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CEE-M Working Paper 2021-03

Version november 2023

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Abstract

This article analyzes the impact of income inequality on environmental policy in the presence of green consumers. We first perform an empirical analysis using a panel of European countries over the period 1995-2021 showing the existence of a negative convex relationship between inequality and public spending in environmental protection. We also highlight that green consumerism can be a driving force of this empirical relationship. We next develop a political economy model with two main ingredients: citizens with different income capacities have access to two commodities whose consumption differs in terms of price and environmental impact, and they vote on the environmental policy. In this setting, a unique political equilibrium exists in which the population is split into two groups that differ in the type of good—conventional *vs* green—they consume. In line with empirical findings, we provide sufficient conditions under which inequality impairs the public policy.

Keywords: income distribution, inequality, green consumption, environmental public expenditure.

JEL classification: Q58, H23, D31, D72

*The authors warmly thank Johanna Choumert-Nkolo, Nicolas Clootens, Julien Daubanes, Philippe de Donder, Emilien Ravigné and Ingmar Schumacher for their helpful feedback on an earlier draft of the paper. Paolo Melindi-Ghidi acknowledges financial support from the French government under the "France 2030" investment plan managed by the French National Research Agency Grant ANR-17-EURE-0020, and by the Excellence Initiative of Aix-Marseille University - A*MIDEX.

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1 Introduction

This paper addresses the old and important question of the link between income distribution, especially income inequality, and public policy. Since the early 2000s, and to a greater extent more recently, the issue has regained attention as it has become necessary to think about the design of policies capable of responding to the many environmental challenges modern societies face while being socially acceptable.

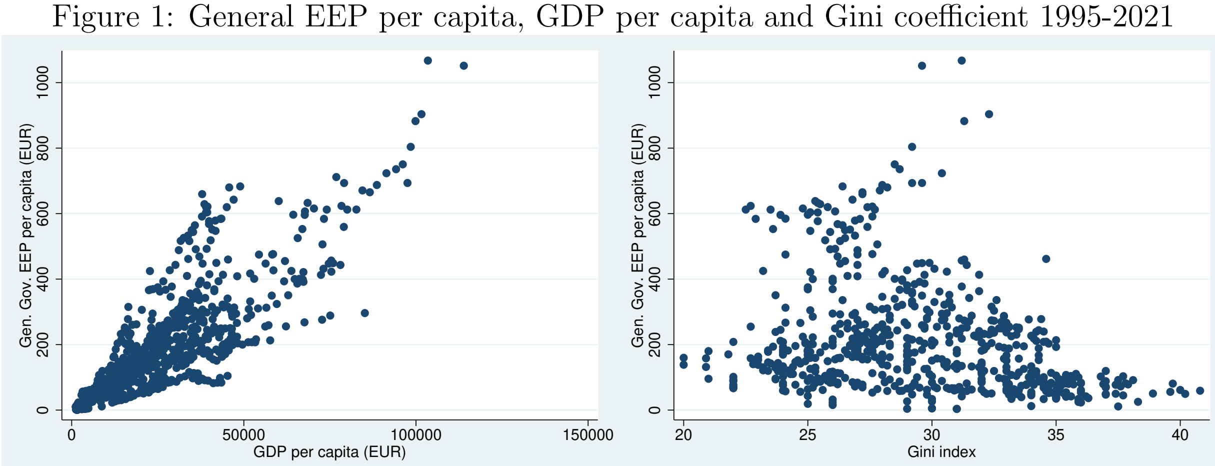
Income inequality and public environmental policy are interconnected in complex ways. As perfectly noticed by Stiglitz (2014), there is a two-way relationship between environmental policy and income distribution. Scholars' contributions on this topic are naturally divided into two distinct focal areas. Some examine the distributional impact of environmental policy (Aubert and Chiroleu-Assouline, 2019 and Jacobs and van der Ploeg, 2019), while others try to understand how income distribution shapes environmental policy (Boyce, 1994, Magnani, 2000 and subsequent contributions). This paper falls within the second category and has been motivated by the following observations, based on recent data collected in Europe over the period 1995-2021.

First, while we observe a strong positive correlation between GDP per capita and general government expenditure in environmental protection (EEP) per capita, the relationship between the latter and income inequality, as measured by the *Gini index* is less clear (see Figure 1).[1] More precisely, we observe that for high level of inequality there is no relationship between expenditure in environmental protection and inequality. Moreover, high general government expenditures are associated with high GDP per capita and low to moderate level of inequality, while the opposite is true for low GDP per capita and high level of inequality. We turned to the existing literature for an explanation and came to two conclusions. Even though this topic has been investigated for twenty years, the liter-

[1]See Appendix B for more information about data sets.

ature is relatively sparse both on theoretical (Magnani, 2000, Eriksson and Persson, 2003, Kempf and Rossignol (2007) and empirical (Grunewald et al., 2017, Martínez-Zarzoso and Phillips, 2020) grounds. Existing theories emphasize the existence of a negative relationship between inequality and environmental policy, which tends to be validated empirically.[2] A possible rationale for this relationship might be that greater income inequality leads to a decrease in both the relative income and the relative weight of the environment in the preferences of the median voter, which, in turn, diverts resources away from the financing of environmental policy toward consumption (Magnani, 2000). However, looking at the right-panel of the Figure 1 the evidence is not so clear. Indeed, the negative correlation between inequality and government expenditures in environmental protection diminishes as inequality increases, and vanishes for levels of the *Gini index* larger than 35. Consequently, the relationship seems to be better represented by an inverted-J curve, suggesting the presence of a non-linear relationship between the two variables. As a result, the relationship between inequality and environmental policy observed in European countries during the last 25 years deserves further investigation.

Figure 1: General EEP per capita, GDP per capita and Gini coefficient 1995-2021



Source: Authors from the Eurostat dataset, period 1995-2021, 31 European countries.

[2]See Section 2 for a literature review on this topic and others connected to our work.

Second, in developed economies individual behaviors change, with repercussions on the environment and the design of environmental policy. Specifically, by embracing (more) sustainable practices, such as consuming organic food or eco-friendly products, recycling, choosing sustainable transports and so on and so forth, individuals can contribute to the promotion of environmental protection. Even though consumers' decisions alone may not be sufficient to address complex environmental problems on a large scale and ensures the transition to a sustainable future, they are expected to play a critical role in reaching this objective (IPCC, 2023).

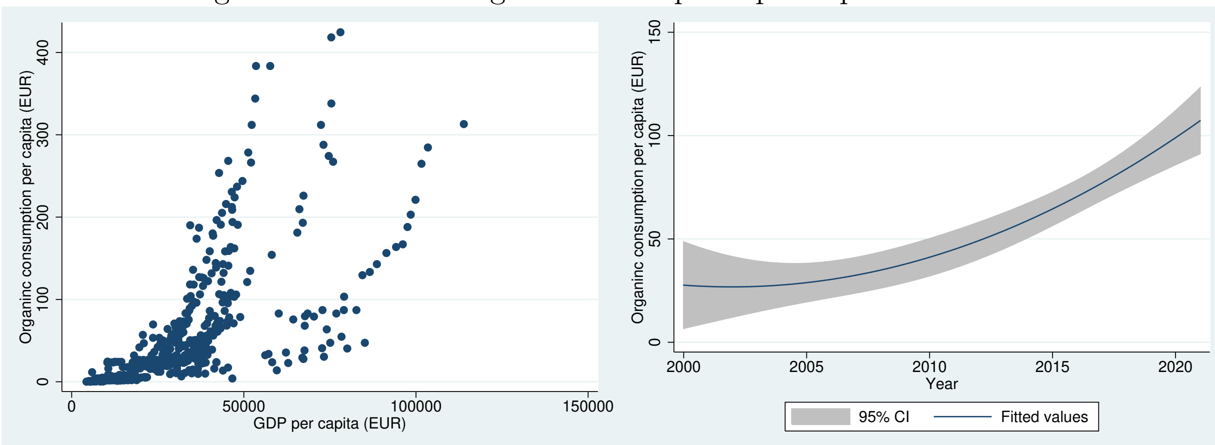
Figure 2 provides a piece of evidence of this behavioral evolution in Europe. It first shows the existence of a positive correlation between organic consumption and GDP per capita (left-panel). The strong correlation coefficient of 0.6859 clearly indicates that green consumption is positively correlated to the mean income. The right panel of Figure 2 also describes the evolution of organic consumption per capita over time: Organic consumption is a relatively recent yet developing fast phenomenon, which likely reflects consumers' rapidly growing concern for sustainable choices.[3] Observing that organic food and green consumption in general seems driven by individuals' wealth, there is a reason to believe that the income distribution is a key factor affecting the private contribution to the environment. This in turn should be an important mechanism to explain the link between environmental policy and inequalities.

On top of that, one should bear in mind that consumers are also citizens who form the collective demand for—and vote for the representatives in charge of implementing—public (environmental) policies.[4] Therefore, when studying the relationship between income distribution and public policy for environmental protection the role of politics should be considered too.

[3]Indeed, the curve indicates a significant increase in organic consumption over the last decade.

[4]For instance, one observes a growing participation of—especially young—citizens in political actions to raise awareness of global warming.

Figure 2: GDP and organic consumption per capita over time



Source: Authors from the Eurostat dataset and from the Research Institutes of Organic Agriculture, period 2000-2021.

This paper aims at exploring this relationship by accounting for the different dimensions mentioned above. Our approach is original in that it gives a central place to green consumerism—the fact that some people display a preference for green goods. Green consumerism has not been considered by the literature so far because it is a relatively new phenomenon. Its impacts on policy making are only beginning to be analyzed (Ambec and De Donder, 2022). Taking account of green consumption is key to understand the interaction between private green consumption and the collective decision on environmental expenditure, and how it is shaped by inequalities. For this reason, our analysis is closely connected to another strand of literature assessing the relationship between the income distribution and the collective choice of public goods provision, like the public funding of education (de la Croix and Doepke, 2009).

