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The emission-inequality nexus across stages of development

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Abstract

Does a more unequal society emit more CO_2? The nexus between carbon emissions and income inequality has been at the core of a vast literature, which has yielded conflicting results. Leveraging panel econometric techniques, we provide robust evidence of a non-linear relationship that depends on the structural composition of the economy. Specifically, we document a positive association between income inequality, measured with five different indicators, and per capita carbon emissions in highly tertiarized countries. In contrast, the relationship in non-service-intensive economies turns negative. We provide evidence for plausible mechanisms mediating this non-linear association: the carbon footprint of the richest individuals—particularly when linked to investment—and the employment share in industry are key factors underlying the observed patterns. Our results point to the stage of "development" as a crucial factor shaping the emission-inequality nexus. Indeed, it helps identify countries for which fighting inequality comes with climate-related benefits.

Keywords: income inequality, climate change, emissions, carbon, mitigation

JEL classification: C23 · D31 · Q50 · Q54

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1 Introduction

Increasing evidence shows that the climate crisis and soaring socio-economic disparities are intertwined phenomena (Hamann et al., 2018; Chancel et al., 2023; Guzzardi et al., 2023). Not only the impacts of climate change are asymmetric (Diffenbaugh and Burke, 2019; Palagi et al., 2022; Coronese et al., 2025), but also responsibilities tend to be unequal. Building on recent work showing that the global rich are accountable for a large share of emissions (Chancel, 2022; Rehm and Chancel, 2023), in this work we adopt a broader perspective and investigate whether more unequal societies are associated with higher per capita carbon emissions.

The relationship between inequality and environmental pressure has been empirically investigated by a large body of studies, providing indefinite conclusions. For example, Berthe and Elie (2015) analyzes a group of studies employing data collected from the 1960s to the late 2000s and fails to identify a systematic relationship between proxies of economic inequality and environmental degradation. A significant negative effect is reported only for the relationship between inequality and biodiversity, and between inequality and environmental policies.

In recent years, the focus has shifted to the relationship between income inequality and carbon emissions. However, even in this case, the literature seems far from a consensus. Some studies have detected a positive relation between top income or wealth shares and emissions. Jorgenson et al. (2017), analyzing data from the 50 U.S. states, find that the share of personal income received by the richest 10% of the population correlates with higher CO_2 emissions; however, no significant association is reported when the Gini coefficient is employed in the place of top income shares. Similarly, Hailemariam et al. (2020) find a positive relationship between income inequality and CO_2 emissions in selected OECD countries using the share of personal income received by the richest 10% of the population to measure inequality. However, the relationship turns negative and significant when the authors employ the Gini coefficient. Focusing on wealth, Knight et al. (2017) report a positive and stable correlation between the wealth share of the top decile and per capita emissions in 26 high-income countries from 2000 to 2010.

Other studies highlight a potential conflict between achieving social equity and implementing climate control measures (Ravallion et al., 2000; Bulte et al., 2001). A negative relationship between income inequality and CO_2 emissions is reported by Guo (2014), who analyzes data from China, and Uddin et al. (2020), focusing on G7 countries (Canada, France, Germany, Italy, Japan, the

United Kingdom and the United States) from 1870 to 2014. In particular, Uddin et al. (2020) find that the trade-off exists only between 1950 and 2000, while no robust association is detected in other periods.[1]

Another strand of the literature—which is the closest to our paper—has suggested the existence of a non-linear relationship between income inequality and emissions. More specifically, Grunewald et al. (2017) find that the association between the Gini coefficient and carbon dioxide emissions depends on a country's income level: it is negative for low- and middle-income economies, while it is positive for high-income economies. The authors explain this result by underlining that in low- and middle-income economies people with poor living conditions live out of the carbon economy and produce little emissions, such that they have a high marginal propensity to emit. On the contrary, in high-income economies political economy effects prevail. Indeed, in this context, a social consensus on environmental policies is relatively easier to find when the society is more equal (Pickett and Wilkinson, 2010), and capital owners profiting from emissions have relatively lower power. The latter results are also in line with a recent work suggesting that the impact of an increase in top 10% income shares raises per capita emissions only when income level is relatively high (Cappelli, 2024). Though this perspective is intriguing, in a global setting, the income level is a poor proxy for both the structural composition of the economy (which determines the sources of emissions) and the degree of support for climate policies. For example, Brazil, China and South Africa share a similar income level (between 8.7 and 10 thousands 2015 US dollars in 2019, before the pandemic) but starkly different sectoral composition and attitudes towards climate policy.

Overall, our reading of the literature points to a complex relationship between income inequality and emissions, where non-linearities seem to matter, and robustness across the use of different inequality indicators is absent.

To better shed light on the emission-inequality nexus, we empirically investigate the relationship between income inequality and per capita CO_2 emissions by building a dataset with 160 countries observed yearly between 1980 and 2018 and by leveraging panel econometric techniques commonly used in the literature. The key innovation is that we include a non-linearity by accounting for the evolving structural composition of the economy during its development path. Our results point to heterogeneous impacts of income inequality on emissions depending on the stage of development of a country. Higher inequality is associated with larger per capita emissions for countries that

[1]For a more complete list of empirical works in the literature, the reader may refer to Hailemariam et al. (2020) and Huang and Duan (2020).

are highly tertiarized, while lower inequality is associated with higher emissions for countries at lower stages of development. We provide evidence for top 10% and top 1% carbon footprint and employment shares in industry as key drivers of our results. Indeed, the findings, which are consistent with most of the theoretical explanations proposed by the literature, may be explained by the following mechanisms. First, we show that in highly service intensive countries higher inequality is associated with higher emissions by the top 10%. More specifically, higher inequality in tertiarized countries is associated with a surge of the carbon footprint of investment activities of the richest 1%. Therefore, in the latter category of countries, top emitters are largely responsible for the positive impacts of inequality on emissions. Second, in societies in which the service sector has a limited weight yet, a reduction in inequalities is associated with larger shares of employment in industry. This yields to increases in industrial and energy production and, relatedly, higher emissions.

Our work introduces the following main novelties: i) to the best of our knowledge, our study represents the widest econometric analysis in terms of number of countries, time span and inequality measures covered; ii) our results are robust across five different inequality indicators, as opposed to changing results in the literature depending on the proxy employed (Hailemariam et al., 2020); iii) while in previous work the mechanisms driving results are often associated with income levels (Grunewald et al., 2017), we uncover associations that are dependent on the stage of development of a country in terms of tertiarization, providing evidence of a non-linearity strictly connected to the composition of the economy. More specifically, we find that tertiarization matters even controlling for income levels, differently from previous work that found that the service sector strengthens the relationship between inequality and emissions only in high-income countries (Dorn et al., 2024). Further, we stress that our results carry significant implications for climate-economy modelling and the analysis of inequality along mitigation pathways. In particular, as long as the emission-inequality nexus depends of the structural composition of the economy, models studying mitigation pathways should incorporate structural change when examining distributional questions. Notwithstanding progress, at present, this remains largely unaccomplished (e.g., Emmerling et al., 2024).

The remainder of the paper is structured as follows. In Section 2 we introduce our dataset and our econometric models. In Section 3 we show our main results. Section 4 provides a broader discussion and interpretation of the key findings. Finally, Section 5 outlines some concluding remarks.

2 Data and model

In this section we describe in detail the different datasets (Section 2.1) and methodologies (Section 2.2) employed in our analysis of the association between income inequality and per capita CO_2 emissions.

2.1 Data

We build an unbalanced panel data set with annual measurements of our key variables from 1980 to 2018, covering 160 countries (listed in Table A.1 in Appendix A), with a resulting total number of 4824 observations. While the data on inequality measures are retrieved from the World Inequality Database[2] (WID), the other indicators employed in our main econometric model are taken from the World Development Indicators (WDI) of the World Bank.[3] Additional variables that we use to investigate possible mechanisms driving our main results are retrieved from WID (Chancel, 2022). The detailed sources, units of measure and descriptive statistics are displayed in Table 1, wherein it can be seen that there is a significant variation in all the variables across countries. We hereby describe in more detail the variables employed.

CO_2 emissions data. We employ production-based per capita CO_2 emissions as our main dependent variable. The data on carbon dioxide emissions include CO_2 produced from the burning of fossil fuels and the manufacture of cement, and are expressed in metric tons per capita. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring, and exclude emissions from land use such as agriculture or deforestation. However, this omission represents a minor limitation as they tend to be relatively stable over time. Furthermore, we carry out robustness analysis with consumption-based per capita CO_2 emissions, i.e. emissions adjusted for trade.

Income inequality metrics. In this study, we use five measures of income inequality: the Gini coefficient, the Palma ratio (i.e. the income share of the top ten percent divided by the income share

[2]https://wid.world, downloaded in October 2021.
[3]https://databank.worldbank.org/source/world-development-indicators, downloaded in October 2021.

Table 1: Descriptive statistics for main variables employed.

Statistic	Source	Unit	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Dependent variable									
CO_2 emissions per capita	WDI	metric tons	4,824	4.099	5.043	0.000	0.561	6.249	36.545
Independent variables									
Gini coefficient	WID	percentage	4,824	57.148	9.331	31.912	50.152	63.399	87.379
Palma ratio	WID	ratio	4,824	6.114	4.710	1.173	3.273	7.574	48.923
20:20 ratio	WID	ratio	4,824	38.024	30.515	7.869	20.402	46.399	302.440
Income share of Top 20%	WID	percentage	4,824	60.752	9.070	37.300	53.733	66.320	88.930
Income share of Top 10%	WID	percentage	4,824	46.114	9.860	22.900	38.508	51.830	82.680
Interaction variable									
Tertiarization	WDI	ratio	4,824	2.504	2.181	0.198	1.242	3.127	27.408
Control variables									
GDP per capita	WDI	2010 US$	4,824	11,820.460	17,580.620	164.337	1,247.313	13,161.520	116,233
Population	WDI		4,824	36,622,497	124,619,284	63,261	3,274,030	26,946,631	1,392,730,000
Urban population	WDI	% of population	4,824	54.605	23.085	4.339	36.063	73.578	100.000
Services, value-added	WDI	% of GDP	4,824	50.655	11.668	10.859	42.661	59.053	82.353
Primary enrollment	WDI	% gross	4,117	99.678	18.087	17.292	96.595	108.323	165.645
Population ages 65 and above	WDI	% of population	4,824	7.141	5.152	0.686	3.219	10.879	27.576
Final households consumption per capita	WDI	% of GDP	4,457	64.212	16.713	6.974	54.073	74.663	228.364
Trade	WDI	% of GDP	4,555	80.586	50.871	0.021	48.262	99.692	437.327
FDI net inflows	WDI	% of GDP	4,723	4.121	14.315	−58.323	0.596	4.401	449.083
Additional variables									
Employment in industry	WDI	% of total employment	3,964	20.030	8.530	1.860	14.070	25.530	54.550
Carbon footprint of Top 10%	WID	tCO_2e per capita	4,026	23.129	24.857	0.093	6.275	31.215	177.801
Consumption carbon footprint of Bottom 50%	WID	tCO_2e per capita	3,499	3.994	4.065	0.009	0.929	6.117	39.152
Consumption carbon footprint of Top 10%	WID	tCO_2e per capita	3,500	13.677	13.624	0.062	4.756	17.670	148.844
Consumption carbon footprint of Top 1%	WID	tCO_2e per capita	3,500	28.369	28.923	0.112	11.008	34.669	278.499
Investment carbon footprint of Top 10%	WID	tCO_2e per capita	3,472	7.866	10.000	0.001	1.210	11.134	93.935
Investment carbon footprint of Top 1%	WID	tCO_2e per capita	3,472	35.781	47.271	0.003	5.447	49.154	424.960
Environmental Policy Stringency Index	OECD	From 0 to 6	1,045	1.833	1.152	0.000	0.806	2.833	4.556

For each variable employed we report the data source, the unit of measure, the number of observations, the average value, standard deviation, minimum, the 25th and 75th percentiles and the maximum value.

of the bottom forty percent), the 20:20 ratio (i.e. the income share of the top twenty percent divided by the income share of the bottom twenty percent) and the income shares of the top 20% and top 10%. They are all retrieved from the World Inequality Database, one of the most complete and widely used datasets on inequality. The income definition employed is pre-tax national income and the statistical units on which the indicators are built are equal-split adults (Alvaredo et al., 2016). Considering multiple inequality indicators allows us to take into account the role of income distribution in a more complete way. Indeed, while the Gini coefficient is one of the most used inequality indicator in the literature, it may fail to capture localized movements in the distribution. Moreover, it is more sensitive to transfers at the center of the distribution than at the tails (Alvaredo, 2011). For this reason, to provide robustness to the analysis we also consider several complementary inequality indicators that are able to catch movements at different points of the distribution.[4]

Interaction variable: tertiarization. In this work, we investigate the heterogeneous impacts of inequality on emissions depending on the stage of development of a country. We use tertiarization, defined in our baseline specifications as the ratio between the value-added by the service sector

[4]While the Gini index is more related to the marginal propensity to emit approach (Hailemariam et al., 2020), findings concerning the concentration of income among the top of the distribution may capture the political and Veblen effect (Jorgenson et al., 2017). Indeed, each index captures dissimilar social dynamics. Therefore, to get the complete picture we include all five measures of income inequality that we mentioned above.

and the sum of value-added by manufacturing and agriculture, as our indicator of the stage of development of a country, and we interact this variable with inequality. The ratio captures the extent to which an economy is biased towards services, that is how much services are predominant with respect to other sectors. The measure is in line with a broadly used definition of structural change, as a variation in the relative weight of the main components of aggregate output, more specifically of tertiarization, as capturing the relative importance of the service sector (Montresor and Vittucci Marzetti, 2011; Deleidi et al., 2020; Dosi et al., 2021).[5] Furthermore, it is constructed by employing variables that are typically used as controls in similar analyses on the inequality-emissions association (Grunewald et al., 2017; Jorgenson et al., 2017). We also employ variations of our main indicator of tertiarization, i.e. an alternative index which considers industry (instead of manufacturing), a modification of our baseline measure that includes also services in the denominator, as well as an indicator defined as the share of value-added generated by services out of the sum of value-added of agriculture, industry (instead of manufacturing) and services, to show that results are robust. Overall, tertiarization is greater than one in most countries, meaning that even in several less tertiarized economies, the value-added of the servie sector exceeds the combined value-added of agriculture and manufacturing (cf. Table 1). Figure 1 shows that, expectedly, our measure of tertiarization is overall increasing in countries in our sample, with some fluctuations, which are quite limited, with the exception of the ones experienced by Argentina.

