	1421.6	9	General Mining
Kumar Birla	18.5	8	36917.5	10	Cement
Jim Ratcliffe	13.7	7	859.4	9	Chemicals: Diversified
John Fredriksen	12.2	6	2720.8	10	Marine Transportation
Ludwig Merckle	11.4	6	18517.6	10	Cement
Dang Yanbao	10.8	5	9000.5	10	Chemicals: Diversified
Thomas Schmidheiny	8.9	4	4976.1	10	Cement
Rahul Bhatia	8.2	3	3029.3	10	Airlines
Viktor Vekselberg	8.4	3	2737.9	10	Aluminum
Benu Bangur	7.4	2	13375.3	10	Cement
Li Shuirong	7.7	2	9950.1	10	Chemicals: Diversified
Rakesh Gangwal	6.6	1	1144.7	9	Airlines

Figure B.2: Average effective tax rates by billionaire CO_2e emission deciles under alternative taxation schemes. Taxation schemes include a carbon wealth tax (see Figure 5) and a carbon tax. Dashed lines indicate baseline tax rates: $\tau = 1$, 2, and 3% for the carbon wealth tax, and \$150 per ton of CO_2e for the carbon tax (as in Figures 6 and 7). Solid lines show the rates required to meet COP29 climate finance goals (≈\$300 billion annually): $\tau \approx 2$, 4, and 6% for the carbon wealth tax, and \$495 per ton of CO_2e for the carbon tax. The colored bar at the bottom indicates the average share of billionaire-level emissions linked to HTA sectors under a strict classification (see Figure 4 for alternative definitions).

