

Gürer, Eren; Weichenrieder, Alfons J.

Article — Published Version

Is there a Green Dividend of National Redistribution?

The Journal of Economic Inequality

Provided in Cooperation with:

Springer Nature

Suggested Citation: Gürer, Eren; Weichenrieder, Alfons J. (2023) : Is there a Green Dividend of National Redistribution?, The Journal of Economic Inequality, ISSN 1573-8701, Springer US, New York, NY, Vol. 22, Iss. 1, pp. 33-47,
<https://doi.org/10.1007/s10888-023-09579-5>

This Version is available at:

<https://hdl.handle.net/10419/312386>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>



Is there a Green Dividend of National Redistribution?

Eren Güler¹ · Alfons J. Weichenrieder²

Received: 8 December 2022 / Accepted: 19 April 2023 / Published online: 13 July 2023
© The Author(s) 2023

Abstract

CO₂ emissions are disproportionately caused by more affluent consumers. In the political debate, this fact has triggered the demand for income redistribution and wealth taxes not only to reduce inequality but also to reduce CO₂ emissions. This paper calculates the possible size of a green dividend, i.e., a reduction in total national CO₂ emissions, of redistribution in 26 countries and concludes that, for most EU countries, it is negative if the redistribution is efficient, in the sense that it keeps average incomes constant. If the redistribution introduces inefficiencies that lead to total income losses, the negative green dividend, otherwise associated with additional redistribution, may be avoided.

Keywords Environment · Redistribution · CO₂ emissions · Inequality · Green dividend

JEL Classification Q56 · D12 · D30

1 Introduction

There is growing awareness that CO₂ emissions are disproportionately caused by the most affluent consumers. Chancel and Piketty (2015) estimate that 10% of the world's population are responsible for approximately 45% of global CO₂ emissions. Oxfam (2020) reckons that the richest five percent of the world's population account for 37% of global CO₂ emissions.

When it comes to the responsibility for CO₂ emissions, considerable attention recently has been given to the rich and super-rich. Barros and Wilk (2021) take stock of the emissions by 20 billionaires and suggest shaming as a measure to reduce their enormous CO₂ footprints, which are driven by yachts, private jets and heating of multiple estates. For the EU, Ivanova and Wood (2020) calculate that the average carbon footprint of the top 1% of

✉ Alfons J. Weichenrieder
a.weichenrieder@em.uni-frankfurt.de

Eren Güler
eguler@metu.edu.tr

¹ Faculty of Economics and Administrative Sciences, Middle East Technical University, 06800 Ankara, Turkey

² Faculty of Economics and Business Administration, Goethe University Frankfurt, Vienna University of Economics and Business & CESifo, 60323 Frankfurt, Germany

households amounts to 55 tons of CO₂-equivalent emissions per person, while in most EU countries the median polluter has a footprint of less than 10 tons. In the political debate, these asymmetric emissions trigger the demand for income redistribution and wealth taxes to reduce emissions by decreasing inequality. The claim has been made that less unequal countries may produce less CO₂ emissions (see Kenner 2015; Dorling 2010).

In this study, we define a green dividend as a reduction in total national CO₂ emissions per capita, coming as a byproduct of more redistribution. In the academic literature, the question whether redistribution from rich to poor within a country could reduce CO₂ emissions, and in that way could provide a green dividend, has received only limited attention. Brännlund and Ghalwash (2008) provide information based on Swedish household data on non-durable goods consumption. Using estimates of a non-linear demand system and pollution intensities of different consumption goods, they show that the income-pollution relationship is positive, but concave, which means that a more equal income distribution would increase, rather than decrease, the amount of three pollutants (CO₂, NO_x, SO₂). This suggests that, contrary to what underlies the popular demand, no green dividend of redistribution would result. There is also scattered evidence from other countries. A working paper by Castellucci et al. (2010) applies the Brännlund and Ghalwash (2008) method to Italian data and also suggests a negative green dividend of redistribution. Sørheim (2021) finds that the carbon intensity of consumption of Norwegian households increases with income. A similar finding for urban China derives from Golley and Meng (2012). Duarte et al. (2012) and Lévy et al. (2021) find the opposite respectively for Spain and Belgium, where the pollution intensity of consumption seems to be lower for high incomes. Levinson and O'Brien (2019) identify concave Engel curves in the U.S. Unlike the present paper, they look at five different more local pollutants, omitting CO₂.

Apart from the studies based on micro data of consumption expenditure, several studies attempt to infer the relationship between income distribution and emissions via times series or panel data with macroeconomic variables. Often, these studies regress the log of national CO₂ emissions on a lag structure of the Gini index and other variables. For the U.S., Baek and Gweisah (2013) find a positive short and long-term association of the Gini index with the level of CO₂ emissions. Demir et al. (2019) find a negative long run association for Turkey, while Uzar and Eyuboglu (2019) empirically claim a positive association.¹ Cheng et al. (2021) report a positive relationship between income inequality and direct CO₂ emissions in China; Ghazouani and Beldi (2022) look at seven Asian economies and also argue that a higher level of inequality increases emissions. For OECD countries, Hailemariam et al. (2020) focus on the top income inequality in a macro-econometric approach and claim that the top 10% share is positively associated with CO₂ emissions. Hübler (2017) derives mixed results dependent on the specific panel data model. Knight et al. (2017) suggest an empirical association of wealth inequality and national CO₂ emissions in high-income countries.

A problem of macro studies that exploit the time dimension is that interactions between income and technical progress, as well as potentially important omitted variables (such as regulation, international commitments, political upheavals), are not included in the analysis. A causal interpretation of these regressions is therefore difficult. Redistribution via

¹ Bae (2018) looks at the interaction between mitigation instruments and the income distribution. Bruckner et al. (2022) evaluate the effect of possible further initiatives of international poverty reduction on CO₂ emissions. The results suggest a modest positive impact of poverty reduction on global CO₂ emissions. The connection between inequality and local air quality is studied in Kasuga and Takaya (2017).

tax-transfer schemes may have a different impact on emissions than empirically observed distributional variation that, among other factors, may derive from changes in trade patterns, innovation, or unionization.