Control variables. We include several control variables in our econometric analysis. Crucially, we control for countries' income level through Gross Domestic Product (GDP) per capita, which is expressed in constant 2010 U.S. dollars. Moreover, urban population refers to the percentage of people living in urban areas as defined by national statistical offices. The share of value-added of services is expressed as a percentage of GDP and is included to ensure that the results depend on the relative size of the service sector, rather than its absolute size. Primary enrollment is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the primary level of education. In line with the definitions provided by the World Bank, trade is the sum of exports and imports of goods and services measured as a share of gross domestic product, and final household consumption expenditure is the market value of all goods and services, including durable products purchased by households, as a percentage of GDP. Finally,

[5]Our approach also relates to the literature on deindustrialization (Rodrik, 2016), although we do not explicitly analyze whether the inequality-emission nexus varies depending on the timing of deindustrialization.

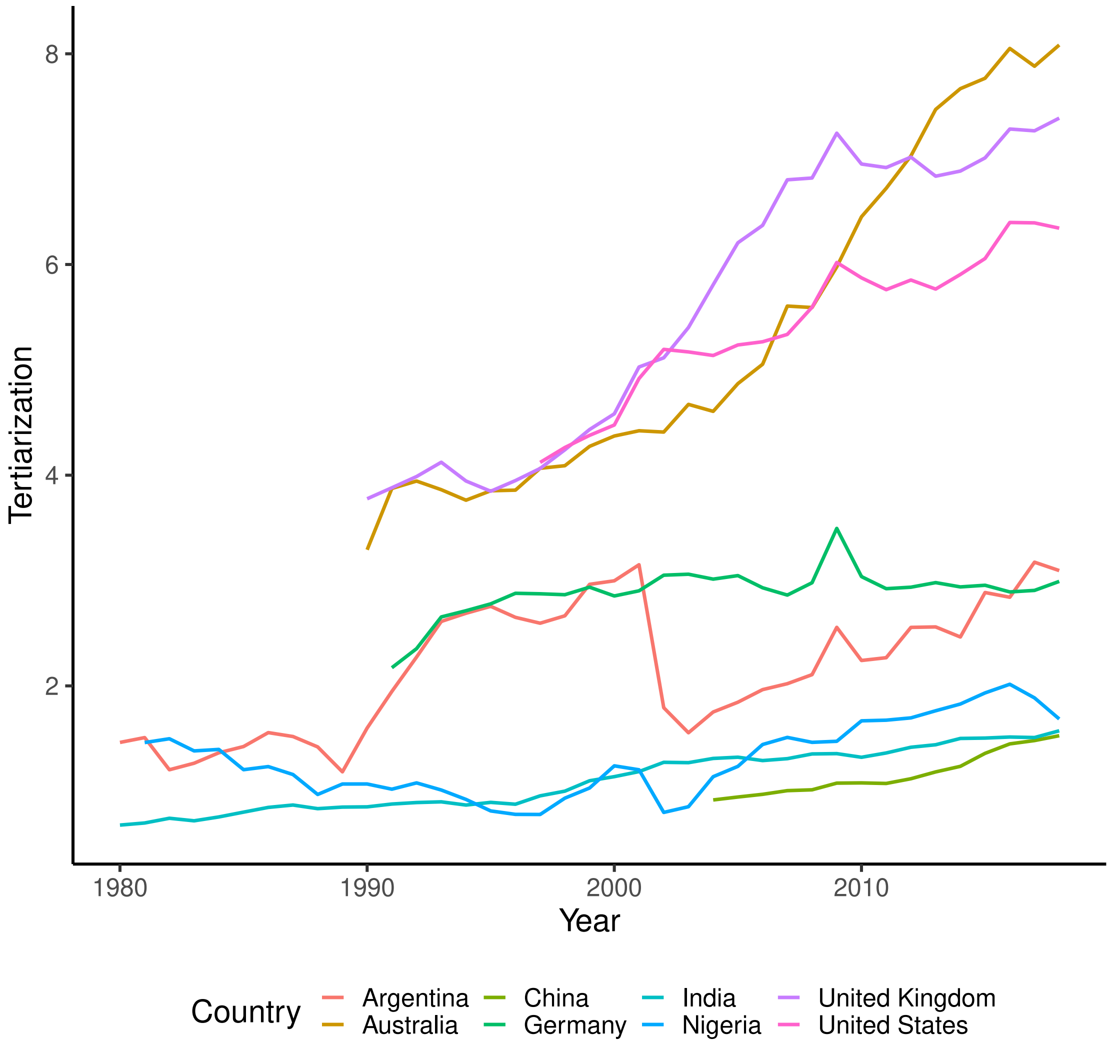

Figure 1: Trends in our baseline tertiarization indicator for selected countries.

FDI stands for foreign direct investments in terms of net inflows.

Additional variables. Finally, we consider a set of additional variables which will be useful to explain the results of the analysis: employment in industry (mining and quarrying, manufacturing, construction, and public utilities) as percentage of total employment (available from 1991), and the average per capita carbon footprint of different income groups of the population (Chancel, 2022). We begin by examining the personal carbon footprint of the top 10% of the income distribution, which is available for years starting from 1990. To provide a more in-depth analysis, we also examine the carbon footprint resulting from the consumption and investment of the top 10% and top 1%, as well as the carbon footprint resulting from the consumption of the bottom 50% of the population. The latter data are available from 1995.

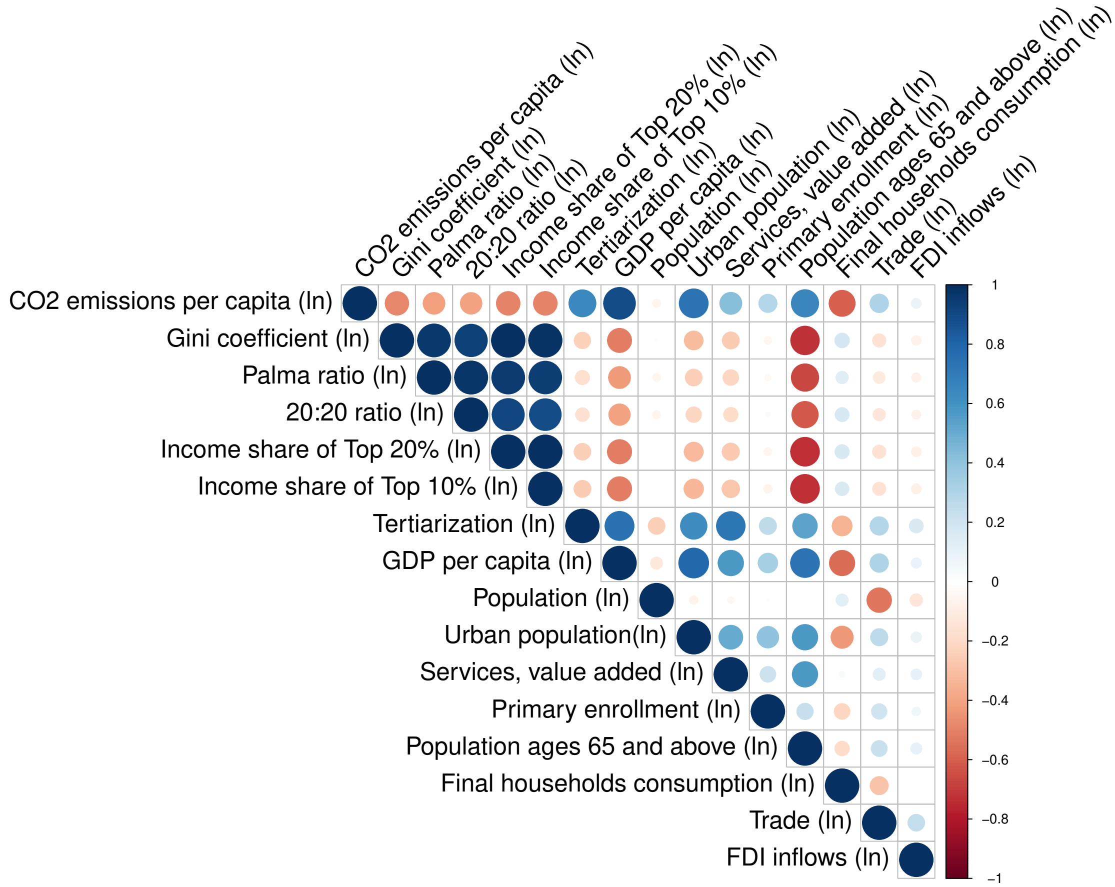

Figure 2: Correlation matrix for our main dependent variable, independent variables and controls.

All variables are transformed in natural logarithms,[6] a traditional approach in research on the drivers of anthropogenic emissions (Rosa and Dietz, 2012). In this way, it is possible to interpret the results of our econometric estimation in terms of the elasticity of emissions with respect to inequality. Besides, the logarithmic form allows to reduce the weight of possible long-run trends of the dependent variable.

Exploring correlation evidence between variables reveals the following. Figure 2, which reports pairwise correlations for all the variables included in the main regression models, shows that CO_2 emissions per capita are negatively correlated with all the income inequality indices. The latter are highly correlated even though, as already explained, they allow to capture inequalities between different portions of the income distribution. As expected, CO_2 emissions per capita are also

[6]More precisely, we take the natural logarithm of the value of each variable plus one in order to obtain only positive values. Since FDI net inflows displays several negative values, we take the logarithm of FDI net inflows adjusted by subtracting its minimum value and adding one, to avoid losing observations for this variable.

strongly positively correlated with GDP per capita, which is instead negatively correlated with income inequality, urban population and with population over 65. The latter variable is also negatively correlated with all inequality indices. Surprisingly, final households consumption is negatively correlated with production-based CO_2 emissions per capita, GDP per capita and urban population. While this preliminary unconditional analysis would suggest a negative correlation between CO_2 emissions and inequality indicators, we demonstrate the strongly non-linear nature of this relationship using panel econometric models.

2.2 Econometric model

We employ panel econometric techniques in line with the literature (Clément and Meunié, 2010; Grunewald et al., 2017; Knight et al., 2017; Hailemariam et al., 2020). In particular, we estimate a panel fixed effects model on our yearly country level data, which allows us to identify associations by controlling for time invariant unobserved heterogeneity. The model may be formalized as follows:

$$e_{it} = \alpha_i + \lambda_t + \beta_1 I_{it} + \beta_2 I_{it} T_{it} + X_{it}\gamma + u_{it}. \tag{1}$$

For country i at time t let e_{it} be the natural logarithm of CO_2 emissions per capita. The natural logarithm of the inequality index is I_{it} and T_{it} denotes the natural logarithm of tertiarization (the ratio between service value-added and the sum of value-added in manufacturing and agriculture), characterizing the stage of development of a country. Additional control variables are collected in matrix X_{it}. Finally, u_{it} is the error term. The parameters α_i represent country-specific fixed effects, which control for all time-invariant factors specific to a country that affect the average value of the dependent variable, while λ_t represent time fixed effects, which instead capture macroeconomic shocks in any given year. In the estimation we calculate standard errors clustered within-countries and heteroscedasticity robust.

The interaction term between the inequality index and tertiarization allows the relationship between income inequality and emissions to depend on the degree of service intensity of each country's economy. This allows us to calculate the turning point in tertiarization at which the relationship changes sign. By differentiating equation (1) with respect to I and setting it to zero, we obtain the elasticity of emissions that depends on the level of tertiarization:

$$\frac{\partial e_{it}}{\partial I_{it}} = \hat{\beta_1} + \hat{\beta_2} T_{it}. \tag{2}$$

As a result, the threshold level of tertiarization where the relationship between emissions and inequality changes its sign is the following:

$$T = -\hat{\beta_1}/\hat{\beta_2}, \qquad T^* = \exp(-\hat{\beta_1}/\hat{\beta_2}), \tag{3}$$

with T^* expressing the turning point in absolute terms instead of in logarithm (T).

We estimate econometric models on five income inequality indicators, i.e. the Gini coefficient, the Palma ratio, the ratio between top 20% and bottom 20% income shares, the top 20% and the top 10% income shares, considering three main specifications in which we progressively include additional control variables. The first specification controls for standard variables employed in the literature (Grunewald et al., 2017), i.e. GDP per capita, the value-added generated by the service sector and controls related to total population and urban population, in addition to our main variables of interest (inequality, tertiarization and the interaction variable given by the inequality indicator and the degree of tertiarization). In the second specification, we add additional controls that describe basic education (% in primary enrollment) and ageing (% of population aging 65 and above), which may impact upon per capita CO_2 emissions (Maranzano et al., 2022). Finally, in the third specification we include measures of consumption (Final households consumption per capita) and trade (Trade and FDI inflows), which also influence a country's emission patterns (for further details on the variables see Section 2.1). In addition, several robustness analyses are carried out (see Section 3 and the Appendix).