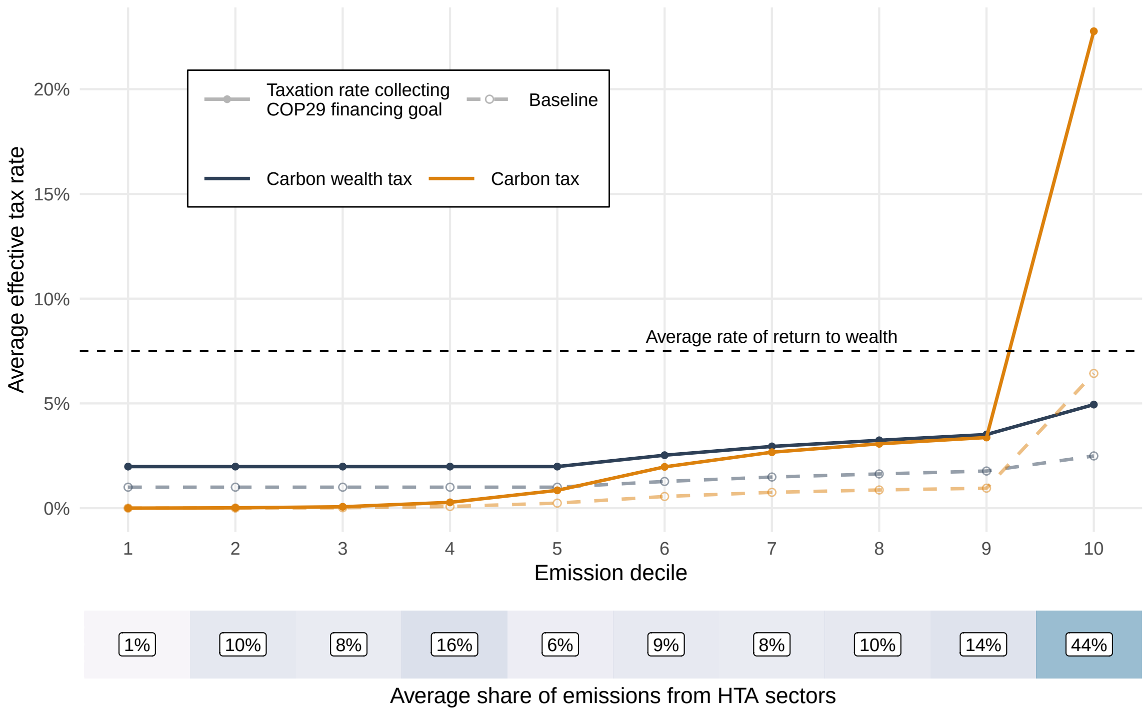
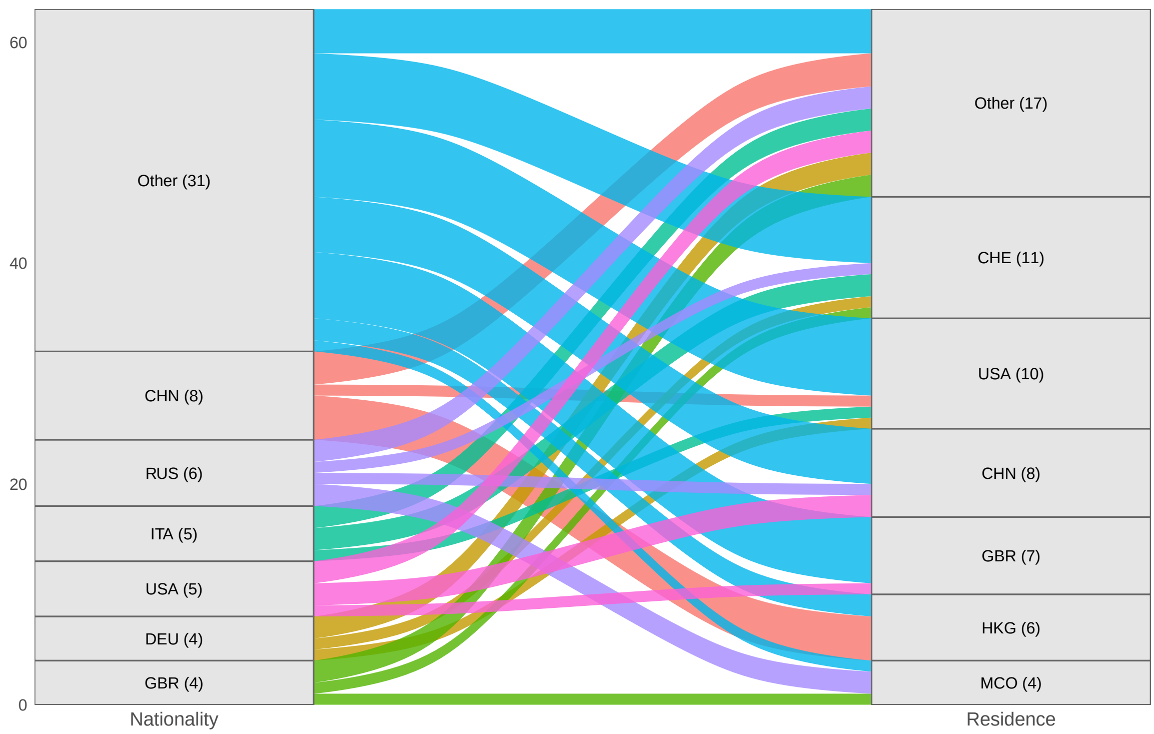


Figure B.3: Nationality and country of residence among billionaire movers. Sankey diagram showing the correspondence between nationality (left) and country of residence (right) for the 63 billionaires in our sample whose country of residence differs from their nationality. Flows are proportional to the number of billionaires moving between each origin and destination country. To improve readability, only countries with at least four observations are shown individually, while all remaining countries are grouped under Other. Labels report the number of billionaires in each nationality and residence group.



C Alternative scenarios

In addition to the baseline scenario, three alternative specifications are developed as a robustness check for the main findings: *(i)* a scenario using Scope 1 emission intensities from Chancel and Rehm (2025) for listed equity instead of the industry-level ratio approach described in Table 1; *(ii)* a scenario assuming an average effective tax rate of 1.7% (Zucman, 2024), with 1.7% applied to the bottom 90% and 2.7% to the top 10 emitters; and *(iii)* a scenario in which only listed equity is considered.