To investigate if and how the rising trend in green consumption shapes the relationship between inequality and environmental public spending, we first perform an empirical analysis using a sample covering 31 European countries over the period 1995-2021 (except for data for organic consumption which are available from year 2000 on). We find that GDP per capita is positively correlated to public environmental spending. In addition, the panel regressions show the existence of a negative relationship between inequality and environmental policy that turns to be non-significant for high level of inequality, thereby confirming the negative but weakening nature of that relationship, also highlighted in Figure 1. Lastly, the empirical investigation shows a significant and negative correlation between public spending and green consumption, as measured by organic consumption per capita. This highlights the substitutable nature of private and public contribution to environmental protection.

We then develop a political economy model to explain those empirical findings. We consider an economy whose citizens display income heterogeneity, take consumption decisions and vote for the public policy. Citizens exhibit green consumerism, that is, a preference for green goods.[5] Preferences also depend on environmental quality that is determined by private green consumption and public expenditure. Green consumption does not find its origin in consumers' ability to perfectly internalize its environmental impact. It is better explained by other private motives like being healthier and the existence of a warm-glow effect (Andreoni, 1990). In other words, there exists an environmental externality of consumption. The public policy consists of taxing citizens' income and using the resulting revenue to finance environmental public expenditure. This public policy is the outcome of a voting procedure.

We first study the existence and features of the political equilibrium. We especially show that the equilibrium income tax is associated with a critical income level that splits the population into two groups, those who consume the green good and those who do not. We next assess how the statistics of the income distribution shape both private decisions and the social demand for environmental spending. We find that an increase in inequality, as captured by a mean preserving spread (MPS) induces a decrease in environmental expenditure if and only if the equilibrium tax is lower than a critical threshold. Green

[5] These goods include organic food, energy-saving household appliances, electric vehicles, etc.

consumerism turns out to be the key mechanism to understand what is going on here. A variation in the level of inequality changes the size and composition of both groups. This, in turn, affects both the marginal benefit and each group's marginal cost of the policy and, consequently, the outcome of the electoral process. We finally provide some conditions involving the main parameters of the model under which a MPS indeed translates into a decrease in environmental spending. These conditions are more likely to be met by economies with pre-existing low to moderate level of inequality, which is perfectly consistent with our empirical finding.

The paper is organized as follows. Section 2 reviews the related literature with a focus on our contribution to it. Section 3 is dedicated to the empirical analysis. Section 4 presents the politico-economic model and assesses the impact of the income distribution on public policy. Section 5 concludes.

2 Related literature

The link between environmental policy and income distribution has been examined recently (see among others, Aubert and Chiroleu-Assouline, 2019 and Jacobs and van der Ploeg, 2019). This strand of literature deals with the impact of environmental tax reform on the different income groups that compose society. It also addresses the optimal design of environmental taxes when distributional effects are considered. It is finally interested in the efficiency of the economic and fiscal system.[6]

[6]Papers on environmental taxation generally conduct their analyses in second-best microeconomic frameworks. They assume that the population is heterogeneous in terms of income capacities and sometimes in terms of exposure to environmental damages. When it comes to the preferences, they often consider non-homothetic utility functions defined over two types of goods, clean *vs* polluting, both featuring the same price. The latter good is named this way because its consumption causes a polluting externality. The public policy combines an income tax with a linear tax on the dirty good, whereas fiscal revenues can be recycled through lump-sum transfers, public spending, or used to reduce distortionary tax.

In the coming analysis, we look at the problem another way by asking how income inequality can shape environmental policy. Economists have long debated this question. Dating back to the seminal paper of Boyce (1994), the literature provides a series of arguments explaining why (more) inequality is bad for the environment. Berthe and Elie (2015) classify these arguments into two categories depending on whether they involve individual behaviors and how they relate to environmental pressure or emphasize collective decision making. Central to all this discussion is the idea that potential conflicts exist in societies among social and income groups, typically the poor *vs* the rich, especially regarding the demand for environmental protection, and that these conflicts are exacerbated by inequality. The authors do, however, note that there is no theoretical nor empirical consensus on this topic.

A few formal studies of the impact of inequality on environmental policy also exist. The most prominent contribution to this line of research is Magnani (2000). The author develops a simple political economy model where individuals' preferences are defined over consumption and environmental quality. The government enhances environmental quality thanks to public expenditure that are financed by an income tax (accounting for the marginal cost of public funds). People vote on the tax rate. Focusing on majority voting, she shows the existence of a negative relationship between inequality and environmental policy if and only if the income elasticity of the preference for environmental quality is large. In her model, the key mechanism that explains this negative link is the dependence of individuals' environmental preferences on relative income. Subsequent contributions (Eriksson and Persson, 2003, Kempf and Rossignol, 2007) also build majority voting models and reach the same unambiguous conclusion, even though they consider different mechanisms.[7]

[7] Eriksson and Persson (2003) consider a uniform distribution of individuals who care about consumption and pollution in Stokey (1998)'s static model. Individual consumption is equal to the product of a collectively chosen pollution standard and production, which is an increasing and convex transformation of the individual type. They capture an increase in inequality by an increase in the gap between the median voter's production and the average voter's production and show that when this gap increases, the

This literature is thus only partially able to explain the situation depicted in the right panel of Figure 1, in particular what we observe for high levels of income inequality where the effect of inequality on environmental policy becomes almost null. This is where the first contribution of our paper lies. We explain this empirical fact proposing a new theory based on the substitution between public environmental spending and private green consumption. Considering green consumption echoes the observation that nowadays, a growing number of people display a willingness to pay (WTP) for green goods and a willingness to accept (WTA) a price premium compared to their neutral counterparts (McFadden and Huffman, 2017; Poder and He, 2017). Ambec and De Donder (2022) are the first to analyze the impact of green consumerism on environmental policy. Our approach differs from theirs as they assume that the proportion of green consumers in the economy is exogenous and do not deal with the heterogeneity of income distribution. On the contrary, we consider that everyone would be keen to consume green, but the budget constraint prevents some to do so. Compared to the above-mentioned literature, our approach is also more general because we pay a great deal of attention to the interplay between individual and collective decisions.[8] Finally, we depart from the literature by using a probabilistic voting model. Thus, our paper has also a connection with the political economy literature on public goods provision, especially with recent contributions on private education *vs* public schooling (de la Croix and Doepke, 2009; Arcalean and Schiopu, 2016; Melindi-Ghidi, 2018). Compared to majority voting, probabilistic voting shifts the political power from the poorer to the wealthier people, who are also those who consume green goods, in the determination of the political outcome.[9]

median voter asks for a less stringent standard. Kempf and Rossignol (2007) build an endogenous growth model *a la* Barro (1990) in which pollution arises from production. The government levies a tax on income that is used to finance both environmental (abatement) and productive (infrastructure) spending. The median voter must choose how to allocate the fiscal revenue between these two types of expenditure. More inequality induces the median voter to support growth at the expense of the environment.

[8]Papers in the literature deal with the collective decision dimension only.

[9]See the discussion on probabilistic voting models in Section 4.2.

On empirical grounds, the literature on the link between income inequality and environmental policy is sparse.[10] Its main contribution lies in the validation of the negative link between inequality and indicators of environmental policy, although there seems to be a dependence of the results on the level of income. Magnani (2000) measures inequality by the *Gini index*, whereas environmental policy is captured by public R&D expenditure to protect the physical environment. Working with a panel data set for OECD countries over the period 1980-1991, the author shows a negative correlation between income inequality and environmental policy.[11] Vona and Patriarca (2011) follow the lead of Magnani (2000). They also study OECD countries and consider a more recent and longer period (1985-2005). They focus on environmental innovations like green R&D and the production of environmental patents, especially by the public sector. Their empirical results highlight that inequality negatively influences the diffusion of innovations in countries with high per-capita incomes. The dependence on GDP results can be explained by the methodology used in these papers. The regressions include a second-order polynomial in the GDP and an interaction term between the GPD and the *Gini index*. This typically falls within the EKC empirical literature tradition.[12]

Our contribution to the empirical literature is two-fold. First, we use a more recent and broader data set, focusing only on European countries, and a more exhaustive variable to capture environmental public expenditure.[13] Second, based on stylized facts, we adopt (and

[10]The literature examining the link between inequality and pollution or environmental degradation indicators is more substantial (see among others, Torras and Boyce, 1998, Heerink et al., 2001 and Baek and Gweisah, 2013). However, it is also more distant from our problem. Indeed, people vote to choose public policies (public spending, taxation) rather than the level of pollution for many reasons, observability and measurement issues being the most important ones.

[11]These results appear to be valid for high-income countries only.

[12]Note that such a dependence also appears in recent papers assessing the relationship between income inequality and environmental degradation, for the very same reason. For instance, Grunewald et al. (2017) find that the relationship between income inequality and CO_2 emissions depends on income levels: at higher (lower) levels of income, higher income inequality increases (decreases) CO_2 emissions.

[13]This variable includes all public expenditure related to the environment, such as waste management, water management, pollution abatement, protection of biodiversity, and also R&D environmental protection expenditure. It is measured both locally and at the national scale. See Section 3.1 for details.

justify) an empirical strategy that accounts for the potential non-linearity of the impact of inequality on environmental policy. We therefore estimate an equation that includes a second-order polynomial in the *Gini index*. This is different from the literature on the environmental Kuznets curve (but similar to Martínez-Zarzoso and Phillips, 2020), that includes second-order and higher polynomial in the GDP per capita in the regressions.

3 Income distribution and environmental policy: empirical evidence

This section aims at examining the general link between income distribution, in particular income inequality, and environmental policy. We first provide a short description of the panel data set we use. We then describe our empirical analysis that draws on a panel regression with country and time fixed effects. As outlined in the introduction, we acknowledge the existence of a two-way relationship between income distribution and public environmental policy. It is worth emphasizing that our analysis primarily provides factual empirical observations, owing to the inherent challenges posed by endogeneity issues.

3.1 Data description

We build our dataset using data from Eurostat, the European Union statistical office, from the Research Institutes of Organic Agriculture (FiBL), and from the Environmental Performance Index (EPI).[14] Values for environmental protection expenditure include many items and ensure a high degree of international comparability. The database covers all government expenditure on waste management, water management, investments in clean technologies, pollution abatement, protection of biodiversity and landscape, R&D

[14] See appendix B for more information on these data sets.

environmental protection, and others.