3 Results

We start our analysis by estimating the linear model described by Equation 1, assuming no role for the degree of tertiarization in mediating the association between inequality and emissions, i.e. with β_2 equal to zero. As showed by Table A.2, the results suggest a negative association between all inequality indices and CO_2 emissions. However, unlike the findings of de Soysa (2025), there is a substantial lack of robustness across different specifications and tests, appearing significant only in the third specification, which includes all controls. The logarithm of Tertiarization, here used simply as a control variable, is also negative and significant, which implies, as expected, a reduction of per capita CO_2 emissions in more tertiarized economies, everything else held equal.

We interpret these findings as evidence against a linear association between emissions and inequality. Motivated by this and by the large evidence suggesting that the structure of the economy affects its trajectory of development as well as its reaction to climate policy and climate risks (Palagi et al., 2022; Abubakar et al., 2024; Dosi et al., 2024), we include a non-linearity in the association between inequality and emissions driven by the sectoral composition of the economy. Parsimonioulsy, we include an interaction term between each inequality index and the degree of tertiarization, as shown in Equation 1. The results, shown in Tables 2, 3 and 4, suggest that this interaction is positive and strongly significant across all specifications—where we progressively add additional control variables—and for all inequality metrics.

Specifically, the coefficient of the inequality index is negative across all models, while the interaction term is positive. This implies that above a certain level of tertiarization the elasticity between carbon emissions and income inequality turns from negative to positive. In more details: an increase in inequality is associated with an increase in emissions in countries that are characterized by a relatively high level of tertiarization (above 2.99 on average across all specifications, i.e., in countries where the service sector contributes nearly three times the combined value-added of manufacturing and agriculture); differently, for less tertiarized countries, an increase in income disparity negatively affects CO_2 emissions. This is shown in Figure 3 with respect to the first specification with the Gini coefficient as dependent variable (see also Table 2). Indeed, Figure 3 confirms that considering the whole distribution of countries in terms of tertiarization, an increase in the Gini coefficient of income in countries is associated with a decrease in per capita CO_2 emissions at lower percentiles. In contrast, at higher percentiles, an increase in inequality is associated with higher per capita CO_2 emissions.

The level of tertiarization at which the relationship changes its sign is shown in the final rows of the regression tables. It is included between 1.82 and 3.8 depending on the inequality index considered and on the specification, with the number of observations above the turning point representing between 29 and 66% of the sample in the last year of observation (2018). In order to identify which countries belong to the group characterized by tertiarization levels above the turning point, and, thus, by a positive association between inequality and emissions, we employ

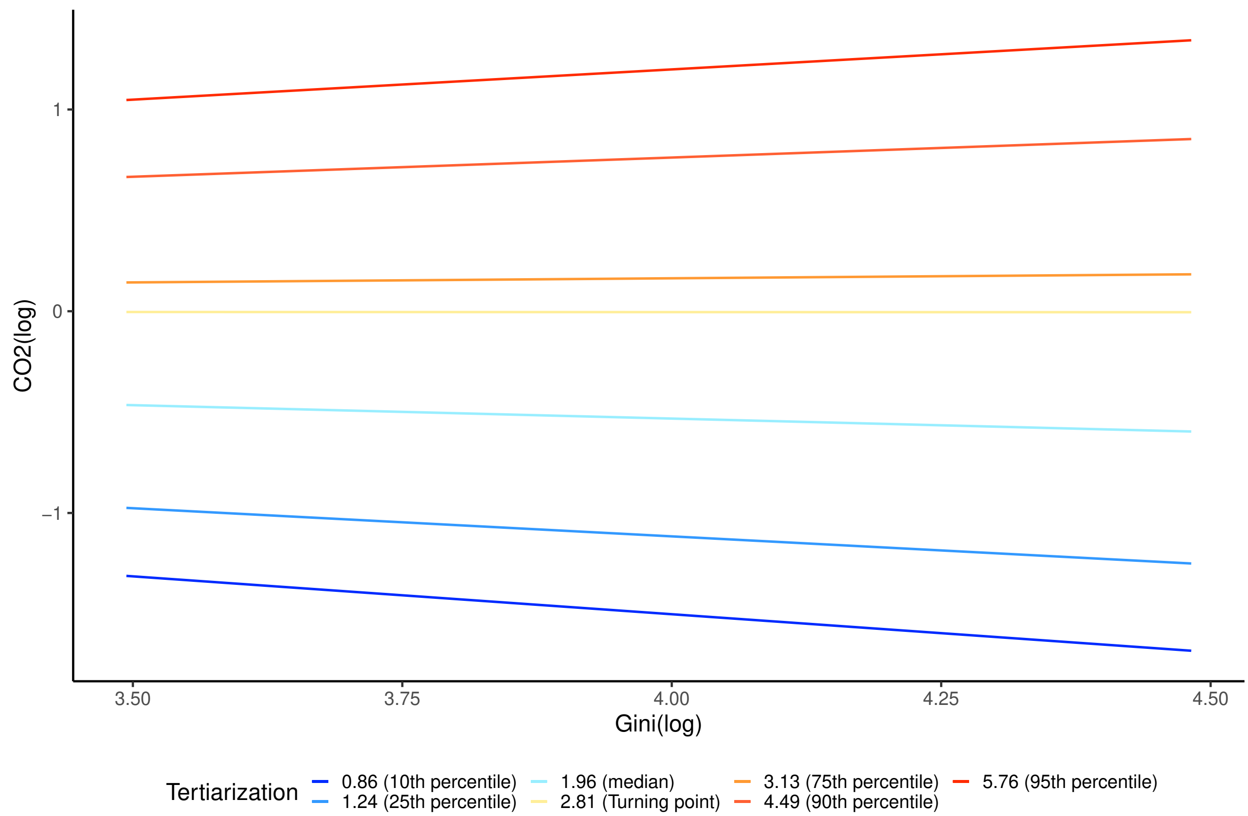

Figure 3: Association between income inequality and CO_2 emissions for different tertiarization levels: an increase in the Gini coefficient is associated with an increase in emissions above a certain level of tertiarization (equal to 2.81 in the first specification).

as reference level the simple mean, i.e. 2.99. Figure 4 (Panel A) illustrates the countries that are characterized by a level of tertiarization above the threshold. More specifically, the colour gradient indicates the percentage of years in which the ratio between value-added by service and the sum of value-added by manufacturing and agriculture (i.e., our preferred measure of tertiarization) is beyond 2.99. Considering all countries in which the ratio is above 2.99 for at least one year, implies that we are dealing with 82 countries, of which 48 are classified by the World Bank as high-income countries, 25 as upper-middle income countries and 9 as lower-middle income countries.[7] Panel B in Figure 4 instead shows that the number of countries in which tertiarization is above 2.99 has greatly increased in the last 40 years.

As mentioned previously, our results are robust across all three specifications, in which we progressively add control variables, as well as to varying the proxy of inequality. As anticipated,

[7]As more extensively explained in the final part of this section, in Table 5 we check that results are coherent when excluding low- and middle-income countries that have a large indicator of tertiarization, and when only considering OECD countries, in order to test that our main results are not driven by some outlier country characterized by, e.g., a large financial sector. Results are indeed in line with what we find in our main specifications.

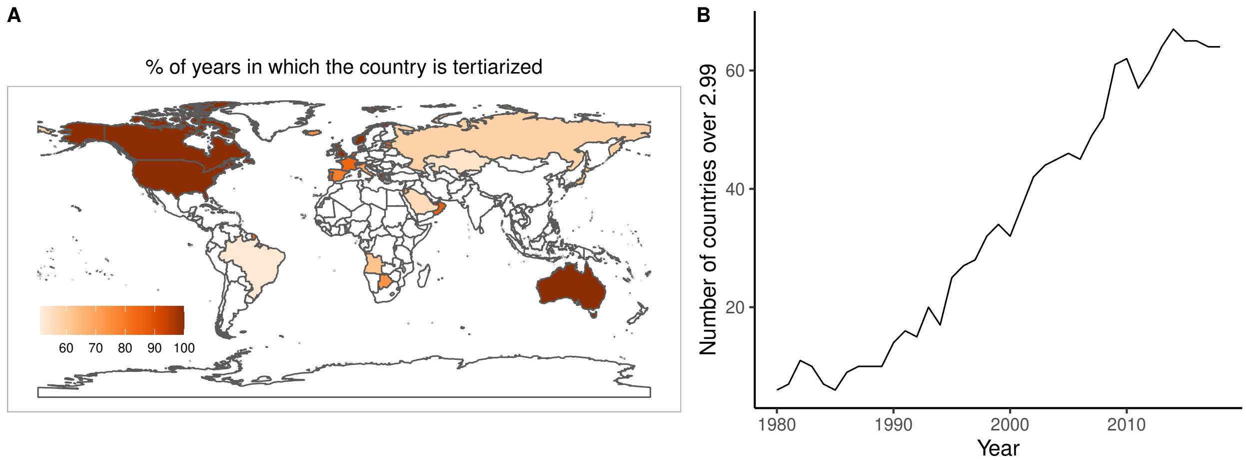

Figure 4: Panel **A**. Percentage of years in which the ratio between value-added by service and the sum of value-added by manufacturing and agriculture (tertiarization) is above the turning point level (2.99). Panel **B**. Number of countries in which tertiarization is above the turning point level (2.99) from 1980 to 2018.

the different inequality indicators capture different aspects of such a complex nexus: findings concerning the concentration of income in the top of the distribution may capture the political and Veblen effect (Jorgenson et al., 2017), while the Gini is more sensitive to transfers at the center of the distribution than at the tails (Alvaredo, 2011), and it is more related to the marginal propensity to emit approach (Hailemariam et al., 2020).

To further assess the robustness of the results, we experiment with different variants of our econometric model starting from the third specification (Table 4). Table 5 synthetically lays out the main results of our robustness analysis. Findings are consistent when controlling for the share of value-added by manufacturing instead of the share of value-added of services, controlling for both, as well as controlling for neither. Results are also robust to the exclusion of GDP among the controls, further confirming that what is driving our results really is our indicator of the stage of development of a country, i.e. tertiarization. By subsetting the time span, i.e. keeping only observations between 1990 and 2018, results have the same sign even though some specifications are less significant, not surprisingly as we loose sample size. Furthermore, changes in the sample of countries analyzed confirm the results. More specifically, excluding countries with a ratio greater than 2.99 in at least 20% of the years and which are not classified by the World Bank as high-income countries does not alter the picture. Moreover, even considering only OECD countries, the results are similar. The latter two robustness exercises highlight that the results are driven by the more developed countries, and not by some outlier economy with, e.g., a large financial sector. However, the categories of High-income and Tertiarized countries are not equivalent, and the degree of tertiarization matters also when controlling for GDP levels, thus confirming the importance of the structure of the economy in mediating the association between inequality and emissions. The final lines in Table 4 also confirm that our results are consistent when controlling for an indicator of policy, the Environmental Policy Stringency Index (Botta and Koźluk, 2014), which is available only for OECD countries. The latter exercise suggests that the association between inequality and emissions that we uncover is not driven by policies that could contemporaneously affect both the explanatory and dependent variables.

Additionally, we experiment with alternative indicators of tertiarization. Indeed, we substitute our baseline indicator of tertiarization with the following indices: (i) a modification of our baseline index in which we consider industry as a whole instead of manufacturing;[8] (ii) an indicator in which we include also service value-added in the denominator; (iii) an indicator which is defined as the value-added of services over the sum of value-added generated by the agricultural, industry (instead of manufacturing) and service sectors. Our main findings hold (see Table A.10). Table A.11 instead shows results considering alternative measures of CO_2 emissions as our dependent variable. More specifically, employing the EORA dataset (Lenzen et al., 2013), we find robust results, although with slightly lower statistical power. In particular, findings are consistent when estimating our model on consumption-based emissions, thus fully accounting for trade.

[8]Industry includes mining and quarrying, construction, and public utilities, in addition to manufacturing (see also Section 2.1).

Table 2: Association between income inequalities and CO_2 emissions, 1980-2018, first specification (baseline controls). Robust standard errors in parentheses. The turning point is calculated using Eq. 3.

	Dependent variable: CO_2 emissions (ln)				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality (ln)	-0.702^{***}	-0.149^{**}	-0.144^{***}	-0.774^{***}	-0.473^{***}
	(0.228)	(0.066)	(0.055)	(0.263)	(0.182)
Tertiarization (ln)	-2.162^{***}	-0.274^{*}	-0.522^{**}	-2.263^{***}	-1.188^{**}
	(0.722)	(0.147)	(0.212)	(0.793)	(0.527)
Inequality*Tertiarization	0.524^{***}	0.131^{**}	0.139^{**}	0.541^{***}	0.302^{**}
	(0.173)	(0.061)	(0.054)	(0.187)	(0.131)
GDP per capita (ln)	0.422^{***}	0.424^{***}	0.425^{***}	0.422^{***}	0.423^{***}
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Population (ln)	0.056	0.081	0.077	0.057	0.065
	(0.076)	(0.079)	(0.079)	(0.077)	(0.078)
Services, value-added (ln)	−0.017	−0.022	−0.021	−0.017	−0.016
	(0.072)	(0.072)	(0.071)	(0.073)	(0.073)
Urban population(ln)	0.186^{**}	0.187^{**}	0.182^{**}	0.186^{**}	0.189^{**}
	(0.088)	(0.091)	(0.091)	(0.088)	(0.089)
Turning point	2.81	2.12	1.82	3.18	3.8
Countries	160	160	160	160	160
% of obs. > turning point	44	59	66	36	29
Observations	4,824	4,824	4,824	4,824	4,824
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.265	0.257	0.261	0.264	0.260
Adjusted R^2	0.233	0.224	0.228	0.232	0.228
F Statistic (df = 7; 4619)	237.944^{***}	227.973^{***}	232.841^{***}	236.721^{***}	232.356^{***}

Note: *p<0.1; **p<0.05; ***p<0.01

% of obs. > turning point denotes the share of observations above the turning point in the year 2018.

