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Abstract

Social norms have been included in the theory of collective action to overcome difficulties in explaining why commons may perform better when self-regulated. The role of trust has been identified in several contexts of local social dilemmas, but only recently has been extended to global commons, based on large descriptive evidence collected by Elinor Ostrom. However, no quantitative evidence was available until now. Using a dataset of 29 European countries over the period 1990-2007, we provide empirical evidence in favor of the role of trust in global dilemmas. We find that trust has a negative impact on greenhouse gas emissions, whose extrapolation to Spain would imply a reduction in emissions of 12.5% if Spaniards would trust each other as Swedish people do.

Keywords

Trust; Social norms; Ecological behavior; Collective action; Climate change; Environmental policy

JEL Classification

A13 - Q54 - Q56

Unconventional Determinants of Greenhouse Gas Emissions: The Role of Trust*

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1 Introduction

Climate change is one of the principal challenges of this century. We observe two main patterns in the way human beings deal with this issue. At the global level, the day of a binding agreement including all principal emitters and targeting a sharp reduction in worldwide greenhouse gas emissions is still to come, although recent Conferences of the Parties suggested a potential deadline for binding abatement targets in 2020. Stalling negotiations are in line with the main theory of collective action, predicting large free-rider behavior and thus huge difficulties in solving this type of global public good dilemma (cf. Olson 1965; Hardin 1968). Despite most governments are reticent to engage in coordinated international policies, examples of unilateral policies, local actions and individual ecological behaviors are however increasingly available. A small set of countries already adopted carbon taxes to stimulate a shift toward a greener economy (Baranzini and Carattini 2013). In this paper, we aim to contribute to explain why countries and individuals may adopt or accept emissions reduction behaviors and policies, in spite of the global public good characteristics of climate change.

We draw on the contributions of Elinor Ostrom and other institutional scholars and apply an empirical framework to determine countries greenhouse gas emissions. In our paper we focus on the importance of social norms, and in particular of trust, in the determination of individual and collective behaviors. As highlighted by Ostrom and Ahn (2003): "The ideas fundamental to the social capital approach cannot be entirely captured by the first-generation collective-action theories that tend to reduce 'cultural' aspects such as trust, trustworthiness, and norms to incentives embedded in social structures of interaction. [...] Trustworthiness is an independent and nonreducible reason why some communities achieve collective action while other fail" (p. xvi).

The concept of trust, understood as mirroring an expectation of trustworthiness, has been applied to the problem of common pool resources and local environmental public goods to explain why self-organized solutions may perform better than regulated environments. A recurrent illustration refers to water management in developing countries:

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field evidence shows that overuse could be lower with self-management than with external control, i.e. the common prisoner's dilemma does not necessarily hold when people trust each other (cf. Joshi et al. 2000). Out of the environmental sphere, the concept of trust has been used in the development literature, in particular by Fukuyama (1995), who elects trust as the key social value for sustained economic growth, and by Knack and Keefer (1997) and Zak and Knack (2001), who show the positive role that trust plays in supporting growth.

In this paper, we aim to explore whether trust has an impact on greenhouse gas emissions, by referring conceptually to the literature criticizing the conventional collective action theory based on local and communitarian environmental solutions, while borrowing the empirical methodology from applications in development economics. Our is not the first attempt to relate social norms, namely trust, with global public goods such as climate change. The seminal paper of Ostrom (2009) already disputes the validity of the traditional view, which contends that the global scale of climate change hampers the emergence of grassroots collective action and dispersed forms of unilateral action, i.e. cooperation is even more unlikely than with local issues. Supported by the collection of case, field and laboratory studies presented in Poteete et al. (2010), Ostrom stresses the limits of conventional theory arguing that it can fail to predict the realized outcome also with global issues, especially whenever participants see each other as trustworthy (i.e. "effective reciprocators"). In particular, she suggests that the same mechanism of trust that leads commons to be successfully managed by self-organized institutions could be effective also with global issues. That is, in a given context, individuals can commit to reduce their own emissions and comply with their commitment, since they trust that others are also sharing the same responsibility and engaging in the same social behavior. To see this mechanism at work, we need to scale down the focus from the global perspective. Thus we can realize how social norms help overcoming the global property of climate change, promoting effective local efforts.

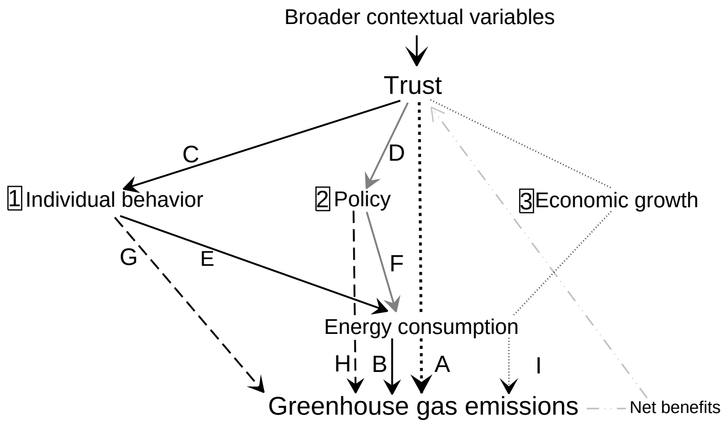
In the empirical side, Grafton and Knowles (2004) propose a series of cross-sectional regressions attempting to identify an effect of social capital on several measures of local environmental performance. They find very little evidence in favor of an effect of social capital, including trust. The authors point to a series of empirical difficulties related to the dataset, concerning both the measures of social capital and of environmental quality, which could explain the negative outcome.