In the coming analysis, the dependent variable is the *general government expenditure in environmental protection* (EEP). To account for different types of political system, we also deal with a second dependent variable that corresponds to EEP by *local* governments. Results for the latter variable are displayed in Appendix C. The main explanatory variables are the *GDP per capita* in current euros and the *Gini index*. Some demographic indicators are also added by means of the variables *Density*, measured by inhabitants per square km, and *population growth* (Δpop) to the database. Both variables are included because they are potential determinants of environmental pressure. All these variables come from the Eurostat dataset. As a measure of the importance of green consumption, we include the variable *organic consumption per capita* from the Research Institutes of Organic Agriculture (FiBL). This variable is built as the organic retail sales per inhabitant and gathers all the products with an organic certification within the country. We also control for the level of environmental performance in the country by introducing three control variables taken from the Environmental Performance Index (EPI) dataset. Each variable belongs to one of the three policy objectives of the EPI: *Environmental Health*, *Ecosystem Vitality*, and *Climate Change*. We employ the variable *Recycling* (REC), that is the proportion of recycled materials from the post-consumer (glass, plastic, paper, and metal), for the policy objective *Environmental Health*. The variable *Sustainable Nitrogen Management Index* (SNM), that is closely connected to organic production and therefore captures the environmental performance of agricultural production, is used for the policy objective *Ecosystem Vitality*. As for the policy objective *Climate Change*, we take the variable *Greenhouse Gas Emissions per Capita* (GHP). The inclusion of these environmental performance controls in the regression is intended to isolate the effect of inequality on EEP.[15] However, it is important

[15]The higher the value of SNM, the more efficient the use of nitrogen by hectare. Variables REC and GHP take values between $[0, 100]$. For the former, the higher the score, the better the performance, while for the latter it is the opposite. Indeed a a high score for GHP means that a country is among the least

to mention that there could be a connection and endogeneity bias between the scope of the environmental policy and the initial environmental quality. Summary statistics are shown in Table 1.

Table 1: Summary statistics

Variable	N. Obs.	Mean	Std. Dev.	Minimum	Maximum
Gen Gov EEP per capita	834	188.46	164.21	0.45	1067.39
GDP per capita	900	26113	19236	1172	121057
Gini index	677	29.39	4.04	20	40.8
Density (hab/km^2)	921	166.92	242.37	14.74	1653.88
Population (millions)	1020	16.28	21.56	0.25	83.23
REC (percentage)	868	31.06	10.13	10.10	55.51
SNM (score)	868	53.51	15.32	10.21	99.48
GHP (score)	868	26.42	11.40	0	53.74
Organic consumption per capita	483	55.80	73.52	0.04	424.56

Source: Eurostat, EPI and FiBL data sets for the period 1995-2021 for the 31 European countries.

3.2 Empirical strategy

Our empirical model is given by the following equation:

$$y_{i,t} = \alpha + \beta_1 Gini_{i,t-k} + \beta_2 Gini^2_{i,t-k} + \beta_3 GDP_{i,t} + \boldsymbol{\beta}_i \mathbf{X}'_{i,t} + u_{i,t} \tag{1}$$

with $y_{i,t}$ and $GDP_{i,t}$, defining the log of the EEP and GDP per capita in country i and year t, respectively. Figure 1 reveals that all European countries are located on the increasing part of the EKC. A linear term is thus sufficient to grasp the relationship between GDP and environmental policy. The variable $Gini_{i,t-k}$ is the $k-$ year lagged *Gini index*. A five-year lag for the *Gini index* ($k = 5$) is a reasonable delay to assess the impact of

polluting on a per capita basis.

income inequality on environmental policy.[16] Gini observations are average values over 5 years. The lagged Gini-squared is also incorporated in the model to account for possible non-linearity, as suggested in the stylized facts described in Figure 1. The vector $\mathbf{X}_{i,t}$ includes our controls: density, population growth, organic consumption per capita and EPI indicators. Parameter α is a common intercept, all the β represent the coefficients associated with the independent variables, and $u_{i,t}$ is the error term. Table 2 summarizes the transformations made in the coming regressions, for each country i and period t.

Table 2: Data description

Variable	**Original variable**	**Transformed variable**
Dependent variables		
Gen Gov EEP per capita	Government expenditure on environmental protection by general government in millions of current euros	$\log\left(\frac{\text{Gov\_10a\_exp\_1}_{i,t}\times 10^6}{\text{Population}_{i,t}}\right)$
Independent variables		
GDP per capita	GDP in million current euros	$\log\left(\frac{\text{nama\_10\_gdp}(t)\times 10^6}{\text{Population}_{i,t}}\right)$
Gini index lagged	Gini coefficient of equivalized disposable income	$\text{lag\_gini}_{i,t} = \frac{\sum_{j=5}^{10}\text{gini}_{i,t-j}}{5}$
Population density	Population over land cover in total	$\frac{\text{Population}_{i,t}}{\text{Total\_Landcover}_i}$
Population growth	Population on January 1st	$\frac{10\times(\text{Population}_{i,t}-\text{Population}_{i,t-1})}{\text{Population}_{i,t}}$
Organic consumption per capita	Organic consumption per capita	log(Organic cons. per cap.)

Source: Eurostat data set, except for organic consumption per capita (FiBL).
Note: to perform our analysis, we transform the population growth (x10) to obtain coefficients on a similar scale.

Several approaches can be used with cross-country panel data. Fixed-effect and random-effect models are the most common.[17] We use the following decomposition: $u_{i,t} = \mu_i + \epsilon_{i,t}$, where μ_i is an unobserved individual-specific effect, and $\epsilon_{i,t}$ refers to an idiosyncratic error term. Whether μ_i is treated as a random or fixed effect determines the estimation method. We run different specification tests, summarized in Table 6 in Appendix C, to decide which model better fits with our panel dataset.[18]

[16] Using a 5-year lag reduces the number of observations for the *Gini index* from 677 to 600. Results are robust when regressions are performed with the current *Gini index*, $Gini_{i,t}$ (See Appendix C).

[17] We exclude pooled OLS because F-tests reject equal fixed effects across units for all dependent variables at 1% level.

[18] We run the main test including the control for organic consumption, despite the model losing 20% of

First, we run the Hausman specification test (Hausman, 1978). The test rejects the null hypothesis (the preferred model is random effects), which suggests that unobserved country-specific effects are better modeled by a fixed-effect model. Even though the Hausman test is valid under restrictive assumptions and does not support robust standard errors, it clearly indicates the existence of a correlation between the individual errors and the regressors in the model that should be analyzed with a fixed-effects model.

We then check if time dummies among the regressors should be included in the regression. We test if the dummies for all years are equal to 0 and reject this assumption for both dependent variables at 1% significance level. Inclusion of time dummies is particularly important here, given that environmental policies have been influenced by European and international treaties for the last 25 years, and cannot be fully explained by variations in observed socio-economic variables at country level. Moreover, introducing both time—and country—invariant fixed effects might adjust for potential omitted-variable bias.

Before moving to the analysis, we should also consider tests for heteroskedasticity, autocorrelation, and cross-sectional dependence. The modified Wald test for groupwise heteroskedasticity in fixed effect models and the Wooldridge test for autocorrelation show that parameters can be consistently estimated using robust or clustered standard errors, that is, by treating each country as a cluster (Wooldridge, 2010). Because the Hausman test does not support robust standard errors, we implement a test of overidentifying restrictions (Sargan-Hansen test) robust to arbitrary heteroskedasticity and within-group correlation (Schaffer and Stillman, 2006). This test again rejects the null hypothesis and suggests implementing fixed effect models at 1% significance level for both outcome variables. We then verify the presence of cross-sectional independence within the residuals using the test of Pesaran (Pesaran, 2020). The cross-sectional dependence test provides

the observations (from 563 to 424 and from 564 to 423 for General and Local government EEP per capita, respectively). Results of all the tests performed in this section are robust if we do not include the control for organic consumption.

evidence of the existence of cross-sectional dependence at 1% level. Moreover, the average absolute correlation of the residuals is very high. Therefore, estimations should preferably be conducted using Driscoll-Kraay standard errors, which are typically employed in the presence of cross-sectional dependence (Hoechle, 2007).

The final check has to do with the model specification. We implement the test developed by Lind and Mehlum (2010) to check for the existence of a non-monotone relationship between our dependent variables and the independent variable measuring income inequality, that is, the *Gini index*. The null hypothesis is either a monotone or inverted U-shaped relationship. The test rejects the null hypothesis for both dependent variables. Finally, the Ramsey regression equation specification error (RESET) test (Ramsey, 1969) suggests no evidence of functional form misspecification, confirming that the model is well specified.

3.3 Empirical analysis

So we estimate equation (1) considering country fixed effects, μ_i, time dummies affecting all countries uniformly, λ_t, Driscoll-Kraay and robust standard errors clustered by country.

Columns (1)-(4), in Table 3, present the results of four regression, with our main dependent variable, the general government EEP, and Driscoll-Kraay standard errors, whereas column (5) shows the result obtained with cluster-robust standard errors. Column (1) only incorporates the inequality and GDP per capita variables. The control variables included in the other regressions are: demographic variables, density, and population growth (Column 2); plus EPI variables, REC, SNM and GHP (Column 3); plus the organic consumption per capita (Columns 4 & 5). All the regressions include both country and time dummies.

The effect of income inequality on environmental policy is captured by the coefficients $Gini$ and $Gini^2$ that are significant in all the specifications. We find a negative effect of the *Gini index* on the EEP variables. A higher *Gini index* is associated with the following first

Table 3: General government EEP per capita

	(1)	(2)	(3)	(4)	(5)
Gini	-0.243***	-0.258***	-0.273***	-0.253***	-0.253**
	(-6.06)	(-6.09)	(-6.92)	(-4.92)	(-2.30)
$Gini^2$	0.00416***	0.00440***	0.00449***	0.00419***	0.00419**
	(5.78)	(5.87)	(6.83)	(5.00)	(2.42)
GDP	0.507***	0.353**	0.541***	0.376*	0.376
	(4.08)	(2.36)	(3.41)	(1.73)	(1.00)
Density		-0.000416	-0.000463	0.000310	0.000310
		(-1.24)	(-0.99)	(0.16)	(0.05)
Δpop		0.596**	0.468**	0.402*	0.402
		(2.77)	(2.56)	(2.04)	(0.98)
REC			-0.0456	0.0401	0.0401
			(-1.12)	(0.64)	(0.40)
SNM			0.00943***	0.00944***	0.00944***
			(6.19)	(4.14)	(3.33)
GHP			0.00716	0.00446	0.00446
			(1.38)	(0.83)	(0.41)
Organic				-0.0630*	-0.0630
				(-1.99)	(-1.51)
Year	YES	YES	YES	YES	YES
N	563	526	526	424	424
R^2_w	0.484	0.484	0.522	0.518	0.518

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

order effect: it makes the environmental policy less stringent. As for the second-order effect, we find that coefficients of $Gini^2$ are positive but very small for all specifications. This means that an increase in the *Gini index* is first associated with a decrease in environmental spending at a decreasing rate. There also exists a turning point, and from this point onward the relation becomes positive, although the connection is almost zero. This is a potentially important feature of the relationship that deserves further discussion. Before that, let us describe the role of GDP and of the different controls.