The present study avoids these issues by following a microeconomic approach. It resembles Brännlund and Ghalwash (2008) in using household budget surveys to study the link between income distribution and CO₂ emissions. Our study differs from existing studies in several ways. First, unlike Brännlund and Ghalwash (2008) and other papers that consider specific countries, we investigate 26 European countries simultaneously thanks to harmonized datasets. Second, we have access to kgCO₂-equivalent emissions of 200 products (direct plus indirect emission products), a considerably higher number than analyzed in previous studies. Brännlund and Ghalwash (2008) use eight products, Castellucci et al. (2010) exploit three direct emission products. Sørheim (2021), Golley and Meng (2012), Duarte et al. (2012) respectively study emission intensities of 61 products, 42 sectors, and 27 economic activities. Third, emission intensities utilized in this study are derived from a multi-regional input–output model. Hence, we do not have to impose the assumption that imported products have the same environmental impact as domestically produced products, a limitation acknowledged by Brännlund and Ghalwash (2008), Golley and Meng (2012) and Duarte et al. (2012).² This limitation may be important if production locations of goods consumed by rich vs. poor systematically differ.

For 26 European countries, we simulate a redistributive tax-transfer policy which comes on top of existing policies. It adds a flat tax of ten percent to finance a lump sum payment for every household. We derive that, for 22 countries, such an income redistribution would result in a negative green dividend, i.e., CO₂ emissions would increase. Only four countries would have a reduced level of CO₂ emissions. Even for those, the green dividend is limited. In the case of the UK, if additional redistribution leads to a 3.5 percentage point decrease in the Gini coefficient, this reduces CO₂-equivalent emissions per capita by 40 kg, which amounts to a mere 0.47% of per capita emissions in the year 2010.

We also explore scenarios when the tax-transfer system is costly and therefore shrinks average income. A vast literature on the deadweight loss of taxation (excess burden) suggests that a transfer system may resemble a leaky bucket: increased taxes could lead to distorted incentives and behavioral effects on labor markets may shrink output. On top of losses due to behavioral changes, taxes imply losses because of compliance and administrative costs. We address these losses in a stylized way by asking how growth-adverse a tax system must be to overturn the results derived under the assumption of a neutral tax-transfer system. We find that if slightly more than 15% of the tax revenues are assumed to be wasted, then this would be enough to generate a green dividend in all countries. This means that, in most countries, only a costly, wasteful redistribution system may carry a green dividend, i.e., lower CO₂ emissions; however a costless system does not.

The reminder of the paper is organized as follows. The next section introduces our methodology and Sect. 3 presents our data. Section 4 contains the main analysis, Sect. 5 concludes. Technical details are described in the Appendix.

² Castellucci et al. (2010) study direct emission products and, hence, imports are not relevant. An exception is Sørheim (2021), which also derives emission intensities from a multi-regional model.

2 Methodology

Simulating how households' CO₂ emissions would change with income may be done in a variety of ways. One approach is to estimate individual demand curves for various goods categories using a structural model. With these demand curves, it is possible to derive a counterfactual demand after some redistribution is applied. In a second step, CO₂ intensities of final output goods are used to calculate CO₂ emission changes from the income effects on demand. This approach is used by Brännlund and Ghalwash (2008). Several assumptions must be imposed for its implementation. For example, some functional form of demand must be specified. In addition, the estimation assumes differently affluent households face the same prices, which has been empirically contested by the literature on shopping behavior (e.g., Aguiar and Hurst, 2007).

A simpler approach, utilized in the present paper, is to regress the actual, observed CO₂ emissions of households over some explanatory variables that include a proxy of their permanent incomes, household type and size. After altering households' net incomes with, e.g., a redistributive policy, counterfactual CO₂ emissions can be predicted using the previous regression's coefficients. While this method requires no assumption on the homogeneity of prices and no specific functional form of demand, it also comes with caveats. An implicit assumption in using this approach is that consumers' goods demand, and hence CO₂ emissions, are changed in the same way irrespective of the source of income changes (e.g., market influences on income vs. tax changes). The same assumption, however, is made for approaches that exploit demand estimates through structural modeling.

Let c_i^{pre} denote kgCO₂-equivalent consumption of household i residing in any country (for brevity country indices are suppressed) directly observed in the data at 2010. Note that c_i^{pre} represents the household's kgCO₂-equivalent consumption before the redistributive policy experiment. Our regression specification that predicts CO₂ consumption reads:

$$c_i^{pre} = \alpha + \sum_{k=1}^7 \lambda_k p_{k,i} + \sum_{k=1}^7 \beta_k^1 p_{k,i} * e_i^{pre} + \sum_{k=1}^7 \beta_k^2 p_{k,i} * (e_i^{pre})^2 + \sum_{k=1}^7 \beta_k^3 p_{k,i} * (e_i^{pre})^3 + \sum_{k=1}^7 \beta_k^4 p_{k,i} * (e_i^{pre})^4 + \sum_{k=1}^7 \beta_k^5 p_{k,i} * (e_i^{pre})^5 + \delta s_i + \varepsilon_i \quad (1)$$

where $p_{k,i}$ denotes a set of household-type dummies with $k \in \{1, 2, \dots, 7\}$ indicating whether household i belongs to household-type group k . Household-type classification is as follows: 1- one adult, 2- two adults, 3- more than two adults, 4- one adult with dependent children, 5- two adults with dependent children, 6- more than two adults with dependent children, 7- others. Note that there are only 22 observations of group 7 in Spain. Parameter e_i^{pre} represents the total annual expenditure (permanent income) of household i before redistribution (observed in the data) and s_i indicates household size. Variables $\beta_k^1, \dots, \beta_k^5$ are the regression coefficients associated with the terms that include different orders of total expenditure. It should be noted that household-type information is missing in Sweden. Thus, explanatory variables in the regressions of Sweden are $e_i^{pre}, \dots, (e_i^{pre})^5$ and s_i .

