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RESEARCH ARTICLE

Freedom of the press, inequality and environmental policy

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Abstract

This paper contributes to the literature on the determinants of environmental standards by studying the role of income inequality and freedom of the press. Given that evidence of the environmental Kuznets curve has only been found for some countries, it is thus crucial to investigate whether other factors besides income per capita levels may be affecting countries' decisions to pass environmentally-friendly legislation. We investigate the effects that inequality and freedom of the press have on environmental stringency for a sample of OECD and BRIICS countries and a global sample of 82 countries using data over the period 1994–2015. We hypothesize that the more unequal a society is, and the greater the oppression of the press is, the less stringent environmental policies are. The results partially confirm our hypothesis. In particular, lack of press freedom is negatively correlated with environmental stringency, whereas inequality shows a non-linear effect only for non-high-income countries.

Keywords: environmental Kuznets curve; environmental stringency; freedom of the press; inequality; panel data

JEL Classification: Q0; Q1; Q3; Q50; Q56

1. Introduction

Whereas numerous studies have investigated the effects of economic growth on the environment (Beckerman, 1992; Grossman and Krueger, 1995; Stern *et al.*, 1996; and Stern, 2004, 2017; among others), less attention has been given to other factors relating to a country's income level, in particular inequality levels and freedom of the press, which can potentially affect pollution levels and environmental policies (Barrett and Graddy, 2000; Coondoo and Dinda, 2008; Grunewald *et al.*, 2017). While Barrett and Graddy (2000) focused on freedom of the press, Magnani (2000), Coondoo and Dinda (2008) and Grunewald *et al.* (2017) focused on income distribution and inequality. To the best of our knowledge, the two aspects have not been considered simultaneously in the corresponding empirical literature, despite the fact of being related. Additionally, the theories explaining why some countries have largely embraced environmental policies while others have been more reluctant have scarcely been investigated.

We propose bridging this gap in the literature by studying the effects of inequality and freedom of the press on environmental standards in developed and developing countries. The main novelty of this paper is to use the Gini coefficient as the measure of inequality, and the level of freedom of the press as a proxy for civil liberties, to investigate the effects these factors might have on the level of environmental stringency and on environmental policy, for the years 1994–2015, using a sample of OECD + BRIICS[1] countries and a global sample comprising 82 countries. We hypothesize that the more unequal a society is, and the greater the oppression of the press is, the less stringent environmental policies are. A possible explanation for this could be that more people will vote for policies that will increase their economic wealth rather than policies that increase environmental quality, in order to catch up to the perceived income norm.

In general, our results suggest that both variables – inequality and press freedom – show significant correlations with environmental policy, but the results are more nuanced than initially suspected. In particular, we find that only for non-high income countries is increasing inequality negatively correlated with stringency of environmental regulation, which is potentially detrimental for environmental quality. The results for environmental tax revenues, however, are less robust. With respect to press freedom, we find that it is significantly and positively correlated to environmental stringency and to environmental tax revenues. This indicates that freedom of the press makes it more likely that people accept a monetary loss to the benefit of the environment. This is especially relevant for non-rich countries, for which the results show a more robust effect.

The rest of the paper is organized as follows. Section 2 revises the closely-related literature and section 3 describes the main data and variables. The empirical model is specified in section 4, where the main results are also presented and discussed. Finally, section 5 concludes.

2. Literature review

In this section we summarize the literature that is closely related to the focal relationships studied in this paper, namely those between environmental degradation, income and income inequality, freedom of speech and environmental regulations.

We start by briefly referring to the vast literature on the environmental Kuznets curve (EKC) linking environmental degradation with income per capita. In general, the consensus on the EKC is unclear because the findings vary greatly depending on the years examined, the pollutants investigated, and the countries considered (Grossman and Krueger, 1995). Stern (2004) reviews the EKC literature and finds that developing countries have already acknowledged the detrimental effects of environmental degradation and started to take action in the late 1990s, disregarding the EKC's hypothesis stating that environmental quality would improve without the need for policy actions when a certain level of GDP per capita is reached. The author highlights the weak statistical foundation on which the EKC stands and proposes that the new decomposition and efficient frontier models can help reveal the true relationship between GDP per capita and environment (Stern, 2004). The more recent literature indicates that an EKC is expected for local pollutants, but not necessarily for global ones, such as CO_2 (Carlsson and Lundström, 2003; Carson, 2010; Stern, 2017). Carson (2010) suggests that the focus should be

[1]The BRIICS countries are Brazil, Russia, India, Indonesia, China and South Africa.

shifted to investigating the transmission channels that affect the income-environment relationship and Stern (2017) concludes that other factors rather than economic growth have been reducing pollution. For instance, environmental policies and regulations are especially relevant for global public goods as in the case of reducing global warming.

A number of authors have argued that environmental degradation is not only related to income per capita but also to income inequality (Boyce, 1994; Scruggs, 1998; Magnani, 2000; Grunewald *et al*., 2017). The argument was already put forward in the 1990s. Boyce (1994) shows that when power and wealth are greatly unequal, higher levels of environmental degradation result. Boyce uses the term 'power-weighted social decision rule' to describe his hypothesis that if the winners are very powerful and the losers have in comparison very little power, then more environmental degradation will occur. Boyce (1994) shows that this is theoretically possible, as long as the winners benefit in the long run.

Scruggs (1998) challenges Boyce's (1994) paper by reinvestigating whether lower levels of inequality always lead to lower levels of environmental degradations, finding that this depends on several factors. Scruggs argues that Boyce's argument is incorrect because it assumes that as a person's income increases, his or her demand for environmental degradation also increases, and this is often not the case. Contrary to Boyce (1994), Scruggs (1998) also argues that the democratic social choices are not always the best solutions for public goods problems and the main outcomes depend on the distribution of preferences among different income groups and the role of the institutions in the country. Even if a country is more democratic, it does not mean that the best decisions are always made. Scruggs (1998) concludes that it is a combination of factors that in the end leads to more ecological decisions.

Magnani (2000) adds inequality as an additional determinant of environmental quality in an EKC framework, arguing that it is mainly a relative income effect, and the political framework of the countries that determine the policy decisions that are taken in a country. Moreover, she stresses the importance of appropriately controlling for unobserved country heterogeneity. Unobserved country heterogeneity could be present, because individuals in different countries react to price and income effects in dissimilar ways. Moreover, there could be other unobserved cultural determinants of environmental outcomes. Magnani (2000) uses as environmental outcome OECD data on public R&D expenditure for environmental protection for the years 1980–1991. She finds that the income distribution functions differently in predicting environmental degradation from what would be expected by the EKC.