Table 3: Association between income inequalities and CO_2 emissions, 1980-2018, second specification, i.e. controlling for education (% in primary enrollment) and ageing (% of population aging 65 and above). Robust standard errors in parentheses. The turning point is calculated using Eq. 3.

	Dependent variable: CO_2 emissions (ln)				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality (ln)	-0.722^{***}	-0.159^{**}	-0.141^{***}	-0.811^{***}	-0.501^{***}
	(0.207)	(0.062)	(0.053)	(0.236)	(0.164)
Tertiarization (ln)	-2.234^{***}	-0.368^{**}	-0.549^{**}	-2.434^{***}	-1.421^{***}
	(0.699)	(0.152)	(0.216)	(0.758)	(0.476)
Inequality*Tertiarization	0.520^{***}	0.131^{**}	0.120^{**}	0.561^{***}	0.339^{***}
	(0.168)	(0.059)	(0.052)	(0.180)	(0.120)
GDP per capita (ln)	0.425^{***}	0.428^{***}	0.431^{***}	0.425^{***}	0.426^{***}
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Population (ln)	0.295^{***}	0.325^{***}	0.321^{***}	0.296^{***}	0.305^{***}
	(0.101)	(0.106)	(0.106)	(0.101)	(0.102)
Services, value-added (ln)	0.035	0.029	0.032	0.034	0.032
	(0.087)	(0.086)	(0.086)	(0.087)	(0.088)
Urban population(ln)	0.161^{**}	0.161^{*}	0.159^{*}	0.160^{**}	0.161^{**}
	(0.080)	(0.083)	(0.083)	(0.080)	(0.081)
Primary enrollment (ln)	−0.089	−0.089	−0.088	−0.088	−0.088
	(0.055)	(0.054)	(0.054)	(0.055)	(0.055)
Population ages 65 and above (ln)	0.335^{***}	0.344^{***}	0.334^{***}	0.338^{***}	0.341^{***}
	(0.101)	(0.103)	(0.103)	(0.101)	(0.101)
Turning point	3.01	2.37	2.23	3.24	3.38
Countries	155	155	155	155	155
% of obs. > turning point	39	52	57	36	34
Observations	4,117	4,117	4,117	4,117	4,117
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.322	0.313	0.314	0.321	0.318
Adjusted R^2	0.287	0.278	0.279	0.287	0.283
F Statistic (df = 9; 3915)	206.279^{***}	198.272^{***}	199.358^{***}	205.996^{***}	202.745^{***}

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 4: Association between income inequalities and CO_2 emissions, 1980-2018, third specification i.e. we control for measures of consumption (Final households consumption per capita) and trade (Trade and FDI inflows). Robust standard errors in parentheses. The turning point is calculated using Eq. 3.

	Dependent variable: CO_2 emissions (ln)				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality (ln)	−0.917***	−0.215***	−0.176***	−1.035***	−0.656***
	(0.232)	(0.073)	(0.060)	(0.265)	(0.187)
Tertiarization (ln)	−2.629***	−0.456***	−0.616***	−2.895***	−1.794***
	(0.742)	(0.157)	(0.221)	(0.818)	(0.523)
Inequality*Tertiarization	0.605***	0.157**	0.128**	0.661***	0.424***
	(0.180)	(0.069)	(0.056)	(0.196)	(0.133)
GDP per capita (ln)	0.415***	0.417***	0.420***	0.415***	0.415***
	(0.064)	(0.063)	(0.063)	(0.064)	(0.064)
Population (ln)	0.338***	0.387***	0.390***	0.338***	0.349***
	(0.100)	(0.103)	(0.101)	(0.100)	(0.102)
Services, value-added (ln)	0.102	0.088	0.091	0.100	0.094
	(0.079)	(0.079)	(0.078)	(0.080)	(0.080)
Urban population(ln)	0.114	0.109	0.108	0.113	0.113
	(0.080)	(0.084)	(0.084)	(0.080)	(0.080)
Primary enrollment (ln)	−0.082	−0.089	−0.092	−0.081	−0.080
	(0.060)	(0.061)	(0.061)	(0.060)	(0.060)
Population ages 65 and above (ln)	0.370***	0.381***	0.371***	0.373***	0.377***
	(0.108)	(0.110)	(0.111)	(0.108)	(0.109)
Final households consumption per capita (ln)	−0.019	−0.014	−0.014	−0.018	−0.016
	(0.056)	(0.057)	(0.058)	(0.056)	(0.056)
Trade (ln)	−0.014	−0.016	−0.017	−0.014	−0.014
	(0.038)	(0.037)	(0.037)	(0.038)	(0.038)
FDI inflows (ln)	0.043*	0.037	0.036	0.043*	0.043*
	(0.024)	(0.024)	(0.023)	(0.024)	(0.024)
Turning point	3.55	2.93	2.94	3.78	3.71
Countries	148	148	148	148	148
% of obs. > turning point	31	42	42	30	30
Observations	3,767	3,767	3,767	3,767	3,767
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.340	0.328	0.327	0.340	0.336
Adjusted R^2	0.303	0.291	0.290	0.303	0.299
F Statistic (df = 12; 3569)	152.981***	145.038***	144.630***	153.058***	150.516***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 5: Association between income inequalities and CO_2 emissions, robustness checks. All control variables (third specification, Table 4) are included, although coefficients are not shown. Robust standard errors in parentheses. Country fixed effects and year dummies are included. The turning point is calculated using Eq. 3.

	Dependent variable: CO_2 emissions (ln)				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Baseline (Table 4)					
Inequality (ln)	-0.917^{***}	-0.215^{***}	-0.176^{***}	-1.035^{***}	-0.656^{***}
	(0.232)	(0.073)	(0.060)	(0.265)	(0.187)
Inequality*Tertiarization	0.605^{***}	0.157^{**}	0.128^{**}	0.661^{***}	0.424^{***}
	(0.180)	(0.069)	(0.056)	(0.196)	(0.133)
Turning point	3.55	2.93	2.94	3.78	3.71
Controlling for the share of value-added by manufacturing					
Inequality (ln)	-0.888^{***}	-0.211^{***}	-0.172^{***}	-1.003^{***}	-0.633^{***}
	(0.229)	(0.071)	(0.058)	(0.262)	(0.184)
Inequality*Tertiarization	0.582^{***}	0.152^{**}	0.123^{**}	0.636^{***}	0.406^{***}
	(0.174)	(0.066)	(0.054)	(0.190)	(0.130)
Turning point	3.6	3	3.05	3.84	3.75
Controlling for neither the share of value-added by manufacturing and by service					
Inequality (ln)	-0.879^{***}	-0.205^{***}	-0.167^{***}	-0.995^{***}	-0.633^{***}
	(0.232)	(0.073)	(0.060)	(0.266)	(0.186)
Inequality*Tertiarization	0.589^{***}	0.153^{**}	0.125^{**}	0.645^{***}	0.413^{***}
	(0.176)	(0.068)	(0.055)	(0.192)	(0.131)
Turning point	3.45	2.83	2.82	3.67	3.63
Controlling for both the share of value-added by manufacturing and by service					
Inequality (ln)	-0.898^{***}	-0.212^{***}	-0.174^{***}	-1.013^{***}	-0.638^{***}
	(0.225)	(0.070)	(0.057)	(0.258)	(0.182)
Inequality*Tertiarization	0.587^{***}	0.153^{**}	0.124^{**}	0.641^{***}	0.409^{***}
	(0.177)	(0.067)	(0.054)	(0.192)	(0.131)
Turning point	3.62	3.01	3.06	3.85	3.76
Not controlling for GDP					
Inequality (ln)	-0.982^{***}	-0.228^{**}	-0.172^{**}	-1.107^{***}	-0.714^{***}
	(0.307)	(0.091)	(0.073)	(0.351)	(0.243)
Inequality*Tertiarization	0.741^{***}	0.192^{**}	0.140^{**}	0.827^{***}	0.544^{***}
	(0.215)	(0.076)	(0.060)	(0.238)	(0.162)
Turning point	2.76	2.29	2.41	2.82	2.71
Time span: 1990-2018					
Inequality (ln)	-0.902^{***}	-0.196^{*}	-0.164^{*}	-1.019^{***}	-0.648^{***}
	(0.296)	(0.110)	(0.088)	(0.336)	(0.234)
Inequality*Tertiarization	0.660^{***}	0.152	0.122	0.733^{***}	0.481^{***}
	(0.232)	(0.097)	(0.077)	(0.255)	(0.178)
Turning point	2.92	2.64	2.82	3.01	2.85
Excluding not High-Income countries above 2.99					
Inequality (ln)	-0.930^{***}	-0.213^{**}	-0.169^{**}	-1.059^{***}	-0.666^{***}
	(0.260)	(0.091)	(0.071)	(0.297)	(0.206)
Inequality*Tertiarization	0.554^{***}	0.139	0.102	0.624^{***}	0.400^{**}
	(0.208)	(0.097)	(0.073)	(0.233)	(0.157)
Turning point	4.36	3.64	4.21	4.45	4.28
Only OECD countries					
Inequality (ln)	-1.184^{***}	-0.450^{***}	-0.417^{***}	-1.258^{***}	-0.669^{***}
	(0.275)	(0.103)	(0.094)	(0.304)	(0.228)
Inequality*Tertiarization	0.700^{***}	0.274^{***}	0.244^{***}	0.731^{***}	0.425^{***}
	(0.202)	(0.077)	(0.063)	(0.224)	(0.163)
Turning point	4.43	4.15	4.5	4.6	3.83
Only OECD countries controlling for Environmental Policy Stringency Index					
Inequality (ln)	-1.154^{***}	-0.468^{***}	-0.417^{***}	-1.261^{***}	-0.759^{***}
	(0.432)	(0.168)	(0.145)	(0.459)	(0.278)
Inequality*Tertiarization	0.721^{**}	0.302^{***}	0.257^{***}	0.789^{**}	0.499^{**}
	(0.299)	(0.115)	(0.094)	(0.318)	(0.212)
Turning point	3.96	3.72	4.07	3.94	3.57

Note: *p<0.1; **p<0.05; ***p<0.01

4 Discussion

In this section we explore possible mechanisms that may explain the non-linear emission-inequality relationship that we uncover in this work.

To start with, we focus on permanently tertiarized countries, which we define as countries whose ratio of tertiarization is above 2.99 in at least 70% of the years for which data are available.[9] The group consists of 33 countries, 26 of which are classified as high-income countries according to the World Bank taxonomy, 6 as upper-middle and 1 as lower-middle. From 1980 to 2018, these countries account for an average of 40% of the world's GDP, despite representing only 8% of the world's population. Robustness exercises in which we consider a different threshold for inclusion in the group of tertiarized countries (i.e., at least 50% of the years), are provided in Appendix A.[10]

Our findings, particularly the non-linearity of the relationship between inequality and emissions depending on the level of tertiarization, can be explained through two main channels. The first channel concerns employment in the industry (macro) sector, while the second relates to emissions by the richest individuals, with a significant contribution from emissions associated with investment activities. The first channel seems to drive the negative association between income inequality and CO_2 emissions per capita in countries where the weight of the service sector is relatively limited with respect to the manufacturing and agricultural sectors. These countries, while accounting for 92% of the world's population, represent only 60% of global GDP. Instead, the second channel can explain the positive impact of inequality on emissions in relatively more tertiarized countries, where a large share of global GDP (with respect to the associated population), and historical cumulative emissions, is concentrated. In this section we provide qualitative evidence for these two mechanisms.

Let us first consider the structure of the economy, in particular the relative importance of industry. Figure 5 suggests that, in less tertiarized countries, an increase in equality is bound to an increase in industrial and energy production, which leads to a surge in CO_2 emissions (e.g., energy use in industry is responsible for 24.2% of global emissions in 2016, Ritchie, 2020). This is even more the case in countries wherein the low carbon transition is still far away from unfolding. Further, an increase in equality corresponds to an increase in employment in industry. Hence, in

[9]The choice to focus on permanently tertiarized countries also helps ensure that our analysis is not driven by outliers.

[10]With a 50% threshold the group of tertiarized countries is composed of 48 countries, of which 34 are classified as high-income countries, 11 as upper-middle and 3 as lower-middle, and from 1980 to 2018 they account on average for 61% of the world's GDP and 17% of the world's population.

addition to mechanically increasing emissions, more equality is linked to greater involvement of the poorest in the industrial economy, i.e. an expansion in occupation in the secondary sector. If the equality increase is due to an improvement of the living conditions of low-income households, this could also lead to an increase in demand for goods and energy consumption, reinforcing the rise in emissions. Indeed, improved living conditions of lower income households will increase their consumption of basic energy-intensive products, such as, among others, housing, home appliances, private vehicles. This mechanism points to the literature studying the equity-pollution dilemma, i.e. the rise of aggregate pollution due to income (Scruggs, 1998; Bulte et al., 2001; Sager, 2019).[11] Instead, in more tertiarized countries employment in the industrial sector tends to remain approximately constant, meaning that an increase in equality is discharged only minimally on industrial production, making this channel essentially irrelevant in explaining the positive association between income inequalities and CO_2 emissions.