Our aim is to generalize Ostrom's intuition and to assess whether the effect of trust is visible not only in small-sized case studies, but also at an aggregated level. In this way, we improve the seminal contribution of Grafton and Knowles (2004) in four ways. First, the measure of environmental quality that we use concerns global pollutants rather than local contaminants, i.e. greenhouse gas emissions. We thus test the full extent of Ostrom's hypothesis on global dilemmas. Second, this measure is compatible across time and countries and does not present the weakness of indices and similar built-in measures of environmental quality. Third, we use a larger set of data that allows for multivariate panel analysis and fixed effects, which limit the risk of omitted variable bias and allow focusing on changes over time. This framework, along with a larger set of control variables, ensures more robust results. Fourth, our dataset of European countries is composed by relatively similar economies, also contributing to reduce the bias possibly caused by missing variables.

Hence, we perform an econometric analysis assessing the effect of trust on greenhouse gas emissions. We end up with a negative coefficient implying a decline in emissions of 0.24% following a percentage increase in trust, ceteris paribus. This fresh evidence is in line with the updated theory of collective action and supports its underlying economic intuition.

The remainder of the paper is structured as follows. Section 2 reviews the economic motivations. Section 3 presents the data, discusses the methodological issues related with the measure of trust and describes the econometric strategy. Section 4 focuses on empirical results. Section 5 concludes.

Figure 1: From trust to greenhouse gas emissions.



Note: Own figure based on Poteete et al. (2010). According to the authors, the level of trust that other participators are reciprocators affects the level of cooperation and in turn generates a beneficial outcome, which in this framework would be a reduction in emissions. The effect of trust on emissions goes through three channels, as described in the text, represented by the numbers 1,2 and 3. Paths A to I are detailed below.

2 Linking trust and greenhouse gas emissions

We expect trust to have a threefold impact on greenhouse gas emissions. First, trust may have a direct effect by promoting pro-social and environmentally-conscious behavior at the individual level (e.g. biking to work rather than driving), as illustrated by the large survey in this field of Pretty and Ward (2001) and Poteete et al. (2010). According to the latter, trust plays a crucial role as the norm defining the actual level of cooperation (cf. Figure 1): if agents acting in a given context perceive most individuals as reciprocators (i.e. trustworthy), we may expect them to adopt a more cooperative behavior (e.g. pro-environmental). In this way, trust generates reciprocity: a mechanism based on the social "obligation" to reciprocate leads people to invest in collective action being confident on other people doing the same (Pretty and Ward 2001).

Second, trust may have an impact on local, regional and national environmental policy as it influences collective action. Whereas there is some theoretical and empirical literature analyzing the effect of environmental policy on trust and intrinsic motivation, suggesting a crowding-out if the policy change makes agents less trustful (see e.g. Frey 1997; Cardenas et al. 2000; Frey and Jegen 2001) and a crowding-in if the policy change makes agents more trustful (Ostrom 2009), the reverse link from trust to environmental policy is still largely unexplored. Consistently with Ostrom (2009) and Grafton and Knowles (2004), we expect a positive relation from trust to environmental policy. In particular, Ostrom's analysis concludes that trust and environmental policy are indeed complements: in some cases, only collective action allows policies to exist and be followed in a manageable way (i.e. without excessive costs of enforcement). Trust is thus the key for having diligent and proactive citizens. She explains in this way the large list of environmental programs undertaken at any level (municipal, regional, inter-regional, etc.) and mentioned in her work.

Yet, we acknowledge that in absence of trust (or at very low levels) there may be some substitution between policy and trust. For instance, Baranzini et al. (2010) consider a global public good problem such as tropical forest conservation and find that when people do not expect spontaneous efforts by the others, they prefer to contribute to a mechanism which is strict and enforceable (i.e. a hypothetical global tax) compared to a mechanism based on voluntary agreements (i.e. a voluntary fund for forest conservation). However, one would argue that in such situation it would be unclear who would promote such a policy. In reality there is no global tax to protect tropical forests. In our view, in spite of the positive demand for environmental policy, the latter fails to rise due to the same reason that leads to the development of its demand, i.e. the lack of trust. That is, at very low levels of trust we may see a pattern of substitutability on the demand side which is however not matched by policy suppliers (i.e. institutions, since collective action is lacking). We thus suggest that pro-social behavior and policy are more likely to go hand in hand rather than be substitutes.

Further evidence in this sense comes from a growing body of literature following an environmental psychological approach. Stern et al. (1999) theorize how engagement in collective action aiming at affecting climate policy, both actively (e.g. writing letters, contributing financially to environmental movements, demonstrating, i.e. environmental citizenship and activism) and passively (e.g. accepting higher taxes), responds to a feeling of obligation to contribute to the provision of a collective good. In this framework, social and personal norms interact and contextual factors such as social expectations and trust contribute to explain pro-environmental behavior in the public sphere along with moral motivations (Stern 2000). Survey-based empirical evidence supports this norm-activation mechanism, by using measures of policy-related collective action such as e.g. being in favor of higher energy prices (i.e. energy taxes), of subsidies to energy efficiency and renewables, signing petitions for tighter environmental laws, supporting green taxation of imports, and so forth (see e.g. Stern et al. 1999; Gaerling et al. 2003; Steg et al. 2005 and the survey of Steg and Vlek 2009).