Magnani (2000) also investigates if relative income effects could cause the turning point in the EKC. If individuals are more concerned with how much wealth they have compared to other citizens, as opposed to how high their income level is in absolute terms, then we would expect the income distribution to also have an effect on the tipping point of the individuals. The results from Magnani's analysis show support for her hypothesis that inequality affects public environmental expenditure. Although a negative correlation was found between public environmental expenditure and inequality, the results were not robust. Furthermore, Magnani (2000) also considered the inequality ratios – that is, the 20 to 80 per cent ratio and the 10 to 90 per cent ratio – and finds that these ratios have a negative and significant effect on public environmental expenditure. The effect of inequality on emissions has been further investigated in Grunewald *et al.* (2017). The authors applied a new estimator that endogenously groups countries according to data and allows for group-specific linear trends in the dependent variable, group fixed effects, and is less demanding in terms of degrees of freedom and variability within units and over time of the target variables than a fixed effects estimator. Their findings indicate that higher income inequality is associated with lower carbon emissions for low- and middle-income economies, while for upper-middle- and high-income economies, higher inequality increases emissions.

The motivation to incorporate a measure of freedom of the press in this modeling framework stems from Barrett and Graddy (2000) who extended Grossman and Krueger's (1995) proposed model by adding political freedom variables. They argue that for citizens to demand higher levels of environmental quality as their income increase, they have to be able to acquire information and to give voice to their preferences for environmental quality. Moreover, governments also need to have incentives to satisfy this demand. For these reasons, measures of civil and political freedoms should be included as explanatory variables of environmental quality. In a similar fashion, Torras and Boyce (1998) hypothesize that it is the distribution of power that contributes to different levels of environmental quality in different countries. They use water and air quality from the Global Environment Monitoring System data set, and access to safe water and sanitation facilities from the national sources, as their dependent variables. Their independent variables include per capita income measured in real purchasing power parity, income inequality measured with the Gini coefficient, literacy rates, political rights and civil liberties from a combination of two variables from Finn (1996), and urbanization. The authors find that in poor countries, literacy, civil liberties, and political rights affect environmental quality (Torras and Boyce, 1998). They also find that the best functional form to describe the relationship in rich countries is cubic – in per capita income – suggesting that at very high levels of income, pollution levels start to increase again (Torras and Boyce, 1998).

The fact that the paths of rich countries and poor counties have developed so differently shows the likelihood of an omitted variable problem. While rich countries have tended to decrease in pollution levels over time, this same trend cannot be found for lower income countries (Roberts and Grimes, 1997). Many different factors have been considered, including population density (Cropper and Griffiths, 1994) and openness to trade (Suri and Chapman, 1998). Cropper and Griffiths show that decreasing the population growth rate is not necessarily the best way to proceed in order to decrease pollution levels, and Suri and Chapman show how the export of manufacturing goods has contributed to rich countries producing more pollution. Magnani and Tubb (2008) test whether an ageing population has any effect on environmental outcomes, finding that an ageing population may impact the incipient pollution through lifestyle changes while negatively affecting abatement due to either government budget constraints or personal preferences. Given that the relationships between these other variables and environmental degradation have not been conclusive, it is crucial to further investigate other factors.

3. Data and variables

We use two different measures of environmental policy in the empirical section. The first dependent variable that is analyzed is taken from the OECD Environmental Policy Stringency Index (Botta and Koźluk, 2014) and is available for 33 countries over the period 1990–2015 (see appendix table A1, sample 1). This dataset was created by the OECD to internationally compare environmental stringency levels using a six-point scale where 0 is not stringent and 6 is very stringent. To build the index, the OECD looked at 14 different environmental policy instruments that primarily relate to climate and air pollution. A detailed report on the composition of this measure can be found in

Botta and Koźluk (2014). We hypothesize that there is a negative relationship between inequality and environmental stringency.

The second dependent variable considered is from the OECD Environment Database – Instruments used for Environmental Policy (OECD, 2016), also known as the Policy Instruments for the Environment (PINE) database. The database contains information on environmentally-related tax revenue as a percentage of total tax revenue, as a percentage of GDP, and tax revenue per capita from 1994–2015 (OECD, 2017). It was created using a combination of quantitative and qualitative information on different countries' tradable permits, environmentally-motivated subsidies, fees and charges, deposit-refund systems, voluntary approaches used for managing natural resources, and environmentally-related taxes. Although the dataset is from the OECD, it contains data for 82 countries, listed in table A1 in the appendix (sample 2). The additional countries ensure that our data set is not very homogenous in terms of income per capita.

Freedom House compiles the lack of freedom of the press indicator, which is measured on a 100-point scale, with 0 representing having total freedom and 100 representing no freedom.[2] The organization calculates each country's numeric value using a base of 23 methodical questions. The data is collected through field research, professional contacts, reports from NGOs and governments, as well as from the domestic and news media. This variable is an important addition to the study as it indicates the access to reliable information. In order for the populous to vote for politicians that support the green movement, the citizens must first be informed about the threats of climate change and the essential role that the government plays in fighting against these risks. We hypothesize that there is a positive relationship between environmentally-friendly legislation and freedom of the press. (Note that this implies a negative coefficient on the lack of press freedom index.) As additional variables that proxy for the level of social and political freedom in countries, we use two additional variables provided by Freedom House,[3] namely lack of *Political Rights* and lack of *Civil Liberties*, both scaled from 1 to 7 and increasing with the degree of lack of rights and liberties.

As a measure of inequality, we use the Gini coefficient from the Standardized World Income Inequality Database (SWIID).[4] The SWIID employs data from the Luxembourg Income Study Database and World Income Inequality Database as well as other datasets to create standardized inequality indicators (Solt, 2016). Due to the large variation that exists between other datasets focusing on inequality, it is often difficult to compare different nations over time. Solt (2016) uses a missing-data algorithm to standardize the UN University's World Income Inequality Database, resulting in about 85 per cent of observations having a standard error of less than three per cent. The aim of the SWIID is to increase comparability between the measurements that are already available; it is for this reason that we believe it is the best inequality measure to use.

GDP per capita and manufactured and services value added as a percentage of total value added are taken from the World Bank's World Development Indicators Database (WDI, 2018). Table 1 provides descriptive statistics for all the variables of interest.

It is important to mention that, due to data availability, there are very few low-income countries in our sample. This implies that the results of the empirical estimations will not

[2] See the Freedom House website at https://freedomhouse.org.

[3] A version in Stata-friendly format is provided by Edgell (2018).

[4] Although the theory presented earlier in the paper refers to wealth inequality, the data on this variable are not available for low-income countries and for this reason we use income inequality.