We find evidence supporting such a mechanism estimating a fixed effect linear model, using all control variables of the previous regression (third specification) and interacting the inequality index with a dummy variable (Tertiarized) which is equal to one if Tertiarization is higher than 2.99 in at least 70% of the disposable years in the country to which each observation refers and zero otherwise. The results are shown in Table 6, which indicates that, as expected, an increase in inequality (measured with all the 5 different indices) exhibits a significant negative association with industry employment in less tertiarized countries, while the effect is only slightly positive and poorly significant in the more tertiarized ones.

This relation is confirmed by robustness checks. In Figure A.1 (in Appendix) we show that the mechanism seems valid and coherent also when choosing alternative criteria for dividing countries between those at lower stages of development and more tertiarized ones, i.e. considering as tertiarized those where the tertiarization index is above 2.99 in at least 50% and 70% of the disposable years. Further, in Table A.3 (in Appendix) we consider as tertiarized countries whose ratio is above 2.99 in at least 50% of the years. Regression results are quite similar and confirm the robust negative association between inequality and employment shares in industry below the turning point of tertiarization, as well as the close-to-zero association in the case of tertiarized countries.

[11] Indeed, estimating a panel fixed effects model on consumption carbon footprint of bottom 50% seems to qualitatively suggest that in less tertiarized countries higher inequality is associated with lower emissions of the bottom 50% of individuals (see Table A.9). However, also note that recent studies have showed that poverty alleviation would overall have a negligible impact on global emissions (Bruckner et al., 2022; Wollburg et al., 2023).

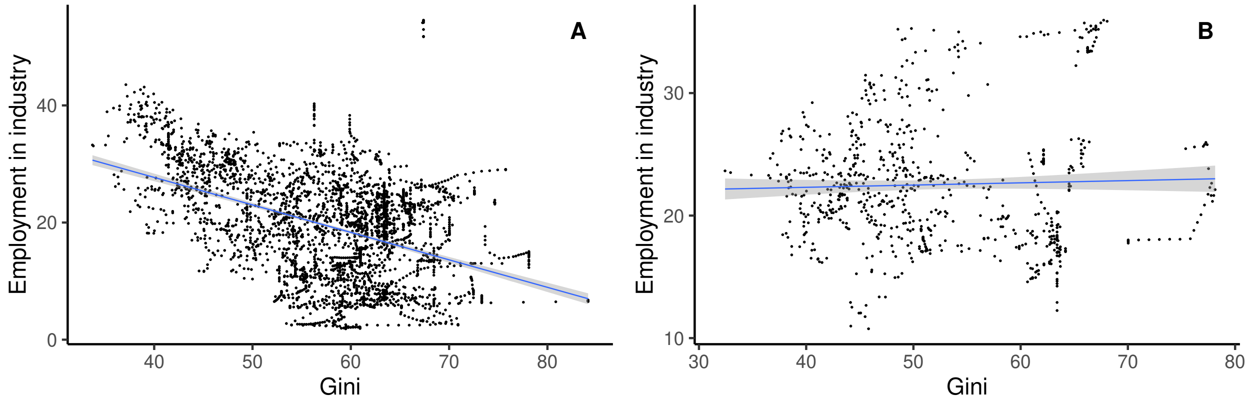

Figure 5: Scatterplots representing the association between the Gini index and employment shares in industry for countries below (A) and above (B) the turning point of tertiarization (2.99) in at least 70% of the disposable years.

In more tertiarized countries, the industrial channel seems unable to explain the positive relationship between income inequality and CO_2 emissions, since, as previously mentioned, employment in industry is about constant for different levels of inequality. Furthermore, being the average income much higher (7255$ in less developed countries versus 32086$ in tertiarized ones), even the standards of living is on average higher, implying that marginal propensity to consume (and emit) is lower. We therefore look for other factors in order to explain the relation between inequality and emissions in more tertiarized economies. Given recent evidence on the distribution of emissions (Weber and Matthews, 2008; Gore, 2020; Chancel, 2022), we investigate whether our results might be linked to the carbon footprint of top income earners.

Figure 6 and Table 6 indeed show that the increase in inequalities is linked to an increase in the emissions of the rich (in our case the Top 10%), whose lifestyle is quite carbon-intensive (Gore, 2020). More specifically, Figure 6 shows that, in Tertiarized countries, an increase in inequality is associated with an increase in personal carbon footprint of the richest 10% of the population. This is instead not the case in less tertiarized countries. Again, these results are confirmed in Figure A.2 by categorizing countries as Tertiarized or not according to different criteria. The corresponding regression exercises, shown in Table 7, overall confirm the intuition. A positive relation between income inequality and carbon footprint of Top 10% is found in both groups of countries, but it is much stronger in the tertiarized ones. The results are significant for three of the five income inequalities indices and are further confirmed by robustness checks in Table A.4.[12]

[12]A due acknowledgment is that the data employed on quantile carbon footprints are constructed based on a consumption-based approach (Chancel, 2022), while our main analysis uses as dependent variable production-based emissions. However, as showed in Table A.11, our results are consistent when we employ a consumption-based measure

Why do the rich emit more especially in highly tertiarized countries? In order to shed further light on the latter question and on the mechanism of top emissions we analyze top carbon footprint disaggregated in the categories of investment and consumption, by using data from WID (Chancel, 2022). Focusing on investment carbon footprint of richest individuals, reveals a larger association between inequality and top 10% emissions in tertiarized countries (see Table 8). By zooming into the very top and by estimating the association between income inequality and top 1% investment carbon footprint shows an even clearer pattern: in tertiarized countries higher inequality is associated with a surge of emissions by the top 1% attributable to investment (Table 8).[13] Note that coefficients for the interaction term between inequality and tertiarization (Inequality*Tertiarized) are three times larger than the ones related to non-tertiarized countries (Inequality). Moreover, the interaction coefficient is also much larger than the ones obtained when we instead employ as our dependent variable consumption carbon footprint of the top 10% or top 1% (see Figure 7, Table A.7 and A.8). Therefore, also the relation between inequality and top emissions related to consumption below and above the turning point of tertiarization is in line with our main results, as inequality is positively and more strongly associated with consumption emissions both for the top 10% and top 1% in more tertiarized countries (Table A.7 and A.8). However, the large coefficients for the relation between inequality and top investment emissions in tertiarized countries lead us to conclude that investments have a pivotal role. This is broadly in line with recent evidence estimating the carbon content of capital for a set of high-income countries. Such studies show that equity is one of the wealth categories with the highest carbon footprint, and it is highly concentrated among the richest (e.g., Rehm and Chancel, 2023).

The top emission channel also aligns with broader considerations from the literature. In particular, the middle class could be subject to a sort of Veblen effect (Berthe and Elie, 2015; Boyce, 1994; Bowles and Park, 2005), since the differences in social status between rich and poor would be particularly evident, intensifying the competition for the possession of more exclusive or expensive goods and increasing social pressure to consume. Moreover, this channel might relate to the literature exploring the link between inequality and demand for environmental policies. In a context of high income and high inequality, the majority of the population could be averse to accepting environmental policies, which could have a sharp regressive effect. The wealthy

of CO_2 emissions.

[13] The latter results are particularly evident when considering the Gini coefficient and top income shares. Instead, the Palma ratio and the 20:20 ratio capture the signal in a more blurred way, and this is likely due to the fact that the two indicators include also bottom income shares in their calculation (see Table A.5 and A.6).

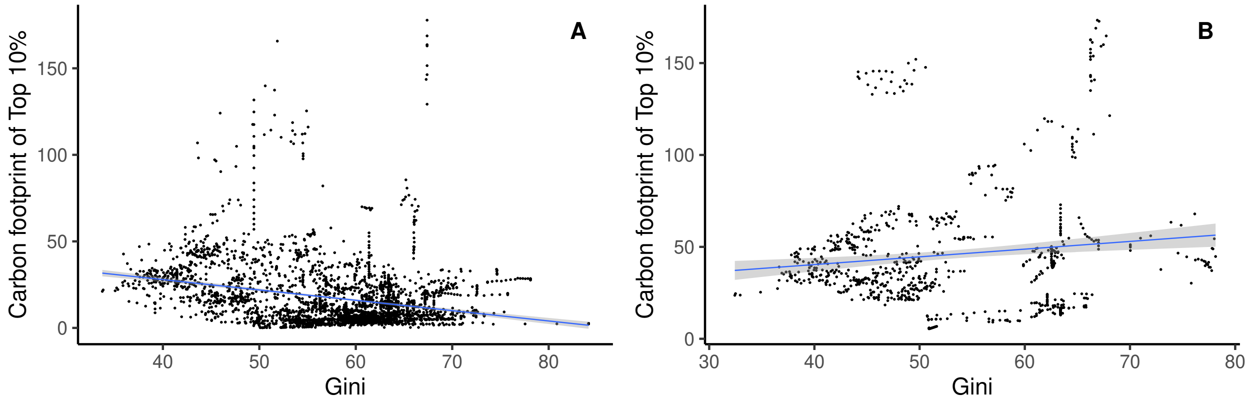

Figure 6: Scatterplots representing the association between the Gini index and the carbon footprint of the top 10% of the population for countries below (A) and above (B) the turning point of tertiarization (2.99) in at least 70% of the disposable years.

classes also have economic interests in avoiding environmental policies and regulations. Indeed, as they own capital and lead a more polluting lifestyle, they are the ones who profit most from the exploitation of the environment (Boyce, 1994), in addition to suffering the lowest damages (Roca, 2003; Palagi et al., 2022). For all the above mentioned reasons, the literature suggests that in a more unequal society the demand for environmental policies is relatively lower, and this may be decisive for emissions in tertiarized countries. On the contrary, in those economies where industry still plays a predominant role in total value-added (and the transition is relatively backward), emissions are associated to industry expansions.