Coefficients for GDP per capita are positive and significant in all regressions, except in column (5) where we use robust-standard errors, with coefficients comprised between 0.353 and 0.507. We observe a difference in the coefficients obtained for GDP per capita, with the values in columns (2) and (4) being lower than the coefficients in columns (1) and (3). However, these variations are relatively small when we consider the 95% confidence intervals for these coefficients. In this case, we cannot conclude that they are statistically different from each other. As to demographic variables, the density of population is never significant, whereas we find a positive and significant correlation for population growth when using the Driscoll-Kraay standard errors. The introduction of EPI variables increases the significance of the model: R^2 (within) in column (3) is equal to 0.522, while it was of 0.484 in columns (1) and (2) where only socio-economic variables are considered. This is true even if the number of observations decreases with their inclusion. Among the EPI controls, only the variable SNM, which measures the environmental performance and sustainability of agricultural production, exhibits significant coefficients. The other EPI variables, GHP, for the Greenhouse Gas Emissions per Capita, and recycling (REC), are not significant.

Importantly, the results in column (4) reveal that organic consumption per capita has a negative and significant impact on the general government EEP per capita. This emphasizes the potential role of green consumption in the overall assessment of the relationship between income distribution and environmental policy. Indeed, it highlights the substitutable nature of green consumption and public policy in environmental preservation. Notice that adding this control reduces the number of observations, resulting in a slight decrease in R^2 (within). In Appendix C we perform several robustness tests confirming our empirical findings.

Let us end this Section with an investigation of the exact shape of the relationship between inequality and public expenditure in environmental protection. As mentioned earlier, the Lind and Mehlum (2010)'s test rejects the null hypothesis of either a monotone or inverted $U-$shaped relationship. However, looking at Figure 1, the data do not seem to fit well with a $U-$shaped relationship. According to Haans et al. (2016), several conditions must be met to confirm the existence of a $U-$shaped curve. First, the coefficients associated with both the linear and quadratic terms must be significant. Second, the turning-point should not be "extreme" and rather lie strictly within the sample interval. Finally, the slope on both sides of the $U-$curve must be steep enough. Although the first two conditions are verified in our analysis, the third condition is not, as the coefficients associated with $Gini^2$ are very small, ranging from 0.0025 to 0.0045 in Table 3.

To test the shape of the relationship between the *Gini index* and public expenditure, we thus perform two more regressions on two sub-samples of our dataset, as suggested by Qian et al. (2010). Computing the ratio $\beta_1/(2\beta_2)$ using coefficients in column (4) in Table 3, we find that the turning point is $Gini = 30, 19$. The lower sub-sample comprises observations with a Gini smaller than this turning point, while the upper sub-sample includes observations with a Gini greater than or equal to this turning point. According to this test, if the $U-$shaped relationship were to be confirmed, we would observe a negative and significant coefficient for the lower sub-sample, and a positive and significant coefficient for the Gini in the upper sub-sample. As expected, for the lower sub-sample, coefficients of the Gini are always significant, as shown in table 4.[19] We also find that coefficients are greater than those obtained when considering the entire sample. For instance, the coefficients for the Gini are even stronger compared to the original regressions. The $Gini^2$ coefficient is again significant but, again, its effect is still very small. For the upper sample, however, the positive coefficients of the *Gini index* (linear and quadratic terms) are never significant regardless of the outcome variable considered (see Table 5). Moreover, the negative effect continue to dominate indicating that the interaction between income inequality and environmental public policy cannot be described by an inverted $U-$shaped curve. Therefore, we can conclude that the effect of inequality is negative and convex, meaning that the

[19] That is true for both the model with Driscoll-Kraay and cluster-robust standard errors.

negative effect decreases and becomes non significant for the large levels of inequality.

Table 4: General government EEP per capita if $Gini < 30.19$

	(1)	(2)	(3)	(4)	(5)
$Gini$	-0.483***	-0.468***	-0.522***	-0.532***	-0.532**
	(-7.08)	(-8.94)	(-6.46)	(-5.61)	(-2.25)
$Gini^2$	0.00885***	0.00863***	0.00961***	0.00992***	0.00992**
	(6.61)	(8.48)	(6.47)	(5.56)	(2.14)
GDP	0.949***	0.895***	0.980***	0.804**	0.804*
	(8.40)	(3.68)	(3.82)	(2.43)	(2.00)
$Density$		-0.000226	-0.000396	0.00566***	0.00566
		(-0.76)	(-1.27)	(3.29)	(1.41)
Δpop		0.0755	0.0484	0.256	0.256
		(0.39)	(0.24)	(0.67)	(0.78)
REC			-0.0462	0.0851	0.0851
			(-0.66)	(1.00)	(0.64)
SNM			0.00154	0.00147	0.00147
			(0.57)	(0.47)	(0.45)
GHP			0.00695	0.0144*	0.0144
			(1.03)	(1.98)	(1.41)
$Organic$				-0.130***	-0.130*
				(-3.47)	(-2.04)
$Year$	YES	YES	YES	YES	YES
N	343	311	311	258	258
R_w^2	0.618	0.598	0.602	0.599	0.599

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

To sum up, the empirical analysis allows us to draw two important conclusions. First, there exists a negative and convex (weakening) relationship between income inequality and public environmental policy. Second, even though it is positively correlated with GDP per capita, green consumption might shape the relationship between inequality and environmental policy through its negative effect on the latter. The next Section will built on this second result to develop a theory suitable to explain the main empirical finding regarding the link between income inequality and environmental policy.

Table 5: General government EEP per capita if $Gini \geq 30.19$

	(1)	(2)	(3)	(4)	(5)
$Gini$	0.112	-0.200	-0.203	0.282	0.282
	(0.23)	(-0.50)	(-0.44)	(0.50)	(0.60)
$Gini^2$	-0.00146	0.00303	0.00310	-0.00410	-0.00410
	(-0.20)	(0.52)	(0.45)	(-0.50)	(-0.59)
GDP	0.237	-0.0693	0.426**	0.304*	0.304
	(1.64)	(-0.70)	(2.78)	(1.92)	(1.75)
$Density$		-0.0284***	-0.0423***	-0.0425***	-0.0425**
		(-6.79)	(-6.24)	(-6.98)	(-2.74)
Δpop		1.103***	1.191***	0.505*	0.505
		(3.44)	(4.35)	(1.82)	(1.15)
REC			-0.120	0.0873	0.0873
			(-1.13)	(0.63)	(0.55)
SNM			0.0103***	0.00641*	0.00641*
			(4.19)	(1.93)	(1.89)
GHP			0.0353***	0.0387***	0.0387
			(3.34)	(2.93)	(1.75)
$Organic$				-0.0779*	-0.0779**
				(-1.92)	(-2.28)
$Year$	YES	YES	YES	YES	YES
N	220	215	215	166	166
R^2_w	0.410	0.510	0.578	0.703	0.703

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

4 Theoretical investigation

4.1 Model

Our modeling approach shares similarities with the theoretical literature on environmental taxation (Aubert and Chiroleu-Assouline, 2019, Jacobs and van der Ploeg, 2019) because of the issue at stake, even if we adopt a different (yet complementary) perspective. We borrow to this literature the following ingredients: a non-homothetic utility function and an environmental impact of consumptions, modeled as an externality. However, the similarity ends there. In the main, we build on de la Croix and Doepke (2009)'s seminal paper on the public funding of education within an heterogenous population.

The population is constant with its size normalized to 1. Individuals differ with respect to their wage. Wages are distributed on the support $[w_m, \infty)$, with $w_m > 0$, according to density and cumulative distribution functions $f(w)$ and $F(w)$. Like Arcalean and Schiopu (2016), we make use of a Pareto distribution: $F(w) = 1 - \left(\frac{w_m}{w}\right)^k$, $f(w) = kw_m^k w^{-(1+k)}$ with $w_m > 0$ and $k > 2$, the parameters of distribution that depend on its two main statistics, the average, μ, and standard deviation, σ.

We consider two types of commodities that differ in terms of their environmental impact and do not necessarily fulfill the same consumption needs. We work with an index of environmental quality, Q, with reference level normalized to 0. This level is defined in relation to a business-as-usual level of pollution taken as given. The first commodity, whose consumption is denoted by c, is environmentally neutral, whereas the second, d, is environmental-friendly. Consuming good d has a positive side-effect on the environment. Typical examples of consumptions that improve environmental quality along some, possibly different, dimensions are organic food (quality of soils, etc.) and electric vehicles (atmospheric pollution). In addition to the consumption channel, environmental quality can be increased through environmental expenditure by the government.

People exhibit a willingness to pay (WTP) for green goods. At the same time, however, it is difficult to assign this WTP to an environmental awareness whereby they would be able to evaluate the impact of their (consumption) decisions on the environment. From a modeling viewpoint, this leads us to represent preferences by a utility function with three arguments: the two consumptions and the level of environmental quality, taken as given. This means that a positive consumption externality exists. For the sake of the analysis, we choose a quasilinear representation of the non-environmental utility combined with a linear environmental benefit. We also assume that people display the same preferences, with utility function:[20]

$$U(c,d,Q) = \gamma \ln(c) + d + \beta Q, \tag{2}$$

where $\gamma, \beta > 0$ are the relative weight of respectively, non-green (or environmentally neutral) consumption and the environment in the preferences. Decisions are subject to the budget constraint:

$$(1-t)w = c + \pi d, \tag{3}$$

where $t \geq 0$ is the (linear) income tax, and π is the (relative) price of the green good. Hereafter, we impose $\pi > 1$, which is a reasonable assumption for the category of goods concerned. Indeed, green goods generally belong to the category of superior goods whose prices are typically higher than those of ordinary goods. For instance, even if c and d need not refer to two versions of the same good, we may refer to the pricing difference that exists between organic and conventional products. The United States Department of Agriculture (USDA, see Coleman-Jensen et al., 2017) actually gets an estimate of the price premium— the price of organic products relative to that of conventional alternatives—that ranges from 7% to 82%. Liu (2014) also measures a differential of about 17% between the mean price of hybrid cars and of conventional cars sold in the US.