Table 1. Summary statistics

Sample 1 (33 countries)					
Variable	Obs	Mean	Std. Dev.	Min	Max
Environmental stringency	616	1.703	0.964	0.375	4.133
GDP per capita	616	30.198	20.644	0.596	91.594
Gini (net)	616	33.448	8.555	21.9	58.8
Lack of press freedom	616	27.157	18.939	5	89
Manuf. VA%	616	18.241	5.241	6.882	33.354
Services VA%	616	65.434	9.410	33.569	81.079
Lack of civil liberties	616	1.929	1.356	1	7
Lack of political rights	616	1.646	1.457	1	7
Sample 2 (82 countries)					
Variable	Obs	Mean	Std. Dev.	Min	Max
Total env. tax per capita	1,480	459.002	474.835	−231.248	2,502.393
GDP per capita	1,480	19.893	21.303	0.272	110.001
Gini (net)	1,480	37.246	9.311	21.1	61
Lack of press freedom	1,480	34.082	20.997	5	87
Manuf. VA%	1,437	16.534	5.823	3.679	39.465
Services VA%	1,480	62.514	10.315	26.124	88.538
Lack of civil liberties	1,480	2.353	1.450	1	6
Lack of political rights	1,480	2.201	1.719	1	7

Notes: Stringency ranges from 0 (not stringent) to 6 (very stringent). GDP per capita and total tax per capita are in US$1,000. Lack of press freedom ranges from 0 (total freedom) to 100 (no freedom). Lack of civil liberties and political rights range from 1, being the most free, to 7, being the least free.

reflect the upward part of the typical EKC, and this has to be taken into account when interpreting the results.

4. Theoretical background, empirical model and main results

4.1 Environmental degradation, income inequality and freedom of the press

Since environmental degradation has significant negative externalities, to avoid high levels of pollution, the market failure problem needs to be addressed. It is widely accepted by the literature that as GDP per capita increases, the society becomes better able to solve this market failure. To better understand the relationship between economic growth, environmental abatement, and preferences, we follow the theoretical background presented in Magnani (2000). She takes from Baldwin (1995) the division of pollution into two components: incipient pollution and abatement. Incipient pollution, represented by I_{it}, is the amount of pollution a country would produce at its current level and composition of output if there were no environmental costs. Hence, if a country has high taxation on pollution and large environmental costs, then the level of incipient pollution will be much higher than the country's actual level of pollution. This difference will be considerably reduced for a country that has relatively low taxes on pollution and low costs for environmental damage. The difference between incipient pollution and actual pollution is referred to as abatement and is represented by E_{it}. Countries with the highest levels of taxation on pollutants will thus also have higher abatement levels. Hence, the level of abatement is given by

$$E_{it} = I_{it} - m_{it}, \tag{1}$$

where E_{it} is the abatement level, I_{it} is the incipient pollution of a country, and m_{it} is the pollution level in any given country i at time t.

Stern *et al.* (1996), among others, argue that growth has a positive impact on incipient pollution, $I_{it} = f(Y_{it}), I'(.) > 0$, where Y_{it} represents the economic wellbeing of a country at time t. For instance, when developing countries start to grow, they begin to industrialize and thus the incipient pollution level, I_{it}, also rises. Economic growth often translates into increased consumption levels, which also increases incipient pollution. This scale effect could be greater than the effect that countries experience when moving into the service industries and out of manufacturing, the so-called composition effect (Grossman and Krueger, 1995). Countries start to better protect their environment when citizens' demand for higher environmental quality is large enough. We would then expect that environmental abatement, E_{it}, increases alongside economic growth. This is especially true if there is a high income-elasticity for environmental standards (Antle and Heidebrink, 1995). If we assume that countries' environmental policies reflect individual preferences, then it is plausible to assume that environmental policy totally adjusts to these preferences, and hence

$$(\partial E_{it}/\partial D_{it}) = 1, \tag{2}$$

which results in:

$$(\partial m_{it}/\partial Y_{it}) < 0 \text{ if } \epsilon > (\partial I_{it}/\partial Y_{it})(Y_{it}/I_{it}), \text{ where } \epsilon \equiv (\partial D_{it}/\partial Y_{it})(Y_{it}/D_{it}), \tag{3}$$

where ϵ represents the income elasticity of the demand for environmental quality; D_{it} represents the demand for environmental quality in country i at time t; Y_{it} equals the economic wellbeing; and I represents incipient pollution (Magnani, 2000). This shows that if the demand for environmental quality is high, then in the latter stages of growth there will be an increase in environmental abatement and hence more stringent environmental policies. For instance, when individuals have a high-income elasticity of demand for environmental quality, the level of environmental protection will be highly dependent on how much income they have. It is only when the income elasticity of demand is high that the income levels play a strong role in improving environmental outcomes. The income elasticity curve shows why the EKC predicts an inverted U shape with respect to economic growth. However, as Magnani (2000) pointed out, it is worth questioning whether economic growth alone is enough to predict environmental abatement.

We hypothesize that inequality and freedom of the press also play a role in determining environmental abatement. If the power to elect change is in the hands of too few individuals, then it is possible that the outcome will disproportionately benefit those in power. When economic means and political power are concentrated in the hands of a few, those at the top of the income distribution will have a greater chance of having their preferences met as opposed to those at the bottom of the spectrum.

Magnani (2000) applies the median voter theorem (Congleton, 2004) when investigating taxes on pollution, as the preferences are single-peaked and there is a monotonic relationship between the voter's relative income and his or her ideal policy. A monotonic relationship refers to the fact that voters' preferences most likely align with their income levels, and that as their income levels change, their preferred environmental policy also adjusts accordingly. If τ represents taxes, l represents an individual, m is the index for the median voter, γ_l is the preference parameter, and $R = (y_m/Y)$ – meaning R represents the ratio between median income, y_m, and average income, Y – then a politician is able to maximize the indirect utility function of the median voter and the equilibrium tax rate is given by

$$\tau^* = 1 - R(1/\gamma_m), \tag{4}$$

to get $\varepsilon \equiv (\delta\gamma_m/\delta R)(R/\gamma_m) > 1$. This shows that if the income elasticity ε of the median voter's preference γ_m for lower levels of environmental degradation is greater than 1, then pro-environment public expenditure is an increasing function of income equality; thus

$$E^* = f(Y, y_m/Y). \tag{5}$$

Moreover, according to Magnani (2000), whether or not abatement would respond to increasing per capita income positively depends on the interdependence between economic inequality and average income. For this reason, the effect of income inequality on environmental stringency depends on the level of per capita income.

In addition, according to Barrett and Graddy (2000), the level of abatement and the induced environmental-policy response do not only depend on the prosperity of the countries, but also on the possibilities that individuals have to acquire information about the level of environmental quality. For instance, those policy responses will depend on the level of political and civil freedoms.

Therefore, we test the reduced form in (5) in the next section of this paper, extended with a component that reflects the level of information of the citizens and a second that accounts for the structure of the economy.