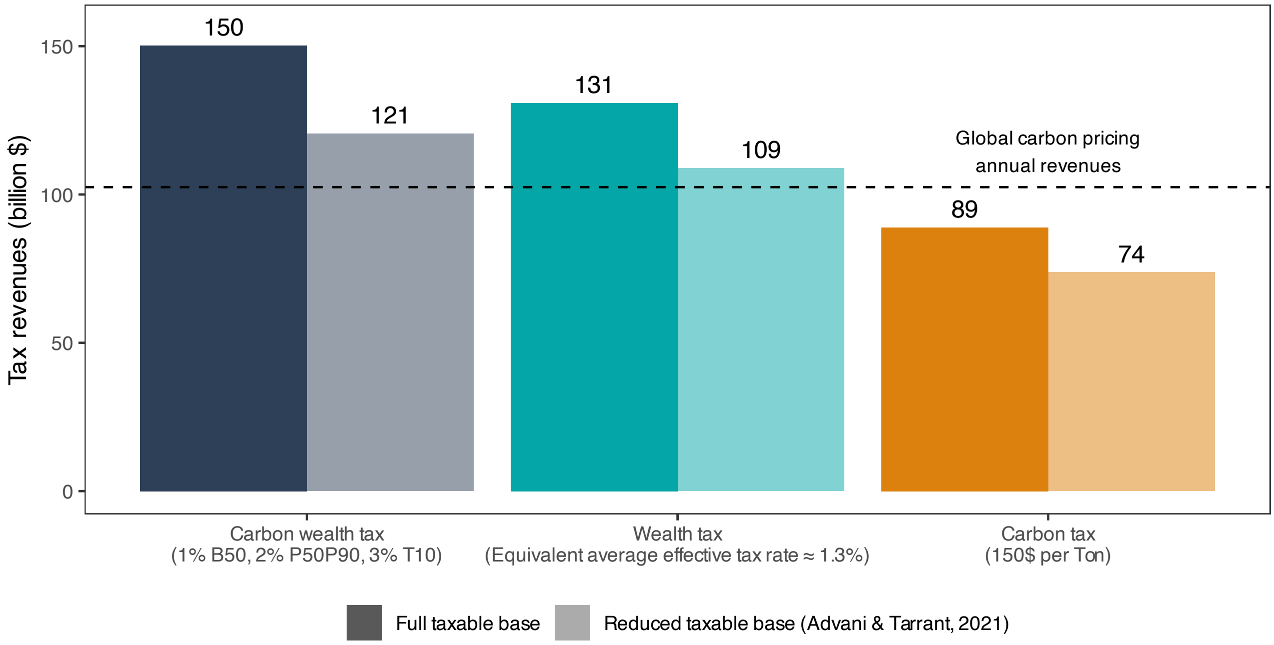
Main alternative emission imputation scenario

The main alternative emission imputation scenario differs from the baseline in the way Scope 1 emissions associated with listed equity are computed. For all other asset classes, the calculation of emissions follows the methodology described in the previous section.

As in the baseline scenario, whenever Thomson/Refinitiv directly reports Scope 1 emissions for publicly traded assets, we rely on those figures. For listed companies where Thomson/Refinitiv provides the total (Scope 1 + Scope 2) emissions and only one of the two components, the missing component is imputed residually by subtracting the reported value from the total. For the remaining publicly listed assets with no emissions data available from Thomson/Refinitiv—neither the sum of Scope 1 and Scope 2 emissions nor either of the two individually—we draw on the 2019 equity-based benchmark estimates for Scope 1 emission intensities provided by Chancel and Rehm (2025). In such cases, we apply the US 2019 Scope 1 benchmark emissions intensity (74.9 tonnes of CO2 per million of USD owned).

Differently from the baseline, for companies reporting only aggregated Scope 1 + Scope 2 emissions but lacking separate Scope 1 values, we no longer rely on industry-level ratios to impute emissions. Instead, we apply the Scope 1 emission intensities from Chancel and Rehm (2025). Results are showed in Figures C.1 and C.2.

Figure C.1: Alternative scenario. Carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO_2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes.



Alternative taxation scenarios

In this scenario, we adopt an average effective tax rate as in Zucman (2024) and introduce an emissions-based differentiation by applying a higher tax rate to top emitters.

Figure C.2: Alternative scenario. Average effective tax rates by billionaire wealth deciles (left panel) and CO_2e emission deciles (right panel), under alternative taxation schemes. Taxation schemes considered (as Figure C.1) are: a carbon wealth tax (see Figure 5) with rates $\tau = 1$, 2, and 3%; a wealth tax calibrated so that the average effective tax rate equals that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at $150 per ton of CO_2e.

