(Un)equal benefits from global warming? Exploring the link between greenhouse gas emissions and the functional income distribution

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Abstract

Previous research on the links between inequality and the climate crisis has shown unequal contributions to and affectedness of increasing global warming and examined interests in the continued use of fossil fuels. This paper poses the question whether the economic benefits of income generated by greenhouse gas (GHG) emissions and polluting production processes are (un)equally distributed between the production factors capital and labour. To answer this question, the paper investigates the link between GHG emissions and the functional income distribution measured by the profit share at the sectoral level, for 12 European countries over the period 1995-2020, using EU KLEMS and OECD data for the main variables. First, descriptive evidence on the distribution of profit shares and emissions across sectors shows that income generated from emissions is distributed unequally between labour and capital in favour of profit shares. One reason for this is that the profit shares of the emissions-intensive energy sector are consistently among the highest sectoral profit shares. In a second step, an econometric analysis shows that emissions and emission intensities do not consistently predict profit shares across model specifications. Rather, differences in profit shares can be explained by sectoral specifications, as shown by the robust statistical significances of sectoral dummy variables. Thus, in a final step of the analysis, the paper zooms in on the case of Germany to investigate a possible explanation for high profit shares in the energy sector based on lobbying. The evaluation of the lobbying data shows that half of the total lobbying expenditure is spent by companies, organisations or individuals with an interest in the energy sector. The results are then discussed in the light of theories of corporate power.

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1 Introduction

The climate crisis is among the biggest challenges of our time. A deep decarbonisation is needed, which will require an extensive transformation of the economy (Tvinnereim and Mehling 2018). This is particularly essential as some planetary boundaries are already being transgressed, which in the long term may lead to the earth system moving out of the Holocene-like state (Rockström et al. 2009; IPCC 2023). However, this state is the only known state which can support contemporary human societies for certain (Steffen et al. 2015).

This challenge is not only environmental but also linked to social and economic issues like inequality. Many researchers have studied the link between inequality and the climate crisis over the last years. Most research has thereby focused on inequality and income distribution measured on a personal level; posing questions such as who is responsible for emissions and who will be most affected by the climate crisis. Regarding the former, Green and Healy (2022) summarise in their literature review that "socioeconomic inequalities causally contribute to climate change" (ibid.: 635). Research on exposure to the consequences of the climate crisis shows that climate-related events and daily temperature extremes occur especially in poorer countries (Byers et al. 2018; Eckstein, Künzel, and Schäfer 2021; Harrington et al. 2016). Furthermore, changes in environmental exposures cause greater marginal damages to poor populations (Hsiang, Oliva, and Walker 2019: 98) so that climate change will further exacerbate inequalities (Smith et al. 2014). The study by Rehm, Huwe, and Bohnenberger (2023) also provides an overview of the links between the climate crisis and socio-economic inequality.

This paper builds on this existing research and looks at the intranational distributional effects of greenhouse gas (GHG) emissions.[1] The research question is whether the economic benefits of emissions are distributed (un)equally between the production factors capital and labour. To answer the question, I conduct different empirical analyses to explore the relationship between GHG emissions and the profit share on a sectoral level for 12 European countries over the period 1995-2020. The profit share is used as a proxy variable for the the functional income distribution, measuring shifts in the income shares of wages and profits. The main data on profit shares come from EU KLEMS; the data on emissions is derived from the OECD database.

The paper first provides descriptive evidence on the distribution of profit shares and GHG emissions across different sectors. One main finding is that capital has benefited more from emissions than labour, with the exception of one country, as shown by the calculation of emission-weighted profit shares. In a second step, the paper examines econometrically whether there is an overall statistically significant relationship between emissions and the profit share in different sectors over the period 2000-2014 by using a fixed effects regression. The estimation results show that there is no robust statistical significant effect between emissions or emission intensities and profit shares. Rather, differences in profit shares can be explained by sector-specific characteristics, as shown by the robust statistical significances of sectoral dummy variables. It is striking that the profit shares of the emissions-intensive energy sector are consistently among the highest sectoral profit shares in all countries in the

[1] In the following, emissions is used synonymously with GHG emissions.

sample. Therefore, in a final step of the analysis, I take an exploratory look at the case of Germany to investigate one sector-specific characteristic that might explain the high profit shares in the energy sector relative to other sectors. Using data on lobbying expenditures and employees, I examine political influence through lobbying as one explanation for high profit shares. The evaluation of the lobbying data shows that half of the total lobbying expenditure is spent by companies, organisations or individuals with an interest in the energy sector.

With this analysis, the paper contributes to the maturing research on emissions and inequality by incorporating the functional income distribution into the analysis. The paper shows general macroeconomic distributional dynamics with respect to the benefits of emissions, with the result that the income from emissions is unequally distributed in favour of profit shares. In addition, I offer one explanation for the empirical results by elaborating on power-based theories. Furthermore, the introduction of emission-weighted profit shares serves as an extension of the functional income distribution to include ecological aspects. Through this extension, this paper contributes on a conceptual level to the integration of post-Keynesian and ecological economics, which as Huwe and Rehm (2022) argue, is a promising approach. Furthermore, a combination of both ecological and post-Keynesian economics seems useful, as it may lead to a "better understanding of how a capitalist economy operates in a natural environment with limits to growth and to better-informed policy advice" (Kronenberg 2010: 1488).

The paper proceeds as follows: The following section outlines political economy theories on corporate power which provides the basis for the discussion of the empirical results of this paper. Section three describes the data used for the analysis and section four presents the methods and results of the empirical analysis. Section five discusses the results, relates them to the theory presented and concludes with the main findings.

2 Theories of corporate power

According to post-Keynesian and Marxist economics, power conflicts underlie economic outcomes (Rehm and Schnetzer 2015: 2515) and factor shares also indicate relative power of different groups (Atkinson 2009: 5). The functional income distribution, as one of the main variables of interest in this paper, can thus be understood as the result of specific power configurations.

In the context of this paper, I will draw primarily on research on power of business vis-à-vis the state. Since power is such a broad field of study, the theories mentioned do not claim to be exhaustive. Still, these theories provide one possible approach to the theoretical explanation of the empirical results in the next part of this paper.