4.2 Model specification

The model specification follows the same logic as Magnani's (2000), and builds off of the previous research on environmental standards that often focused on per capita emissions; we instead focus on environmental policy as the outcome variable. The baseline model includes GDP per capita (x_{it}), the net Gini coefficient (r_{it}), the index of freedom of the press (p_{it}), and the share of manufacturing/services value added in total va (va_{it}),

$$e_{it} = \alpha + \beta_0 x_{it} + \beta_1 r_{it} + \beta_2 p_{it} + \beta_3 va_{it} + \varphi_t + u_{it}, \tag{6}$$

where e_{it} is our environmental policy variable of interest. The error term can be decomposed (Magnani, 2000) into unobservable country-specific effects, represented by μ_i, and a white noise component denoted ε_{it}, with $u_{it} = \mu_i + \varepsilon_{it}$. The unobserved effects are controlled for by estimating (6) using panel data techniques. Technology progress is assumed to be common to all countries and time variant and is captured by the year-specific dummy variables, φ_t, which are added to all models.

In order to test if there is a non-linear relationship between GDP per capita and environmentally-friendly legislation – such as posited by the EKC - we include the square of GDP per capita in our second specification, and in a third one we investigate whether the effect of inequality on the outcome variables may be non-linear by adding also the squared term of the Gini.

Furthermore, we investigate if the inequality effect depends on the level of development in the country through the interaction term between the Gini variable and the GDP per capita variable, as hypothesized by Magnani (2000) and Grunewald *et al.* (2017), and also consider an interaction term between our two target variables, namely, lack of freedom of the press and the Gini coefficient.

Panel data methods allow us to control for unobserved heterogeneity. Fixed effects methods treat the unobserved differences between countries, μ_i, as a set of fixed parameters that can be directly estimated using country dummies or taking within differences of the variables in the estimating equations (Allison, 2009). As an alternative, the random effects model uses the unobserved heterogeneity to construct the variance of the residuals. In a generalized least squares procedure, the estimated variance is then used to re-weight the observations. However, this is only valid if the unobserved effects are uncorrelated with all of the explanatory variables. We use a regression-based Hausman-type test to determine if we should use random effects (RE) or fixed effects (FE) (Hausman, 1978; Mundlak, 1978). If the test rejects the null hypothesis that the estimates from both RE and FE are statistically similar, it is likely that the RE model is biased (Wooldridge, 2016). The reason is that FE is still unbiased whether or not the unobserved variables are correlated with the explanatory variables. We tested the hypothesis of no systematic difference between FE and RE and found that it was rejected by the test for the smaller sample of OECD + BRIICS countries, but only in some cases for the second sample and thus we present the corresponding results in our main analysis. The results from the RE regressions augmented with the averages of the time variant variables (Mundlak approach) are located in the appendix,[5] in tables A2 and A3. Those results are used to run a regression-based Hausman test, which tests for the joint significance of the averages of the time-variant coefficients. The test results are shown at the bottom of tables A2 and A3. Regarding year FE, φ_t, those are included in all the regressions as a proxy for technology progress. It is important to notice that whereas the time specific effects explain 39 per cent of the variation of the first dependent variable (environmental policy stringency, EPS), they only explain less than 1 per cent of the second, environmental tax revenue per capita (ETR). The country specific effects instead explain 34 per cent of the variability of EPS and 94 per cent of the variability of ETR. In addition, given the nature of the dependent variables, we also estimated a panel-Poisson model, whose results can also be found in the appendix, in tables A4 and A5.

4.3 Main results

The models specified in the previous subsection have been estimated for two different dependent variables and the corresponding sample of countries using data over the period 1994–2015. Panel data methodology has been used to account for unobserved country-specific heterogeneity that is country specific and time invariant. For the sample of OECD + BRIICS, an RE model was always rejected according to the Hausman test,[6] whereas for the sample of 82 countries this was not the case.

[5]We used the Breusch-Pagan Lagrange multiplier test to test for RE versus pooled OLS (Woodridge, 2016) and obtained a p-value = 0.000, meaning we should not use pooled OLS.

[6]The so-called Mundlak (1978) approach is suitable for implementing a robust Hausman test, which consists of testing for the joint significance of the averaged variables added to the model. When the test rejects the null hypothesis of non-significance of the considered coefficients, a pure RE approach would provide biased results.

Table 2. Main results for stringency of environmental laws

Explanatory variables	(1) linear	(2) quadr1	(3) quadr2	(4) interac	(5) CivLib	(6) PolRig
GDP per cap.	0.0711*** [0.0190]	0.108*** [0.0387]	0.0714*** [0.0196]	0.0761 [0.0481]	0.0720*** [0.0202]	0.0651*** [0.0203]
Gini (net)	0.0224 [0.0423]	0.0271 [0.0425]	0.00782 [0.174]	0.0245 [0.0505]	0.0239 [0.0428]	0.0201 [0.0381]
Lack of press freedom	−0.0153** [0.00737]	−0.0139* [0.00738]	−0.0153** [0.00734]	−0.0151** [0.00680]	−0.0148* [0.00797]	−0.0220*** [0.00783]
Manuf. VA%	−0.0458** [0.0209]	−0.0473** [0.0199]	−0.0456** [0.0207]	−0.0460** [0.0207]	−0.0463** [0.0211]	−0.0386 [0.0238]
GDP per cap. sq.		−0.000336 [0.000256]				
Gini (net) sq.			0.000185 [0.00237]			
Gini × GDP per cap.				−0.000172 [0.00164]		
Lack of civil liberties					−0.0163 [0.0891]	
Lack of political rights						0.145* [0.0808]
Country & time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	616	616	616	616	616	616
R^2 within	0.750	0.753	0.750	0.750	0.750	0.756
R^2 overall	0.874	0.875	0.874	0.874	0.874	0.877

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is stringency of environmental laws. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. Sample of 33 countries over the period 1994–2015.
Dependent variable: environmental stringency.

Table 2 shows our results for the panel regression using two-ways fixed – country and time FE – considering as explanatory variables of environmental policy stringency: GDP per capita, the Gini coefficient, lack of freedom of the press, and the share of manufacturing value added in the economy.

The results in specification (1) of table 2 indicate that the coefficient of lack of freedom of the press had the expected negative and significant correlation with environmental stringency at the 5 per cent level. GDP per capita shows a positive coefficient, significant at the 1 per cent level, which means that as people's incomes increase, their concern for the environment also increases. In particular, an increase of GDP per capita of US$13,500 is associated with an increase in the index of environmental policy stringency by 1 standard deviation. However, the Gini coefficient is not statistically significant. It is worth noticing that the Gini coefficient had a negative and significant coefficient when the model was estimated without country FE.