Third, trust may influence emissions through an additional channel, namely economic growth (see Knack and Keefer 1997, Zak and Knack 2001). However, our focus is on trust and collective action toward environmental-friendly changes. For that reason, our empirical strategy is limited to the impact of trust on environmental behavior and policy.

Figure 1 summarizes. The mechanism of Poteete et al. (2010) is updated by introducing the link between trust and greenhouse gas emissions. This link is represented by path A. In detail, however, we expect this effect to go through lower energy consumption (path B). In this sense, energy consumption acts as a mediator, in the spirit of Baron and Kenny (1986). Indeed, we would expect an increase in pro-environmental behavior (C) to lead to lower energy consumption (path E), as we would expect local, regional and national environmental policy to do it (paths D and F). In theory, both individual behavior and policy could also affect emissions without passing by the level of energy consumption, e.g. by affecting the energy-mix (i.e. technological development and adoption). That is why we include two dashed arrows for paths G and H[1]. Path I corresponds to the effect of trust to emissions through economic growth, which is omitted in our empirical framework. Finally, following Poteete et al. (2010), we add a feedback mechanism, reinforcing the existing pattern. In the case of climate change, direct benefits of climate policies or green behavior may not be visible for the individual, but those efforts could contribute to more perceptible local co-benefits, e.g. in terms of better air quality. However, we do not expect this effect to be particularly large as to be an issue for identification.

3 Methodology

3.1 Data sources and measurement issues

We access the Eurostat database for 30 European countries over 1990-2007, namely the 27 members of the European Union as well as the EFTA members Iceland, Norway and Switzerland. Our sample includes 9 transition economies. Greece is not included in the estimations, due to missing values. Eurostat provides the data for all the explicative variables used in the econometric model except trust, which comes from the World Values Survey (WVS)[2]. The

[1] Path H relates to the so-called "Porter hypothesis" (see Baranzini and Carattini 2013 and Ambec et al. 2013 for an empirical review; Acemoglu et al. 2012 for a theoretical analysis).

[2] See Table 4 for data sources.

variable trust that we use in this study is the share of respondents marking the answer "Most people can be trusted" when asked "In general, do you think that most people can be trusted, or that you cannot be too careful in dealing with other people?". The alternative answer is "You cannot be too careful in dealing with other people". The number of individuals surveyed depends on both timing and country: observations vary between a minimum of 375 (for Malta in 1991) and a maximum of 2574 (for Belgium in 1990). In general, the largest part of our values is given by a sample reaching or exceeding the symbolic threshold of 1000 individuals.

Unfortunately, we do not possess yearly observations for trust, given that the survey is administered sporadically and with different timing across countries (i.e. one wave can take more than one year to be completed). The latest available wave is of 2007. For this reason, the sample ends in 2007 and is composed by a theoretical maximum of 540 observations. Countries included in the sample represent more than 10% of world greenhouse gas emissions (UNEP 2012).

Main descriptive statistics are provided by Table 1. Greenhouse gas emissions present very large variation, since they depend closely on the economy's size. In per capita terms, each European citizen emits about 11 tons of CO_2-equivalent emissions per year on average over the observed period. As shown by Figure 2, per capita greenhouse gas emissions decreased in European countries in the early 90s and leveled off thereafter. However, in the case of transition economies, the early 90s are characterized by a sharp change in the economic structure and a heavy collapse of output resulting in a strong decrease in emissions. Afterward, transition economies switched to a recovery path, but emissions lagged behind until 2000. All this suggests dealing carefully with this subset of countries.

Manufacturing represents on average about 20% of European GDP. Since Eurostat does not include mining and fossil fuel extraction in the category manufacturing (but only fossil fuels refining), we decide to add mining and resource extraction to manufacturing whenever data are available (cf. Xu and Ang 2013). This is economically justified by the large energy-intensity of mining and resource extraction, which we relate to the so-called "composition effect". Looking at the data, we see an important structural change taking place in European economies during the 90s and the 2000s, with the largest drops in manufacturing share being related with transition economies (from more than 30% of GDP to 20% in about two decades).

As it is common in the literature, trade is given by the sum of imports and exports over GDP (trade intensity ratio). Trade openness evolves similarly for both transition and Western European economies, with the average level of trade moving from about 40% of GDP in 1990 to slightly less than 60% in 2007. However, cross-country differences are important. On average, transition economies are related to larger trade openness. Still, Western small open economies such as Belgium, Ireland, Luxembourg or Malta show even larger values.

Our main variable of interest is trust. Data inspection shows some supportive variation over time in the level of trust[3]. For instance, trust in Spain moved from 34.3% in 1990 up to 39.8% in 1995, but then decreased to 34% in 2000 and 20% in 2007. Trust also possesses a large variation between countries. Although the average shows moderate levels of trust for Europe (i.e. one out of three respondents stating that most people are trustworthy), extremes indicate relatively low levels of trust for Cyprus, Portugal and Romania (with values below 10%) and large levels of trust at the other end of the spectrum, mainly related with Scandinavian countries (about two out of three respondents trusting most people).