The theoretical discussion of corporate power began in the 1970s with contributions highly critical of corporate capitalism (Vogel 1987: 386). One important contribution came from Robert Dahl and Charles Lindblom. In the beginning, both were representatives of a pluralistic view in which the power of corporations is seen as no different from that of other groups. However, both then recognised shortcomings in the discussion of pluralism, especially regarding business groups and argued that business groups are more powerful than other interest groups (Dahl and Lindblom 1976: xxxvi; as cited in Vogel 1987: 386).

Furthermore, Lindblom has argued that business firms are in a privileged position because the state tends to follow the preferences of business due to the state's dependence on business investment decisions. He therefore argued that "market systems imprison policy" (Lindblom 1982: 336). This type of power is also called structural power. This structural advantage of corporations arises primarily from the threat that corporations pose to the state in the context of market reforms. Such reforms could be directly punished by companies through a decline in investment, unemployment or a stagnating economy (ibid.: 325). According to Lindblom (1982), examples of areas in which these mechanisms of imprisonment are at work include policies regarding decision-making powers of businessmen in their business and the prerogatives of the management, policies on the distribution of income and wealth, or policies to keep the labour movement under control (ibid.: 330).

Another type of power is instrumental power. While companies have structural power because of their position in the economy, instrumental power is actively exercised by the companies (Culpepper and Reinke 2014: 448). Instrumental power includes means that are not part of a company's core functions, such as campaign donations and privileged access to policymakers (ibid.: 429). Structural power can result from instrumental power (Culpepper 2015: 396). Thus, both forms of power interact (Woll 2016: 376) and both are prevalent in advanced industrial democracies, but may vary at different stages of the policy-making process (Hacker and Pierson 2002: 283).

Debates about structural power have been revived especially by the financial crisis in 2008 (Woll 2016: 375). Braun (2020) analysed how the European Central Bank has shaped financial policy-making and the power of financial institutions. He not only distinguished between structural and instrumental power, but also used the concept of infrastructural power. This concept goes back to Mann (1984) who defined the infrastructural power of the state towards civil society as the "capacity of the state to actually penetrate civil society, and to implement logistically political decisions throughout the realm" (ibid.: 189). In contemporary analyses, infrastructural power is seen as a sub-type of structural power. It operates through the policymakers' expectation that reforms harming markets will undermine their own market-based policy instruments and the ability to govern the economy (Braun 2020: 400). Whereas, in the case of structural power, the expectation is that reforms will harm economic performance (ibid.: 410).

Besides research in the aftermath of the financial crisis there are also other empirical studies with a focus on climate policies and the extent of lobbying especially by emission-intensive companies. Brulle (2018) developed an empirical estimation of lobbying expenditures related to climate change for the US. The study shows that fossil fuel and transportation companies, utilities, and affiliated trade associations were the major sectors involved in lobbying. Cho, Patten, and Roberts (2006) also found for the US that firms with a lower environmental performance are more involved in corporate political activities.

However, it is not the case that only companies with high emissions lobby. They mainly lobby to maintain the status quo, while companies with lower emissions lobby for regulation because they might benefit from it (Delmas, Lim, and Nairn-Birch 2015: 3). Yet, an analysis of political lobbying on the most prominent climate regulation in the US, the Waxman-Markey bill, shows that “lobbying by firms expecting losses from the policy was more effective than lobbying by firms expecting gains” (Meng and Rode 2019: 472).

The overview of theories and empirical studies on the topic of power is intended to serve as a basis for the discussion of the empirical findings. However, I do not undertake a classical theory testing in this paper. Rather, I use the concept of power as a lens through which to interpret the results and the particular role of the energy sector. The evaluation of lobbying data as an aspect of instrumental power substantiates the discussion of power, but remains indicative.

3 Data

The empirical analysis is based on an unbalanced panel data set with annual measurements covering 12 European countries, each with 5 different sectors. The countries are Austria, Belgium, the Czech Republic, Germany, Spain, Finland, France, the United Kingdom, Italy, Latvia, the Netherlands and Sweden. The time period covered is 1995-2020 in the descriptive analysis and 2000-2014 in the regression analysis due to missing data for control variables. Following Soener (2019), the sector classification in this analysis is based on the UNFCCC and IPCC guidelines and includes the following sectors: agriculture, manufacturing and construction, energy industries, transportation and waste and other. A detailed overview of how I have summarised the sectors is in Table 4 in the appendix. The dataset for the descriptive analysis, which only includes data on emissions and the functional income distribution, contains 1560 observations. The total number of observations for the regression analysis is 899.

In my analysis, I use the profit share as a proxy variable for the functional income distribution, which takes into account the distribution of total income between wages and profits. This variable is the dependent variable of the analysis. It is measured as capital compensation as a percentage of gross value added (GVA) in current prices. Capital compensation is derived as gross value added minus labour compensation which includes the sum of compensation of employees and an imputation for the compensation of self-employed (Bontadini et al. 2023: 14). Data are taken from the EU KLEMS (2023b) database. The summary statistics in Table 1 show a wide range of profit shares from 0.27% to 90.63%, indicating a large variation in profit shares across sectors and/or countries.

Table 1: Summary statistics for the data from 2000-2014 ($N = 899$)

Variable	**Mean**	**SD**	**Min.**	**Max.**
Profit share (%)	41.54	19.15	0.27	90.63
GHG emissions (Mt)	63.12	69.76	1.36	407.30
GHG intensity	1685.92	2154.09	1.78	12637.98
ICT share (%)	2.20	2.10	0.01	12.92
Trade openness (%)	274.12	23.06	238.75	333.79
Financialisation	1.65	2.21	0.23	12.18
Rate of GVA change (%)	3.39	7.66	-30.76	38.47
Capital intensity	1048.90	2519.92	17.60	19222.05

The independent variable is GHG emissions measured in megatonnes (Mt) of CO_2-equivalents, taken from OECD (2023b). These OECD greenhouse gas data are taken from National Inventory Submissions to the UNFCCC and cover 6 different GHG emissions: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The analysis also makes use of sectoral GHG intensities. These are calculated as GHG emissions in tonnes divided by gross value added at current prices in millions of the national currency for each sector.[2] As can be seen in Table 1, GHG emissions and intensities vary widely across the sample, as do the profit shares.