In specification (2) in table 2, we test whether the relationship between per capita income and environmental stringency is non-linear, as suggested by the EKC hypothesis. We add the square of GDP per capita as a regressor and find that it is not statistically significant at conventional levels, thus implying that the relationship between GDP per capita and environmental stringency is linear and environmental stringency monotonically increases with GDP per capita. The statistical significance of lack of freedom of the press is now weaker in this model, as expected. Similarly, we test whether the Gini coefficient has a non-linear relationship with environmental stringency and find that the squared Gini coefficient is not statistically significant (column (3)). In specification (4) of table 2, the interaction between GDP per capita and the Gini coefficient is added to the model to test whether the effect of inequality varies with income. We find that the corresponding coefficient is also not statistically significant. In all specifications we allow for the model to be flexible by allowing for non-linear time effects through the use of year dummies. The coefficients of the year dummies are (jointly) significantly different from zero and explain almost 40 per cent of the variability in the dependent variables, as pointed out before. Freedom of the press is found to be significant in determining environmental stringency in all models and has the expected negative sign.[7] If there is less freedom of the press (the index increases from 20 to 40, for example), environmental policy stringency will decrease by 0.3 (since the EP index varies from 0.33 to 4.13, this is an economically non-negligible effect). In columns (4) and (5), we add two measures that are closely related to lack of freedom of the press, namely, lack of civil liberties and lack of political rights, respectively. The former enters the model with the expected sign, but its coefficient is not statistically significant, whereas the latter is statistically significant only at the ten per cent level and does not change the sign or the significance of the coefficient obtained for lack of freedom of the press. Since the correlation between the three proxies is high (around 0.91 per cent), we also estimated the model with only the latter two variables and the results indicate that neither civil liberties nor political rights are statistically significant, not even at the 10 per cent level.

In table 3, we present the main results for the second dependent variable considered, namely environmental tax revenue per capita. As indicated by the results of the regression-based Hausman test (table A3 in the appendix), an FE specification is preferred when the squared term of GDP per capita is included in the model, otherwise the RE specification is preferred. Therefore, we estimate the model with RE in all columns of table 3, apart from (3) and (4).

For the first specification[8] in table 3 we find that, as expected, less press freedom is negatively correlated with environmental tax revenue per capita, with a coefficient significant at the 5 per cent level in model (1). This means that when the press in a country starts to become less free (their freedom of the press score moves from a 10 to a 30, for example), then the amount of environmental tax revenue per capita decreases by about €52. This could be the case as people have less reliable information available to them, which is needed if they are going to make an informed decision regarding environmental policy. Also, similar to our regressions with environmental stringency, GDP per capita shows a positive and significant coefficient at the 1 per cent level and the coefficient of the Gini has the expected negative sign, which is statistically significant at the 5 per cent

[7] We also tested for a squared term in lack of freedom of the press and the estimated coefficient was not statistically significant at conventional levels. The same was the case for the interaction between lack of freedom of the press and the Gini.

[8] We added services value added as a percentage of total value added in the country instead of the corresponding figure for manufactures (as in table 2) because in this model the latter variable was never statistically significant, whereas the former was in some cases, and was also available for more observations.

Table 3. Main results for total environmental tax revenue per capita

Explanatory variables	(1) linear	(2) quadr1	(3) quadr2	(4) interac	(5) CivLib	(6) PolRigh	(7) ManuVA
GDP per cap.	13.22*** [2.010]	34.53*** [8.030]	34.48*** [8.059]	38.86*** [11.62]	38.55*** [11.36]	38.79*** [11.59]	38.70*** [12.21]
Gini (net)	−8.349** [4.009]	−3.527 [5.659]	−15.47 [35.58]	−1.425 [4.655]	−0.600 [4.553]	−1.482 [4.597]	−0.968 [4.817]
Press freedom	−2.599** [1.267]	−1.889 [1.443]	−1.917 [1.425]	−2.402* [1.298]	−1.316 [1.057]	−2.487** [1.214]	−2.684* [1.431]
Serv. VA%	3.885** [1.833]	3.416* [1.834]	3.308* [1.878]	4.089** [1.908]	3.736** [1.826]	4.100** [1.920]	
GDP per cap. sq.		−0.181*** [0.0680]	−0.179** [0.0688]				
Gini (net) sq.			0.144 [0.390]				
Gini × GDP per cap.				−0.852** [0.338]	−0.848*** [0.328]	−0.850** [0.337]	−0.825** [0.356]
Lack of civil liberties					−36.13*** [12.53]		
Lack of political rights						1.874 [9.334]	
Manu.VA%							−0.836 [2.491]
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Turning point GDP		95.387					
Observations	1,480	1,480	1,480	1,480	1,480	1,480	1,437
Method	RE	FE	FE	RE	RE	RE	RE
R^2 within		0.267	0.268				
R^2 overall	0.960	0.963	0.963	0.963	0.964	0.963	0.963

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is total environmental tax revenue per capita (in US$1,000). GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. Sample of 82 countries over the period 1994–2015. FE (RE) denotes that a model with country fixed effects (random effects) has been estimated.
Dependent variable: environmental tax revenue per capita

level. An increase in the Gini of 10 percentage points is associated with a decrease in environmental tax revenue per capita of about US$83.

In specification (2) the squared of GDP per capita is added, whose coefficient is statistically significant at the 5 per cent level, indicating that there is a non-linear relationship between income and the outcome variable. Freedom of the press loses its significance under this specification. We also test whether there is a non-linear relationship between the Gini coefficient and environmental tax revenue per capita and find that the coefficient of the Gini squared is not statistically significant at conventional levels in column (3) of table 3. Given that the turning point for the EKC with respect to GDP per capita is out of sample, with the only exception being Luxembourg, we proceed in the next column including an interaction between GDP per capita and the Gini coefficient instead of the squared term.

In the 4th specification of table 3, the results show that the interaction between the Gini and GDP per capita shows a negative and significant coefficient, and the corresponding marginal effect is statistically significant at the 5 per cent level, indicating that the partial negative effect of inequality on environmental taxes increases with income per capita. In columns (5) and (6) we add lack of civil liberties and lack of political rights respectively as control variables. Whereas the former is statistically significant at the 1 per cent level and shows the expected negative sign, the second is not. An improvement in political rights moving from the top to the middle of the ranking (from 7 to 3.5) will be associated with an increase in environmental tax revenues of about €126.50 per capita. In this model, lack of press freedom is not shown to be statistically significant, but since the correlation between this variable and civil liberties is around 90 per cent, this is not surprising. Finally, column (7) includes as a control variable the value added in the manufacturing sector as a percentage as total value added and shows that it is not relevant in this model and even reduces the sample size. Similar to the models in table 2, time FE have been added in all models and are jointly significant, however in this case they explain less than 1 per cent of the variability of the dependent variable.