Since trust is not directly observable, it can only be approximated from individual perceptions in surveys. A long list of potential biases could raise from survey measures, such as selection issues, translation difficulties (i.e. different framing) and response bias (cf. Knack and Keefer 1997). For example, in their study about trust and

[3]We start with 84 values for trust and interpolate linearly to reach 340 observations. In a conservative vein, we do not extrapolate. Furthermore, by extrapolating we would have had to deal with negative (thus zero) values, which is a very extreme case. Still, the number of observations used for the estimations varies depending on the completeness of control variables. Own computations show that the way we ipolate does not have a particular impact on the empirical findings in the next section, e.g. by applying cubic or cubic spline ipolations and multiple imputation techniques. We matched the WVS measures of trust for Great Britain and West Germany with Eurostat variables for United Kingdom and Germany, respectively (cf. Knack and Keefer 1997).

economic growth, Knack and Keefer (1997) point to a selection bias related to the WVS measure of trust may leading to over-correlation with education and income. However, they argue that this issue mainly applies to developing countries. Ostrom and Ahn (2003) present other drawbacks of survey measures related to trust. For instance, it seems that measures from the General Social Survey, another large-scale survey similar to the WVS but administered only to the US population, do not lead to good forecasts of individual cooperation in the lab.

However, other studies reviewed by Ostrom and Ahn (2003) provide a more optimistic picture, showing that although general survey questions may struggle to depict the trust pattern (e.g. if a participant trust the other participants when playing first), they are generally successful in predicting trustworthiness (e.g. the amount of money given back by trustees if players in the first round decide to trust). Furthermore, Knack and Keefer (1997) not only provide a list of potential risks linked to the WVS measure of trust, but also favorable evidence for its application. In particular, they test whether the ambiguous terminology used in the question (i.e. the reference to "most people") may lead respondents to think to other people as their family, which is not necessarily the scope of trust for our study, since we are interested in trust in the others in a large sense[4]. The authors point out that in low-trust countries a large share of interactions probably occurs within the family, which could eventually lead to a bias. Yet, they find a low correlation (of 0.24) between the WVS measure of trust and the measure of trust in the family. We are thus more confident that our variable measures trust in the others in a large sense. The authors also look at the nexus between the WVS measure of trust and the share of returned wallets in a cross-country experiment wherein wallets were "lost" with 50$ in cash and a card with the owner's contact, finding a supportive correlation of 0.67. In addition, correlations tend to get higher when controlling for income per capita (thus trying to simulate the reaction to a purchasing-power-adjusted "lost" wallet, i.e. testing individual's "real" trustworthiness)[5].

In the same vein, we examine the link between the measure that we choose for this study ("Most people can be trusted") and additional measures of trust that were included in the WVS, although for some waves only. In particular, we consider the answers to the questions "Trust: other people in country", "Do you think most people try to take advantage of you?", "Trust: people you know personally", "Trust: people you meet for the first time" and "Trust: your neighborhood". This investigation confirms our priors. Trusting other people in country is positively correlated with the measure of trust that we use. We find positive and significant links both in correlation tables and with panel regressions for both the positive answers, viz. "Trust completely" and "Trust a little", as well as for the sum of the two[6]. Therefore, we are confident that the national measure of trust that we include in our empirical framework makes sense and captures a plausible range of social interactions to be linked with collective action.

"Take advantage of you" is very highly correlated with trust (correlation of 0.88). The correlation is positive since the variable is coded in a scale over 10 points whose maximum indicates an expectation of full fair treatment. "Take advantage of you" and "Most people can be trusted" provide different and comparable answers to a very similar question, simply framed differently. This is very helpful since it allows for double checking respondent's answers (although framing may matter).

Not surprisingly, both "Trust: people you know personally" and "Trust: people you meet for the first time" are strongly correlated between themselves (0.75) and with "Most people can be trusted" (0.6 and 0.72, respectively). Since trust is self-reinforcing and can be accumulated, it follows from practice that people tend to apply their own experience in shaping their everyday behavior while interacting with new agents (Pretty and Ward 2001).

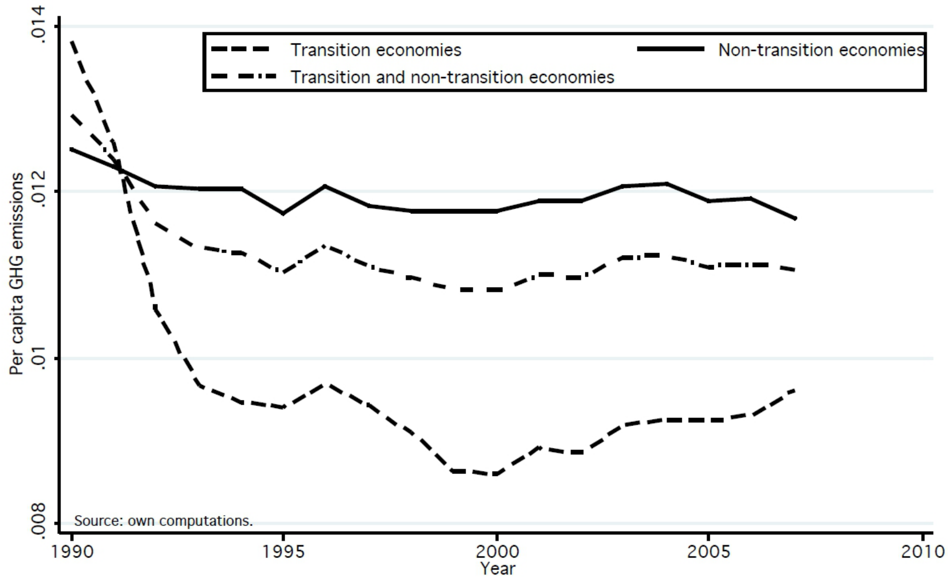
The correlations for "Trust: your neighborhood" goes in the same direction. It is correlated at 0.84 and 0.86 with "Trust: people you know personally" and "Trust: people you meet for the first time", respectively, and at 0.6

[4]More precisely, we shall say that we mainly focus on "intrinsic reciprocity" rather than "instrumental reciprocity". Knack and Keefer (1997) use the term "generalized trust" referring to the same concept. Cf. Sobel (2005) for a discussion on terminology and sound economics of reciprocity.