In the same vein as de la Croix and Doepke (2009), we consider a generic income tax whose purpose is to finance the public provision of environmental quality, or environmental public spending, S. In addition, the government follows a balanced budget rule: $S = \int_{w_m}^{\infty} twf(w)dw = t\mu$. Public spending is adding to private consumption of the green good to determine the realized level of environmental quality: $Q = S + \int_{w_m}^{\infty} df(w)dw$.

The sequence of events is as follows: citizens first elect a government that pre-commits

[20] Our results would be qualitatively the same with Stone–Geary preferences in consumption (like in Aubert and Chiroleu-Assouline, 2019), and a (strictly) concave function for the environmental benefit. However, the resolution and comparative statics would require an unnecessarily complicated algebra. In addition, the non-linearity in c ensures that if a (low income) individual only consumes one good, it will be the non-green one.

to a policy platform $\{t, S\}$. Once elected, the government sets the tax rate. People then choose their consumption levels, which finally results in a level of environmental spending and quality. We assume perfect foresight which especially means that when political parties choose their strategy in the electoral competition, they perfectly anticipate people's reaction to the public policy. This is a typical Stackelberg game that can be solved backwards by first determining individual decisions as a function of policies and then choosing policies that take this dependency into account.[21]

This baseline model serves as a vehicle for the coming analysis where our main goal is first to establish that the problem above has a solution—a political equilibrium—and next to examine how the equilibrium features, especially the public policy, change when the main characteristics of the income distribution, average and standard deviation, vary.

4.2 Political equilibrium

Let us start with individual decisions: each consumer takes environmental quality as given when they maximize (2) subject to (3), and $d \geq 0$. Solving for this program, we identify a threshold income level

$$\tilde{w}(t) = \frac{\gamma\pi}{1-t}, \text{ with } \tilde{w}'(t) = \frac{\tilde{w}(t)}{1-t} > 0, \tag{4}$$

that determines whether or not a consumer purchases the green good. For an interesting problem, this threshold must belong to (w_m, ∞) for some $t \in [0, 1]$.[22]

For any such t, the population can be split into two groups, respectively labeled by

[21] de la Croix and Doepke (2009) consider the other timing where individuals "move first," before the policy is chosen. They provide the argument that, unlike public policy, decisions on fertility and education cannot be revised frequently. In our setting, we can support the suggested timing by providing the exact opposite argument because we are dealing with consumption decisions. Moreover, this timing is similar to the one arising in second best analyses of environmental taxation (Jacobs and van der Ploeg, 2019).

[22] This defines two boundaries, $t_{\min}$ and $t_{\max}$, with $t_{\min} = 1 - w_m^{-1}(\gamma\pi)^{\frac{1}{1-\alpha}} < 1 = t_{\max}$. The lower bound $t_{\min}$ can be positive or negative, which will not affect the coming analysis.

G and N (for "green" *vs* "non green" consumers). Membership to a particular group is determined by the individual's income. Wealthier people, those with $w \geq \tilde{w}(t)$, form group G, whereas poorer folks are part of group N. This dichotomy is in line with, for instance, descriptive statics provided by Liu (2014), that illustrates that demand for hybrid cars essentially arises from people who are part of the upper income classes. Decisions made by individuals within each group are given by (a superscript letter is used for decisions):

$$\begin{aligned} &d^n = 0,\ c^n(w,t) = (1-t)w, \\ &d^g(w,t) = \pi^{-1}(1-t)w - \gamma,\ c^g = \gamma\pi. \end{aligned} \tag{5}$$

A member of group N cannot afford the green good and thus devotes her entire income to purchasing the environmentally neutral and cheaper good. By contrast, a green consumer spends a constant amount of money on the neutral good and the extra money goes to the green good. Note that the quasilinear utility explains why c^g is constant. This has no influence on the analysis. The level of environmental quality is obtained by adding environmental public expenditure to aggregate private consumption of the green good:

$$Q(t) = t\mu + \frac{\gamma}{k-1}N^g(t), \tag{6}$$

with $N^g(t) = \left(\frac{w_m}{\tilde{w}(t)}\right)^k \in (0,1)$, the size of group G. Increasing the tax has two opposite effects on Q: a higher tax first means more public expenditure for a given tax base, which is good for the environment. It also diverts consumers away from the green good, which negatively affects Q. The overall effect remains positive, however.

These decisions result in the indirect utility functions (IUF):

$$\begin{aligned} &v^n(t,w) = \gamma \ln\left[(1-t)w\right], \\ &v^g(t,w) = \gamma \ln(\gamma\pi) + \pi^{-1}(1-t)w - \gamma. \end{aligned} \tag{7}$$

One can then determine the optimal taxe rate of an individual within each group, by internalizing the environmental externality, that is, by adding $\beta Q(t)$ to the IUF in (7):[23]

$$
\begin{aligned}
&t^n \text{ such that } \tfrac{\gamma}{1-t} = \beta Q'(t), \\
&t^g(w) \text{ such that } \pi^{-1} w = \beta Q'(t).
\end{aligned} \tag{8}
$$

The individual marginal cost of taxation is the same for all group N's members (LHS, first eq. in 8), and so is the marginal benefit (RHS). So they would all choose the same tax rate if they could take account of the externality. For members of group G, the optimal tax is decreasing in income because the wealthier the individual, the higher the tax burden.

The electoral competition is described by a probabilistic voting (PV) model as in de la Croix and Doepke (2009), Arcalean and Schiopu (2016), and Melindi-Ghidi (2018). The median voter (MV) approach, that is commonly used in the literature, raises two problems in the present setting. The first concerns the (in)capacity of any individual voter, including the median, to take the external effect into account. Considering that an individual is unable to internalize the externality at the voting stage, we get a trivial solution that does not depend on the level of inequality, whatever the identity of the MV.[24] Otherwise, we get the solution in (8). Whether or not the externality is internalized, the second problem arises with the determination of the equilibrium because the MV's membership to group N or G, which is critical for the analysis, depends on the location of the median income with respect to $\tilde{w}(t)$, that is itself determined by the tax chosen... by the MV. Of course, this problem can be fixed by imposing appropriate condition on the main parameters of the model. As it turns out, the result obtained by working with (8) is qualitatively the same as the one obtained with the PV model. That is why we work with the PV model,

[23]And assuming that the optimization problem is convex (concave IUF) for each individual.

[24]IUF in (7) are single-peaked. Taking Q as given, a citizen equalizes her marginal cost, defined in (8) to the marginal benefit that reduces to $\beta\mu$. As a result, a voter in group N's optimal tax is interior but independent of the variance, whereas the optimal tax of a green consumer is corner. It is equal to 0 for those with an income above the average, and to 1 otherwise.

that also displays the following interesting features.

PV introduces “noise” in the outcome of the electoral process. Indeed, it is assumed that in addition to the policy platforms the different candidates offer, voters’ preferences also depend on a non-policy outcome of the election. In the literature, this additional concern is typically associated with an ideology. In the end, for any policy platform, a party does not know the exact number of voters who will support it. Indeed, unlike MV models, individuals belonging to the same economic group do not have the same ideological preferences. The best a party can do is to evaluate its vote share, which is defined as the sum of probabilities that people in each group vote for it multiplied by the relative group size.[25] A party’s objective is then to choose the platform that maximizes its vote share. As in a two-party electoral competition, parties’ decision problems are identical, one generally focuses on the symmetric Nash equilibrium in pure strategies of the zero-sum game. It is then easy to show that parties’ equilibrium policies maximize the following utilitarian social welfare function:

$$\int_{w_m}^{\tilde{w}(t)} (v^n(t,w) + \beta Q(t))\theta(w)f(w)dw + \int_{\tilde{w}(t)}^{\infty} (v^g(w,t) + \beta Q(t))\theta(w)f(w)dw,$$

with $Q(.)$, $v^n(.)$ and $v^g(.)$ defined in (6) and (7), and where $\theta(w)$ represents the political power of a voter with income w. For simplicity, we assume away this particular dimension of the problem by considering that citizens share the same political power, that is, $\theta(w) = 1$ for all w.[26] This implies that the only weights that matter in the objective function, denoted by $W(t)$, are given by the relative size of each group, and this function reduces to:

$$W(t) = \int_{w_m}^{\tilde{w}(t)} v^n(t,w)f(w)dw + \int_{\tilde{w}(t)}^{\infty} v^g(w,t)f(w)dw + \beta Q(t).$$

[25]If there are two parties A and B, then the probability that an individual votes for party A is an increasing function of the difference of utility levels brought by each party once elected. This function is a cumulative distribution function that captures how ideology is distributed in society.

[26]It is not the aim of the paper to account for this additional source of heterogeneity. It would be an interesting extension of the present work, however.

After some computations, we get a meaningful expression of its first derivative,

$$W'(t) = -\frac{\gamma}{1-t}(1 - N^g(t)) - \frac{k}{k-1}\frac{\gamma}{1-t}N^g(t) + \beta[\mu - \frac{k}{k-1}\frac{\gamma}{1-t}N^g(t)], \tag{9}$$

which illustrates the simple trade-off faced by the economy when collectively deciding on the public policy. The first term, in absolute value, represents the aggregate marginal cost of taxation for group N, MC^n. It is simply equal to the individual (common) marginal cost multiplied by the size of this group. The second term captures the aggregate marginal cost for group G, MC^g. It can be written as the product of an average individual marginal cost, $\frac{k}{k-1}\frac{\gamma}{1-t}$, and this group's size. Finally, taxation comes with a net environmental marginal benefit, MB, according to which the direct (marginal) benefit of higher environmental spending, μ, is partly offset by the decrease in green consumption. This environmental marginal cost, MC^e, that shows up in the last term, is a proportion β of MC^g.