In our next estimations, we divide up the sample of countries by income per capita levels into two groups. We create a 'high income' group and a 'middle-low income' group using the World Bank definition in 2016 (countries with GNI per capita higher than US$12,000; see table A1 in the appendix). The reason for doing that is that the correlations of the Gini coefficient and freedom of the press with environmental stringency and environmental tax revenue per capita could vary depending on how rich countries are. For instance, when countries have a lower GDP per capita, they are more concerned with catching up to the rest of the world than with protecting the environment. Thus, they might vote for policies that would increase their economic wealth as opposed to protecting the environment. On the other side of the spectrum, when countries reach a certain level of GDP per capita, citizens' preferences may change and cause them to care more about the environmental quality. This is the idea behind the EKC. It could be the case that inequality and freedom of the press only play a significant role for certain income levels, which is the reason why we divided up the sample into two groups.

Table 4 shows the results when environmental stringency is used as a dependent variable and for above-average income per capita (seen in the left side of the table, specifications (1)–(4)), and below-average income per capita (seen in specifications (5)–(8)). Similar results are presented for the second outcome variable, environmental tax revenue per capita, in table 5. When investigating the effect of the Gini coefficient in table 4, we see that the Gini only has a significant effect for specifications (5) to (8) and the effect is non-linear, suggesting that the inequality has a negative effect on the outcome variable only before a certain inequality level is reached (the turning point is for Gini = 46.25). Therefore, rising inequality is in general negatively correlated with the income dedicated to protecting the environment and could indicate that more egalitarian societies tend to better protect the environment.

The group of countries considered here are Brazil, China, India, Indonesia, Mexico, Russia and South Africa; therefore it is important to remark that, for these new industrialized countries, both freedom of the press and inequality play an important role in shaping environmental policy stringency. Concerning inequality, reductions in inequality

Table 4. Results by income group for stringency of environmental law

Explanatory variables	High-income countries (1) linear	(2) quadr1	(3) quadr2	(4) interac	Non high-income countries (5) linear	(6) quadr1	(7) quadr2	(8) interac
GDP per cap.	0.0229 [0.0152]	0.0677** [0.0328]	0.0690** [0.0321]	0.135* [0.0658]	0.207** [0.0797]	0.390*** [0.0896]	0.466*** [0.108]	0.407* [0.212]
GDP per cap. sq.		−0.000391 [0.000259]	−0.000395 [0.000256]	−0.000458** [0.000218]		−0.0140* [0.00716]	−0.0172* [0.00821]	−0.0139 [0.00749]
Gini (net)	0.0128 [0.0552]	0.0213 [0.0561]	−0.0675 [0.322]	0.0883 [0.0986]	0.0187 [0.0278]	−0.0166 [0.0278]	−0.395* [0.175]	−0.0140 [0.0266]
Gini (net) sq.			0.00157 [0.00625]				0.00427* [0.00189]	
Press freedom	−0.0111 [0.00789]	−0.00714 [0.00816]	−0.00769 [0.00812]	−0.00277 [0.0103]	−0.0203** [0.00757]	−0.0190** [0.00716]	−0.0183** [0.00574]	−0.0188** [0.00655]
ManuVA%	−0.0550* [0.0293]	−0.0597** [0.0268]	−0.0591** [0.0262]	−0.0634** [0.0276]	−0.0111 [0.0169]	−0.0188 [0.0173]	−0.0115 [0.0160]	−0.0195 [0.0167]
Gini × GDP per cap.				−0.00208 [0.00212]				−0.000481 [0.00544]
Turning point GDP			147.379				13.546	
Turning point Gini							46.253	
Observations	455	455	455	455	161	161	161	161
R-squared	0.866	0.869	0.866	0.866	0.730	0.744	0.752	0.730

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. Sample from 1994–2015 with 25 countries in left panel with GDP per capita>12 in 2015, and 8 in the right panel (listed in table A1, sample 1). Countries with lower income per capita are: Brazil, China, India, Indonesia, Mexico, Russia, South Africa and Turkey.

Table 5. Results by income group for environmental tax revenue per capita

Explanatory variables	High-income countries				Non high-income countries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	linear	quadr1	quadr2	interac	linear	quadr1	quadr2	interac
GDP per cap.	5.815** [2.298]	39.70*** [4.232]	39.70*** [4.220]	43.65*** [8.647]	12.79*** [2.697]	37.93* [19.83]	34.59*** [6.801]	66.69*** [16.08]
GDP per cap. Sq.		−0.325*** [0.0354]	−0.321*** [0.0358]			−0.156 [0.106]	−0.127*** [0.0442]	
Gini (net)	−2.618 [5.727]	−2.425 [5.367]	−40.50 [45.20]	28.82*** [10.03]	−5.938 [6.979]	−2.771 [6.346]	−60.67** [29.57]	1.062 [1.975]
Gini (net) sq.			0.655 [0.737]				0.632** [0.311]	
Press freedom	−4.040*** [1.298]	−1.348 [1.230]	−1.565 [1.237]	−2.616** [1.298]	−1.904 [1.904]	−1.809 [1.868]	−1.968** [0.903]	−2.386** [0.939]
	5.147* [2.784]	0.0985 [2.314]	−0.00775 [2.299]	4.248 [2.933]	3.196 [2.036]	2.891 [2.079]	2.829*** [0.988]	3.075*** [1.007]
Gini × GDP per cap.				−1.309*** [0.289]				−1.565*** [0.476]
Turning point GDP		61.077					136.181	
Turning point Gini							47.998	
Observations	694	694	694	694	786	786	786	786
R-squared	0.302	0.408	0.410	0.444	0.140	0.177	0.188	0.254

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. The sample includes 36 high-income countries with GPD per capita>12 in 2015 in the left-panel and 46 in the right panel (listed in table A1, sample 2).

will favor increases in environmental stringency for not very high levels of Gini. However, the Gini coefficient is not statistically significant for rich countries in any of the specifications. Concerning lack of freedom of the press, the results indicate that this variable is strongly relevant for specifications (5) to (8), indicating that for new industrialized countries more freedom of the press (decrease in the variable) will be positively associated with more environmental policy stringency.

The results shown in table 5 when the outcome variable is environmental tax revenue per capita are along a similar line as those found for environmental stringency. In particular, less freedom of the press contributes to more environmental revenues per capita for rich and poor countries. But for rich countries, the effect vanishes once the EKC specification is considered in model (2), whereas for less-rich and poor countries, the coefficient is statistically significant after including the squared GDP term and the squared of the Gini in specification (7) and also when including the interaction between Gini and GDP per capita in (8). Hence, a non-linear relationship is also found for the Gini index, which is more prevalent for specifications (5)–(8) including less-rich countries.