[5]See also Grafton and Knowles (2004) for a similar discussion.

[6]All following measures except "Take advantage of you" are coded according to the following answers: "Trust completely", "Trust a little", "Not trust very much" and "Not trust at all". We use the two positive answers and their sum (as percentage share of total answers).

Figure 2: Evolution of GHG emissions per capita over 1990-2007 for the whole sample and subsets of countries.



Note: Own figure.

with “Most people can be trusted”. The evidence concerning the last three variables is encouraging since we focus on a global dilemma that needs to be dealt with through cooperation between people at different scales. That is, it seems that social context matters and at different levels[7]. Therefore, we are confident that the variable trust that we chose from the WVS has the potential for performing well and can thus be used in quantitative studies, even in the case it would measure more trustworthiness than trust (cf. Knack and Keefer 1997; Pretty and Ward 2001; Ostrom and Ahn 2003). Moreover, we are reassured that our measure performs well in explaining trust between citizens of the same country as well as in narrower contexts.

3.2 Econometric approach

Starting from earlier empirical works on environmental quality (see in particular Antweiler et al. 2001) and following the previous discussion on trust and emissions, we may suppose that the relevant drivers of per capita greenhouse gas emissions are the level of per capita income, the economy's composition, the economy's openness to trade and the level of trust as given in the following equation:

$$\begin{aligned} Emissions_{i,t} &= \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} \\ &\quad + \beta_4 Trust_{i,t} + \epsilon_{i,t} \end{aligned} \tag{1}$$

where $Emissions_{i,t}$ stands for per capita greenhouse gas emissions at time t in country i (in log); $GDP_{i,t}$ is real GDP per capita (in log); $Manufacturing_{i,t}$ is the aggregated industrial sector's share in the economy; $Trade_{i,t}$

[7] All correlations we refer to are statistically significant at least at 10%. However, further studies are needed to have more robust results. Indeed, all these variables are not included in all WVS waves as it is “Most people can be trusted”. Hence, the explanatory power is limited by the small number of available observations.

measures trade openness; $Trust_{i,t}$ is the share of population showing trust as measured by the WVS; a_i is a country-specific fixed effect and $\epsilon_{i,t}$ represents the error term.

The estimated coefficients can be directly interpreted in terms of elasticities, since all variables are in logs or in shares.

The use of panel-data methods allows for different specifications, in particular the use of fixed- and random-effects estimators. In their seminal contribution, Antweiler et al. (2001) evaluate the limits of one or the other approach in a very similar framework where they have a panel of 293 observation sites measuring sulfur emissions in 109 urban areas across 44 countries, looking for the effect of trade on emissions. In particular, they remark that fixed-effects estimators treating country-specific excluded variables as constants are appropriate when the aim is to apply the model to the countries in the sample, as we do. In our framework, it would be difficult to argue that our set is a random draw of countries from a larger underlying population. Inconsistency related to omitted variables would be the consequence of applying random effects when not appropriate, whereas the intrinsic drawback of a fixed-effects model is represented by the fixed effects themselves, i.e. the need of simplifying the model by assuming country effects to be constant and focusing on variation over time. The Hausman test (Hausman 1978) supports the theoretical arguments. As a consequence, we introduce country-specific fixed effects in (1)[8].

Except for trust, the determinants of emissions included in (1) are standard with respect to the literature. We control for structural changes in the composition of the economy using the share of manufacturing, following Cole (2000), Cole (2004) and Buehn and Farzanegan (2013). Then, we take into account the remaining effect of income per capita, similarly to e.g. Antweiler et al. (2001). Observing the effect of trade openness is central in Antweiler et al. (2001) and in other works dealing with geographical carbon leakage. De Melo and Mathys (2010) review the main links between trade and the environment: trade liberalization may increase economic activity (but we already control for GDP per capita), it may lead to specialization, displacement of polluting activities and structural changes (but we already control for most energy-intensive industries) and it may affect the type of technology used to produce goods and services within the country. We expect the measure of trade openness to capture predominantly the last effect.

Energy consumption is a very recurrent control variable in the literature (cf. Buehn and Farzanegan 2013), but it is not included in model (1), which estimates path A in Figure 1, i.e. the direct effect of trust on emissions. Energy consumption enters model (2), whose role is twofold. First, it tests the effect of energy consumption on emissions, which is expected to be positive and significant (path B). Second, it tests for residual mediation. Provided that equation (1) shows a significant effect of trust on emissions, if energy mediates trust, the relation between the latter and emissions should be no longer significant, or at least substantially reduced[9]. Model (2) is given as follows:

$$\begin{aligned} Emissions_{i,t} &= \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} \\ &\quad + \beta_4 Trust_{i,t} + \beta_5 Energy_{i,t} + \epsilon_{i,t} \end{aligned} \tag{2}$$

where $Energy_{i,t}$ stands for per capita gross inland energy consumption (in log). A last step is required for mediation, testing the effect of trust on energy (paths C plus D). If energy is a valid mediator, the coefficient for trust should be significant. Model (3) displays then an analogous specification for energy consumption:

[8] The Hausman test rejects the null of always consistent random-effect estimators with a Chi-2(5)=80.12 and Chi-2(4)=8.32 with and without per capita energy consumption, respectively (p-value of 0.0000 and 0.0804). Breusch and Pagan Lagrangian multiplier test for random effects gives Chi-2(1)=1025.08 and Chi-2(1)=1161.83, respectively (p-value of 0.0000 in both cases).