The regression analysis controls for further explanatory variables of the functional income distribution as mentioned in the literature (e.g. Stockhammer 2017). The variables considered in this analysis are technological progress, trade openness, business cycle effects, financialisation and capital intensity. To control for the effects of technological progress, I use the share of ICT capital stock in the total capital stock with data from EU KLEMS (2023a). The ICT capital stock is calculated as the sum of computing equipment, communications equipment and computer software and databases. I include trade openness, measured as the sum of exports and imports as a percentage of the respective sectoral output, to control for possible effects of trade globalisation on the profit share. The data are taken from the World Input Output Database (Timmer et al. 2015). To control for business cycle effects, I include the change in gross value added measured in current prices with data from EU KLEMS (2023b). For financialisation, following Stockhammer (2017), I use data on financial globalisation as external assets plus external liabilities divided by GDP. This data is taken from Lane and Milesi-Ferretti (2018). As this is a measure of a country's exposure to the international financial system, this variable is only available at the country level and not at the sector level like the other variables are. Therefore, the same value of financialisation is used for all sectors in a country and a year. Capital intensity is measured as the total net capital stock at current prices in millions of the national currency divided by persons employed using data from EU KLEMS (2023a) and EU KLEMS (2023c). Other than e.g. Stockhammer (2017), I do not explicitly control for welfare state retrenchment as this is also a country-level rather than a sector-level variable. Country-specific differences that may also affect the welfare state are

[2] The unit tonnes was used for the calculation instead of megatonnes, as otherwise the division by GVA would result in values between 0 and 1, for which the logarithm would not be applicable.

included in the country fixed effects. Summary statistics for the control variables are also in Table 1.

For the case of Germany and the analysis of lobbying as one possible explanation for high profit shares in the energy sector, I use data on lobbying expenditure and employees from the lobby register of the German Bundestag (Deutscher Bundestag 2023). As the lobby register only came into force in 2022, data are only available for that year. Furthermore, the data do not contain information on meetings with politicians, but instead e.g. on fields of interests, expenses and employees for lobbying activities. But some companies, organisations or persons have also refused information. The total number of lobby register entries used for the analysis is 5849.

4 Analysis

As a first step of the analysis, I provide descriptive evidence on the distribution of profit shares and emissions across sectors and calculate emission-weighted profit shares. In a second step, I examine econometrically whether there is a general relationship between the level of emissions and the level of profit shares in different sectors, or whether the effect is driven by sector-specific characteristics. The energy sector in particular stands out in the analysis, as it is consistently the sector with both high emission intensities and a high profit share. Therefore, in a final step of the analysis, I look at the case of Germany to explore one possible explanation for high profit shares in the energy sector based on lobbying.

4.1 Descriptive analysis

GHG emissions are unevenly distributed across countries and sectors. Table 3 provides an overview of the absolute emissions measured in Mt and the sectoral shares of these emissions in 2020. Across countries Germany had the highest total emissions with 728.74 Mt in 2020, while Latvia had the lowest with only 10.45 Mt in the same year. Across sectors the emission shares are ambiguous. The transport and energy sector have the highest contribution to the total emissions in the largest number of countries, followed by the manufacturing sector and the waste and other sector. Summarising the total amount of emissions per sector of the countries in the sample shows that the total emissions in the transport sector were the highest in 2020 with about 628 Mt, followed by the energy sector with 622 Mt.

Table 2: Total emissions (in Mt) and sectoral shares in 2020

Country	Total	Shares				
		Agriculture	**Manufacturing**	**Transport**	**Energy**	**Other**
AUT	73.59	9%	35%	29%	12%	14%
BEL	106.43	9%	30%	20%	18%	22%
CZE	112.79	7%	23%	16%	39%	16%
DEU	728.74	8%	24%	20%	30%	18%
ESP	274.74	14%	23%	27%	17%	18%
FIN	47.72	14%	24%	22%	28%	13%
FRA	399.41	18%	22%	28%	10%	23%
GBR	405.75	10%	18%	24%	21%	27%
ITA	381.25	9%	20%	22%	23%	26%
LVA	10.45	22%	15%	30%	14%	20%
NLD	163.92	11%	22%	16%	30%	21%
SWE	46.28	15%	27%	33%	17%	7%

Data: OECD

Just as emissions vary widely between sectors, so do profit shares. The variation in profit shares between sectors is shown in Figure 1. It is striking that the energy sector in particular has predominantly higher profit shares than the other sectors.

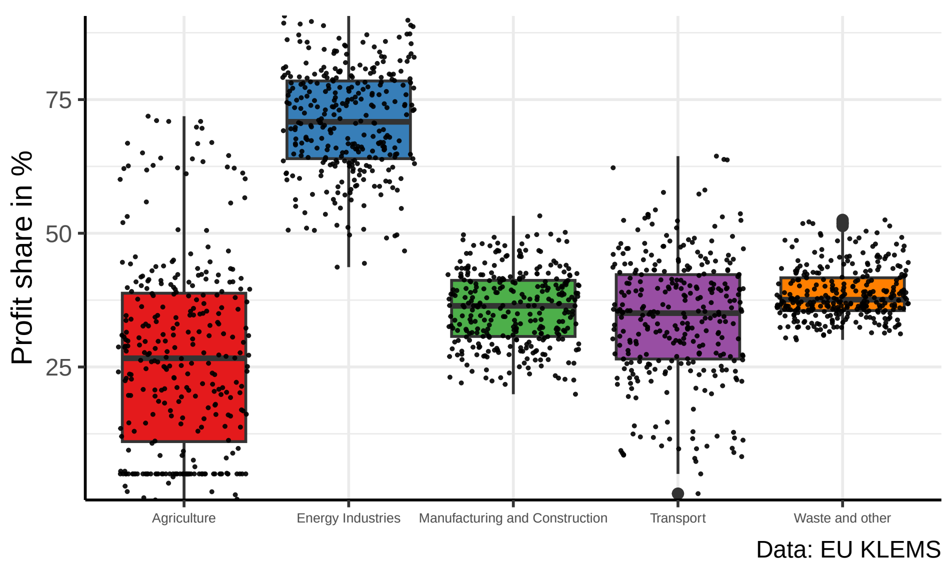

Figure 1: Profit shares for 12 European countries (1995-2020)