Table 6: Association between income inequalities and employment shares in industry, 1991-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Employment in industry				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	−0.158**	−0.377***	−0.046***	−0.167**	−0.134*
	(0.074)	(0.142)	(0.017)	(0.081)	(0.075)
Inequality*Tertiarized	0.223*	0.665**	0.060	0.240*	0.223*
	(0.126)	(0.275)	(0.059)	(0.128)	(0.135)
GDP per capita (ln)	7.077***	7.034***	7.083***	7.103***	7.161***
	(1.169)	(1.140)	(1.148)	(1.166)	(1.165)
Population (ln)	7.667***	7.890***	7.912***	7.694***	7.815***
	(2.638)	(2.555)	(2.564)	(2.640)	(2.633)
Services, value-added (ln)	0.364	0.344	0.392	0.355	0.292
	(1.283)	(1.314)	(1.324)	(1.288)	(1.302)
Urban population (ln)	10.418***	10.507***	10.359***	10.396***	10.428***
	(3.344)	(3.363)	(3.432)	(3.330)	(3.336)
Primary enrollment (ln)	0.865	0.572	0.739	0.879	0.868
	(1.499)	(1.472)	(1.518)	(1.496)	(1.493)
Population ages 65 and above (ln)	−4.050	−4.543*	−4.830*	−4.000	−3.997
	(2.608)	(2.655)	(2.703)	(2.611)	(2.627)
Final households consumption (ln)	0.299	0.233	0.128	0.305	0.337
	(1.124)	(1.129)	(1.137)	(1.125)	(1.127)
Trade (ln)	0.696	0.654	0.582	0.703	0.697
	(0.639)	(0.630)	(0.616)	(0.641)	(0.644)
FDI inflows (ln)	−0.475	−0.460	−0.443	−0.474	−0.471
	(0.313)	(0.305)	(0.301)	(0.315)	(0.324)
Observations	3,081	3,081	3,081	3,081	3,081
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.362	0.366	0.360	0.362	0.360
Adjusted R^2	0.322	0.325	0.319	0.322	0.319
F Statistic (df = 11; 2896)	149.609***	151.787***	148.180***	149.486***	147.960***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 7: Association between income inequalities and carbon footprint of top 10%, 1990-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Carbon footprint of top 10%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.154**	0.171	0.009	0.169**	0.154**
	(0.076)	(0.124)	(0.019)	(0.082)	(0.076)
Inequality*Tertiarized	1.012***	1.162	0.206	1.049***	0.925***
	(0.311)	(1.245)	(0.182)	(0.318)	(0.304)
GDP per capita (ln)	15.787***	15.821***	15.804***	15.766***	15.802***
	(4.082)	(4.122)	(4.140)	(4.081)	(4.099)
Population (ln)	3.020	1.862	1.721	3.053	3.104
	(3.307)	(3.557)	(3.579)	(3.297)	(3.320)
Services, value-added (ln)	1.872	1.672	1.673	1.886	1.991
	(1.911)	(1.982)	(2.018)	(1.904)	(1.927)
Urban population (ln)	−0.685	−0.648	−0.702	−0.568	−0.397
	(3.041)	(3.146)	(3.130)	(3.017)	(3.021)
Primary enrollment (ln)	2.759	2.690	2.536	2.759	2.732
	(1.860)	(1.882)	(1.858)	(1.857)	(1.863)
Population ages 65 and above (ln)	−0.199	−0.599	−0.523	−0.264	−0.333
	(3.978)	(4.178)	(4.221)	(3.985)	(3.978)
Final households consumption (ln)	10.709*	10.833*	10.806*	10.647*	10.677*
	(6.291)	(6.329)	(6.296)	(6.280)	(6.285)
Trade (ln)	0.087	0.045	0.052	0.087	0.096
	(1.298)	(1.323)	(1.322)	(1.300)	(1.324)
FDI inflows (ln)	0.319	0.450	0.456	0.348	0.470
	(0.686)	(0.866)	(0.878)	(0.677)	(0.681)
Observations	3,145	3,145	3,145	3,145	3,145
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.217	0.194	0.194	0.218	0.216
Adjusted R^2	0.169	0.144	0.144	0.170	0.168
F Statistic (df = 11; 2961)	74.661***	64.847***	64.645***	75.189***	74.169***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8: Association between income inequalities and carbon footprint from investment of top 10% and of top 1%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable:					
	Investment carbon footprint of top 10%			Investment carbon footprint of top 1%		
	Gini	Top 20%	Top 10%	Gini	Top 20%	Top 10%
Inequality	0.065***	0.072**	0.076**	0.642***	0.684***	0.705***
	(0.028)	(0.030)	(0.033)	(0.132)	(0.143)	(0.155)
Inequality*Tertiarized	0.370**	0.389**	0.337*	3.230***	3.301***	3.209***
	(0.169)	(0.176)	(0.184)	(1.066)	(1.128)	(1.201)
GDP per capita (ln)	4.730***	4.711***	4.729***	20.265***	20.087***	20.219***
	(0.984)	(0.985)	(0.979)	(4.480)	(4.510)	(4.445)
Population (ln)	1.180	1.171	1.211	4.440	4.318	4.632
	(1.792)	(1.783)	(1.785)	(8.228)	(8.206)	(8.124)
Services, value-added (ln)	0.069	0.086	0.097	−0.613	−0.426	−0.278
	(0.973)	(0.971)	(0.976)	(4.576)	(4.556)	(4.516)
Urban population(ln)	1.828	1.896	1.974	5.261	5.795	6.601
	(1.833)	(1.820)	(1.818)	(9.163)	(9.027)	(9.001)
Primary enrollment (ln)	−0.231	−0.234	−0.216	−1.378	−1.400	−1.357
	(0.696)	(0.700)	(0.708)	(3.388)	(3.401)	(3.482)
Population ages 65 and above (ln)	−1.525	−1.567	−1.619	−0.718	−1.035	−1.524
	(1.990)	(1.993)	(2.010)	(7.695)	(7.699)	(7.792)
Final households consumption (ln)	4.600***	4.560***	4.593***	22.886***	22.495***	22.825***
	(1.332)	(1.334)	(1.343)	(6.424)	(6.440)	(6.522)
Trade (ln)	−0.299	−0.302	−0.315	−0.172	−0.185	−0.245
	(0.397)	(0.399)	(0.407)	(1.878)	(1.886)	(1.899)
FDI inflows (ln)	−0.313	−0.320	−0.277	−4.815	−4.706	−4.338
	(0.545)	(0.534)	(0.539)	(4.185)	(4.117)	(4.002)
Observations	2,736	2,736	2,736	2,736	2,736	2,736
Country fixed effects	✓	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓	✓
R^2	0.103	0.104	0.104	0.143	0.143	0.154
Adjusted R^2	0.041	0.042	0.042	0.083	0.084	0.095
F Statistic (df = 11; 2558)	26.614***	27.074***	26.963***	38.659***	38.957***	42.293***
Note:				*p<0.1; **p<0.05; ***p<0.01		

Figure 7: Elasticities of consumption and investment footprints produced by the top 1% individuals in the national income distributions, in countries below (Not tertiarized) and above (Tertiarized) the threshold of tertiarization; 95% level of significance confidence bands. Coefficients and standard errors for building the chart are retrieved from Table 8.

5 Conclusions

In this work we uncover heterogeneous associations between income inequality and per capita CO_2 emissions on a sample exhibiting much lager geographical and temporal coverage than previous studies. We employ five different inequality indicators and find consistent results. A key novelty with respect to related works is that our results point to the stage of development of the economy, defined as the relative weight of services with respect to other sectors, as a key gradient through which the inequality-emission nexus varies. Hence, the composition of the economy appears as a fundamental factor to be taken into account in order to understand the relationships at study. Indeed, we find a robust positive association between income inequality and per capita carbon emissions in countries where tertiarization is high. On the contrary, in less service intensive economies the effect is negative. Furthermore, we find evidence of the following mechanisms plausibly underlying our results. First, in countries at a higher stage of development the positive association between inequality and emissions is driven by larger carbon footprint of the top 10% within economies. More specifically, the carbon footprint associated to investments of the richest 1%

represents a key mechanism determining the non-linear relation between inequality and emissions. Second, in countries at lower stages of development more equality is associated with a larger share of employment in the industry sector, which is energy-intensive and, thus, producing high emissions.

A large fraction of the world's GDP (particularly if considered in relation to the associated population), and the bulk of cumulative emissions, is concentrated in countries above our threshold of tertiarization, where the inequality-emission nexus is positive. Moreover, as in the latter group of countries inequality trends are on the rise in the last years (see, e.g., Piketty et al., 2018; Guzzardi et al., 2024), our results point to further threats for the achievement of the Paris agreements goals of emission reduction. Hence, we confirm the need for mitigation strategies particularly addressing the most industrialized economies and the richest individuals therein. Such policies should take distributive concerns into account, given that our results seem to be partly driven by the carbon footprint of the Top 10% and Top 1%.

Future work might go in the following directions: (i) while our analysis uncovers associations, possible causal links could be better explored; (ii) building a unified empirical framework that takes into account both climate impacts and emissions could highlight possible vicious cycles in the relation between climate change and income distribution, with the structural composition of economies playing a pivotal role.

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Appendix A Supplementary tables and figures

Table A.1: List of the 160 countries in our dataset

Afghanistan	Czech Republic	Kyrgyz Republic	Romania
Albania	Denmark	Lao PDR	Russian Federation
Algeria	Dominican Republic	Latvia	Rwanda
Angola	Ecuador	Lebanon	Sao Tome and Principe
Argentina	Egypt, Arab Rep.	Lesotho	Saudi Arabia
Armenia	El Salvador	Liberia	Senegal
Australia	Equatorial Guinea	Lithuania	Serbia
Austria	Estonia	Luxembourg	Seychelles
Azerbaijan	Eswatini	Malawi	Sierra Leone
Bahamas, The	Ethiopia	Malaysia	Singapore
Bahrain	Finland	Maldives	Slovak Republic
Bangladesh	France	Mali	Slovenia
Belarus	Gabon	Malta	South Africa
Belgium	Gambia	Mauritania	Spain
Belize	Georgia	Mauritius	Sri Lanka
Benin	Germany	Mexico	Sudan
Bhutan	Ghana	Moldova	Suriname
Bolivia	Greece	Mongolia	Sweden
Bosnia and Herzegovina	Guatemala	Montenegro	Switzerland
Botswana	Guinea	Morocco	Tajikistan
Brazil	Guinea-Bissau	Mozambique	Tanzania
Brunei Darussalam	Guyana	Namibia	Thailand
Burkina Faso	Haiti	Nepal	Timor-Leste
Burundi	Honduras	Netherlands	Togo
Cabo Verde	Hungary	New Zealand	Trinidad and Tobago
Cambodia	Iceland	Nicaragua	Tunisia
Cameroon	India	Niger	Turkey
Canada	Indonesia	Nigeria	Turkmenistan
Central African Republic	Iran, Islamic Rep.	North Macedonia	Uganda
Chad	Iraq	Norway	Ukraine
Chile	Ireland	Oman	United Arab Emirates
China	Israel	Pakistan	United Kingdom
Colombia	Italy	Panama	United States
Congo, Dem. Rep.	Jamaica	Papua New Guinea	Uruguay
Congo, Rep.	Japan	Paraguay	Uzbekistan
Costa Rica	Jordan	Peru	Venezuela, RB
Cote d'Ivoire	Kazakhstan	Philippines	Vietnam
Croatia	Kenya	Poland	Yemen, Rep.
Cuba	Korea, Rep.	Portugal	Zambia
Cyprus	Kuwait	Qatar	Zimbabwe

Table A.2: Effect of income inequalities on CO_2 emissions, 1980-2018, linear model. All three specifications are shown. Robust standard errors in parentheses.

	Dependent variable: CO_2 emissions (ln)														
	Gini	Palma	20:20 ratio	Top 20%	Top 10%	Gini	Palma	20:20 ratio	Top 20%	Top 10%	Gini	Palma	20:20 ratio	Top 20%	Top 10%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Inequality (ln)	−0.218	−0.038	−0.024	−0.266	−0.188	−0.238*	−0.047	−0.036	−0.282*	−0.182*	−0.326**	−0.072*	−0.058*	−0.382**	−0.239**
	(0.139)	(0.038)	(0.033)	(0.155)	(0.101)	(0.138)	(0.037)	(0.033)	(0.150)	(0.093)	(0.139)	(0.038)	(0.033)	(0.155)	(0.101)
Tertiarization (ln)	−0.027	−0.024	−0.024	−0.027	−0.026	−0.127	−0.122	−0.123	−0.127	−0.126	−0.171**	−0.161**	−0.163**	−0.171**	−0.169**
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.085)	(0.086)	(0.086)	(0.085)	(0.085)	(0.078)	(0.080)	(0.080)	(0.078)	(0.079)
GDP per capita (ln)	0.428***	0.426***	0.425***	0.428***	0.428***	0.434***	0.433***	0.433***	0.434***	0.434***	0.425***	0.423***	0.423***	0.426***	0.426***
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.057)	(0.056)	(0.057)	(0.057)	(0.057)	(0.065)	(0.064)	(0.064)	(0.065)	(0.065)
Population (ln)	0.102	0.114	0.115	0.101	0.099	0.346***	0.361***	0.362***	0.346***	0.344***	0.414***	0.437***	0.438***	0.413***	0.412***
	(0.080)	(0.081)	(0.081)	(0.080)	(0.081)	(0.105)	(0.107)	(0.106)	(0.105)	(0.106)	(0.097)	(0.098)	(0.098)	(0.097)	(0.099)
Services, value-added (ln)	−0.009	−0.013	−0.012	−0.008	−0.009	0.043	0.037	0.038	0.043	0.040	0.085	0.077	0.079	0.085	0.080
	(0.073)	(0.073)	(0.073)	(0.073)	(0.074)	(0.087)	(0.088)	(0.087)	(0.087)	(0.088)	(0.077)	(0.078)	(0.077)	(0.078)	(0.079)
Urban population(ln)	0.200**	0.200**	0.200**	0.200**	0.198**	0.174**	0.173**	0.173**	0.174**	0.171**	0.136	0.132	0.132	0.136	0.132
	(0.092)	(0.094)	(0.095)	(0.091)	(0.091)	(0.086)	(0.087)	(0.088)	(0.085)	(0.085)	(0.087)	(0.090)	(0.091)	(0.087)	(0.087)
Primary enrollment (ln)						−0.084	−0.084	−0.083	−0.083	−0.083	−0.087	−0.091	−0.091	−0.086	−0.086
						(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.062)	(0.063)	(0.063)	(0.062)	(0.062)
Population ages 65 and above (ln)						0.351***	0.352***	0.350***	0.351***	0.349***	0.400***	0.402***	0.399***	0.401***	0.398***
						(0.104)	(0.105)	(0.105)	(0.104)	(0.104)	(0.112)	(0.113)	(0.113)	(0.112)	(0.112)
Final households consumption (ln)											−0.004	−0.003	−0.003	−0.003	−0.002
											(0.060)	(0.061)	(0.061)	(0.060)	(0.060)
Trade (ln)											−0.014	−0.015	−0.016	−0.014	−0.014
											(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
FDI inflows (ln)											0.028	0.027	0.027	0.028	0.027
											(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Countries	160	160	160	160	160	155	155	155	155	155	148	148	148	148	148
Observations	4,824	4,824	4,824	4,824	4,824	4,117	4,117	4,117	4,117	4,117	3,767	3,767	3,767	3,767	3,767
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.251	0.249	0.248	0.252	0.252	0.308	0.304	0.304	0.308	0.308	0.321	0.316	0.316	0.322	0.321
Adjusted R^2	0.219	0.216	0.215	0.219	0.220	0.272	0.269	0.269	0.273	0.272	0.284	0.279	0.279	0.285	0.283
F Statistic (df = 11; 3570)	258.606***	254.991***	254.192***	259.335***	260.097***	217.416***	214.275***	214.003***	217.721***	217.391***	153.775***	150.234***	150.074***	154.055***	153.185***