We run the regression specification given in (1) separately for each country and collect the predicted values $\hat{\alpha}_k, \hat{\lambda}_k, \hat{\beta}_k^1, \dots, \hat{\beta}_k^5, \hat{\delta}$ and $\hat{\varepsilon}_i$ with $k \in \{1, 2, \dots, 7\}$. In the next step, we perform the redistributive policy experiment by taxing the 10% of e_i^{pre} and redistributing the resulting tax revenue equally to every household country-by-country. Let e_i^{post} denote the total expenditure (permanent income) of household i located in any country after redistribution. Resulting kgCO₂-equivalent consumption of any household can be predicted by:

$$\begin{aligned}
c_i^{post} = & \hat{\alpha} + \sum_{k=1}^7 \hat{\lambda}_k p_{k,i} + \sum_{k=1}^7 \hat{\beta}_k^1 p_{k,i} * e_i^{post} + \sum_{k=1}^7 \hat{\beta}_k^2 p_{k,i} * (e_i^{post})^2 + \sum_{k=1}^7 \hat{\beta}_k^3 p_{k,i} * (e_i^{post})^3 \\
& + \sum_{k=1}^7 \hat{\beta}_k^4 p_{k,i} * (e_i^{post})^4 + \sum_{k=1}^7 \hat{\beta}_k^5 p_{k,i} * (e_i^{post})^5 + \hat{\delta} s_i + \hat{\varepsilon}_i
\end{aligned} \quad (2)$$

Hereafter, one can calculate kgCO₂-equivalent consumption per-capita, $\bar{c}^{post}$, in every country. Country-by-country differences, $\bar{c}^{pre} - \bar{c}^{post}$, yield the bars presented below in Fig. 5.

3 Data

Our data comes from two sources.³ Information on households' good demands is taken from the 2010 European Union Household Budget Surveys (EU HBSs) provided by Eurostat. For most of our 26 European countries, we facilitate 63 different product baskets (51 for Germany and 59 for Sweden). In a next step, the goods demands need to be transformed into the direct and indirect CO₂ emissions that go with these product baskets.⁴ For this, we use the 2010 wave of EXIOBASE v3.8.2 database, which relies on country-specific input–output matrices and technical coefficients to yield CO₂ emissions of 200 different product categories in each country. More specifically, EXIOBASE gives kgCO₂-equivalent emissions per euro spent on these 200 product categories.⁵ Because of national differences in transport costs, input–output matrices, and production processes these data differ between countries.

As the product categories between the EU HBSs and EXIOBASE3 differ, a rule on how to assign the 63 HBS groups into the 200 EXIOBASE3 groups is required. To achieve this, we rely on a concordance table provided by Ivanova and Wood (2020).

A couple of examples may be helpful to illustrate how CO₂ coefficients of EXIOBASE are linked to the EU HBSs. In the EU HBSs, the air travel expenditures of households are recorded under a category named 'Passenger transport by air'. At the same time, we observe the CO₂-equivalent emissions induced by one Euro expenditure on 'Kerosene' (jet fuel) and on 'Air transport services' in EXIOBASE. According to the concordance tables of Ivanova and Wood (2020), 25% of the money spent on air transport services is attributable to expenditure on kerosene, whereas the remaining 75% is attributable to air transport services. Accordingly, CO₂ emissions caused by each household's expenditure on air travel can be determined. Similarly, the concordance tables of Ivanova and Wood (2020) suggest that the HBS expenditure category 'Electricity expenditure' can be broken into several sub-categories such as 'Electricity by coal (6%)', 'Electricity by gas (14%)', 'Electricity by nuclear (40%)', 'Transmission and Distribution Services (37%)'. The CO₂-equivalent

³ The datasets and data preparation procedures are described in more detail in Appendix.

⁴ A direct CO₂ emission occurs in the use phase of a product (e.g., when a household buys gasoline and burns it while driving). An indirect emission occurs when a consumer purchase leads to emissions in the production chain.

⁵ EXIOBASE reports CO₂ content of goods in per euro expenditure in basic prices (excluding trade & transport margins and taxes). EU HBSs provide expenditures in purchaser prices. We follow Ivanova and Wood (2020) and convert HBS expenditures in purchaser prices into basic prices by removing taxes and allocating trade & transport margins into associated products.

emissions associated with the sub-categories are observable in EXIOBASE and, thus, one can calculate the total amount of emissions caused by each household's electricity demand.

In the HBSs, reported expenditures by households may be too large or too small to match country-wide levels despite the representative nature of the EU HBSs. We follow Ivanova and Wood (2020) in scaling HBS expenditures of each household proportionately to match country level expenditures reported in EXIOBASE (national accounts). On average, this leads to a scaling factor of 1.37.

Scaling of expenditures for specific goods comes at a cost as it may alter total household level expenditures in asymmetric and slightly arbitrary ways: a household's expenditure for motor vehicles may be scaled up if it bought a car, whereas for another household that did not buy a car, expenditure cannot be scaled up. We identify four product categories that reduce the correlation between total raw expenditures and total scaled expenditures in a visible way and exempt them from scaling if under reported:

- Motor vehicles, trailers and semi-trailers (25 out of 26 countries under report)
- Kerosene (5 out of 26 countries under report)
- Financial intermediation services, except insurance and pension funding services (26 out of 26 countries under report)
- Other business services (26 out of 26 countries under report)

The first two categories frequently have zero expenditures for households, as car purchases and holiday flights clearly may not occur each year.⁶ Many households with zero reported expenditure for the last two categories may simply not be aware of having those expenditures.

Outliers exist in every country, both in terms of CO₂-equivalent consumption and total household expenditure. We drop households that constitute the top 0.1% of household CO₂ consumption and the top 0.1% of household total expenditure. The total number of dropped observations amounts to 425 out of 274,396 (the remaining sample size after performing other cleaning procedures is further described in Appendix).

While it is widely accepted that, in general, the climate effect of CO₂ emissions does not depend on where and in what way CO₂ is emitted, there is one exception: aviation. The radiative forcing that measures the climate relevance of all side effects to CO₂ emissions is deemed higher for aviation, because high layer contrails and other effects tend to aggravate aviation induced global warming. This was emphasized by the International Panel on Climate Change, IPCC (1999). One way of expressing the climate effect of aviation is to divide the sum of climate effects (radiative forcing) by the radiative forcing that resulted from aviation's CO₂ emissions alone, leading to a frequently used upscaling factor of about three (Wit et al. 2005, p. 34). While more recent literature seems to suggest a somewhat smaller average factor, a large variation of estimates between 1.9 and 5 still prevails (cf. Jungbluth and Meili 2019, p. 405). We decided to introduce a factor three for CO₂ emissions from kerosene. Considering the role of inequality for CO₂ emissions, it is important to recognize the role of kerosene in this research, as air travel services are disproportionally consumed by the rich. This weighting has not been done in previous work on the nexus between inequality and CO₂ emissions. However, we argue that ignoring the fact that a ton of CO₂ emitted via air travel has a larger climate impact than a ton emitted by public buses

⁶ Scaling of kerosene consumption from air travel may also be problematic if some of national consumption should be attributed to foreign flight guests.

would systematically distort our calculations that are concerned about distributional issues. Because air travel is consumed disproportionately by the more affluent, the weighting of kerosene tends to produce a higher green dividend compared to using no weight.