The variance of means of the profit share across groups can also be calculated using the intraclass correlation coefficient. To calculate this coefficient, I set up a simple null model that allows for group differences in the means of y using the data from 1995 to 2020. $y_{i,j}$

represents the value of y for the i-th observation in the j-th group. The model has the following structure:

$$y_{i,j} = \beta_0 + u_j + e_{i,j}$$

The ICC value indicates how much variance at level 1 can be explained by level 2, and can be calculated as follows (Hox, Moerbeek, and Schoot 2018: 13):

$$ICC = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}$$

I calculate the variance of the means of the profit shares once with j as sectors and once as countries. The ICC value for sectors is 0.703, which means that 70.3% of the variation in the profit share is between sectors. The ICC value for the variation between countries is only 0.098, which shows that the variation in profit shares across countries is rather low. When calculating the ICC values for GHG intensity of gross value added, a similar picture occurs. For the GHG intensity, 48.7% of the variation in mean GHG intensity is between sectors and 14.8% between countries. Only for the total amount of GHG emissions a higher amount of variation of mean GHG emissions is between countries (69.6%) than between sectors (10.6%) - just as Table 3 has already shown the distribution of emissions.

Looking at the GHG intensity of production and profit shares, it is striking that the energy sector is both very GHG intensive and, as already shown above, has high profit shares (see Figure 2). As Figure 3 shows, a similar distribution pattern of sectors is found in all countries.

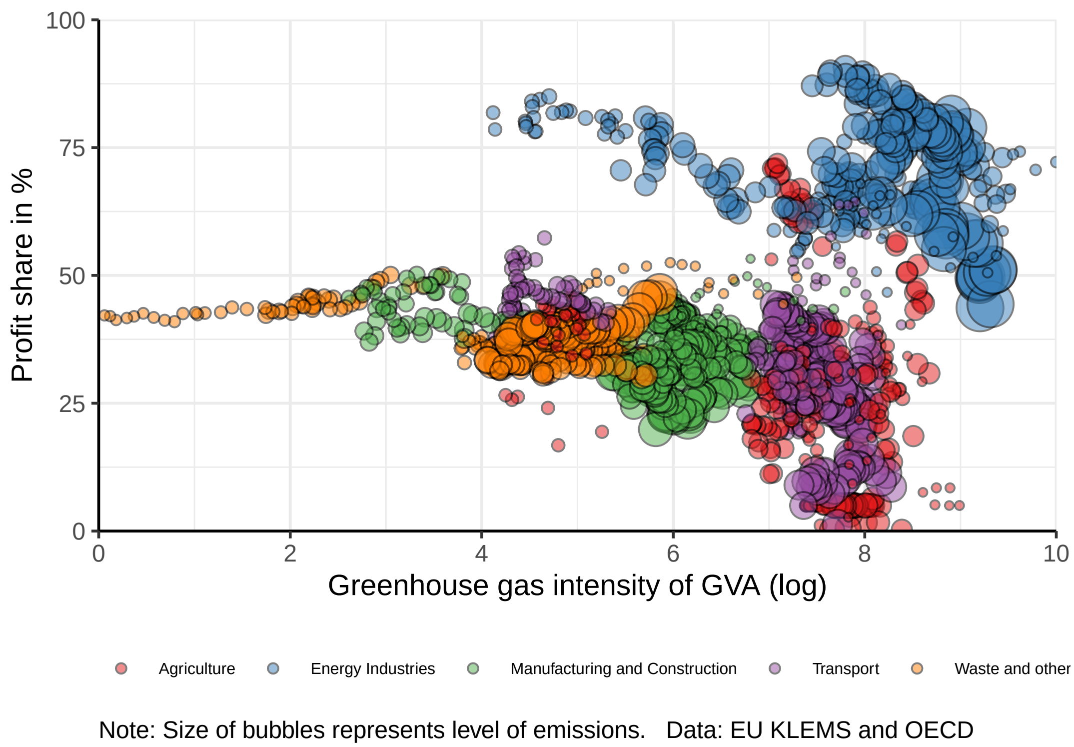

Figure 2: GHG intensities and profit shares for 12 European countries (1995-2020)