[9] Baron and Kenny (1986) refers to "perfect mediation" when the residual effect of the independent variable on the dependent variable controlling for the mediator is zero. In this framework, a positive residual effect would imply that the effect of trust on emissions would be mediated also by the energy-mix, i.e. paths G and H. Instead, a non-significant coefficient for trust would suggest that almost all mediation goes through energy consumption, although we would refrain from calling it perfect mediation for straightforward empirical reasons. In our view, this is the best way to assess the impact of trust on the energy-mix, which is hardly available in the data. Hence, we omit a specific model for this path but still test its plausibility adding some variables to the main specifications (see next section).

$$Energy_{i,t} = \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Trust_{i,t} + \epsilon_{i,t} \quad (3)$$

In theory, additional levels of mediation could be tested. For instance, paths C and D could be tested by e.g. controlling whether environmental policy does act as a mediator for trust to energy consumption and in what extent. However, we face important shortage of data on policy, as discussed in the next section.

To summarize, the expected impacts of included variables are the following:

- Real income per capita (+): although there is no clear-cutting evidence on the precise role of income per capita on global emissions, a general consensus points to a positive effect due to the dominance of the so-called scale effect.
- Manufacturing (+): we expect industry to be on average more emissions-intensive than services and an increase in the share of manufacturing to be positively related with emissions.
- Trade (±): there is no conclusive evidence on the effect of trade on emissions, even if we control for income per capita and manufacturing.
- Trust (−): trust is supposed to foster collective action toward cleaner goods, greener attitudes and more effective environmental policy. We thus expect trust to decrease emissions by reducing energy consumption.
- Energy (+): energy consumption is directly and positively linked with emissions, provided that energy sources are mainly fossil fuels.

We discuss the outcome of the estimations in the next section.

4 Empirical results

Estimation results for models (1), (2) and (3) are displayed by Table 2. Column (1) and (2) exhibits the estimates for model (1), testing the direct effect of trust on greenhouse gas emissions (path A)[10]. Column (1) includes transition economies, whereas all other columns do not. Regressions in columns (1) and (2) provide very large goodness of fit, which are however in large part driven by fixed effects, as shown by the difference between overall-R^2 and within-R^2. Robustness tests for model (1) without transition economies are shown in Table 2. Results are robust both to heteroskedasticity and autocorrelation. Indeed, the Wald test rejects the null of homoskedasticity in our panel, as well as the Breusch-Pagan (Cook-Weisberg) test. We thus allow errors to be heteroscedastic in Table 2, where model (1) is estimated using heteroscedastic-consistent White standard errors and bootstrapped standard errors (with 50 replications), cf. columns (2) and (3), respectively. Significance is only slightly reduced. Then, the Wooldridge test for first-order autocorrelation rejects the null hypothesis of no autocorrelation. We also allow for autocorrelation in the residuals estimating Driscoll-Kraay heteroscedastic and autocorrelated standard errors, cf. column (3). Coefficients of interest are still statistically significant. This holds true for the whole sample, i.e. including transition economies. We also test for multicollinearity: for model (1) mean variance inflation factor is 6.96 with fixed effect, 1.35 without. Both values are below the common threshold value of 10, the second is even below the more restrictive threshold value of 5. Multicollinearity is not an issue also for model (2), which includes energy consumption as a regressor, and model (3).

We start commenting reported estimates in Table 2 by focusing on columns (1) and (2). Coefficients for most control variables behave as expected. Since we control for manufacturing (a proxy for the composition effect),

[10] The model is assumed to be linear and estimated with OLS. Given the data available we consider linear regression as the best tool for estimating empirically the link between trust and greenhouse gas emissions.

the coefficient for GDP per capita is supposed to capture both scale and technique effect[11]. This coefficient is negative and significant with the full sample (1), but it becomes positive and significant when transition countries are excluded from the sample (2). The case of transition economies is exceptional. For instance, Millock et al. (2008) find a very large technique effect for CO_2 emissions in transition economies. Their explanation refers to the simultaneous heritage of devastated environmental resources and unsuccessful planned economies in ex-Soviet countries. In particular, they mention a series of environmental stresses especially related to ex-communist countries, many of them being linked with global pollutants such as greenhouse gases. Jobert et al. (2010) use the terminology "ecologists despite themselves" for Eastern European countries that experienced the collapse of the Soviet Union. Overall, the positive coefficient for GDP per capita is in line with most studies focusing on global pollutants and in particular CO_2, which represents the bulk of greenhouse gas emissions (see e.g. Lin and Li 2011 for a recent assessment).

In line with expectations, a greater share of manufacturing implies higher emissions. Taking the coefficient of column (2), an increase of 1 percent in the share of manufacturing leads to an average increase in emissions of 2.2 percent, everything else fixed (cf. e.g. Jobert et al. 2010 for a similar finding and discussion).

Trade openness is associated to a negative effect. Since we control for the share of manufacturing in the economy, we expect this effect to be related with the technique effect, i.e. the exposition of exporters to new markets with own standards, the effect of foreign investment and technology transfers. However, it is also possible that it accounts for firm's relocation of dirty activities that is not fully captured by the control variables.