Solving for the political equilibrium requires searching for the tax that maximizes $W(t)$. We first identify a critical rate,

$$t^l = 1 - w_m^{-1}\gamma\pi\,(1+\beta k)^{-\frac{1}{k}}\,(> t_{\min}),$$

such that $W''(t) < 0 \Leftrightarrow t > t^l$. Without loss of generality, this critical tax rate is assumed to be positive. Then, we can establish the following existence result (all the proofs are gathered in the Appendix, see Appendix A.1):

Proposition 1. *A necessary and sufficient condition for the existence of a unique political equilibrium associated with policy platform* (t^p, S^p), *with* $t^p \in (t^l, 1)$, *is:*

$$\beta\pi > (1+\beta k)^{\frac{1}{k}}. \tag{10}$$

For given income distribution—(μ, σ) given—the existence condition (10) can be interpreted in terms of price and preference parameters, (π, β). There is a scarce literature that tries to identify the drivers of the environmental preference, captured by β.[27] When it comes to the representation of the utility function, it is however difficult to obtain a precise estimate of this parameter. One may argue that as individuals prioritize consumption, the relative weight of the environment should be lower than one. From a more aggregate perspective, findings of this literature strongly suggest that on average, environmental concern should be the highest in the richest countries. Taking $\beta \in (0, 1)$ and reminding that $\pi > 1$, we obtain that people should care enough about the environment, and the price of the green good should be high enough for them to be willing to incur the cost of the public provision of environmental quality. A political equilibrium of this sort is then more likely to arise in relatively rich countries, like the OECD and EU member states.

The equilibrium tax t^p is defined implicitly only. However, it is quite easy to check that t^p is increasing in both β and π. On the one hand, a larger β means that the population cares more about the environment, which raises the incentive to tax incomes in order to finance public expenditure on the environment. On the other hand, a larger π makes green consumption costlier, thereby lowering it. Thus, taxation and public provision of the environment should increase as compensation.

We can next discuss the role of (μ, σ), for given (π, β) (Appendix A.1).

Corollary 1. *If $\beta \geq \hat{\beta}(< 1)$ defined by $e^{\frac{2\hat{\beta}}{1+2\hat{\beta}}} = 1 + 2\hat{\beta}$, then the RHS of (10) is decreasing in k for all $k > 2$. Else, there exists a unique $\hat{k} > 2$ such that for all $k > \hat{k}$, the RHS of (10) is decreasing in k.*

Under the conditions of Corollary 1 ($\beta \in [\hat{\beta}, 1)$, or $\beta < \hat{\beta}$ and $k > \hat{k}$), and given that k is decreasing in σ but increasing in μ, we observe that the existence of the political equilibrium is more likely when the level of inequality (respectively the average income) is

[27] Following a tradition that finds its origin in Sociology, scholars run surveys that include a series of questions to elicit respondents' WTP for environmental protection, knowledge about environmental issues, and so on and so forth. For an interesting work representative of this line of research, see Franzen and Meyer (2009).

sufficiently low (respectively high). This will prove useful in the coming analysis where our aim is precisely to explain how public policy responds to these two statistics of the income distribution.

4.3 Impact of a change in the income distribution

This section examines the change in the equilibrium tax resulting from 1/ a variation in the average income, taking the standard deviation as given, and 2/ a variation of the standard deviation taking the average income as given (mean preserving spread, MPS). Our analysis, summarized in the Appendix A.2, leads to the following results:

Proposition 2.

- *There exists a critical tax rate $t^s < 1$, with*

$$t^s = 1 - w_m^{-1} \gamma \pi \exp^{-\frac{\beta}{1+\beta k}},$$

  such that an increase in the standard deviation induces a decrease in the equilibrium tax, t^p, for given average income, if and only if $t^p > t^s$.

- *Under the conditions of Corollary 1, $t^s < t^l$: The impact on a MPS is negative whatever the equilibrium tax.*

- *Under the same conditions, an increase in the average income translates into an increase in the equilibrium tax, t^p, for given standard deviation.*

We find that countries with a high average income levy a larger fiscal revenue to finance environmental quality than countries with lower average income. This outcome is very much in line with the stylized facts presented in the Introduction. A change in μ has repercussions on all the components of marginal welfare (9), especially on the MB through a tax base effect (see the last term in (9)). Dissecting the various channels through which μ impacts $W'(t^p)$ would be an interesting yet unnecessary exercise. Indeed, the comparative statics result is unambiguous, and the analysis would share many similarities with what comes next.

Hereafter, we focus on the interpretation of the impact of a MPS, captured by a change in the standard deviation.[28] This induces changes in both the distribution of the population between the two groups (size effect) and within each group (composition effect). In fact, it affects all of the marginal cost components, MC^i for $i = e, g, n$, of the trade-off captured by (9). So we have to disentangle the different effects playing on the different groups. By definition, the size effect pushes in opposite direction: if N^g decreases, then MC^n increases and, everything else equal, MC^g (and $MC^e = \beta MC^g$) decreases. Now, we can show that $\frac{\partial N^g}{\partial \sigma} < 0$ is equivalent to:

$$N^g(t^p) > \exp^{-\frac{k}{k-1}} . \tag{11}$$

It would be possible to develop further this condition but it is intuitively very appealing: higher inequalities are associated with a smaller group G if and only if its initial size is pretty high. Under condition (11), the composition effect also comes into play for group G. The higher the inequality, the larger the group of the wealthiest people. As a result, the average marginal cost necessarily increases as σ increases. The balance between these two effects is therefore unclear. But, it is shown to be negative if and only if:

$$N^g(t^p) > \exp^{-\frac{k(k-2)}{(k-1)^2}} . \tag{12}$$

This means that under condition (12), the cost of environmental policy increases for group N but decreases for group G, and so does the environmental cost. In this situation, the conditions of Corollary 1 ensure that the overall marginal cost increases, which induces a decrease in the tax rate in the equilibrium. Interestingly, this is the case when the initial

[28] In fact, working with a constant mean, a variation of σ exactly corresponds to a variation of the coefficient of variation, that is a measure of the level of inequality. It is different yet positively correlated to the *Gini index*, which is used in the empirical analysis.

level of inequality is low to moderate, which perfectly echoes our empirical result.[29]

Let us now conclude the discussion by explaining how green consumption, by allowing for the substitution between private consumption and public policy, is the key mechanism behind our results. The level of the critical income, $\tilde{w}(.)$, determines whether only rich people, or rich and medium income people, consume the green good. Accounting for the negative correlation between per capita income and inequality, that is, between μ and σ, in European countries (Pearson correlation coefficient of -0.3355, $p - value = 0.000$), two cases have to be envisioned: an initially low σ/high μ *vs* the opposite. With a high μ, $\tilde{w}(.)$ is high, which implies that green consumption is limited to rich people. But a high μ is also accompanied by a high equilibrium tax and a high level of public spending. There is a substitution effect at work: the fact that rich people only consume the green good is "compensated by" the high level of public spending (to meet the social demand). In this situation, following an MPS, the middle-income class shrinks, whereas the number of people located at both tails of the income distribution rises (there are more rich and more poor people at the same time). The increase in the number of rich people tends to stimulate green consumption, whereas the decrease in the middle class is innocuous. The overall impact of the MPS on private green consumption is expected to be positive. Then, according to the substitution effect, lower level of public environmental spending is needed. This is the reason why the effect of income inequality on policy turn out to be negative for high level of GDP and low level of inequality.[30]

[29]Note that condition (12) is stronger than (11), thus there are in general three cases. The same conclusion is reached in the two other cases. Under the opposite of the inequality (11), we get opposite results as to the impact on groups G and N but the overall impact of inequality on environmental policy is negative. Under (11) and opposite of inequality (12), all the marginal costs increase.

[30]The analysis of the second case follows by symmetry.

5 Conclusion

In this paper, we have investigated the nature of the interaction between income distribution and environmental policy. We first conduct an empirical investigation of the relationship between income distribution and environmental policy, for European countries over the period 1995-2021. The dependent variable corresponds to government public expenditure on environmental protection. We analyze the impact of the *Gini index* on this policy variable using an empirical model accounting for potential non-linearity. Results show the existence of a negative and convex relationship between inequality and environmental spending as well as a negative relationship between organic (green) consumption and public policy.

We then develop an original political economy model that helps to explain the factors that shape the relationship between income inequality and environmental protection policy. Among the key factors is the opportunity for people to choose between conventional and green consumption, and to vote for environmental policy. Both decisions are dictated by individuals' income capacities, while both green consumption and environmental public expenditure enhance environmental quality. Our analysis shows that a change in the level of inequality induces variations in the size and composition of the two groups of citizens, those who consume green and those who do not. Their respective importance, in turn, determines whether such a change stimulates public policy. We provide some conditions under which it is possible to conclude that inequality impairs environmental policy.

In future research, it would be interesting to include the different political powers in the hands of socio-economic groups to understand how this could affect the outcome of the electoral process and resulting public policy. Such analysis would contribute to the literature discussing how political power and conflict among opposing interest groups shape the design of environmental policy.

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A Appendix

A.1 Proof of Proposition 1

The first order derivative of the welfare function (9) can be rewritten as:

$$W'(t) = \beta\mu - \frac{\gamma}{1-t}\left(1 + \frac{1+\beta k}{k-1} N^g(t)\right). \tag{13}$$

with $N^g(t) = \left(\frac{w_m}{\tilde{w}(t)}\right)^k$. Given that $N^{g\prime}(t) = -\frac{k}{1-t}N^g(t)(<0)$, we get:

$$W''(t) = -\frac{\gamma}{(1-t)^2}[1 - (1+\beta k)N^g(t)],$$

Then, $W''(t) < 0$ is equivalent to

$$t > t^l \text{ with } t^l = 1 - w_m^{-1}\gamma\pi\,(1+\beta k)^{-\frac{1}{k}}.$$

and one may note that $t^l > (\leq) 0$ if and only if $w_m > (\leq)\gamma\pi\,(1+\beta k)^{-\frac{1}{k}}$.