Figure C.3: Carbon wealth tax (see Figure 5), with tax rates calibrated so that the average effective tax rate matches that of a 1.7% wealth tax ($\tau = 1.25\%$, 2.5%, and 3.7%); a baseline wealth tax of 1.7% (in line with Zucman, 2024); and a 1.7% wealth tax with an emissions top-up, under which the top 10% of emissions are taxed at 2.7%. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021).

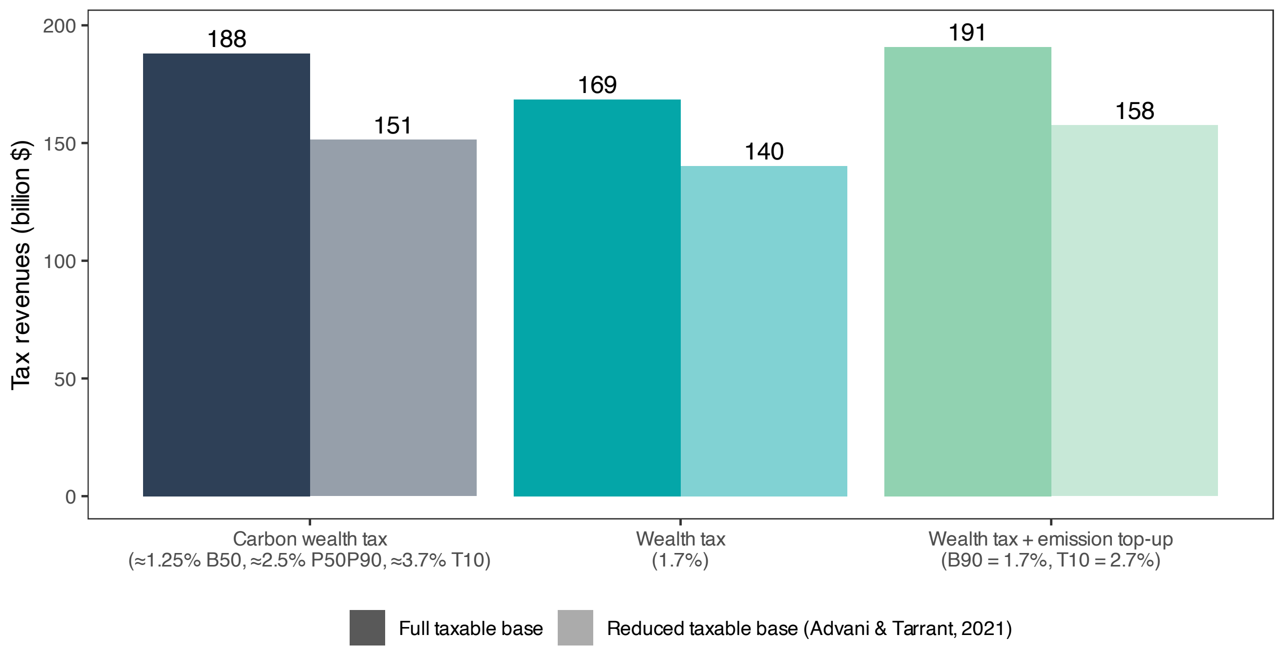


Figure C.4: Average effective tax rates by billionaire wealth deciles (left panel) and CO_2e emission deciles (right panel), under alternative taxation schemes. Taxation schemes considered (as Figure C.3) are: a carbon wealth tax (see Figure 5), with tax rates calibrated so that the average effective tax rate matches that of a 1.7% wealth tax ($\tau = 1.25\%$, 2.5%, and 3.7%); a baseline wealth tax of 1.7% (in line with Zucman, 2024); and a 1.7% wealth tax with an emissions top-up, under which the top 10% of emissions are taxed at 2.7%. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021).

Accounting only for listed equity

In this alternative scenario, we restrict the analysis to a single asset class in our sample, namely publicly listed equity. While this naturally leads to lower revenue estimates, the overall pattern of results remains qualitatively robust. This is an important finding from an implementation perspective: if a carbon wealth tax of the kind proposed in this paper were to be introduced, computing portfolio-level carbon footprints would likely be more straightforward for listed equity, since the underlying data are public and can be measured more easily and consistently.

Figure C.5: Alternative scenario with only publicly listed equity. Carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO_2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes. In this exercise we do not deduct liabilities, as we are not considering billionaires' entire wealth.