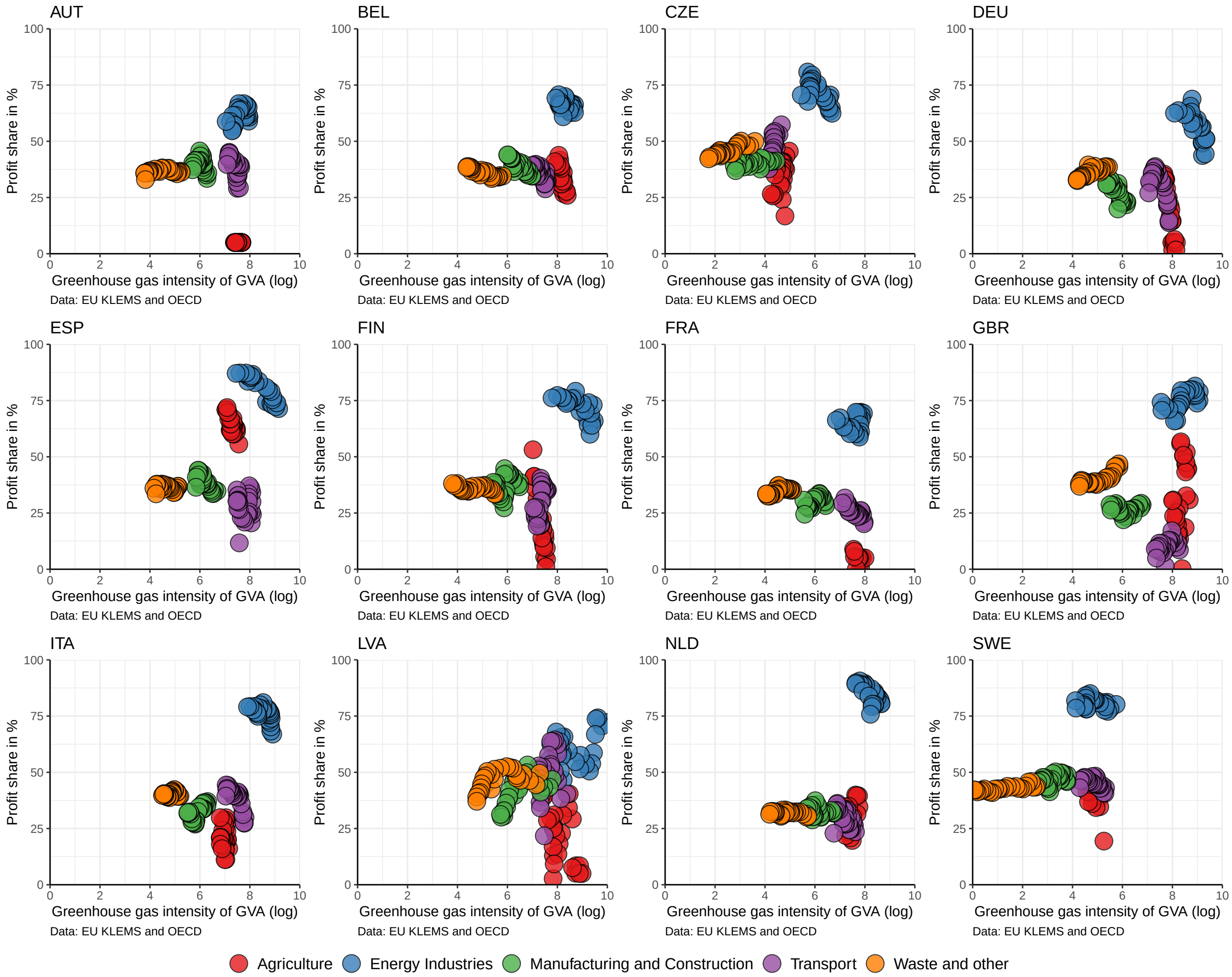

Figure 3: GHG intensities and profit shares by country (1995-2020)

As a further approach to the research question, I calculate profit shares and emission-weighted profit shares at the country-level and then compare both shares. A country's profit share is calculated as follows:

$$p.share_i = \frac{\sum_{j=1}^{5} p_{i,j}}{\sum_{j=1}^{5} g_{i,j}}$$

$j = 1, ..., 5$ denotes the 5 different sectors. $p_{i,j}$ is the absolute value of the compensation of capital per sector and $g_{i,j}$ is the gross value added per sector.

To weight the sectoral profits by their amount of emissions, I further calculate emission-weighted profit shares at the country-level by multiplying each sector's capital compensation and gross value added by its share in total emissions:

$$w - p.share_i = \frac{\sum_{j=1}^{5} e_{i,j} * p_{i,j}}{\sum_{i=1}^{5} e_{i,j} * g_{i,j}}$$

The emissions share of a sector $e_{i,j}$ is calculated for each country as $\frac{Emissions_{i,j}}{Emissions_i}$. Calculating the difference between both the weighted profit share $w-p.share$ and the profit share $p.share$ show that in most countries the emission-weighted profit share is higher than the normal profit share. This indicates that capital has benefited in these countries more from emissions than labour. Only in France the emission-weighted profit share is mostly lower than the profit share (see Figure 4).

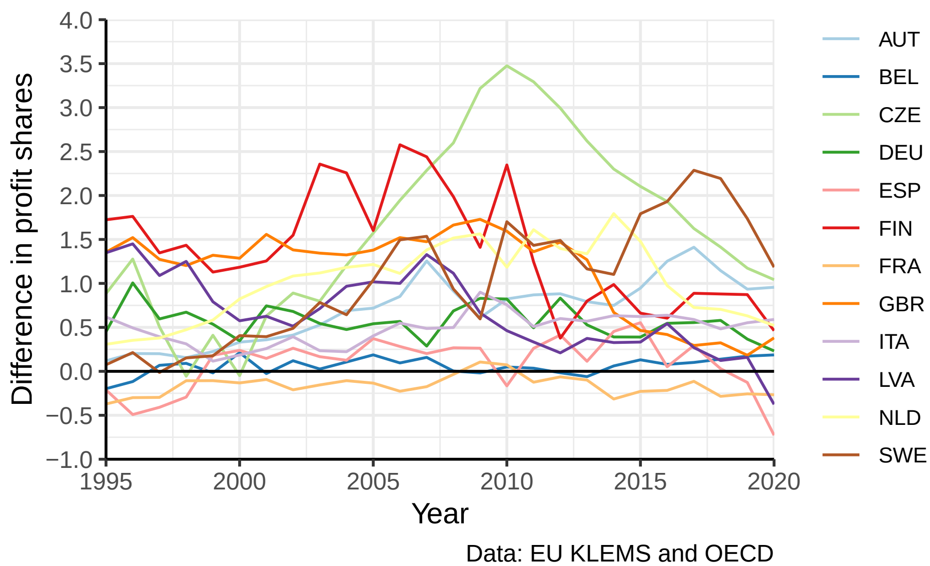

Figure 4: Difference between the emission-weighted and the regular profit share by country

4.2 Regression analysis

4.2.1 Regression model

To answer the question whether there is a general effect of emissions on the profit share, or whether the previous descriptive results are due to sectoral specifications, I conduct a fixed effects regression analysis with the following model:

$$P_{i,j,t} = \beta_0 + \beta_1 * log(E_{i,j,t-1}) + \beta_2 * AG_{i,j,t} + \beta_3 * MA_{i,j,t} + \beta_4 * EN_{i,j,t} + \beta_5 * TR_{i,j,t} + \gamma * Z_{i,j,t} + \alpha_i + \lambda_t + u_{i,j,t}$$

$P_{i,j,t}$ is the profit share in percent in country i, sector j at time t. $E_{i,j,t-1}$ is the total amount of GHG emissions in Mt in the first model and the GHG intensity in the second model. In both models, this independent variable is included as logarithm and lagged by one year due to a potential simultaneity bias between emissions and the profit share, which could lead to endogeneity. $AG_{i,j,t}$, $MA_{i,j,t}$, $EN_{i,j,t}$ and $TR_{i,j,t}$ are dummy variables for the different sectors and take the value 1 if the observation belongs to the respective sector and 0 otherwise. The waste and other sector is not included in the model as it serves as a base category in the analysis. The sectoral dummy variables are included to see whether there are sectoral effects on the profit shares. The control variables are summarised in the vector $Z_{i,j,t}$; the error term is $u_{i,j,t}$. The control variables are included in the model in different forms: capital intensity, trade openness, the ICT share and financialisation as logarithms and the rate of change of gross value added as level. The variable of the ICT share is lagged by one year due to potential simultaneity bias. The coefficients are estimated by fixed effects estimators including country- and year-specific effects (α_i, λ_t). A Breusch-Pagan test and a Durbin-Watson test indicate that the error structure is heteroskedastic and autocorrelated. Therefore, Newey-West standard errors are used, which are robust to cross-sectional and time dependence.