As expected, the coefficient for trust is negative and statistically significant. An estimate of –0.24 implies that a change of 1 percent in trust (i.e. one percentage of respondents switching from the answer "You cannot be too careful in dealing with other people" to the option "Most people can be trusted") leads to a decline in per capita greenhouse gas emissions of 0.24%[12].

The coefficient for trust is however not robust to the inclusion of energy consumption. That is, in model (2), which adds energy consumption, the coefficient for trust becomes non-significant, as shown by column (3). This result confirms our previous discussion, since we expect trust to decrease energy consumption both directly and indirectly. Regarding the coefficient for energy, its sign is in line with expectations, as well as the boost in the goodness of fit. The estimate of column (3) implies that for one percent increase in energy consumption, emissions increase by 0.8%, which makes sense since not all energy sources are related to all greenhouse gases in the same way. This figure represents path B in Figure 1. We also see that all control variables are stable to the inclusion of energy consumption, which is positive sign of robustness. The exception is GDP per capita, which turns out to be negative. However, this comes as no surprise, since the scale effect is likely to be captured by the coefficient of energy consumption, which controls for the dirty component of economic growth.

The last step for testing mediation estimates the impact of trust on energy consumption (path C). Estimates for model (3) are shown by column (4). We find that trust does indeed affect energy consumption, and with a negative sign. The coefficient of -0.32 implies that a percentage increase in the level of trust would lead to a reduction in energy consumption of about 0.3%. Control variables behave very similarly to model (1). Indeed, a larger share of manufacturing is related with larger energy consumption, as well as GDP per capita. Abstracting from issues of endogeneity, which are not crucial while dealing with controls, column (4) suggests that economic growth is responsible for larger energy consumption, thus supporting the positive coefficient on emissions.The coefficient for trade becomes instead non-significant. Interestingly, it may imply that trade does not affect emissions through the level of energy consumption but through its content (i.e. the energy-mix), which may support the technique effect.

Altogether, Table 2 provides evidence in favor of the role of energy consumption as mediator. Results also rule out the mediation of the energy-mix. However, we take them as evidence that the largest effect goes through

[11] In this sense we follow the standard approach in the literature, even though some conceptual doubts can be casted about the plausibility of a technique effect (cf. Roca 2003; Dinda 2004).

[12] This figure is robust to the addition of a time trend or time dummies. Results available upon request.

the level of energy consumption and not through its content, rather than as a case of perfect mediation. We also perform some additional mediation regressions with a series of variables proxying technology or the energy-mix, e.g. patents, dirty sources such as coal and oil, share of renewable energy, share of nuclear energy (cf. Roca et al. 2001, Buehn and Farzanegan 2013)[13]. Still, the coefficient for trust is not affected. Hence, we conclude that we fail to find evidence on the role of the energy-mix as mediator.

Since it is possible that trust has a delayed impact on emissions, we account for a non-simultaneous relation by introducing lags between trust and emissions per capita. We expect that the influence of trust decreases with time and we are interested to know how long the "memory" is influencing emissions. We find however that including lags do not substantially improve our model (results not reported here). We estimate an optimal lag for each time series (i.e. for each country i) with a sufficient number of observations, borrowing from the tools of vector autoregression (VAR) analysis. Only in a minority of cases the optimal lag exceeds the fourth lag. However, autocorrelation is still present even at the fourth lag, according to a Lagrange-multiplier test. Hence, we prefer to rely on the contemporaneous model presented here.

To illustrate the impact of trust on emissions, consider for instance Spain in 2007, which has emissions per capita of about 9.8 tons of CO_2-equivalent and a level of trust of 0.2 (i.e. 20% of respondents asserting that most people can be trusted). If we iterate the marginal change of one unit in trust by using the coefficient of column (2) of Table 3 to have Spain attaining the level of trust of Sweden (i.e. from 20% to 68%), Spanish emissions per capita would decrease by about 12.5% (i.e. 1.2 tons per capita)[14]. That is, if Spain would have the level of trust of Scandinavian countries, their emissions would be by far smaller, *ceteris paribus* (i.e. assuming that the other drivers of emissions would not be affected by this large increase in trust). Despite recent evidence calls for emissions reductions of about 40% with respect to 1990 and of 60% compared to 2010 to avoid dangerous interferences with the climate system (see e.g. UNEP 2012), the magnitude of the effect related to trust is considerably large for a variable that was neglected until very recently and thus justifies its inclusion as a determinant of greenhouse gas emissions.

As discussed in Section 2, the impact of trust on energy consumption and thus emissions cumulates the impact on individual behavior and environmental policy (paths C and D). Obviously, we would have preferred to disentangle the two effects, e.g. by isolating the role of environmental policy. However, environmental policy is very difficult to measure and proxies hardly capture the panoply of possible local and national efforts. Yet, we consider some indicators for domestic and international policy (i.e. top-down initiatives) such as Eurostat's total environmental tax revenue and the climate-policy components of the Climate Change Cooperation Index and of the Climate Change Performance Index[15]. Unfortunately, the overlap between our panel and the latter is too short for obtaining any meaningful result. Instead, we are able to test for mediation with the remaining indicators. Although we find a negative effect of both environmental taxation and the C3-I on the level of energy consumption, the coefficient for trust is unaffected. In addition, the estimate for the C3-I does not reach statistical significance. Even though this evidence does not play in favor of the policy channel, we recall that the variables used are only rough proxys for the sum of local, regional and national efforts towards curbing energy consumption and reducing greenhouse gas emissions.