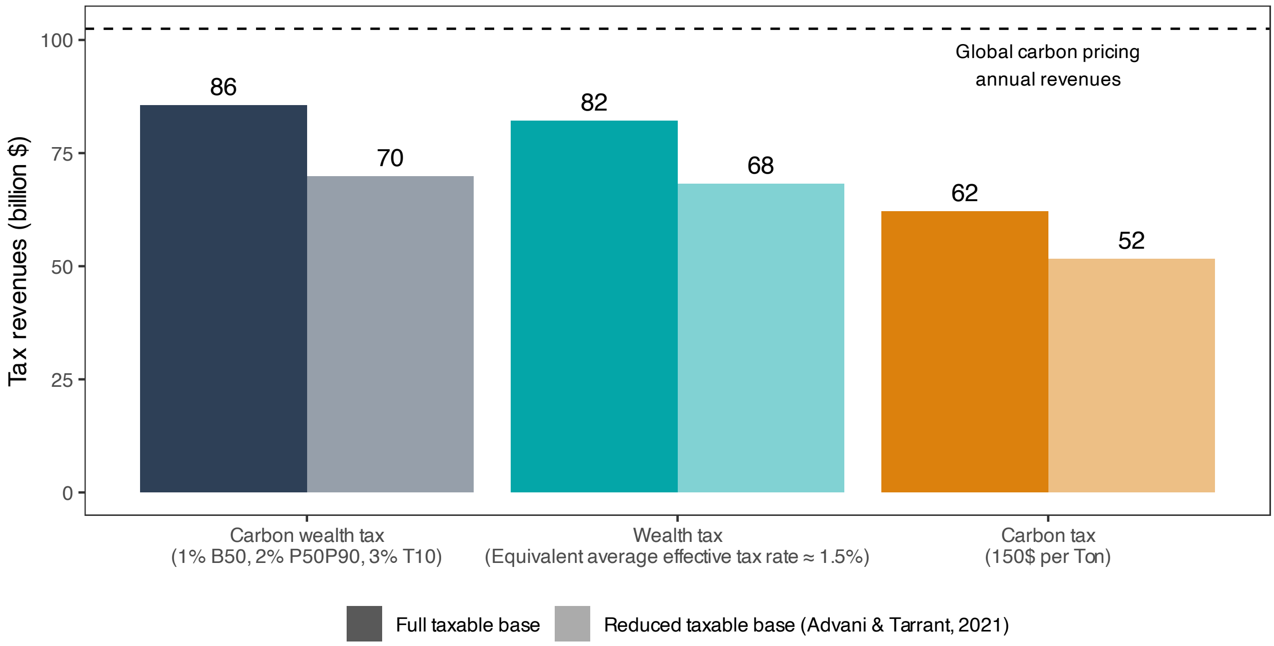


Figure C.6: Alternative scenario with only publicly listed equity. Average effective tax rates by billionaire wealth deciles (left panel) and CO_2e emission deciles (right panel), under alternative taxation schemes. Taxation schemes considered (as Figure C.3) are: a carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO_2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes.

Figure C.7: Alternative scenario with progressive tax rates based on emission intensity instead of total emissions. Carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO_2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes.