Next, we can easily verify that $\lim_{t\to 1} W'(t) = -\infty$. Assuming $t^l > 0$, a necessary and sufficient condition for existence is: $W'(t^l) > 0$. This is equivalent to:

$$\beta\pi > (1+\beta k)^{\frac{1}{k}} \equiv g(k).$$

This completes the proof of Proposition 1.

Finally, the first order derivative of $g(k)$, for $k \in (2, \infty)$,

$$g'(k) = \frac{(1+\beta k)^{\frac{1}{k}}}{k^2}\left[-\ln(1+\beta k) + \frac{\beta k}{1+\beta k}\right],$$

is negative if and only if

$$\beta k > h(x(k)) \text{ with } h(x(k)) = x(k)\exp^{x(k)} \text{ and } x(k) = \frac{\beta k}{1+\beta k} \in \left(\frac{2\beta}{1+2\beta}, 1\right).$$

Because $x'(.), h'(.) > 0$, $x''(.) < 0$, $h''(.) > 0$ ($h(x(k))$ convex in k), and $h(1) < \infty$, $g'(k)$ is always negative for $k > 2$ if $2\beta \geq h(x(2))$, which is equivalent to

$$\beta \geq \hat{\beta} \text{ with } \hat{\beta} \text{ such that } 1 + 2\hat{\beta} = \exp^{\frac{2\hat{\beta}}{1+2\hat{\beta}}}.$$

Otherwise ($2\beta < h(x(2)) \Leftrightarrow \beta < \hat{\beta}$), there exists a unique $\hat{k}$ such that $\beta\hat{k} = h(x(\hat{k}))$ and $\beta k > h(x(k))$ for all $k > \hat{k}$. This completes the proof of Corollary 1.

A.2 Proof of Proposition 2

First, we express the two parameters of the Pareto distribution in terms of the average, μ, and standard deviation, σ: $w_m(\mu, \sigma) = \frac{(k(\mu,\sigma)-1)\mu}{k(\mu,\sigma)}$ and $k(\mu, \sigma) = 1 + \sqrt{1 + \left(\frac{\mu}{\sigma}\right)^2}$, and after some computations, we obtain: $\frac{\partial w_m}{\partial \mu}, \frac{\partial k}{\partial \mu} > 0$, and $\frac{\partial w_m}{\partial \sigma}, \frac{\partial k}{\partial \sigma} < 0$.

Next, using (13), the total differentiation of $W'(t^p) = 0$ yields:

$$W''(t^p)dt^p = -\beta d\mu + \frac{\gamma}{1-t^p}\left[-\frac{1+\beta}{(k-1)^2}N^g dk + \frac{1+\beta k}{k-1}\left(\frac{\partial N^g}{\partial w_m}dw_m + \frac{\partial N^g}{\partial k}dk\right)\right]. \quad (14)$$

Hereafter, we study the impact of a mean preserving spread (MPS): change $d\sigma > 0$ taking $d\mu = 0$. Then we turn to the analysis of a change in μ keeping σ constant.

A.2.1 Mean preserving spread

Under a MPS, the joint variation of w_m and k satisfies: $\frac{dk}{dw_m} = \frac{k(k-1)}{w_m}$. Using this relationship in (14), we get:

$$\frac{dt^p}{d\sigma} = \frac{\gamma N^g(t^p)}{(k-1)(1-t^p)W''(t^p)}\left[\beta + \frac{1+\beta k}{k}\ln N^g(t^p)\right]\frac{dk}{d\sigma}.$$

So, we immediately obtain that $\frac{dt^p}{d\sigma} < 0 \Leftrightarrow N^g(t^p) < \exp^{-\frac{\beta k}{1+\beta k}}$, which is equivalent to:

$$t > t^s \equiv 1 - \gamma\pi w_m^{-1} \exp^{-\frac{\beta}{1+\beta k}},$$

which completes the second part of the proof of Proposition 2.

As to the third part, it is easy to check that $t^s < t^l$ if and only if $h(x(k)) < \beta k$. From Corollary 1, we know that this ranking holds true when $\beta < \hat{\beta}$, or when $\beta \in [\hat{\beta}, 1)$ and $k(\mu, \sigma) > \hat{k}$.

A.2.2 Average income variation (constant standard deviation)

We combine $d\mu > 0$ and $d\sigma = 0$, the latter restriction imposing $\frac{dk}{dw_m} = \frac{k(k-1)(k-2)}{w_m(k-1+k(k-2))}$ and from the definition of the μ, $d\mu = \frac{(k-1)}{k(k-2)}\mu dk$. Substituting these relations into (14) and rearranging, we get:

$$W''(t^p)dt^p = \left[-\frac{\beta(k-1)}{k(k-2)}\mu + \frac{\gamma}{1-t^p}\frac{N^g(t^p)}{k-1}\left(\frac{(k-1)(1+\beta k)}{k-2} + \beta + \frac{1+\beta k}{k}\ln N^g(t^p)\right)\right] dk$$

Making use of (13), the latter expression can then be rewritten as:

$$\frac{dt^p}{d\mu} = \frac{\gamma}{(1-t^p)W''(t^p)}\left[\frac{k-1}{k(k-2)}\left((1+\beta k)N^g(t^p) - 1\right) + \frac{N^g(t^p)}{k-1}\left(\beta + \frac{1+\beta k}{k}\ln N^g(t^p)\right)\right]\frac{dk}{d\mu}.$$

We can finally conclude that the two terms between square brackets are negative. The negativity of the first term comes from the concavity of $W(t)$, while the conditions for the second term to be negative have been set in Appendix A.2.1. This completes the proof of the third claim in Proposition 2.

B Data sources

Data comes from Eurostat (the statistical office of the European Union), the Research Institutes of Organic Agriculture (FiBL), and the Environmental Performance Index (EPI), developed by the Yale Center for Environmental Law and Policy (YCELP) and the Center for International Earth Science Information Network (CIESIN) at Columbia University.

The Eurostat dataset provides the general and local government expenditure by functions and by type of institution. In this dataset there are data for 31 European countries over the period 1995-2021. We study the following countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom. Variables are extracted from *gov_10a_exp*. According to the European System of Accounts (ESA), general governments are *"institutional units which are non-market producers whose output is intended for individual and collective consumption, and are financed by compulsory payments made by units belonging to other sectors, and institutional units principally engaged in the redistribution of national income and wealth"*. Local government are: *"public administration whose competence extends to only a local part of the economic territory, apart from local agencies of social security funds."* All monetary variables are expressed in per capita terms. Data for GDP per capita, Gini index, population size and density also come from the Eurostat dataset and can be downloaded on the following link `https://ec.europa.eu/eurostat/web/main/data/database`.

From the Research Institutes of Organic Agriculture (FiBL), we collect data for organic consumption per capita. This variable is built as the organic retail sales per inhabitant. Are included all products with an organic certification within the country. Data for the European countries and the world are available at `https://statistics.fibl.org/data.html`.

From the Environmental Performance Index (EPI) dataset we take three variables, one of which is included in one of the three policy objectives of the EPI: Recycling (REC) for the policy objective *Environmental Health*, Sustainable Nitrogen Management Index (SNM), for the policy objective *Ecosystem Vitality*, and Greenhouse Gas Emissions per Capita for the policy objective *Climate Change*. See https://epi.yale.edu/epi-results/2023/component for definitions and values.

C Statistical tests and robustness analysis

Table 6 summarizes the main tests implemented during the analysis.

Table 6: Specification tests

Test	Gen gov EEP	Loc Gov EEP
Hausman test H0: random vs fixed	$\chi^2(10) = 30.09$ $Pr > \chi^2 = 0.0004$	$\chi^2(10) = 21.20$ $Pr > \chi^2 = 0.0118$
Time-fixed effects test H0: No time dummies	$F(21, 370) = 3.03$ $Pr > F = 0.0000$	$F(21, 369) = 1.93$ $Pr > F = 0.0087$
Modified Wald test H0: $\sigma(i)^2 = \sigma^2 \forall i$	$\chi^2(24) = 4538.74$ $Pr > \chi^2 = 0.0000$	$\chi^2(28) = 6828.12$ $Pr > \chi^2 = 0.0000$
Wooldridge test H0: no first-order autocorrelation	$F(1, 23) = 19.182$ $Pr > F = 0.0002$	$F(1, 23) = 8.237$ $Pr > F = 0.0087$
Sargan-Hansen test H0: random vs fixed (robust)	$\chi^2(9) = 59.446$ p-value = 0.0000	$\chi^2(9) = 89.748$ p-value = 0.0000
Pesaran's test H0: cross sectional independence	6.77 $Pr = 0.0000$	5.72 $Pr = 0.0000$
Test of presence of a U-shape H0: monotone or inverse U-shape	t-value=4.65 $P > \|t\| = 0.0001$	t-value=3.12 $P > \|t\| = 0.0026$
Ramsey Reset test H0: functional form specification	F(2,23)=3.51 $Pr > F = 0.0466$	F(2,23)=1.43 $Pr > F = 0.2598$

Note: to perform the Hausman test, we have scaled the variable population growth (x10) to obtain coefficients on a similar scale.

We implement some robustness tests to confirm the main empirical results provided in the main text of the paper. In the first robustness test, we consider another dependent variable: the local government EEP. Overall, we obtain the same qualitative results as those found with general government EEP per capita. We report in Table 6 the results of the statistical tests for this policy variable and in Table 7 the estimated coefficients considering, in columns (1) to (4), the coefficients for the Driscoll-Kraay standard errors based on the controls we include. In the first column there are no controls, in the second column we add the population variables, in the third, we include the EPI indicators, and in the fourth the organic consumption. Column (5) reproduces the results of the fourth column with cluster-robust standard errors. As for general EEP, the coefficients for $Gini$ and $Gini^2$ show a significant convex and negative correlation between inequalities and local government environmental spending. The GDP per capita has a positive and significant effect on local government expenditures in all specifications with Driscoll-Kraay standard errors, as suggested by our theoretical results. As in previous regressions, the introduction of controls, and especially the environmental ones, increases the quality of the model, as suggested by the value of the within R^2.

