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The nexus between social inequality and CO_2 emissions revisited: Challenging its empirical validity

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ABSTRACT

Recently, a discussion about the ambiguity of the nexus between social inequality and anthropogenic CO_2 emissions has emerged. Macroeconomic panel studies applying region and time fixed effects (FE) regression models and measuring inequality by the Gini coefficient discovered a flat relationship. Only two of these studies substituting Gini by the more appropriate share held by the top 10 percent of the income or wealth distribution find a positive effect. This paper revisits this nexus and challenges the empirical validity of the contribution of an increase in wealth and income inequality to higher CO_2 emissions lately found by Knight et al. (2017) on country-level and by Jorgenson et al. (2017) on U.S. state-level. The positive inequality effects spotted in these two studies are not robust with respect to the regions and time spans observed as well as to the inequality indicators, estimation techniques, and confounders selected. Hence, this in-depth investigation suggests that there is no sound empirical evidence for a substantial nexus between social inequality and CO_2 emissions. After all, lately proposed policy approaches combining efficient cap-and trade programs with income and wealth redistribution (so-called cap-and-dividend schemes) are not, by themselves, suitable for an effective climate policy. In fact, the analysis points at the relevance of treating key predictors of CO_2 emissions including energy prices for the U.S. for effective climate change mitigation.

1. Introduction

Abating anthropogenic carbon dioxide (CO_2) emissions is a focus for climate change mitigation (IPCC, 2014). To achieve this ambitious goal it is of great political importance to identify the predictors of the CO_2 emissions of countries. Newest longitudinal studies in this line of research confirm that the main drivers are population size and gross domestic product (GDP, e.g. Dietz et al., 2010; Franzen and Mader, 2016; Liddle, 2015; Rosa and Dietz, 2012; Rosa et al., 2015). Smaller impacts are observed for non-fossil energy production, energy prices and international environmental agreements (e.g. Franzen and Mader, 2016).

A largely separate discussion on the nexus between social inequality and CO_2 emissions has emerged since the 1990s. Boyce (1994) introduced a now widely disputed political economy argument. He hypothesizes that more social inequality leads to more environmental degradation. According to Boyce (1994) income/wealth concentration at the top leads to more political influence of rich people on environmental policy. His ‘power-weighted social decision rule’ assumes that rich producers and consumers benefit more from polluting the environment than the poor, and that the latter are more prone to bear the social costs of environmental deterioration. While not directly targeted at spatially and temporally dispersed pollutants like CO_2 emissions, this argument has often been applied to them (see for instance Jorgenson et al., 2017; Knight et al., 2017).

Because of the ambiguity of Boyce’s (1994) and others’ arguments (e.g. Borghesi, 2006; Grunewald et al., 2017; Ravallion et al., 2000), a debate on the empirical validity of a substantial nexus between social inequality and carbon emissions arose. Though early studies using cross-sectional data find both a positive (e.g. Ravallion et al., 2000) and a negative (e.g. Heerink et al., 2001) effect, more recent panel studies utilizing region and time fixed effects (FE) regression models and measuring inequality by the Gini coefficient discover no substantial relation between income inequality and CO_2 (Borghesi, 2006; Grunewald et al., 2017; Hübler, 2017; Jorgenson et al., 2016 and 2017; Knight et al., 2017). Most recently, two of these studies substituting Gini by the more appropriate share held by the top ten percent of the income or wealth distribution spot a positive effect (Jorgenson et al., 2017; Knight et al., 2017).

This paper revisits this nexus and challenges the empirical validity of the contribution of an increase in wealth and income inequality to CO_2 emissions recently found by Knight et al. (2017) on country-level and by Jorgenson et al. (2017) on U.S. state-level for various methodological reasons.

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This contribution proceeds in four further steps: the second section discusses the ambiguous theoretical approach of Boyce (1994) on the positive nexus between social inequality and CO_2 emissions, and it presents the latest empirical evidence utilizing FE panel regression models. Sections three and four provide an in-depth investigation of the empirical validity of the two most recent contributions. In particular, the third section replicates the country-level analysis of Knight et al. (2017), relaxing its assumptions and extending the model, while in the fourth section the same is undertaken for the U.S. state-level analysis of Jorgenson et al. (2017). The last section summarizes and discusses the main results, and closes with some concluding remarks.

2. Theoretical considerations and empirical evidence

Political economist James K. Boyce (1994) argues that more social inequality yields higher levels of environmental deterioration. According to him a more pronounced income/wealth concentration at the top of the distribution leads to more political influence of rich people on environmental policy causing higher levels of environmental pollution. The proponents of this so-called 'power-weighted social decision rule' of producers and consumers of goods and services claim that when the economic elite gains more power, more benefits can be generated from polluting activities. Also, the social costs of pollution can more easily be externalized on the poor respectively less powerful population. In other words, it is easier for more wealthy rich producers and consumers to achieve a level of emissions higher than the one incorporating the social costs of environmental degradation related to these economic activities. This is because the higher economic and in turn political power of the rich allegedly makes it easier to externalize the social costs of polluting activities on the relatively poorer population within a country/state. This in turn increases the rich's benefits and makes the poor more vulnerable to bear the social costs of environmental pollution.