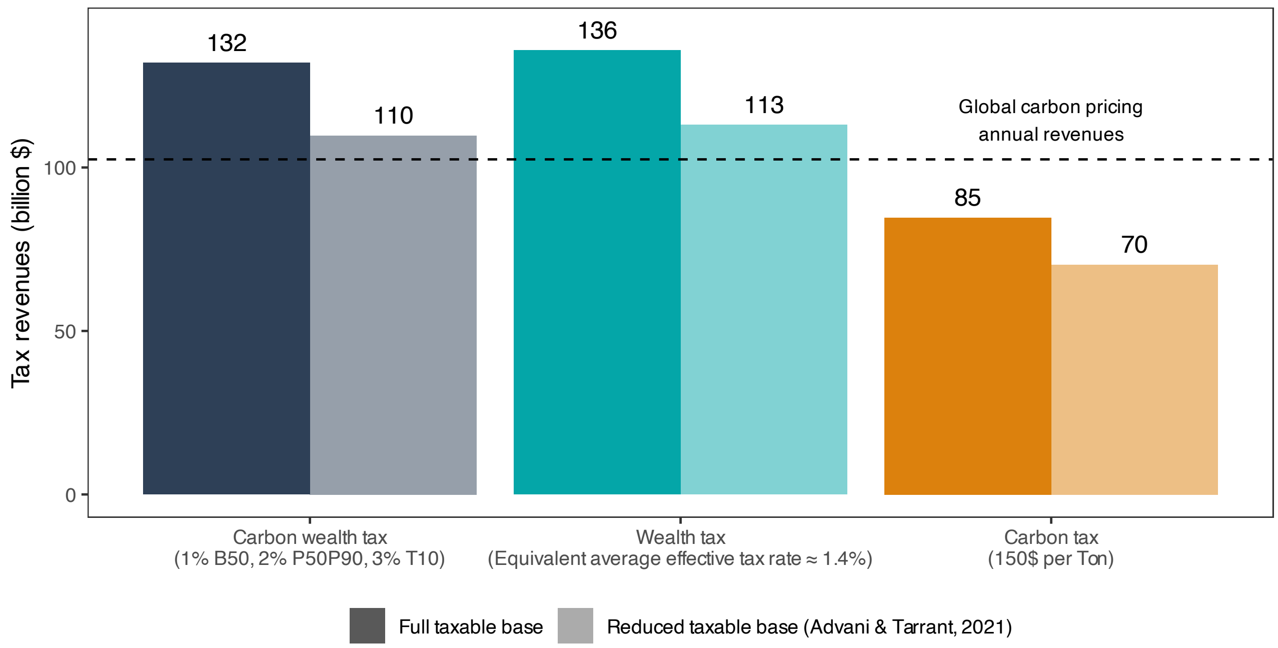
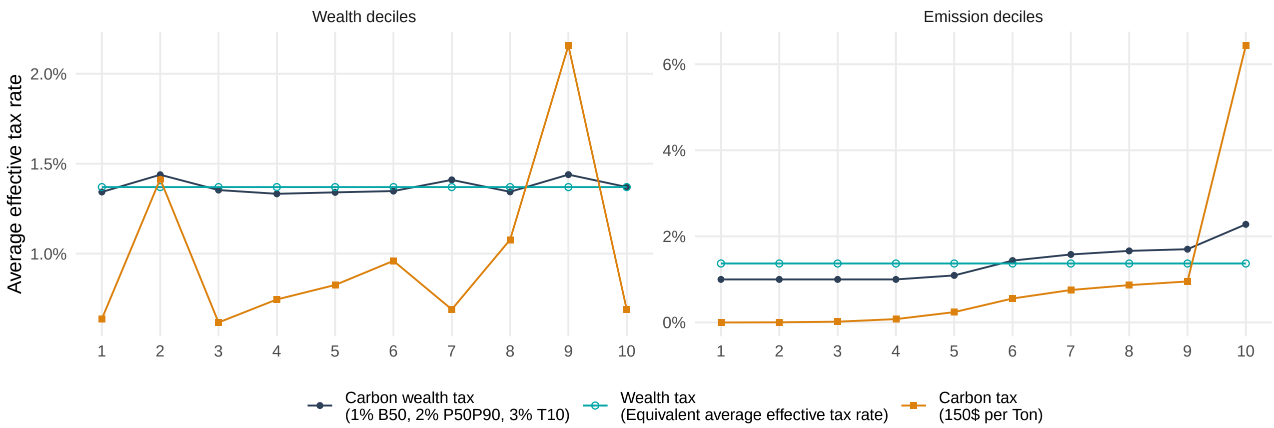


Figure C.8: Alternative scenario with rogressive tax rates based on emission intensity instead of total emissions. Average effective tax rates by billionaire wealth deciles (left panel) and CO_2e emission deciles (right panel), under alternative taxation schemes. Taxation schemes considered (as Figure C.3) are: a carbon wealth tax (see Figure 5), with tax rates set at $\tau = 1$, 2, and 3%; a wealth tax with the rate calibrated so that the average effective tax rate matches that of the carbon wealth tax ($\approx 1.4\%$); and a carbon tax at \$150 per ton of CO_2e. Shaded bars indicate revenues under tax-elusion behavior, following Advani and Tarrant (2021). The dashed horizontal line shows annual global revenues from existing carbon pricing schemes.