However, there are some differences from the main analysis. First of all, the EPI variables are now significant. We find significant coefficients for GHP, which is an indicator that captures the position of the country in terms of emission of GHG per capita: the higher the value, the lower the emissions per capita. We obtain the same results for SNM that we obtain in the main section, *i.e.* a higher value of this indicator and, therefore, a better use of fertilizer in agriculture is associated with a higher local government EEP per capita. Therefore, we find that the better the environmental policies, the higher the local government EEP per capita. However, we find a negative and significant coefficient for REC in column (3). This variable captures the share of waste that is recycled in a country and thus a similar phenomenon to organic consumption, which is the effect of private participation in environmental quality. However, the coefficient for organic consumption is never significant when the dependent variable is local government EEP.

Table 7: Local government EEP per capita

	(1)	(2)	(3)	(4)	(5)
Gini	-0.242***	-0.228**	-0.257***	-0.239***	-0.239***
	(0.0816)	(0.0893)	(0.0779)	(0.0687)	(0.0809)
$Gini^2$	0.00431***	0.00410**	0.00443***	0.00423***	0.00423***
	(0.00149)	(0.00160)	(0.00138)	(0.00118)	(0.00128)
GDP	0.569***	0.481**	0.767***	0.454**	0.454
	(0.193)	(0.226)	(0.202)	(0.214)	(0.381)
Density		-0.000307	-0.000563*	0.00209	0.00209
		(0.000292)	(0.000315)	(0.00144)	(0.00468)
Δpop		0.487**	0.328*	0.239	0.239
		(0.222)	(0.161)	(0.158)	(0.446)
REC			-0.102**	-0.0323	-0.0323
			(0.0412)	(0.0536)	(0.0872)
SNM			0.0110***	0.0116***	0.0116***
			(0.00199)	(0.00196)	(0.00266)
GHP			0.0100***	0.0126***	0.0126*
			(0.00350)	(0.00351)	(0.00687)
Organic				0.0283	0.0283
				(0.0469)	(0.0543)
Year	YES	YES	YES	YES	YES
N	564	527	527	423	423
R^2_w	0.367	0.367	0.429	0.387	0.387

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

In a second robustness test, we perform the analysis for higher-order polynomials of the Gini-index. This can help better capture the non-linear relationship between inequality and environmental policy. Results are presented in table 8. We find significant coefficients for all Gini Index variables, including $Gini^3$. However, the coefficients are now much larger for $Gini$, with values ranging from -1.56 to -1.15 compared to the coefficients obtained in previous regressions -0.27 to -0.15. As for the other coefficients, the results remain the same in terms of sign and magnitude, for GDP, SNM and organic consumption. This regression confirms that the relationship between government EEP per capita and inequalities is characterized by a negative non-linear relation.

In a third robustness test we perform the analysis considering the current Gini, that

Table 8: High-order Gini

	(1)	(2)	(3)	(4)	(5)
Gini	-1.241***	-1.355***	-1.347***	-1.556***	-1.556*
	(0.339)	(0.372)	(0.332)	(0.351)	(0.776)
$Gini^2$	0.0395***	0.0433***	0.0425***	0.0509***	0.0509*
	(0.0120)	(0.0133)	(0.0118)	(0.0132)	(0.0277)
$Gini^3$	-0.000408***	-0.000451***	-0.000438***	-0.000546***	-0.000546
	(0.000137)	(0.000153)	(0.000137)	(0.000161)	(0.000326)
GDP	0.500***	0.341**	0.554***	0.380*	0.380
	(0.120)	(0.143)	(0.158)	(0.214)	(0.368)
Density		-0.000255	-0.000412	0.000534	0.000534
		(0.000322)	(0.000471)	(0.00194)	(0.00601)
Δpop		0.610**	0.489**	0.428*	0.428
		(0.217)	(0.180)	(0.211)	(0.410)
REC			-0.0427	0.0512	0.0512
			(0.0407)	(0.0677)	(0.103)
SNM			0.00915***	0.00897***	0.00897***
			(0.00159)	(0.00248)	(0.00266)
GHP			0.01000**	0.00855*	0.00855
			(0.00433)	(0.00491)	(0.0121)
Organic				-0.0717**	-0.0717
				(0.0279)	(0.0450)
Year	YES	YES	YES	YES	YES
N	563	526	526	424	424
R^2_w	0.492	0.494	0.532	0.532	0.532

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

is without introducing a lag of 5 years. The results in Table 9 are again robust and the regressions in columns (1) to (3) are very significant with the within R^2 nearing 0.7. The only difference that we observe is relative to the GDP per capita in columns (1) to (3), which now presents a higher coefficient than in the previous analysis when the Gini was lagged. When we add the organic consumption per capita in column (4), we find a coefficient for GDP per capita closer to the previous results and significant results for organic consumption per capita.

Our fourth robustness test consists of checking how robust the results are to alternative measures of inequality. We consider the share of income of the top 10% of the population.

Table 9: General government EEP per capita with current Gini

	(1)	(2)	(3)	(4)	(5)
Gini	-0.249**	-0.238**	-0.263***	-0.232***	-0.232*
	(0.0976)	(0.102)	(0.0816)	(0.0591)	(0.118)
$Gini^2$	0.00409**	0.00392**	0.00419***	0.00358***	0.00358*
	(0.00168)	(0.00172)	(0.00142)	(0.000991)	(0.00179)
GDP	1.202***	1.223***	1.187***	0.409*	0.409
	(0.0677)	(0.0689)	(0.0477)	(0.220)	(0.397)
Density		-0.000114	0.000383	-0.000549	-0.000549
		(0.000312)	(0.000455)	(0.00127)	(0.00659)
Δpop		-0.377*	-0.379*	0.223	0.223
		(0.185)	(0.184)	(0.194)	(0.458)
REC			0.0236	0.0165	0.0165
			(0.0362)	(0.0564)	(0.105)
SNM			0.00928***	0.0108***	0.0108***
			(0.00214)	(0.00227)	(0.00329)
GHP			0.00579	-0.00158	-0.00158
			(0.00539)	(0.00605)	(0.0115)
Organic				-0.0738**	-0.0738
				(0.0340)	(0.0469)
Year	YES	YES	YES	YES	YES
N	718	666	666	436	436
R^2_w	0.687	0.688	0.705	0.520	0.520

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

It is directly obtained from the Eurostat dataset. As for *Gini index*, we include a lag of 5 years. The results are presented in Table 10 and we also take the square of these dependent variables. We find very similar results for the inequality variables, however, for the controls, results are not significant for population density and population growth (in columns (4) and (5) with organic consumption). As in the main regressions, we obtain significant coefficient for SNM, but not for the other environmental controls.

We also test the results by restricting the period of analysis to control for the effect of COVID. We expect those results to be less significant because of the reduction in the number of observations. Table 11 presents the results for the period 1995 to 2019. We can see here that the coefficients remain the same, except for the organic consumption, which

Table 10: EEP per capita using an alternative measure of inequality

	(1)	(2)	(3)	(4)	(5)
$\%Income\,10^{th}dec.$	-0.330***	-0.280**	-0.334***	-0.406**	-0.406**
	(0.113)	(0.113)	(0.104)	(0.149)	(0.159)
$Sq.\%Income\,10^{th}dec.$	0.00655**	0.00544**	0.00653***	0.00816**	0.00816**
	(0.00234)	(0.00234)	(0.00212)	(0.00301)	(0.00317)
GDP	0.256*	-0.0202	0.210	0.0688	0.0688
	(0.136)	(0.132)	(0.139)	(0.189)	(0.303)
$Density$		0.000171	0.000226	0.00250	0.00250
		(0.000260)	(0.000313)	(0.00188)	(0.00534)
Δpop		0.588***	0.477**	0.251	0.251
		(0.204)	(0.185)	(0.232)	(0.472)
REC			-0.0391	0.0780	0.0780
			(0.0623)	(0.0794)	(0.151)
SNM			0.00860***	0.00835***	0.00835***
			(0.00182)	(0.00194)	(0.00186)
GHP			0.00350	0.00267	0.00267
			(0.00355)	(0.00490)	(0.00925)
$Organic$				-0.0179	-0.0179
				(0.0288)	(0.0513)
$Year$	YES	YES	YES	YES	YES
N	468	431	431	359	359
R^2_w	0.498	0.507	0.547	0.548	0.548

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-5) and Cluster-robust (6) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

is not significant. This might be explained by the smaller number of observations. As for the relationship between inequalities and general government EEP per capita, we obtain negative coefficients for $Gini$ and positive coefficients for $Gini^2$. Therefore, even when we take into consideration the short-term shocks, our main results remain significant. This is also probably explained by the fact that most of the environmental policies are not linked to short-term decisions and that we consider a lag in inequalities variables.

Table 11: General government EEP per capita (until 2019)

	(1)	(2)	(3)	(4)	(5)
$Gini$	-0.241***	-0.268***	-0.295***	-0.274***	-0.274**
	(0.0350)	(0.0351)	(0.0362)	(0.0514)	(0.110)
$Gini^2$	0.00410***	0.00450***	0.00480***	0.00450***	0.00450**
	(0.000625)	(0.000625)	(0.000597)	(0.000846)	(0.00173)
GDP	0.591***	0.405*	0.656***	0.421	0.421
	(0.156)	(0.214)	(0.227)	(0.284)	(0.474)
$Density$		-0.00104**	-0.00151*	-0.00104	-0.00104
		(0.000439)	(0.000813)	(0.00219)	(0.00735)
Δpop		0.718**	0.593**	0.470**	0.470
		(0.254)	(0.213)	(0.173)	(0.437)
REC			-0.0436	0.0379	0.0379
			(0.0515)	(0.0742)	(0.109)
SNM			0.00871***	0.00873***	0.00873***
			(0.00156)	(0.00211)	(0.00285)
GHP			0.0127*	0.00907	0.00907
			(0.00632)	(0.00550)	(0.0111)
$Organic$				-0.0530	-0.0530
				(0.0336)	(0.0433)
$Year$	YES	YES	YES	YES	YES
N	503	472	472	378	378
R^2_w	0.431	0.434	0.473	0.466	0.466

Notes: ***p<0.01 **p<0.05 *p<0.10. Driscoll-Kraay (1-4) and Cluster-robust (5) standard errors are in parentheses. All regressions include country fixed effects. Year represents the time fixed effect. The dependent variable, GDP per capita and organic consumption per capita are expressed in log.

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