While EU HBSs contain self-reported household income, we found this variable to be fraught with considerable noise, including negative values. For example, CO₂ consumption vs. reported net incomes curve exhibits a second peak at the bottom of the distribution. This may reflect a temporary income shock such as capital losses. We therefore decided to take scaled reported household expenditure as a measure of permanent income as in Brännlund and Ghalwash (2008).

Figure 1 reports our calculations of the CO₂ footprint for four different household types in each country. The ranking of countries is based on mean (per-capita) kgCO₂-equivalent consumption (green dots); in each country, the footprint of the 10th and 90th percentiles and the median are also reported.⁷

Figure 2 illustrates the unweighted average of CO₂-equivalent consumption shares for each consumption expenditure decile. Across countries, the top 30% percent, in terms of consumption expenditure, is responsible for more than 50% of CO₂.

4 Redistribution and CO₂ emissions

It is recognized that convexity or concavity of the Engel curves for carbon intensive consumption is decisive for the role of redistribution on carbon emissions (Brännlund and Ghalwash 2008). In the case of a concave relationship, redistribution, which puts more households from the ends of the income distribution to the middle, should tend to increase total emissions. The opposite should be the case if the Engel curve is convex. The five panels in Fig. 3 illustrate Engel curves for CO₂ consumption for five selected countries. We find concave curves for the vast majority of countries, exemplified in Fig. 3 by Germany, France and Belgium. Convex curves, on the other hand, are depicted in Fig. 3 for Ireland and the UK; they are also found in Luxemburg and Cyprus.

While the role of the Engel curve's shape is recognized in the literature, it is unclear how large the changes of CO₂ emissions from redistribution are. In this section, we therefore simulate a policy measure that reduces national inequality. This policy measure, which is added to the existing system in each country, collects from each household 10 percent of total expenditure (our proxy of permanent income) and uses the revenues to pay a limited, universal demogrant to each household. Neither the tax, nor the demogrant is conditioned on household size. This policy measure would not affect all countries in the same way. If a country exhibits a rather equal distribution to begin with, then our measure has a modest impact compared to a pre-existing situation of a very unequal distribution. Figure 4 illustrates the impact of our policy measure on the Gini coefficient, measured in percentage points (ppt.), in all 26 countries. For most countries, a flat tax of 10% plus a lump sum grant would reduce the Gini coefficient between three and four ppt., where three ppt., for example, equals the difference in the Gini coefficient for disposable income between Portugal and Sweden in 2019.⁸

⁷ Unexpectedly, Cyprus ranks highest in mean CO₂ footprint, which is not due to a single expenditure category, but based on several CO₂-intensive consumption categories.

⁸ Based on data from the OECD inequality database (<https://data.oecd.org/inequality/income-inequality.htm>).

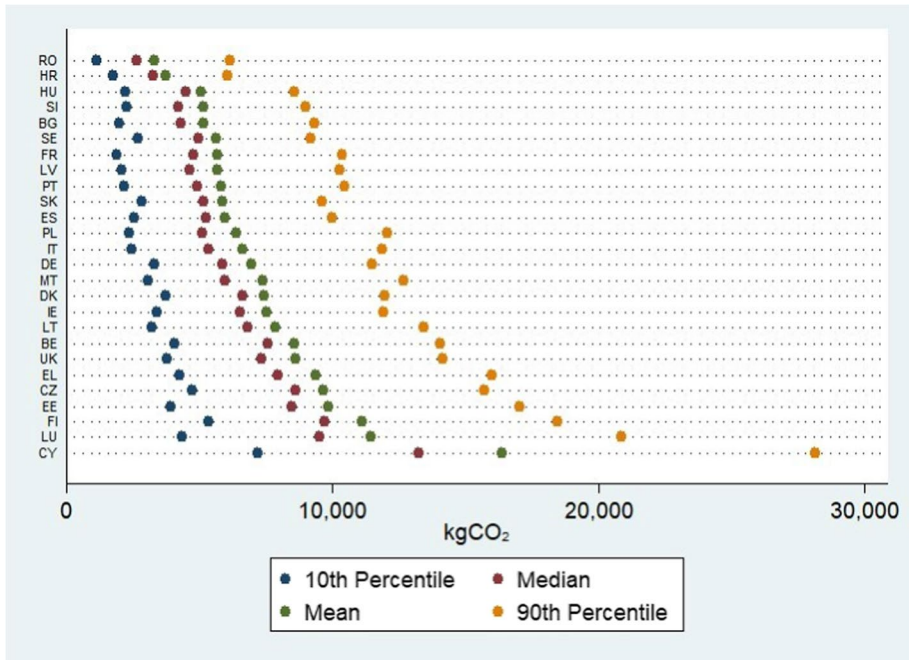


Fig. 1 CO₂ footprints across countries. Note: Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Cyprus (CY), Denmark (DK), Germany (DE), Estonia (EE), Finland (FI), Greece (EL), Spain (ES), France (FR), Croatia (HR), Hungary (HU), Italy (IT), Ireland (IE), Lithuania (LT), Latvia (LV), Luxembourg (LU), Malta (MT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovakia (SK), Sweden (SE), United Kingdom (UK)