Note: *p<0.1; **p<0.05; ***p<0.01

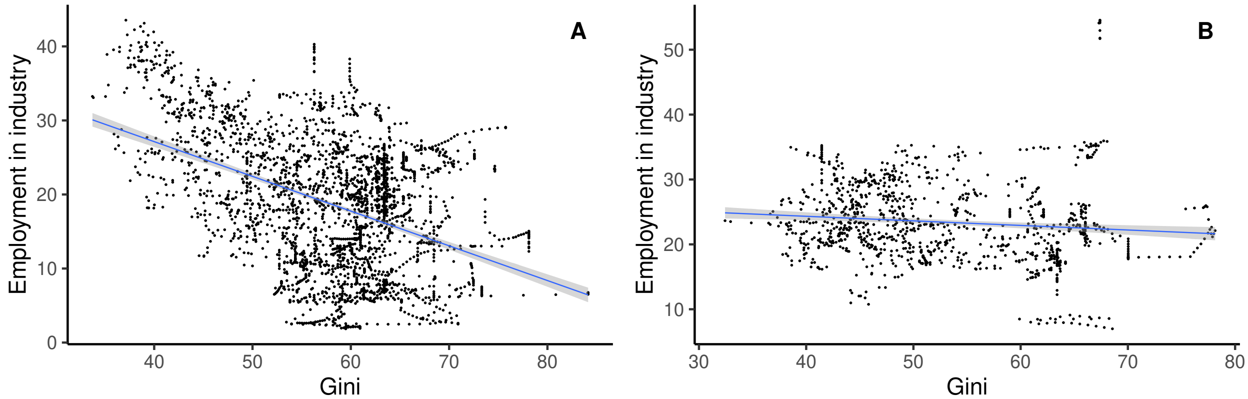

Figure A.1: Scatterplots representing the association between the Gini index and the employment in manufacturing for countries below (A) and above (B) the turning point of tertiarization (2.99) in at least 50% of the disposable years

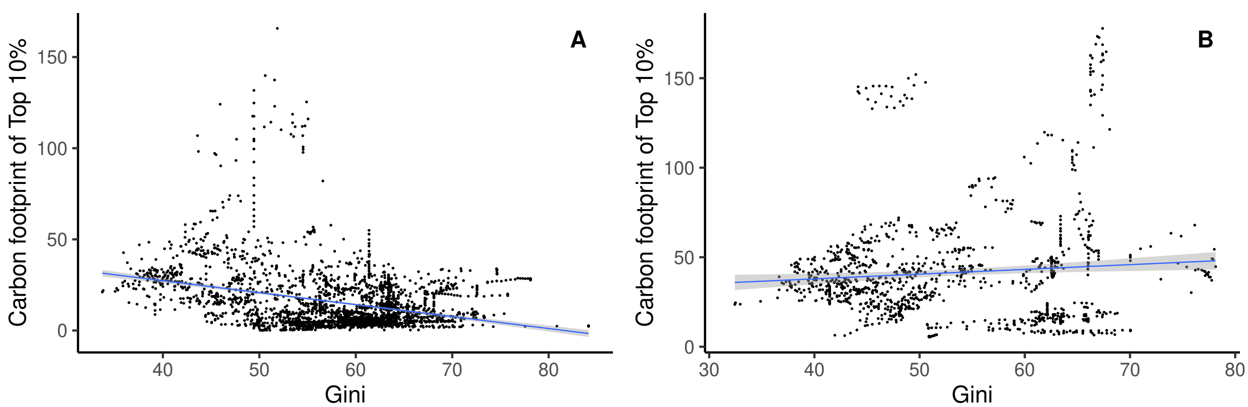

Figure A.2: Scatterplots representing the association between the Gini index and the carbon footprint of the top 10% of the population for countries below (A) and above (B) the turning point of tertiarization (2.99) in at least 50% of the disposable years

Table A.3: Association between income inequalities and employment in industry, 1991-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 50% of available years. Robust standard errors in parentheses.

	Dependent variable: Employment in industry				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	-0.149^{**}	-0.373^{***}	-0.045^{***}	-0.158^{*}	-0.127^{*}
	(0.076)	(0.144)	(0.017)	(0.084)	(0.076)
GDP per capita (ln)	7.096^{***}	7.052^{***}	7.098^{***}	7.117^{***}	7.155^{***}
	(1.175)	(1.143)	(1.151)	(1.172)	(1.171)
Population (ln)	7.627^{***}	7.891^{***}	7.904^{***}	7.639^{***}	7.740^{***}
	(2.656)	(2.570)	(2.572)	(2.656)	(2.651)
Services, value-added (ln)	0.306	0.338	0.394	0.297	0.231
	(1.319)	(1.328)	(1.330)	(1.325)	(1.338)
Urban population(ln)	10.423^{***}	10.468^{***}	10.340^{***}	10.403^{***}	10.421^{***}
	(3.360)	(3.368)	(3.436)	(3.347)	(3.352)
Primary enrollment (ln)	0.857	0.552	0.736	0.876	0.870
	(1.497)	(1.472)	(1.517)	(1.495)	(1.494)
Population ages 65 and above (ln)	−4.235	-4.682^{*}	-4.909^{*}	−4.186	−4.182
	(2.619)	(2.659)	(2.701)	(2.623)	(2.638)
Final households consumption (ln)	0.293	0.198	0.103	0.303	0.331
	(1.133)	(1.130)	(1.136)	(1.136)	(1.136)
Trade (ln)	0.657	0.629	0.570	0.663	0.660
	(0.636)	(0.628)	(0.615)	(0.639)	(0.643)
FDI inflows (ln)	−0.456	−0.459	−0.443	−0.457	−0.462
	(0.293)	(0.300)	(0.298)	(0.295)	(0.304)
Inequality*Tertiarized	0.110	0.539^{*}	0.047	0.123	0.117
	(0.143)	(0.322)	(0.059)	(0.148)	(0.150)
Observations	3,081	3,081	3,081	3,081	3,081
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.360	0.364	0.359	0.360	0.357
Adjusted R^2	0.319	0.324	0.319	0.319	0.316
F Statistic (df = 11; 2896)	148.040^{***}	150.746^{***}	147.757^{***}	147.809^{***}	146.329^{***}
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.4: Association between income inequalities and carbon footprint of top 10%, 1990-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 50% of available years. Robust standard errors in parentheses.

	Dependent variable: Carbon footprint of top 10%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.152**	0.182	0.011	0.166**	0.148*
	(0.076)	(0.125)	(0.019)	(0.083)	(0.077)
GDP per capita (ln)	15.954***	15.854***	15.857***	15.913***	15.887***
	(4.091)	(4.130)	(4.152)	(4.088)	(4.107)
Population (ln)	2.986	1.865	1.707	2.944	2.984
	(3.347)	(3.571)	(3.593)	(3.326)	(3.333)
Services, value-added (ln)	1.676	1.663	1.685	1.709	1.810
	(1.888)	(1.981)	(2.016)	(1.879)	(1.892)
Urban population(ln)	−0.613	−0.707	−0.753	−0.459	−0.301
	(3.085)	(3.157)	(3.144)	(3.057)	(3.050)
Primary enrollment (ln)	2.563	2.659	2.513	2.604	2.583
	(1.869)	(1.892)	(1.862)	(1.865)	(1.862)
Population ages 65 and above (ln)	−1.050	−0.843	−0.798	−1.062	−1.059
	(4.051)	(4.222)	(4.275)	(4.043)	(4.029)
Final households consumption (ln)	10.732*	10.771*	10.727*	10.676*	10.718*
	(6.295)	(6.329)	(6.296)	(6.281)	(6.287)
Trade (ln)	−0.071	−0.001	0.011	−0.058	−0.019
	(1.293)	(1.321)	(1.320)	(1.295)	(1.316)
FDI inflows (ln)	0.357	0.452	0.455	0.381	0.493
	(0.724)	(0.876)	(0.886)	(0.710)	(0.715)
Inequality*Tertiarized	0.782***	0.909	0.162	0.851***	0.782***
	(0.275)	(0.963)	(0.146)	(0.281)	(0.260)
Observations	3,145	3,145	3,145	3,145	3,145
Country fixed effects	✓	✓	✓	✓	✓
Year dummies	✓	✓	✓	✓	✓
R^2	0.213	0.193	0.192	0.215	0.214
Adjusted R^2	0.164	0.143	0.142	0.167	0.166
F Statistic (df = 11; 2961)	72.890***	64.243***	63.862***	73.807***	73.454***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.5: Effect of income inequalities on carbon footprint from investment of top 10%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Investment carbon footprint of top 10%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.065***	0.095*	0.007	0.072**	0.076**
	(0.028)	(0.057)	(0.008)	(0.030)	(0.033)
GDP per capita (ln)	4.730***	4.785***	4.761***	4.711***	4.729***
	(0.984)	(1.006)	(1.010)	(0.985)	(0.979)
Population (ln)	1.180	1.205	1.146	1.171	1.211
	(1.792)	(1.865)	(1.864)	(1.783)	(1.785)
Services, value-added (ln)	0.069	0.109	0.110	0.086	0.097
	(0.973)	(0.978)	(0.977)	(0.971)	(0.976)
Urban population(ln)	1.828	1.789	1.760	1.896	1.974
	(1.833)	(1.845)	(1.839)	(1.820)	(1.818)
Primary enrollment (ln)	−0.231	−0.197	−0.236	−0.234	−0.216
	(0.696)	(0.674)	(0.676)	(0.700)	(0.708)
Population ages 65 and above (ln)	−1.525	−1.264	−1.256	−1.567	−1.619
	(1.990)	(1.998)	(2.003)	(1.993)	(2.010)
Final households consumption (ln)	4.600***	4.601***	4.599***	4.560***	4.593***
	(1.332)	(1.321)	(1.328)	(1.334)	(1.343)
Trade (ln)	−0.299	−0.275	−0.258	−0.302	−0.315
	(0.397)	(0.402)	(0.402)	(0.399)	(0.407)
FDI inflows (ln)	−0.331	−0.289	−0.288	−0.320	−0.277
	(0.545)	(0.675)	(0.677)	(0.534)	(0.539)
Inequality*Tertiarized	0.370**	0.065	0.018	0.389**	0.337*
	(0.169)	(0.497)	(0.071)	(0.176)	(0.184)
Observations	2,736	2,736	2,736	2,736	2,736
R^2	0.103	0.084	0.083	0.104	0.104
Adjusted R^2	0.041	0.020	0.020	0.042	0.042
F Statistic (df = 11; 2558)	26.614***	21.293***	21.071***	27.074***	26.963***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.6: Effect of income inequalities on carbon footprint from investment of top 1%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Investment carbon footprint of top 1%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.642***	0.933***	0.078	0.684***	0.705***
	(0.132)	(0.290)	(0.050)	(0.143)	(0.155)
GDP per capita (ln)	20.265***	20.766***	20.528***	20.087***	20.219***
	(4.480)	(4.622)	(4.660)	(4.510)	(4.445)
Population (ln)	4.440	4.732	4.129	4.318	4.632
	(8.228)	(8.825)	(8.851)	(8.206)	(8.124)
Services, value-added (ln)	−0.613	−0.216	−0.324	−0.426	−0.278
	(4.576)	(4.596)	(4.625)	(4.556)	(4.516)
Urban population(ln)	5.261	5.170	4.888	5.795	6.601
	(9.163)	(9.425)	(9.402)	(9.027)	(9.001)
Primary enrollment (ln)	−1.378	−1.340	−1.607	−1.400	−1.357
	(3.388)	(3.261)	(3.275)	(3.401)	(3.482)
Population ages 65 and above (ln)	−0.718	1.855	2.061	−1.035	−1.524
	(7.695)	(7.889)	(7.882)	(7.699)	(7.792)
Final households consumption (ln)	22.886***	23.185***	23.172***	22.495***	22.825***
	(6.424)	(6.381)	(6.434)	(6.440)	(6.522)
Trade (ln)	−0.172	0.147	0.274	−0.185	−0.245
	(1.878)	(1.977)	(1.991)	(1.886)	(1.899)
FDI inflows (ln)	−4.815	−4.484	−4.462	−4.706	−4.338
	(4.185)	(5.378)	(5.408)	(4.117)	(4.002)
Inequality*Tertiarized	3.230***	1.199	0.217	3.301***	3.209***
	(1.066)	(3.397)	(0.444)	(1.128)	(1.201)
Observations	2,736	2,736	2,736	2,736	2,736
R^2	0.143	0.079	0.075	0.143	
Adjusted R^2	0.083	0.015	0.011	0.084	0.095
F Statistic (df = 11; 2558)	38.659***	19.843***	18.843***	38.957***	42.293***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.7: Effect of income inequalities on carbon footprint from consumption of top 10%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Consumption carbon footprint of top 10%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.115**	0.143*	0.008	0.121**	0.107**
	(0.049)	(0.085)	(0.013)	(0.053)	(0.048)
GDP per capita (ln)	10.002***	10.118***	10.074***	9.971***	10.006***
	(2.473)	(2.488)	(2.492)	(2.470)	(2.471)
Population (ln)	2.641	2.814	2.633	2.616	2.655
	(2.166)	(2.247)	(2.293)	(2.150)	(2.154)
Services, value-added (ln)	−0.623	−0.544	−0.579	−0.589	−0.539
	(1.394)	(1.431)	(1.444)	(1.373)	(1.378)
Urban population(ln)	2.555	2.776	2.620	2.650	2.731
	(2.329)	(2.445)	(2.437)	(2.317)	(2.328)
Primary enrollment (ln)	1.533	1.291	1.270	1.520	1.513
	(1.032)	(1.033)	(1.036)	(1.027)	(1.022)
Population ages 65 and above (ln)	−0.441	0.020	0.020	−0.503	−0.535
	(3.248)	(3.291)	(3.347)	(3.248)	(3.234)
Final households consumption (ln)	8.933**	9.275**	9.283**	8.871**	8.912**
	(4.506)	(4.548)	(4.532)	(4.499)	(4.502)
Trade (ln)	0.328	0.425	0.424	0.328	0.336
	(0.763)	(0.790)	(0.793)	(0.763)	(0.778)
FDI inflows (ln)	0.140	0.167	0.175	0.157	0.225
	(0.381)	(0.473)	(0.488)	(0.375)	(0.379)
Inequality*Tertiarized	0.591***	0.933	0.154**	0.632***	0.571***
	(0.184)	(0.631)	(0.074)	(0.199)	(0.178)
Observations	2,750	2,750	2,750	2,750	2,750
R^2	0.285	0.265	0.262	0.288	0.286
Adjusted R^2	0.236	0.214	0.211	0.239	0.236
F Statistic (df = 11; 2572)	93.336***	84.125***	82.860***	94.709***	93.468***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.8: Effect of income inequalities on carbon footprint from consumption of top 1%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Consumption carbon footprint of top 1%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	0.492***	0.706***	0.058**	0.517***	0.448***
	(0.104)	(0.179)	(0.027)	(0.114)	(0.110)
GDP per capita (ln)	20.743***	21.131***	20.958***	20.615***	20.649***
	(4.987)	(5.047)	(5.071)	(4.988)	(4.982)
Population (ln)	4.159	4.546	3.979	4.045	4.130
	(4.537)	(4.829)	(4.966)	(4.517)	(4.442)
Services, value-added (ln)	−2.543	−2.236	−2.389	−2.427	−2.264
	(2.985)	(3.105)	(3.146)	(2.925)	(2.906)
Urban population(ln)	5.746	6.136	5.762	6.029	6.426
	(4.991)	(5.338)	(5.370)	(4.944)	(4.944)
Primary enrollment (ln)	3.140	2.527	2.366	3.112	3.117
	(2.176)	(2.231)	(2.256)	(2.161)	(2.147)
Population ages 65 and above (ln)	−0.419	1.423	1.561	−0.644	−0.897
	(6.617)	(6.855)	(7.003)	(6.613)	(6.555)
Final households consumption (ln)	18.260**	19.190**	19.255**	18.056**	18.205**
	(8.896)	(9.045)	(9.041)	(8.881)	(8.893)
Trade (ln)	0.787	1.149	1.196	0.780	0.774
	(1.542)	(1.624)	(1.636)	(1.538)	(1.565)
FDI inflows (ln)	−0.412	−0.324	−0.303	−0.357	−0.149
	(1.036)	(1.528)	(1.577)	(0.993)	(0.963)
Inequality*Tertiarized	1.673***	2.148	0.362*	1.762***	1.718***
	(0.451)	(1.697)	(0.193)	(0.492)	(0.463)
Observations	2,750	2,750	2,750	2,750	2,750
R^2	0.298	0.244	0.236	0.301	0.309
Adjusted R^2	0.250	0.192	0.183	0.253	0.262
F Statistic (df = 11; 2572)	99.275***	75.632***	72.112***	100.790***	104.614***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A.9: Effect of income inequalities on carbon footprint from consumption of bottom 50%, 1995-2018. Countries are considered tertiarized if Tertiarization is greater than 2.99 in at least 70% of available years. Robust standard errors in parentheses.