4.4 Robustness checks

As robustness, we first estimated several variations of the models presented in the previous section. When including the interaction between the Gini and lack of press freedom, it was never statistically significant. The same was the case for the interaction between Gini and political rights.[9]

As a second robustness check, we estimated a model with interactions between the dummy variable for high-income countries and all the regressors and tested for the equality of the coefficients. The test indicates that only for the coefficients on the income variables (GDP per capita and GDP per capita squared) and the time dummy variables can we reject the null hypothesis that the coefficients are equal. Indeed, it can be seen in tables 4 and 5 that the turning points for the income variable are very different in the left- and right-hand side of the tables.

Finally, we estimated a Poisson pseudo maximum likelihood model, due to the fact that the dependent variables have limited support. The results are presented in tables table A4 and table A5 in the appendix and in general confirm our main outcomes.

5. Conclusions

In this paper it is hypothesized that not only the level of income per capita but also income inequality is expected to play a role as a determinant of environmental regulations, and that the degree of lack of freedom of the press is also correlated with environmental policy stringency. By considering as determinants of environmental stringency and environmental taxes a number of factors – namely income levels, income inequality, the structure of the economy and a number of proxies for the degree of freedom of the press, political rights and civil liberties – a panel data model is estimated for a cross section of countries over the period 1994–2015, which provides a number of results.

First, we find that the first hypothesis that income inequality would be negatively correlated with environmentally-friendly legislation is only valid for some countries.

[9]The results are available from the authors on request.

While there is no direct linear effect of inequality on either of the two dependent variables considered, for environmental stringency such an effect is found for a subsample of countries. This suggests that for some newly industrialized countries, equality favors environmental stringency. For the second outcome variable considered, environmental tax revenue, a non-linear effect of inequality is also found for a subset of non-rich countries. For our second hypothesis, we find that lack of freedom of the press is significantly and negatively correlated to both environmental policy stringency and environmental tax revenue. This indicates that a free press makes it more likely that people accept a monetary loss to the benefit of the environment.

Moreover, there seems to be an EKC relation between income and environmental tax revenue, suggesting that the EKC relation between income and actual emissions may very well be driven by the ability of countries to implement regulations, but the turning point of GDP per capita is out of sample. In terms of inequality there seems to be limited evidence of such a relation, although the results suggest it may apply for higher income countries. The significant relationship between press freedom and environmental regulations may reflect other factors related to press freedom but not included in the study. The results are not robust to the inclusion of political rights, whereas adding civil liberties as a control variable does not affect the estimates.

Summarizing, our results suggest that the level of income per capita, the structure of the economy and the degree of freedom of the press have an effect on environmental policy. However, the effects are more nuanced than initially suspected and hence further research is required to investigate other potential factors that affect environmental policy.

One important limitation of this study is that the negative correlation between income inequality and environmental policy stringency found in this paper cannot be generalized to low-income countries, since those are underrepresented in our dataset. The same is the case for lack of political freedom, which is more prevalent in some poor countries. Potential suggestions for further research are the extension of the sample to also include low-income countries using alternative proxies for environmental policy stringency, such as for example the environmental performance index provided by Purdue University.

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Appendices

Table A1. List of countries

Sample 1	Freq.	Sample 2	Freq.	Sample 2 (cont)	Freq.
Australia	21	Argentina	22	**Japan**	21
Austria	19	**Australia**	21	Kazakhstan	18
Belgium	19	**Austria**	22	Kenya	7
Brazil	21	Bahamas, The	13	**Latvia**	21
Canada	22	**Belgium**	22	**Lithuania**	21
China	22	Belize	16	Malaysia	22
Czech Republic	19	Bolivia	22	**Malta**	17
Denmark	19	Brazil	8	Mauritius	6
Finland	19	**Bulgaria**	21	Mexico	21
France	22	Cabo Verde	17	Morocco	15
Germany	22	Cameroon	19	**Netherlands**	22
Greece	19	**Canada**	21	**New Zealand**	22
Hungary	19	Chile	22	Nicaragua	21
India	19	China	17	Niger	15
Indonesia	22	Colombia	15	**Norway**	22
Ireland	19	Congo, Dem. Rep.	9	Panama	22
Italy	22	Costa Rica	22	Paraguay	22
Japan	21	Cote d'Ivoire	22	Peru	22
Mexico	21	**Croatia**	18	Philippines	22
Netherlands	19	**Cyprus**	21	**Poland**	22
Norway	19	**Czech Republic**	22	**Portugal**	22
Poland	19	**Denmark**	22	Rwanda	19
Portugal	19	Dominican Republic	22	Senegal	10
Russian Federation	22	Ecuador	21	**Serbia**	13
Slovak Republic	19	El Salvador	15	Singapore	11
Slovenia	5	**Estonia**	21	**Slovak Republic**	22
South Africa	22	**Finland**	22	**Slovenia**	21
Spain	19	**France**	22	South Africa	22
Sweden	19	**Germany**	22	**Spain**	22
Switzerland	19	Ghana	4	Swaziland	15
Turkey	22	**Greece**	20	**Sweden**	22
United Kingdom	22	Guatemala	21	**Switzerland**	22

(*continued*)

Table A1. Continued.

Sample 1	Freq.	Sample 2	Freq.	Sample 2 (cont)	Freq.
United States	22	Guyana	14	Togo	11
		Honduras	22	Trinidad and Tobago	12
		Hungary	22	Tunisia	13
		Iceland	21	Turkey	22
		India	7	Uganda	20
		Ireland	22	**United Kingdom**	22
		Israel	20	**United States**	22
		Italy	22	Uruguay	22
		Jamaica	11	Venezuela, RB	21

Note: High-income countries in **bold** type.

Table A2. Stringency of environmental policy RE Mundlak approach

	(1)	(2)	(3)	(4)
Explanatory variables	linear	quadr1	quadr2	interac
GDP per cap.	0.0664*** [0.0178]	0.0975*** [0.0368]	0.0669*** [0.0188]	0.0692 [0.0455]
Gini (net)	0.0141 [0.0412]	0.0168 [0.0403]	−0.0248 [0.169]	0.0132 [0.0482]
Lack of press freedom	−0.0133* [0.00728]	−0.0125* [0.00748]	−0.0133* [0.00720]	−0.0133** [0.00668]
ManuVA %	−0.0425** [0.0202]	−0.0424** [0.0202]	−0.0420** [0.0201]	−0.0421** [0.0199]
GDP per cap. sq.		−0.000286 [0.000252]		
Gini (net) sq.			0.000497 [0.00239]	
Gini × GDP per cap.				−9.85e-05 [0.00150]
Av. GDP per cap.	−0.0600*** [0.0174]	−0.0592 [0.0395]	−0.0614*** [0.0183]	−0.0779 [0.0570]
Av. Gini (net)	−0.0506 [0.0433]	−0.0468 [0.0426]	0.0869 [0.207]	−0.0553 [0.0489]
Av. lack of press freedom	0.00290 [0.00890]	0.00754 [0.00794]	−0.00175 [0.00976]	0.00325 [0.00791]
Av. ManuVA %	0.0311 [0.0275]	0.0350 [0.0269]	0.0395 [0.0299]	0.0330 [0.0277]
Av. GDP per cap. sq.		-9.79×10^{-5}		
		[0.000316]		
Av. Gini (net) sq.			−0.00176 [0.00286]	
Av. Gini × GDP per cap.				0.000646 [0.00193]
Robust 'Hausman type' (p value)	0.0051	0.0028	0.0018	0.0048
Observations	616	616	616	616
Number of countries	33	33	33	33

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. The robust Hausman type test is a test of the joint significance of the averaged time-variant variables, and indicates rejection of the null hypothesis of non-significance. Hence FE is preferred to RE estimation.