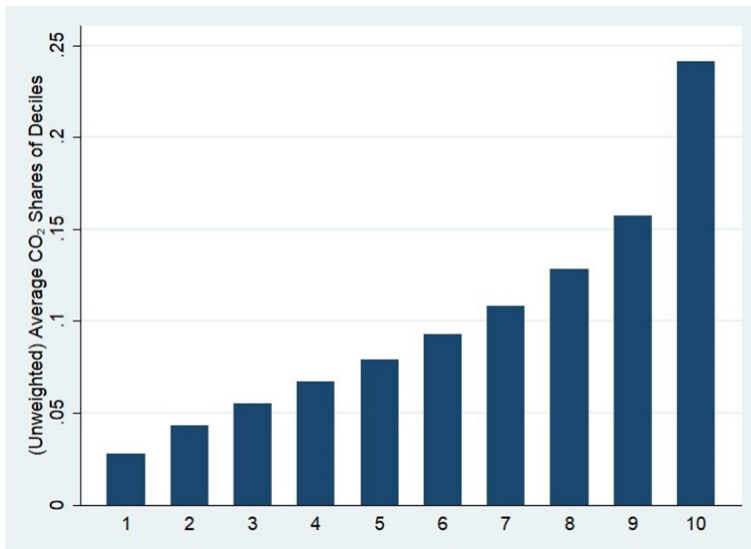


Fig. 2 Distribution of CO₂ across consumption expenditure deciles. Note: The length of the bar for decile 1 (and analogous for the other bars) is derived by calculating the CO₂ consumption share of those 10 percent of the population with the smallest total expenditure in each country and then taking the unweighted average across the 26 countries

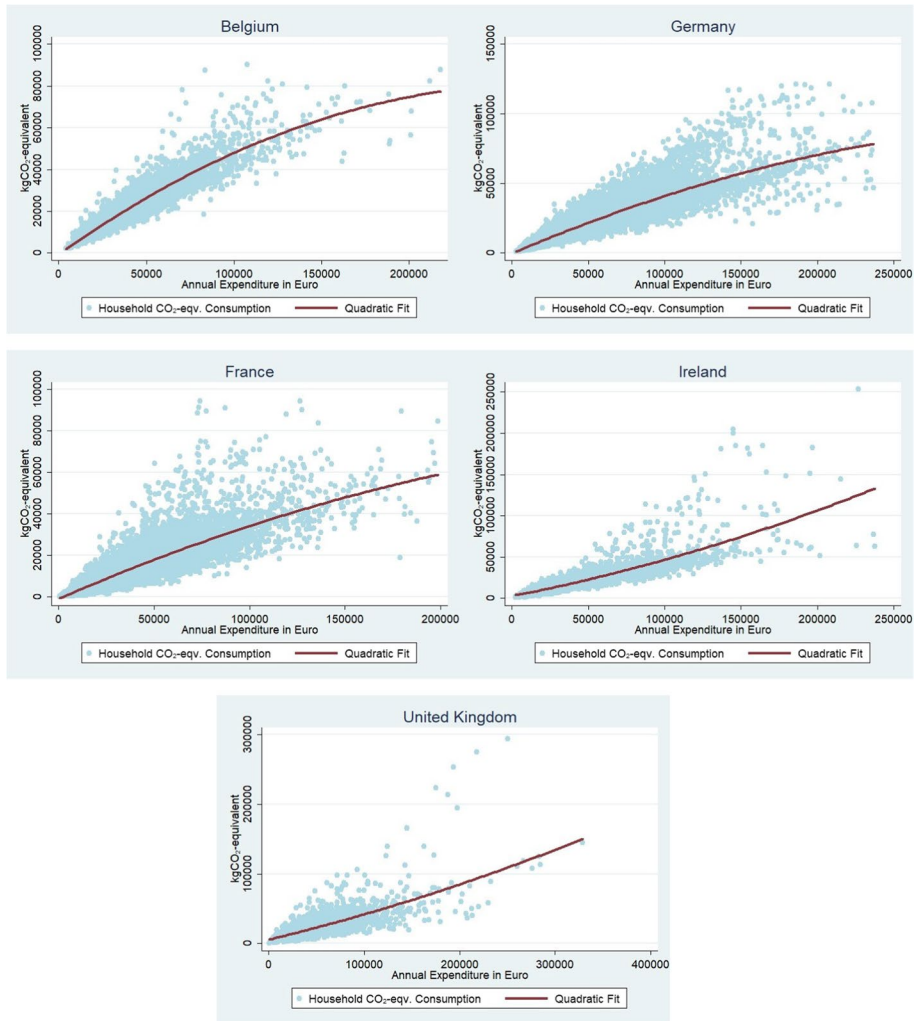


Fig. 3 CO₂ emissions vs. total expenditures

As mentioned in Sect. 2, we assume that the CO₂ emission of a household is a function of the total expenditure (permanent incomes) up to its fifth order,⁹ household type and size. Thus, after altering the total expenditures of households via our experiment, we can predict a household's post-redistribution emissions using the coefficients estimated in the initial regressions. Hence, the new CO₂ consumption of a household is calculated by using the behavior of households of comparable size and type, which also had the same total expenditure/permanent income before introducing the measure.

⁹ Akaike Information Criterion (AIC) scores favor regression models with the fifth order of total expenditure over simpler models. We stopped at the fifth order for simplicity.

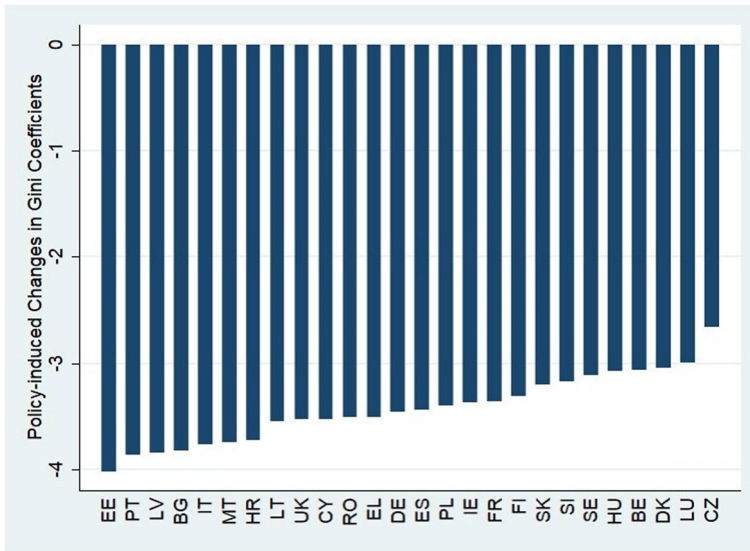


Fig. 4 A policy measure and its impact on the Gini coefficient. Note: The bars illustrate the differences in Gini coefficients that represent inequalities in total annual household expenditure observed in the data vs. after the policy experiment (10% tax over total expenditures plus equally distributed demogants). Gini coefficients are calculated using the “fastgini” command of Stata. For country codes, see Fig. 1