	Dependent variable: Consumption carbon footprint of bottom 50%				
	Gini	Palma	20:20 ratio	Top 20%	Top 10%
Inequality	−0.035**	−0.082**	−0.013***	−0.036**	−0.025*
	(0.015)	(0.033)	(0.004)	(0.016)	(0.013)
GDP per capita (ln)	3.165***	3.157***	3.168***	3.173***	3.186***
	(0.842)	(0.836)	(0.833)	(0.840)	(0.837)
Population (ln)	1.632**	1.662**	1.652**	1.643**	1.672**
	(0.693)	(0.689)	(0.691)	(0.691)	(0.692)
Services, value-added (ln)	0.149	0.142	0.183	0.146	0.128
	(0.358)	(0.355)	(0.354)	(0.358)	(0.357)
Urban population(ln)	0.100	0.158	0.085	0.105	0.129
	(0.700)	(0.696)	(0.687)	(0.703)	(0.706)
Primary enrollment (ln)	0.237	0.196	0.224	0.235	0.236
	(0.329)	(0.320)	(0.316)	(0.329)	(0.324)
Population ages 65 and above (ln)	−0.371	−0.488	−0.571	−0.365	−0.367
	(1.071)	(1.059)	(1.072)	(1.070)	(1.063)
Final households consumption (ln)	2.427	2.452	2.409	2.429	2.436
	(1.552)	(1.547)	(1.534)	(1.550)	(1.544)
Trade (ln)	0.075	0.061	0.048	0.076	0.071
	(0.257)	(0.263)	(0.262)	(0.258)	(0.264)
FDI inflows (ln)	0.100	0.102	0.105	0.100	0.103
	(0.124)	(0.124)	(0.125)	(0.123)	(0.123)
Inequality*Tertiarized	0.057	0.204***	0.032***	0.065	0.060
	(0.049)	(0.060)	(0.009)	(0.049)	(0.043)
Observations	2,750	2,750	2,750	2,750	2,750
R^2	0.257	0.259	0.262	0.256	0.255
Adjusted R^2	0.205	0.208	0.211	0.205	0.203
F Statistic (df = 11; 2572)	80.713***	81.633***	82.995***	80.597***	79.916***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.10: Effect of income inequality on CO_2 emissions, alternative tertiarization indicators, third specification

	Dependent variable: CO_2 emissions (ln)								
	Gini	Top 20%	Top 10%	Gini	Top 20%	Top 10%	Gini	Top 20%	Top 10%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inequality (ln)	-0.800^{***}	-0.936^{***}	-0.621^{***}	-1.176^{***}	-1.334^{***}	-0.845^{**}	-0.832^{*}	-0.994^{**}	-0.675^{**}
	(0.288)	(0.313)	(0.205)	(0.420)	(0.483)	(0.339)	(0.444)	(0.480)	(0.308)
Tertiarization (with industry)	-2.681^{***}	-3.100^{***}	-2.020^{***}						
	(0.935)	(1.025)	(0.615)						
Services/All sectors (with manufacturing)				-7.768^{**}	-8.756^{**}	-5.257^{**}			
				(3.504)	(3.954)	(2.529)			
Services/All sectors (with industry)							-5.139	-6.212^{*}	-4.111^{*}
							(3.380)	(3.680)	(2.215)
GDP per capita (ln)	0.397^{***}	0.397^{***}	0.398^{***}	0.416^{***}	0.417^{***}	0.417^{***}	0.407^{***}	0.407^{***}	0.407^{***}
	(0.072)	(0.071)	(0.071)	(0.068)	(0.068)	(0.068)	(0.072)	(0.072)	(0.071)
Population (ln)	0.374^{***}	0.370^{***}	0.373^{***}	0.410^{***}	0.409^{***}	0.413^{***}	0.425^{***}	0.422^{***}	0.421^{***}
	(0.095)	(0.095)	(0.096)	(0.099)	(0.100)	(0.101)	(0.097)	(0.097)	(0.098)
Urban population(ln)	0.124	0.123	0.122	0.144^{*}	0.143^{*}	0.142^{*}	0.140	0.139	0.137
	(0.083)	(0.082)	(0.082)	(0.085)	(0.085)	(0.085)	(0.087)	(0.087)	(0.087)
Services, value-added (ln)	0.095	0.092	0.087						
	(0.093)	(0.093)	(0.094)						
Primary enrollment (ln)	-0.073	-0.072	-0.071	-0.067	-0.066	-0.066	-0.068	-0.067	-0.067
	(0.060)	(0.060)	(0.060)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.060)
Population ages 65 and above (ln)	0.404^{***}	0.405^{***}	0.403^{***}	0.393^{***}	0.394^{***}	0.395^{***}	0.404^{***}	0.404^{***}	0.402^{***}
	(0.116)	(0.116)	(0.115)	(0.115)	(0.115)	(0.115)	(0.117)	(0.116)	(0.116)
Final households consumption (ln)	-0.003	-0.004	-0.004	0.010	0.010	0.011	0.010	0.009	0.009
	(0.062)	(0.061)	(0.060)	(0.063)	(0.063)	(0.063)	(0.064)	(0.063)	(0.062)
Trade (ln)	-0.007	-0.006	-0.007	-0.012	-0.012	-0.012	-0.009	-0.008	-0.009
	(0.040)	(0.040)	(0.040)	(0.039)	(0.039)	(0.039)	(0.039)	(0.040)	(0.040)
FDI inflows (ln)	0.042^{*}	0.043^{*}	0.044^{*}	0.021	0.021	0.021	0.023	0.023	0.024
	(0.025)	(0.025)	(0.025)	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)	(0.022)
Inequality*Tertiarization (with industry)	0.623^{***}	0.716^{***}	0.488^{***}						
	(0.241)	(0.259)	(0.171)						
Inequality*(Services/All sectors) (with manufacturing)				1.853^{**}	2.065^{**}	1.303^{**}			
				(0.852)	(0.949)	(0.648)			
Inequality*(Services/All sectors) (with industry)							1.234	1.476^{*}	1.036^{*}
							(0.825)	(0.885)	(0.569)
Turning point	2.61	2.7	2.57	0.89	0.91	0.91	0.96	0.96	0.92
Countries	148	148	148	148	148	148	148	148	148
Observations	3,763	3,763	3,763	3,767	3,767	3,767	3,763	3,763	3,763
R^2	0.327	0.328	0.327	0.316	0.316	0.314	0.311	0.312	0.311
Adjusted R^2	0.289	0.291	0.289	0.279	0.279	0.277	0.274	0.274	0.274
F Statistic	144.097^{***} (df = 12; 3565)	144.937^{***} (df = 12; 3565)	144.093^{***} (df = 12; 3565)	150.028^{***} (df = 11; 3570)	150.264^{***} (df = 11; 3570)	148.858^{***} (df = 11; 3570)	146.573^{***} (df = 11; 3566)	147.201^{***} (df = 11; 3566)	146.630^{***} (df = 11; 3566)

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.11: Effect of income inequality on CO_2 emissions, alternative measures of CO_2 emissions, third specification

	Dependent variable:								
	CO_2 from production (ln), Word bank (baseline)			CO_2 from production (ln), EORA			CO_2 from consumption (ln), EORA		
	Gini	Top 20%	Top 10%	Gini	Top 20%	Top 10%	Gini	Top 20%	Top 10%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inequality (ln)	−0.982***	−1.107***	−0.714***	−0.494*	−0.538*	−0.333	−0.494*	−0.538*	−0.333
	(0.307)	(0.351)	(0.243)	(0.274)	(0.311)	(0.215)	(0.274)	(0.311)	(0.215)
Tertiarization (ln)	−3.096***	−3.492***	−2.172***	−1.730*	−2.003*	−1.293*	−1.730*	−2.003*	−1.293*
	(0.863)	(0.971)	(0.612)	(0.892)	(1.030)	(0.673)	(0.892)	(1.030)	(0.673)
Population (ln)	0.152	0.152	0.164	−0.080	−0.081	−0.073	−0.080	−0.081	−0.073
	(0.107)	(0.108)	(0.110)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)
Urban population(ln)	0.207*	0.205*	0.206*	0.234*	0.233*	0.237*	0.234*	0.233*	0.237*
	(0.114)	(0.114)	(0.115)	(0.133)	(0.133)	(0.134)	(0.133)	(0.133)	(0.134)
Services, value-added (ln)	0.101	0.098	0.094	0.123	0.120	0.118	0.123	0.120	0.118
	(0.071)	(0.071)	(0.071)	(0.079)	(0.079)	(0.079)	(0.079)	(0.079)	(0.079)
Primary enrollment (ln)	−0.071	−0.070	−0.069	0.066	0.067	0.067	0.066	0.067	0.067
	(0.062)	(0.062)	(0.062)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Population ages 65 and above (ln)	0.483***	0.485***	0.492***	0.192	0.191	0.194	0.192	0.191	0.194
	(0.130)	(0.129)	(0.129)	(0.122)	(0.121)	(0.120)	(0.122)	(0.121)	(0.120)
Final households consumption (ln)	−0.125**	−0.124**	−0.121**	−0.080	−0.079	−0.078	−0.080	−0.079	−0.078
	(0.049)	(0.049)	(0.049)	(0.071)	(0.071)	(0.070)	(0.071)	(0.071)	(0.070)
Trade (ln)	0.004	0.004	0.005	−0.058	−0.059*	−0.059*	−0.058	−0.059*	−0.059*
	(0.039)	(0.039)	(0.040)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
FDI inflows (ln)	0.046	0.047*	0.049*	0.026*	0.027*	0.028*	0.026*	0.027*	0.028*
	(0.028)	(0.028)	(0.028)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Inequality*Tertiarization	0.741***	0.827***	0.544***	0.415*	0.476*	0.326*	0.415*	0.476*	0.326*
	(0.215)	(0.238)	(0.162)	(0.222)	(0.252)	(0.177)	(0.222)	(0.252)	(0.177)
Turning point	2.76	2.82	2.71	2.28	2.1	1.78	2.28	2.1	1.78
Countries	148	148	148	145	145	145	145	145	145
Observations	3,767	3,767	3,767	3,145	3,145	3,145	3,145	3,145	3,145
R^2	0.162	0.162	0.159	0.050	0.050	0.050	0.050	0.050	0.050
Adjusted R^2	0.116	0.116	0.113	−0.009	−0.008	−0.008	−0.009	−0.008	−0.008
F Statistic	62.632*** (df = 11; 3570)	62.870*** (df = 11; 3570)	61.225*** (df = 11; 3570)	14.098*** (df = 11; 2961)	14.236*** (df = 11; 2961)	14.230*** (df = 11; 2961)	14.098*** (df = 11; 2961)	14.236*** (df = 11; 2961)	14.230*** (df = 11; 2961)

Note: *p<0.1; **p<0.05; ***p<0.01