4.2.2 Regression estimation

The results of the regression analysis show that there is no robust statistically significant relationship between emissions or emissions-intensity and the distribution between profits and wages. The coefficient in the first model with the total amount of GHG emissions as the independent variable indeed shows a statistically significant negative effect. The coefficient in the second model estimated with the GHG intensity however does not show any statistical significance (see Table 3). Furthermore, the estimation with other sectors according to the NACE classification show positive coefficients without any statistical significance indicating low robustness of the effect of emissions on the profit share (see Table 5 in the appendix).

Rather, the results show sectoral effects on the profit share, as the coefficients of the agricultural, energy and transportation dummy variable are statistically significant, whereas the coefficient of the transportation dummy is only significant in the first model. Only the coefficient of the manufacturing and construction dummy variable does not show a significant effect. The coefficients of the agricultural, manufacturing and the transportation dummy are negative, indicating that the profit shares in these sector are smaller compared to the base category sector waste and other. The coefficients of the dummy variable for the sector energy industries show positive coefficients (see Table 3).

The control variables show effects similar to those from the literature but just some of them are statistically significant. The coefficient of capital intensity is positive but statistically not significant; the same goes for the ICT share and financialisation variable. The rate of GVA change has a significant positive effect on the profit share at the 1% level. Trade openness has a significant positive effect at the 10% level in model 2.

Although I use lags for some of the variables to avoid potential endogeneity, the coefficients of the regression analysis should be treated with caution as the model is of rather low robustness. The results of the estimation with other sector classification show different statistical significances and coefficients for the dependent and control variables (see Table 5 in the appendix). However, almost all sectoral dummy variables show statistical significance. Moreover, the coefficients for mining and quarrying (B) and electricity, gas and steam supply (D), which can both be classified as part of energy industries, are the highest sectoral coefficients. This shows that the sectoral effects of the regression analysis are robust.

Table 3: Parameter estimates

	Dependent variable:	
	Profit share	
	(1)	(2)
log(GHG emissions in Mt) (t-1)	-3.13^{**}	
	(1.43)	
log(GHG intensity) (t-1)		-0.21
		(1.31)
log(Capital intensity)	2.19	2.26
	(2.13)	(2.26)
log(1+ICT share) (t-1)	0.73	0.87
	(1.66)	(1.70)
Rate of GVA change	0.16^{***}	0.16^{***}
	(0.05)	(0.05)
log(Trade openness)	20.39	22.92^{*}
	(12.86)	(13.24)
log(1+Financialisation)	3.36	2.90
	(2.33)	(2.28)
Agriculture (Dummy)	-13.52^{***}	-13.24^{***}
	(2.22)	(2.68)
Manufacturing and Construction (Dummy)	-4.84	-4.77
	(3.27)	(3.52)
Energy Industries (Dummy)	25.67^{***}	28.79^{***}
	(4.74)	(5.64)
Transportation (Dummy)	-4.91^{**}	-5.07
	(1.97)	(3.48)
Observations	899	899
R^2	0.75	0.75
Adjusted R^2	0.74	0.74
Note:	*p<0.1; **p<0.05; ***p<0.01	

4.3 Case study

One approach to the question which characteristics of the energy sector might explain the higher profit shares compared to other sectors and the overall economic average is to examine whether there is a relationship between lobbying activities and profit shares. This approach is based on the theories on corporate power (see section 2) and is examined using descriptive analysis for Germany.[3]

Unfortunately, for a long time there was no data on lobbying activities in Germany. The lobbying register of the German Bundestag was first introduced 2022 and contains data only for this year. Thus, I cannot compare these data with my previous data set over the period 1995 to 2020 directly.

Figure 5 shows lobbying data for Germany in 2022. It shows the shares of the number of entries in the lobbying register, expenditure and employees for lobbying activities, disaggregated by different fields of interest.[4] It is important to note that companies could report more than one field of interest and are therefore represented in the figure under a variety of topics. In addition, it is not clear from the data what the institutions lobbied for. For example, both environmental NGOs and fossil fuel companies are listed under 'Energy' - both of which are likely to have very different interests. A final limitation of the data is that the topics in the lobby register do not perfectly match the sectoral classification of the other data. For the analysis, I use all the supercategories given, and for the topic 'Economy' I also include the subcategory 'Industrial policy'.

With regard to the topic of energy, it is striking that about half of the reported lobbying expenditure in Germany is spent by organisations, companies or individuals that are also involved in the topic of energy. Presumably, there was a lot of lobbying on energy not only in 2022 but also in the years before. Due to the limitations mentioned above, it is difficult to draw firm conclusions from the data. Nevertheless, they give an indication that representatives with an interest in the energy sector put extensive capacity into influencing the political process.

[3] There are two reasons for focusing on one country instead of the previous sample of 12 countries. First, there is a lack of transnational sectoral data on lobbying for all countries. And second, there might be different effects or explanatory approaches depending on the country.

[4] Expenditures and employees are shown as a range in the data set. In order to calculate the absolute values for the two variables, I have used the maximum values in each case.