Figure 5 presents our main results. For most countries, the green dividend is negative: implementing the additional redistribution increases CO₂ emissions. Except in three states (Poland, Lithuania and Estonia), the annual redistribution-induced emissions are

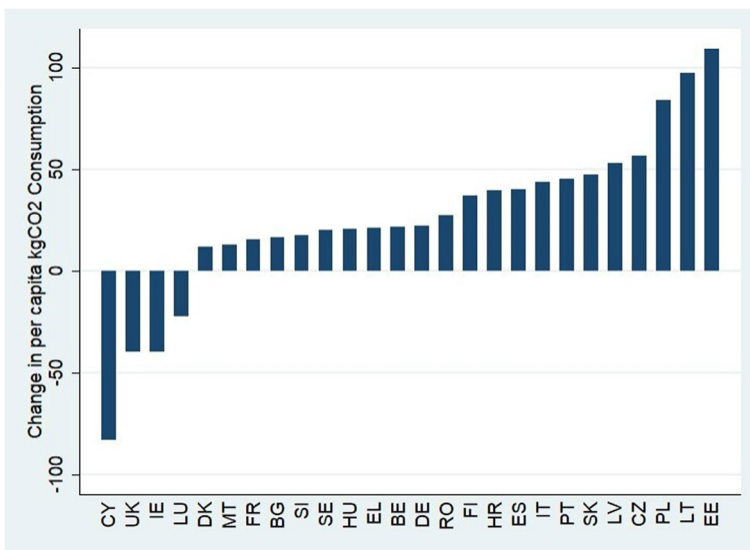


Fig. 5 The effect on emissions from a 10 percent flat-tax experiment. Note: See Sect. 2 for the calculation of the emission effects represented in the bars. For country codes see Fig. 1

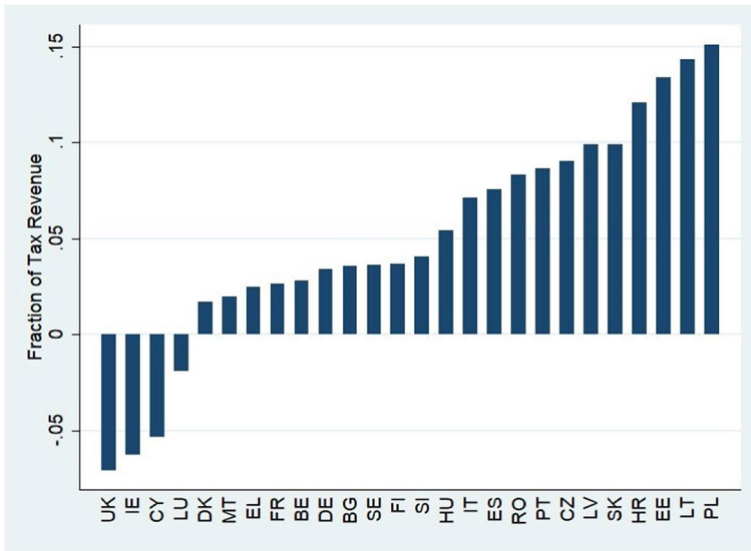


Fig. 6 Required tax revenue losses to overturn green dividend effect. Note: The bar for each country is calculated as follows. Let TR denote the tax revenue of a country after imposing a 10% tax on total annual household expenditures/permanent incomes. In the redistributive policy experiment, TR is equally distributed to all the households within a country. Bars in this figure represent a factor x , which neutralizes the environmental effect of redistribution after altering the tax revenue as $TR(1 - x)$

approximately 50 kg or below per-capita. Of the four countries that show a green dividend, the three largest dividends are found on islands: Cyprus, the UK and Ireland.

The calculations behind Fig. 5 assume that the 10 percent tax on permanent income and the lump sum transfer have no behavioral effects. This assumption is overoptimistic. First, as most income taxes fall on labor, there is a tax-induced reduction in the net wage that can have effects on labor supply and the number of hours worked. Second, the payment of a lump sum transfer to all households can also affect labor supply via an income effect.

From a theoretical point of view, the labor supply reaction of such a reform is uncertain. Individuals facing a higher tax on their labor income may feel poorer and may therefore be willing to trade in leisure for additional hours of work. Typically, however, empirical studies of national labor markets find a negligible income effect on labor supply, but a statistically significant, positive effect of the net wage (e.g., Bargain et al. 2014). This implies that we can expect to have a negative effect on hours worked from a tax increase plus lump sum transfer, which tends to shrink total income and expenditures. If we use the elasticity of hours worked findings of Bargain et al., for several countries across Europe, we may expect that a 10% reduction of the effective wage may lead to a reduction in hours worked of up to 4% for single men and 5% for single women. Although labor productivity may react somewhat to this reduction in hours worked, this figure gives a rough magnitude of the possible output loss. Further losses may arise from additional administration and compliance costs of implementing the additional tax.

How large must output losses (and losses in consumption expenditure) be in order to turn a negative green dividend into a positive one? Fig. 6 addresses this issue. For each country, Fig. 6 depicts the proportional cut in permanent income and expenditures that would be necessary to eliminate the (mostly negative) green dividend of redistribution.

Indeed, for roughly a third of the 26 countries analyzed, an expenditure reduction amounting to approximately three percent of tax revenues (triggered by inefficiencies of the tax-transfer system) would eliminate a negative green dividend. A loss of slightly more than 15 percent of the tax revenues would eliminate the negative green dividend for all countries.

5 Conclusion and policy implications

Households with high income are responsible for a disproportionally large share of CO₂ emissions. In the political arena, this has led to calls for more redistribution, not only to benefit the lower income groups, but also to reduce emissions.

The present paper analyzes possible environmental effects of redistribution and the resulting magnitudes in a large set of European countries. Because in most countries there is a concave relationship between households' CO₂ consumption and their total expenditures, a redistribution from rich to poor is expected to increase CO₂ emissions rather than reduce them. For those countries, our simulations suggest that a ten percent income tax (on top of existing taxes), which is used for a lump sum transfer to all households, may increase per capita CO₂ consumption between 10 and 110 kg, implying a negative green dividend of redistribution. In four countries, mostly islands, we find the opposite effect, a positive green dividend.