Table A3. Total environmental tax revenue per capita RE Mundlak approach

	(1)	(2)	(3)	(4)
Explanatory variables	linear	quadr1	quadr2	interac
GDP per cap.	11.40*** [2.791]	33.69*** [7.956]	33.60*** [7.990]	37.11** [16.05]
Gini (net)	−4.950 [5.738]	−3.518 [5.606]	−18.45 [35.00]	1.098 [6.588]
Press freedom	−2.503* [1.505]	−1.822 [1.489]	−1.862 [1.476]	−2.341 [1.599]
ServVA %	3.130 [2.030]	3.039* [1.767]	2.942 [1.815]	3.444* [2.076]
GDP per cap. sq		−0.178*** [0.0685]	−0.176** [0.0694]	
Gini (net) sq.			0.179 [0.384]	
Gini × GDP per cap.				−0.831* [0.460]
Average GDP per cap.	2.717 [3.415]	−25.66*** [8.876]	−27.41*** [9.144]	0.656 [13.23]
Average Gini (net)	−7.686 [5.935]	−10.52* [5.771]	−64.88* [36.32]	−6.672 [6.369]
Average press freedom	0.877 [2.591]	−0.195 [2.666]	0.867 [2.427]	0.829 [2.339]
Average SErVA%	−1.156 [3.335]	0.167 [2.922]	1.061 [2.938]	6.974* [3.571]
Average GDP per cap. sq.		0.253*** [0.0701]	0.258*** [0.0703]	
Average Gini (net) sq.			0.683* [0.411]	
Average Gini × GDP per cap.				0.0131 [0.413]
Robust 'Hausman type' (p value)	0.481	0.0034	0.004	0.794
Observations	1,541	1,541	1,541	1,541
Number of countries	82	82	82	82

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space. The robust Hausman type test is a test of the joint significance of the averaged time-variant variables, and indicates rejection of the null hypothesis of non-significance. Hence FE is preferred to RE estimation.

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Table A4. Results by income group for stringency of environmental policy

	High-income countries				Non high-income countries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Explanatory variables	linear	quadr1	quadr2	interac	linear	quadr1	quadr2	interac
GDP per cap.	0.0139 [0.00913]	0.0495* [0.0257]	0.0535** [0.0245]	0.0776* [0.0414]	0.200*** [0.0647]	0.282*** [0.0736]	0.343*** [0.0752]	0.282 [0.176]
GDP per cap. sq.		−0.000314 [0.000229]	−0.000327 [0.000223]	−0.000339* [0.000203]		−0.00683 [0.00658]	−0.00931 [0.00675]	−0.00683 [0.00657]
Gini (net)	−0.0285 [0.0319]	−0.0237 [0.0326]	−0.332* [0.187]	0.00722 [0.0671]	0.0344 [0.0213]	0.0154 [0.0279]	−0.398*** [0.121]	0.0155 [0.0258]
Gini (net) sq.			0.00545 [0.00360]				0.00473*** [0.00134]	
Press freedom	−0.0114* [0.00685]	−0.00800 [0.00713]	−0.00968 [0.00600]	−0.00628 [0.00731]	−0.0234*** [0.00581]	−0.0225*** [0.00548]	−0.0219*** [0.00402]	−0.0225*** [0.00522]
ManuVA%	−0.0301 [0.0211]	−0.0324* [0.0196]	−0.0316* [0.0188]	−0.0334* [0.0197]	−0.0195 [0.0194]	−0.0241 [0.0193]	−0.0216 [0.0152]	−0.0242 [0.0181]
Gini × GDP per cap.				−0.000886 [0.00148]				-2.21×10^{-5} [0.00410]
Turning point Gini								
Observations	455	455	455	455	161	161	161	161
Number of countries	25	25	25	25	8	8	8	8

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space.
Poisson pseudo likelihood estimation.

Table A5. Results by income group for total environmental tax revenue per capita

	High-income countries				Non high-income countries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Explanatory variables	linear	quadr1	quadr2	interac	linear	quadr1	quadr2	interac
GDP per cap.	−0.00276 [0.00627]	0.0474*** [0.0135]	0.0485*** [0.0123]	0.0989*** [0.0345]	0.00111 [0.00730]	0.146** [0.0649]	0.132** [0.0649]	0.233*** [0.0752]
GDP per cap. sq.		−0.000428*** [0.000111]	−0.000419*** [0.000101]	−0.000454*** [0.000103]		−0.000812** [0.000365]	−0.000706* [0.000378]	−0.000780** [0.000334]
Gini (net)	−0.00853 [0.0191]	−0.00806 [0.0179]	−0.181* [0.103]	0.0404 [0.0430]	−0.0318 [0.0350]	0.0123 [0.0369]	−0.136 [0.249]	0.0515 [0.0399]
Gini (net) sq.			0.00308* [0.00182]				0.00168 [0.00271]	
Press freedom	−0.00979** [0.00417]	−0.00536 [0.00367]	−0.00660* [0.00356]	−0.00297 [0.00340]	−0.0124 [0.00761]	−0.0104 [0.00643]	−0.0115** [0.00581]	−0.0129** [0.00604]
SerVA%	0.00564 [0.00791]	−0.00843 [0.00548]	−0.00815 [0.00576]	−0.00930 [0.00574]	0.0164 [0.0100]	0.0147 [0.0117]	0.0140 [0.0121]	0.0153 [0.0120]
Gini × GDP per cap.				−0.00169* [0.000945]				−0.00288** [0.00119]
Turning point GDP		55.373				89.901		
Observations	747	747	747	747	787	787	787	787
Number of countries	36	36	36	36	46	46	46	46

Notes: Robust standard errors clustered by country in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample split by GDP per capita. GDP per capita is in US$1,000. Country and year dummies added in all columns, not shown to save space.
Poisson pseudo likelihood estimation.