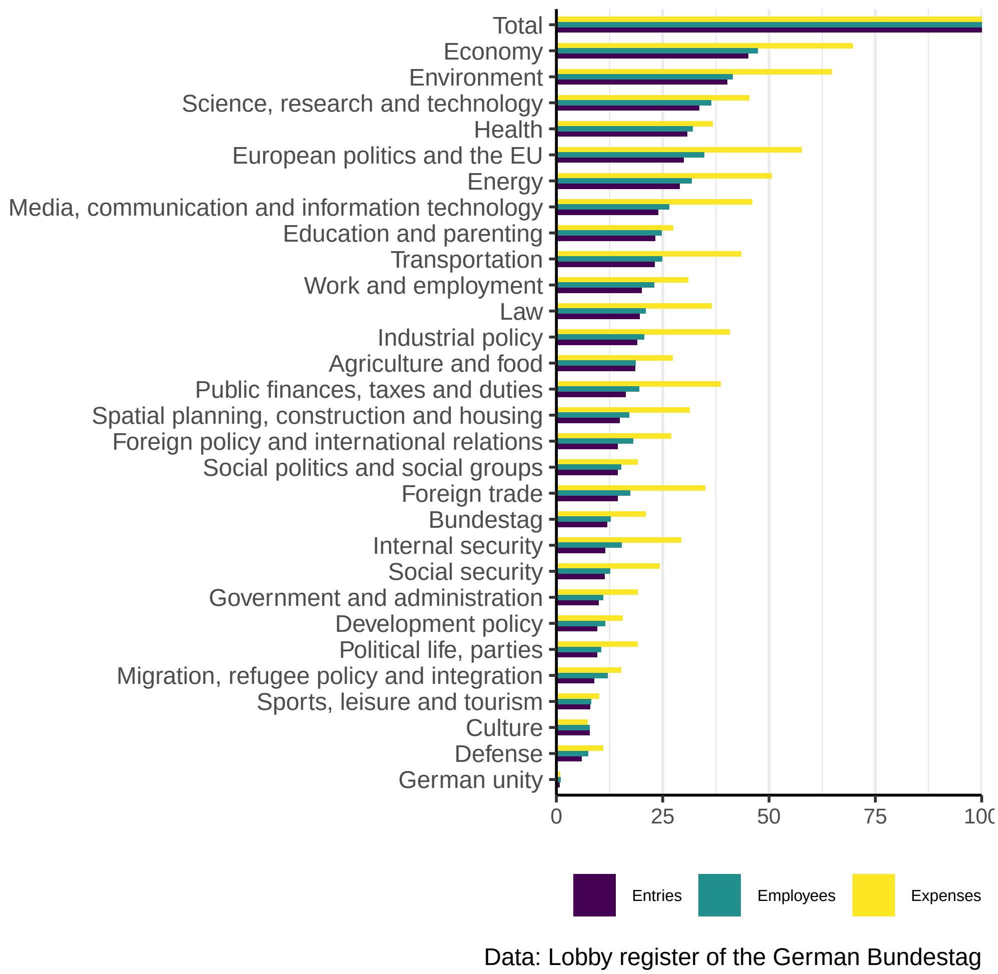

Figure 5: Lobbying data for Germany in 2022

5 Discussion and Conclusion

The aim of this paper was to explore the link between GHG emissions and the functional income distribution to answer the question whether the factors of capital and labour have benefited (un)equally from emissions and the underlying production processes. The descriptive analysis of the data showed that both profit shares and GHG-intensities vary more between sectors than between countries. Furthermore, a similar distribution pattern of emission intensities and profit shares emerges across countries. Through adding emission weights to the analysis of the functional income distribution, I was able to show that - with the exception of France - capital has benefited more from GHG emissions than labour. Adding this ecological aspect to the functional income distribution shows a promising way forward for merging ecological and post-Keynesian economics. Furthermore, estimating regression models and controlling for both emissions and sectors, gave a first indication for the relative explanatory importance of sector-specific characteristics in explaining differences in profit shares.

The lack of a general link between emissions and profit shares indicates that both issues interact through more complex mechanisms. It also shows that a closer look at sectors is needed to better explain differences in profit shares.

Following post-Keynesian and Marxist economics which emphasize conflicts underlying economic outcomes (Rehm and Schnetzer 2015: 215), the functional income distribution can be understood as the result of specific power configurations. In this regard one can conclude from the empirical results showing profit shares above the average for the energy sector, that the companies and capital owners operating in the energy sector may have more power regarding profit shares compared to other sectors.

In relation to the theories of power discussed in section 2, I argue that the sector has structural power because of its special position in the economic system compared to other sectors. One reason for this can be that energy is an important element of the individual, social and economic life:

> "Energy systems are deeply co-produced with human affairs [. . .]. As a consequence, energy is integral to the core functioning of every critical infrastructure: food, water, transport, manufacturing, security, communication, habitation, and more." (Sovacool et al. 2020: 3f)

Within the economic system, the energy sector serves as an upstream sector for other industries as it produces energy which is used as energy inputs by other industries. This results in a relationship of dependency. Arguing in terms of structural power vis-à-vis the state, companies in the energy sector can furthermore theoretically not only threaten unemployment and economic stagnation by withholding investment. Rather, the (lack of) guarantee of energy supply security is an additional aspect of their potential threat. This is particularly important given that in Germany, for example, security of energy supply is a state objective laid down in the Law on the Fuel and Electricity Industries ('Energiewirtschaftsgesetz'). To achieve this goal, the state is dependent on the energy companies.

The state depends on the largely private energy sector not only for security of energy supply, but also for the energy transition, to implement energy transition policies that include the expansion of electricity grids, renewable energy production and the decommissioning of fossil energy infrastructure. In order to accompany and govern the energy transition, the state relies on policy instruments that work. Companies' reactions to too much regulation of the energy sector could make the state fear for its ability to govern. This mechanism corresponds to infrastructural power.

The energy sector seems to not only have structural and infrastructural but also instrumental power actively exercised by companies (Culpepper and Reinke 2014: 448). On the one hand, despite the limitations in the use of lobbying data, this data does indicate that representatives with an interest in the energy sector have invested capacities in influencing policy. On the other hand, e.g. Brulle's work for the US has shown that energy companies were very active in countermovements to maintain an emissions-intensive status quo (Brulle 2021). It has also been shown that fossil fuels companies were among the major sectors involved in lobbying activities (Brulle 2018).

High profit rates in the currently emission-intensive energy sector are furthermore likely to be an obstacle to the necessary decarbonisation. These high profit rates in a structurally powerful energy sector may create vested interests. Actors in the sector can in turn exercise instrumental power and mobilise accumulated resources to influence the political process and further cement the status quo structures from which they benefit.

Moreover, linking the results of the paper to previous research on inequality and emissions shows that wealthy people, who are particularly capital owners, both contribute relatively more to climate warming through their consumption patterns (Cappelli and Di Bucchianico 2021; Ivanova and Wood 2020; Oswald, Owen, and Steinberger 2020; Wiedmann et al. 2020) and benefit from relatively higher incomes in functional terms through capital returns in carbon-intensive sectors. Following Nielsen et al. (2021), the group of wealthy people with a high socio-economic status thus also occupy the additional role of profiteers besides being consumers or investors. As the functional income distribution is an important determinant of the personal income distribution (Daudey and García-Peñalosa 2007), unequal benefits from emissions may also increase personal income inequality and the associated ecological consequences through consumption- and production-mechanisms.