If the extension of the tax-transfer system is inefficient and wasteful to a certain extent, the negative green dividend can be averted via lower incomes and reduced total expenditures.

Our study shows only small and often counter-productive effects of a redistribution on emissions, even with a quite pronounced tax hike. This suggests that policies to reduce CO₂ emissions should target emission reduction more directly. An example of such policies is the Swedish carbon tax; it seems to have a more significant positive effect than the green dividend of redistribution found in this study, even among the four countries where the green dividend is positive.¹⁰ The existence of more direct measures to reduce CO₂ emissions also implies that it would not be recommendable to make the redistribution system less efficient just to reduce CO₂ emissions.

An important limitation as well as an opportunity for future research should be mentioned. Our study, in line with previous literature on income distribution and CO₂ emissions, does not take into account the effects of the EU emissions trading system. So far, only some part of all CO₂ emissions falls under this system—emissions from residential heating and car traffic are not included. A bias in the calculations may arise when differently affluent households have diverse consumption patterns. If the sum of total tradable permits is fixed, then the CO₂ emissions triggered by some consumption purchases needs to be neutralized elsewhere in the economy. This is not the case if the emissions triggered are not subject to the EU emissions trading system. In a hypothetical world in which the rich are predominantly responsible for CO₂ emissions that are capped via the trading system, but the less affluent are responsible for emissions that do not fall under this system, a redistribution of income towards the poor could have a more negative green dividend

¹⁰ For a detailed analysis of the CO₂ reduction due to the Swedish carbon tax, see Andersson (2019).

compared to a world without a trading system. Accounting for the EU carbon trading system would require a more sophisticated accounting of CO₂ emissions, because for each production step a distinction between capped and uncapped CO₂ emissions would be necessary to calculate the size of a green dividend.

A further concern may be that household surveys miss the super-rich. Recently, Barros and Wilk (2021) provided estimates for 20 billionaires and concluded that, on average, these individuals seem to be responsible for some 36 thousand tons of CO₂ equivalent emissions in 2018. This finding, as impressive as it may be, does not rule out that taxation of these billionaires and giving the money to poorer households would increase emissions. While the CO₂ budgets of billionaires are stunningly high, their emissions per dollar of income are quite small: assuming that permanent incomes of the super-rich can be approximated by a 7% return to their wealth as reported in Barros and Wilk (2021), we find that they consume 3 g of CO₂-equivalent emissions per dollar of income. This compares to an unweighted average of the median household's emissions across 26 countries in our 2010 data of 831 g. The value is lower for richer countries, e.g., 440 g in Germany and 341 g in France. While the figure of 3 g¹¹ relies on Barros and Wilk's (2021) analysis of highly visible consumption (yachts, flights, heating and air-conditioning of multiple estates) and does not incorporate daily, regular expenses of super-rich, the calculations are instructive. It shows that, even for the super-rich, the CO₂ intensity of permanent income may well fall far below the equivalent of the much less affluent. Consequently, redistribution from these super-rich to poorer households could still be expected to increase CO₂ emissions.

Overall, our analysis suggests that redistribution and CO₂ reduction are distinct goals. Therefore, in general, they seem best addressed by distinct instruments.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10888-023-09579-5>.

Authors' contributions AW and EG jointly developed the research idea. AW wrote the main text of the manuscript. EG performed the empirical analyses. Both authors reviewed the manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. This research received no funding.

Data availability The paper combines Eurostat's Household Budget Survey (HBS 2010) with the 2010 wave of EXIOBASE v3.8.2 database.

•HBS 2010 has been received under the condition of confidentiality and the authors must not share it. However, the data is available for replication subject to an individual data application. Details for data applications are available at <https://ec.europa.eu/eurostat/web/microdata/household-budget-survey>.

•EXIOBASE v3.8.2 is available for researchers free of cost from <https://www.exiobase.eu>.

As part of our data is confidential, we are not able to disclose our final data set.

Declarations

Ethical approval Not applicable.

Competing interests The authors have no conflicting interests.