D Indirect ownership and organizational boundaries

A potential concern with an ownership-based accounting framework is that corporate assets may themselves hold interests in other companies. In principle, a billionaire may own equity in firm i, while firm i owns subsidiaries, joint ventures, associates, minority stakes, debt claims, or managed investment exposures linked to further entities. The relevant question is therefore whether the emissions of these second-tier entities are already included in the first-tier company's reported Scope 1 emissions, or whether they fall outside the company's organizational boundary and are therefore reported, if at all, as Scope 3 emissions.

Under the GHG Protocol (Bhatia et al., 2004), this depends on the consolidation approach used to define organizational boundaries. Under the equity-share approach, a company accounts for emissions in proportion to its equity stake in the operation; under the financial- or operational-control approaches, it accounts for 100% of the emissions of operations over which it exercises the relevant form of control, and excludes operations in which it has an ownership interest but no control. In our framework, chain ownership is not treated by mechanically reconstructing all corporate ownership trees. Instead, it is handled through the reporting boundary of the company whose emissions are observed. When a subsidiary or controlled operation is already included in the parent's Scope 1 inventory, adding it again through a separate indirect-ownership calculation would double count the same emissions.

Our empirical implementation relies on the reported Scope 1 emissions of each corporate holding, and therefore inherits the organizational boundary chosen by the reporting firm. To assess whether this creates a material omission, we reviewed the boundary definitions for a selected set of companies in the sample. The firms examined appear to rely predominantly on financial-control and/or operational-control boundaries rather than on the equity-share approach. This pattern is observed both among non-financial firms, such as Meta, Amazon, Tesla, Oracle, and Microsoft, and among financial firms, such as U.S. Bancorp, Interactive Brokers Group, and United Bank for Africa. This evidence is consistent with a broader pattern on GHG reporting practices, in which operational control is the dominant consolidation approach. For large non-financial multinationals, a control-based approach generally reduces the issue of indirect ownership, because the operating subsidiaries and controlled entities that form the corporate group are already consolidated within the parent's Scope 1 boundary. For example, if Amazon applies a control approach, the relevant Scope 1 figure should capture the direct emissions of the Amazon group entities and assets over which Amazon exercises operational and/or financial control. The residual omission for non-financial firms mainly concerns associates, unconsolidated joint ventures, and minority holdings over which the parent does not exercise control.

The issue is more consequential for companies providing financial services such as commercial banks and asset management companies. In this case, it is important to distinguish between equity investments, debt or other financial exposures. The GHG Protocol treats "investments" under Scope 3, Category 15, and this category is broader than equity shareholdings alone: it includes equity investments, debt investments, project finance, and managed investments and client services. Debt investments, such as loans and bonds, generally give rise to financed-emissions relevance for the lender or investor, but they do not constitute emissions from sources owned or controlled by the financial firm. They are therefore outside Scope 1 regardless of the organizational-boundary approach, and are reported, when reported, under Scope 3. Equity investments require a further distinction. If the investee is a controlled subsidiary, or a joint operation that is effectively controlled, its direct emissions are normally already reflected in the parent's Scope 1 boundary under a control approach. By contrast, where the financial firm holds a non-controlling equity stake, such as an associate or minority holding, the investee's emissions may be excluded from Scope 1.

This implies that our Scope 1 figures should be interpreted differently for financial and non-financial corporate holdings. For non-financial companies, the main residual source of underestimation is the exclusion of non-controlled associates, minority stakes, and some joint arrangements. Given the prevalence of control-based reporting and the group structure of large operating multinationals, this omission is unlikely to overturn the interpretation of reported Scope 1 as a measure of direct emissions controlled by the corporate group. For financial firms, by contrast, the omission can be more substantial, because a large part of the climate-relevant footprint of banks, brokers, asset managers, and investment companies is associated with financed emissions rather than with their own direct operations. We nevertheless exclude Scope 3 Category 15 emissions by construction. Including them would change the object of measurement from direct ownership-based emissions to financed emissions, would require additional assumptions on attribution across loans, bonds, managed assets, and minority equity positions, and would risk counting the same operating emissions both at the investee level and again through the financial intermediary. Accordingly, for financial holdings our estimates are best read as conservative lower bounds on emissions directly controlled by the firms owned by billionaires, not as estimates of the full financed climate impact of those firms' portfolios.