As Borghesi (2006), Grunewald et al. (2017), Jorgenson et al. (2017), Knight et al. (2017), and Ravallion et al. (2000) suggest, Boyce's (1994) argument is a priori ambiguous: The argument is prone to the assumption that "the net benefit from polluting activities is positively correlated with individual income" (Grunewald et al. 2017: 250, see also Scruggs, 1998). In other words and building on the demand function for carbon dioxide emissions from the consumption or production of goods and services, Ravallion et al. (2000) reason that the effect of an increase in social inequality on CO_2 emissions depends on the relation of poor to rich people's marginal propensities to emit (MPE). More specifically, if poor people's MPE is greater than rich people's, an increase in inequality lowers CO_2 emissions. Conversely, if poor people have a lower MPE than the rich, an increase in inequality raise CO_2. It is hard to identify the MPE ratio of poor and rich people a priori, leaving the validity of a substantial inequality –CO_2 emissions nexus an empirical question (see also Borghesi, 2006).

Moreover, Boyce's (1994) argument is formulated for pollutants with spatially and temporally limited but direct hazardous impact like sulfur and nitrogen oxides (SO_X and NO_X) as well as water pollution. It is questionable, whether the argument also applies to CO_2 emissions, as its impact on the climate is spatially and temporally dispersed. First, CO_2 emissions of both poor and rich people in a country contribute to warming on a global scale. Second, dangerous climate change will primarily harm future generations (IPCC, 2014). Therefore, both poor and rich people are expected to have the same MPE, as both groups benefit equally from carbon emitting activities and can externalize the social costs of dangerous climate change and its mitigation to either other countries and – even more so – to future generations. Consequently, this perspective does not expect a substantial effect of increasing inequality in a country on carbon emission levels. Nevertheless, Boyce's argument has been applied to them assuming a positive inequality –CO_2 emissions nexus (see for instance Jorgenson et al., 2017; Knight et al., 2017).

Other arguments hypothesizing a positive, negative, inverted U-shaped, or GDP-depending relation between inequality and CO_2 are more targeted at overall GDP than its distribution or not directed at causal explanation and therefore not repeated here (see also Berthe and Elie, 2015; Borghesi, 2006; Cushing et al., 2015; Grunewald et al., 2017; Hübler, 2017; Jorgenson et al., 2017; Knight et al., 2017).

Turning to the existing empirical evidence, I only refer to macroeconomic studies applying fixed effects panel regressions of CO_2 emissions on social inequality. In comparison to cross-sectional ordinary least squares regression, the FE model has the advantage of exploiting the longitudinal data structure as it only takes within country variations into account. Thus, the FE model is not biased by cross-sectional unobserved heterogeneity (Brüderl and Ludwig, 2015; Wooldridge, 2010). If the strict exogeneity assumption ($r\ (\boldsymbol{x}_{it},\ \varepsilon_{it}) = 0$) holds, FE models adequately estimate unbiased causal effects (Vaisey and Miles, 2017). The model can be written as

$$y_{it} - \bar{y}_i = (\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_i)\boldsymbol{\beta} + \boldsymbol{Z}_t\,\boldsymbol{\gamma} + \varepsilon_{it} - \bar{\varepsilon}_i \quad (1)$$

y_{it} denotes the CO_2 emissions of country i in year t. $\bar{y}_i$ represents country i's average of the whole observation period. $\boldsymbol{x}_{it}$ stands for the vector of all exogenous variables for country i at time t, and $\bar{\boldsymbol{x}}_i$ for the mean of the whole observation period. The model also comprises a vector of dummy variables ($\boldsymbol{Z}$) for every year, which controls period effects for all countries (time FE). A country's time varying stochastic error term is represented by ε_{it}.

To the best of my knowledge, there are only six studies that apply region and time FE panel regression to directly test whether changes in income or wealth inequality affect CO_2 emissions. Table 1 summarizes the results, data, and methods of these studies.

As Table 1 reveals, Borghesi (2006), Grunewald et al. (2017), Jorgenson et al. (2016), and Knight et al. (2017), utilizing FE regression models, find no substantial effect of the income Gini coefficient on CO_2 emissions on country-level. This finding is independent from the time spans (8 to 29 years covering 1980 to 2010) and the number of countries (26 to 141) observed as well as from the use of either production-based accounting (PBA) or consumption-based accounting (CBA) of CO_2, the different data sources employed, and the covariates included. However, Grunewald et al. (2017) report a substantially negative inequality –CO_2 emissions nexus making use of group fixed effects (GFE) estimation (Bonhomme and Manresa, 2015) to account for grouped patterns of unobserved heterogeneous growth. Nonetheless, the data-driven grouping of regions might be artificial, as the trajectories of individual countries or states are the natural sampling and statistical unit of interest here. FE regression that allows for individual constants and slopes (FEIS) accounts for heterogeneous growth over time by simply fixing the interaction between regions and years in addition to the independent incorporation of region and time fixed effects. This cancels out potential individual time-varying unobserved heterogeneity (Brüderl and Ludwig, 2015; Polachek and Kim, 1994; Wooldridge, 2010). Thus, the use of FEIS is more appropriate than GFE here. Replication of Grunewald et al. (2017) utilizing FE and FEIS models finds no substantial effect of income Gini on CO_2 p.c. emissions. The results are available from the author upon request.

Another recent study by Hübler (2017) applies quantile FE regression with 149 countries from 1985 to 2012. Quantile regressions are more robust to influential cases than conventional mean estimators (Cameron and Trivedi, 2010). Also this study finds no substantial effect of income Gini on the 0.1, 0.25, 0.5, 0.75, and 0.9 quantile of CO_2 per capita (p.c.).

Aside from the advantage of being a broad indicator of inequality, the Gini coefficient a priori has the limitation of not being unique for a specific distribution. Different distributions can result in the same Gini coefficient value (e.g. Atkinson, 1970; Schutz, 1951) and it is not a direct measure of income and wealth concentration at the top of the distribution (Jorgenson et al., 2017). A more appropriate, albeit partial, measure of social inequality and in turn power concentration is the income/wealth share held by a given percentile group at the top (Alker