¹¹ This figure would be 11 g if we assume a 2% return on wealth and be even lower for returns bigger than 7%.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Andersson, J.J.: Carbon taxes and CO₂ Emissions: Sweden as a case study. *Am. Econ. J. Econ. Pol.* **11**(4), 1–30 (2019)
- Aguiar, M., Hurst, E.: Life-cycle prices and production. *Am. Econ. Rev.* **97**(5), 1533–1559 (2007)
- Bae, J.H.: Impacts of income inequality on CO₂ emission under different climate change mitigation policies. *Korean Econ. Rev.* **34**(2), 187–211 (2018)
- Baek, J., Gweisah, G.: Does income inequality harm the environment? Empirical evidence from the United States. *Energy Policy* **62**, 1434–1437 (2013)
- Bargain, O., Orsini, K., Peichl, A.: Comparing labor supply elasticities in Europe and the United States: New results. *J. Human Res.* **49**(3), 723–838 (2014)
- Barros, B., Wilk, R.: “The outsized carbon footprints of the super-rich”, *Sustainability: Science. Pract. Policy* **17**(1), 316–322 (2021)
- Brännlund, R., Ghalwash, T.: The income–pollution relationship and the role of income distribution: An analysis of Swedish household data. *Res. Energy Econ.* **30**, 369–387 (2008)
- Bruckner, B., Hubacek, K., Shan, Y., Zhong, H., Feng, K.: Impacts of poverty alleviation on national and global carbon emissions. *Nature Sustain.* **5**, 311–320 (2022)
- Castellucci, L., D’Amato, A., Zoli, M.: Environmental quality and inequality: The impact of redistribution on direct household emissions in Italy. Working Paper, Università di Roma Tor Vergata. Retrieved from <http://www.siepweb.it/siep/wp/wp-content/uploads/2021/10/201064.pdf> (2010)
- Chancel, L., Piketty, T.: Carbon and inequality: From Kyoto to Paris, Trends in the global inequality of carbon emissions (1998–2013) & prospect for an equitable adaptation fund. WID.world Working Paper Series No: 2015/7. Retrieved from <http://piketty.pse.ens.fr/files/ChancelPiketty2015.pdf> (2015)
- Cheng, Y., Wang, Y., Chen, W., Wang, Q., Zhao, G.: Does income inequality affect direct and indirect household CO₂ emissions? A quantile regression approach. *Clean Technol. Environ. Policy* **23**, 1199–1213 (2021)
- Demir, C., Cergibozan, R., Gök, A.: Income inequality and CO₂ emissions: Empirical evidence from Turkey. *Energy Environ.* **30**(3), 444–461 (2019)
- Dorling, D.: Opinion: social inequality and environmental justice. *Environ. Sci.* **19**(3), 9–13 (2010)
- Duarte, R., Mainar, A., Sánchez-Chóliz, J.: Social groups and CO₂ emissions in Spanish households. *Energy Policy* **44**, 441–450 (2012)
- Ghazouani, T., Beldi, L.: The impact of income inequality on carbon emissions in Asian countries: Non-parametric panel data analysis. *Environ. Model. Assess.* **27**, 441–459 (2022)
- Golley, J., Meng, X.: Income inequality and carbon dioxide emissions: The case of Chinese urban households. *Energy Econ.* **34**, 1864–1872 (2012)
- Hailemariam, A., Dzhumashev, R., Shahbaz, M.: Carbon emissions, income inequality and economic development. *Empirical Econ.* **59**, 1139–1159 (2020)
- Hübler, M.: The inequality-emissions nexus in the context of trade and development: A quantile regression approach. *Ecol. Econ.* **134**, 174–185 (2017)
- IPCC. IPCC special report – Aviation and the global atmosphere. In: Penner, J.E., Lister, D.H., Griggs, D.J., Dokken, D.J., McFarland, M. (eds.) A special report of IPCC working groups I and III. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. Retrieved from <https://www.ipcc.ch/site/assets/uploads/2018/03/av-en-1.pdf> (1999)
- Ivanova, D., Wood, R.: The unequal distribution of household carbon footprints in Europe and its link to sustainability. *Global Sustain.* **3**, e18 (2020)
- Jungbluth, N., Meili, C.: Recommendations for calculation of the global warming potential of aviation including the radiative forcing index. *Int. J. Life Cycle Assess.* **24**, 404–411 (2019)

- Kasuga, H., Takaya, M.: Does inequality affect environmental quality? Evidence from major Japanese cities. *J. Clean. Prod.* **142**, 3689–3701 (2017)
- Kenner, D.: Inequality of overconsumption: The ecological footprint of the richest, Global Sustainability Institute, Anglia Rusking University, Working Paper No: 2015/2. Retrieved from <https://whygreeneconomy.org/wp-content/uploads/2015/11/Inequality-of-overconsumption.-The-ecological-footprint-of-the-richest-Dario-Kenner.pdf> (2015)
- Knight, K.W., Schor, J.B., Jorgenson, A.K.: Wealth inequality and carbon emissions in high-income countries. *Social Currents* **4**(5), 403–412 (2017)
- Lévay, P.Z., Vanhillea, J., Goedeme, T., Verbista, G.: The association between the carbon footprint and the socio-economic characteristics of Belgian households. *Ecol. Econ.* **186**, 107065 (2021)
- Levinson, A., O'Brien, J.: Environmental Engel curves: Indirect emissions of common air pollutants. *Rev. Econ. Stat.* **101**(1), 121–133 (2019)
- Oxfam. Confronting carbon inequality - Putting climate justice at the heart of the COVID-19 recovery. Retrieved from <https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621052/mb-confroning-carbon-inequality-210920-en.pdf?sequence=1> (2020)
- Peters, G., Hertwich, E.: Production factors and pollution embodied in trade: Theoretical development. Norwegian University of Science and Technology Industrial Ecology Programme Working Paper No.5/2004. Retrieved from https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/242583/122109_FULLTEXT01.pdf?sequence=1&isAllowed=y (2004)
- Sørheim, H.: The relationship between household income, expenditure profiles, and CO₂ emissions in Norway. University of Oslo, Thesis (2021)
- Solomon, S., Qin, D., Manning, M., Marquis, M., Averyt, K., Tignor, M.M.B., Miller, Jr., H.L.R., Chen, Z.: Climate change 2007: The physical science basis, Contribution of working group I to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY USA. Retrieved from <http://www.ipcc.ch/report/ar4/wg1/> (2007)
- Stadler, K., Wood, R., Bulavskaya, T., Södersten, C.-J., Simas, M., Schmidt, S., Usubiaga, A., Acosta-Fernández, J., Kuenen, J., Bruckner, M., Stefan, G., Lutter, S., Merciai, S., Schmidt, J.H., Theurl, M.C., Plutzar, C., Kastner, T., Eisenmenger, N., Erb, K.-H., Koning, A., Tukker, A.: EXIOBASE 3: Developing a time series of detailed environmentally extended multi-regional input-output tables. *J. Ind. Ecol.* **22**(3), 502–515 (2018)
- Stadler, K., Wood, R., Bulavskaya, T., Södersten, C.-J., Simas, M., Schmidt, S., Usubiaga, A., Acosta-Fernández, J., Kuenen, J., Bruckner, M., Stefan, G., Lutter, S., Merciai, S., Schmidt, J.H., Theurl, M.C., Plutzar, C., Kastner, T., Eisenmenger, N., Erb, K.-H., Koning, A., Tukker, A.: EXIOBASE 3 (3.8.2) [Data Set]. Zenodo. (2021). <https://doi.org/10.5281/zenodo.5589597>
- Stadler, K.: Pymrio – A Python based multi-regional input-output analysis toolbox. *J. Open Res. Software* **9**, 8 (2021). <https://doi.org/10.5334/jors.251>
- Uzar, U., Eyuboglu, K.: The nexus between income inequality and CO₂ emissions in Turkey. *J. Clean. Prod.* **227**, 149–157 (2019)
- Wit, R.C.N., Boon, B.H., van Velzen Martin Cames, A., Deuber, O., Lee, D.S.: Giving wings to emission trading: Inclusion of aviation under the European emission trading system (ETS): Design and impacts. Delft, CE. Report for the European Commission. Publication no: 05.7789.20. Retrieved from https://www.asser.nl/upload/eel-webroot/www/documents/aviation_et_study.pdf (2005)

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.