This paper also provides useful insights for climate justice and labour movements, as it highlights the larger macroeconomic dynamics of profiting from emissions and contributing to the climate crisis. In particular, the finding that emission-weighted shares are skewed towards capital opens up a point of contact between labour and climate concerns, as both movements have an interest in reducing the power of capital.

This paper should be seen as a first approach to empirically investigate the link between the functional income distribution and GHG emissions, providing indications of macroeconomic dynamics. In addition, this work offers a starting point for questions about the design of transformation and decarbonisation in terms of who should or will benefit from it. At the same time, many aspects remain open. First, it would be insightful to incorporate qualitative research methods with a targeted emphasis on the energy sector. Such an approach promises to facilitate a deeper comprehension of potential explanatory factors for the high profit shares and bring to light more sector specific characteristics. Furthermore, a case study regarding lobbying towards measures with an effect on profit shares is intriguing. Second, as the scope of the analysis in terms of country selection and time period was limited due to data availability, an analysis over a longer period would be particularly interesting, given the higher wage shares in the economy as a whole during the Fordist period after the Second World War. It would be interesting to see how the emission-weighted shares would have behaved compared to the regular rates over the longer period. Third, an endeavor into comparative analyses involving non-EU countries would prove intriguing. Such research could shed light on the question whether the distinct frameworks inherent to Europe serve as explanatory factors, or if energy sectors worldwide hold a distinctive stance within the economic system. Subsequently, it would be helpful to look more closely at the owners of capital in the energy sector to identify who exactly benefits from profits. Analyses at the personal level to complement the research at the production factor level would advance the field and yield valuable insights.

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7 Appendix

Table 4: Matching of the different sector classifications

Sector	EU.KLEMS	OECD	WIOD
Agriculture	Agriculture, forestry and fishing (A)	Agriculture (3)	Agriculture (A01-A03)
Manufacturing and Construction	Manufacturing (C) and Construction (F)	Manufacturing industries and construction (1A2) and Industrial processes and product use (2)	Manufacturing (C10-C33) and Construction (F)
Energy Industries	Mining and quarrying (B) and Electricity, gas, steam and air conditioning supply (D)	Energy Industries (1A1) and Fugitive Emissions from Fuels (1B)	Mining and quarrying (B) and Electricity, gas, steam and air conditioning supply (D35)
Transportation	Transportation and storage (H)	Transport (1A3)	Transportation and storage (H49-H53)
Waste and Other	Water supply; sewerage, waste management/ remediation activities (E), Wholesale and retail trade; repair of motor vehicles/ motorcycles (G), Accommodation and food service activities (I), Information and communication (J), Financial and insurance activities (K), Real estate activities (L), Professional, scientific and technical activities (M), Administrative and support service activities (N), Public administration and defence; compulsory social security (O), Education (P), Human health and social work activities (Q), Arts, entertainment and recreation (R) and Other service activities (S)	Residential and other sectors (1A4), Energy - Other (1A5), Waste (5) and Other (6)	All other sectors (E36-E39, G45-G47, I, J58-J63, K64-K66, L68, M69-M75, N, O84, P85, Q, R_S)

Table 5: Parameter estimates with NACE sector classification

	Dependent variable: Profit share	
	(1)	(2)
log(GHG emissions in Mt) (t-1)	0.02	
	(0.49)	
log(1 + GHG intensity) (t-1)		0.47
		(0.55)
log(Capital intensity)	11.02***	10.99***
	(0.73)	(0.74)
log(1+ICT share) (t-1)	−0.32	−0.35
	(0.94)	(0.94)
Rate of GVA change	0.16***	0.17***
	(0.03)	(0.03)
log(Trade openness)	−11.76	−12.08
	(8.18)	(8.27)
log(1 + Financialisation)	2.13	2.09
	(1.83)	(1.84)
Agriculture, forestry and fishing (A) (Dummy)	2.05	2.00
	(3.99)	(3.98)
Mining and quarrying (B) (Dummy)	24.08***	22.11***
	(4.08)	(4.21)
Manufacturing (C) (Dummy)	17.07***	15.57***
	(3.35)	(3.59)
Electricity, gas, steam and air conditioning supply (D) (Dummy)	23.44***	22.22***
	(3.72)	(3.34)
Water supply; sewerage, waste management (E) (Dummy)	11.97***	9.81**
	(3.56)	(3.87)
Construction (F) (Dummy)	9.37***	7.47**
	(2.37)	(2.93)
Wholesale and retail trade (G) (Dummy)	17.65***	17.01***
	(2.01)	(1.94)
Transportation and storage (H) (Dummy)	2.99	2.65
	(3.30)	(3.19)
Accommodation and food service activities (I) (Dummy)	10.83***	9.28***
	(2.47)	(2.59)
Information and communication (J) (Dummy)	16.19***	15.78***
	(2.04)	(2.05)
Financial and insurance activities (K) (Dummy)	21.18***	21.56***
	(2.97)	(3.03)
Real estate activities (L) (Dummy)	20.79***	21.36***
	(4.18)	(4.31)
Professional, scientific and technical activities (M) (Dummy)	4.24*	4.79**
	(2.27)	(2.34)
Administrative and support service activities (N) (Dummy)	18.45***	18.57***
	(2.10)	(2.12)
Public administration and defence (O) (Dummy)	−7.82***	−8.07***
	(2.04)	(2.02)
Education (P) (Dummy)	−6.75***	−7.05***
	(1.66)	(1.62)
Observations	1,784	1,784
R^2	0.89	0.89
Adjusted R^2	0.88	0.88
Note:	*p<0.1; **p<0.05; ***p<0.01	

The sector classification in this analysis is based on the Statistical Classification of Economic Activities in the European Community (NACE). The data for GHG emissions are taken from the air emission accounts of the OECD (2023a). For the other variables, the same data are used as in the main analysis. Complete data for all 12 countries are only available from 2008 onwards. Earlier data are only available for Belgium, the United Kingdom and the Netherlands. Human health and social work activities (Q) is used as a basic category in the regression analysis. The two sectors Arts, entertainment and recreation (R) and Other service activities (S) are not included in this regression analysis because of missing data on trade openness.