Hence, we look back to the WVS and examine the relationship between trust and collective action as expressed

[13] All variables come from Eurostat. Patents stands for patents applications to the European Patent Office. Results available upon request.

[14] This implies a change in trust and emissions of about 3 standard deviations (cf. Table 1).

[15] Total environmental tax revenue is available e.g. as a percentage of GDP (cf. Costantini and Mazzanti 2012). The C3-I is developed by Bernauer and Boehmelt 2013 and updates the Cooperation Index of Baettig et al. (2008). The C3-I's policy component evaluates the efforts of a country for the success of international negotiations, by giving marks based on commitments to the United Nations Framework on Climate Change (UNFCCC), ratification of the Kyoto Protocol, emissions reporting and financing to the UNFCCC structure. Instead, the policy component of the Climate Change Performance Index, released by Germanwatch, is based on local climate change experts' opinions. The C3-I goes back until 1997 and encompasses 172 countries, whereas the Climate Change Performance Index delivers reliable policy evaluation starting from 2006 (available in the index of 2007, cf. Burck and Bals 2012).

by the following two questions: "Would give part of my income for the environment" and "Increase in taxes if used to prevent environmental pollution". In both cases the possible answers are: "Strongly agree", "Agree", "Disagree" and "Strongly disagree". 125 observations are available for the first question (out of 35, by interpolation). If we take the share of people answering "Strongly agree" and "Agree" to the first question, the correlation with "Trust most people" is positive (0.23) and significant (at 1%). Regressing "Give part of income" on GDP per capita, the time trend, fixed effects and trust leads to a positive coefficient for trust (0.792, significant at 1%). This suggests that an increase of trust by 1% leads to an increase of about 0.8% of people accepting to forsake part of their income for helping the environment. For the question on environmental taxation, we find a correlation of 0.29 with trust, significant at 1% (based on 192 observations out of 54). By regressing "Increase in taxes if used to prevent environmental pollution" on income per capita, existing levels of environmental taxation, the time trend, fixed effects and trust, we find a coefficient for trust of 0.581, statistically significant at 1%. This coefficient implies that a change of 1% in trust leads to 0.6% increase in people strongly agreeing or agreeing to increase taxes used for environmental purposes. Arguably, it implies being ready to give up part of their income. However, the correlation between "Give part of income for the environment" and "Increase in taxes" is of "only" 0.7, leaving room for direct pro-environmental behavior. Given the small set of observations and the previous findings, we take these findings as descriptive evidence supporting the case for further analyses on the policy channel. That is, we thus leave for future studies the task to measure the contribution of each of the two channels, as well as the net impact on emissions (including the trust-to-growth effect). In addition, one may see as appropriate to include trust in foreign people in the analysis of the policy channel.

Another avenue for future research would consist in analyzing how societies can address the issue of trust and foster the level of cooperation among individuals. Some recent works convey converging evidence emphasizing the need to target the "push factors" determining environmental behavior through normative discourses (e.g. by exhibiting the neighbors' level of cooperation), attempting to stimulate agent's trust in a shared effort toward climate change mitigation (see e.g. Cialdini 2003; Schultz et al. 2007; Steg and Vlek 2009; von Borgstede et al. 2013). More in general, reducing inequalities, improving institutional quality and enhancing education (especially teaching cooperation) should contribute in building trust (Knack and Keefer 1997; Zak and Knack 2001). It is thus important to use existing trust networks (see Catney et al. 2013a) but also to overcome social barriers impeding the emergence of new ones (Catney et al. 2013b).

5 Conclusion

Recent contributions in the theory of collective action have shown that predicted non-cooperative attitudes in social dilemmas sometimes fail to be verified in empirics. This fact is supportive for the new strand of research highlighting the importance of social norms and social contextualization for understanding collective action. However, until recently, social aspects of economic behavior related with environmental goods were confined to local issues. Elinor Ostrom eventually extended the concept revealing the extent of grassroots projects tackling climate change from different perspectives. This phenomenon was in the public eye, but an important contribution was necessary to realize what has then become evident: struggling international negotiations are only a side of the coin of climate change mitigation. Ostrom (2009) explains the willingness of many citizens to provide collective efforts to curb emissions as a result of trust among them, broadening the trust-and-reciprocation mechanism of commons.

We apply her insights and test for an aggregated effect of trust on greenhouse gas emissions and offer evidence in favor of the Ostrom Hypothesis. Indeed, we find a negative effect of trust on emissions, based on a panel of 29 European countries over the period 1990-2007. The estimated negative elasticity implies that a percentage increase in trust reduces emissions of 0.24%, by leading to a decline in energy consumption of about 0.32%. This impact is not negligible, since it implies, for instance, that a level of trust similar to the one of Sweden would lead Spain to a decline in emissions by about 10%.

The correlation between trust and growth (Knack and Keefer 1997; Zak and Knack 2001) and the nexus we find from trust to emissions may explain why some economists attempted to link income growth with emissions. In our opinion, trust and social values may contribute to answer to Esty and Porter's (2005) quest for an explanation beyond the Environmental Kuznets Curve regarding cross-country differences in environmental quality. Hence, not accounting for trust would lead to an omitted variable bias attributing to other variables, e.g. income per capita, the effect of trust and social values.

In conclusion, we agree with Elinor Ostrom and co-authors with the need of a paradigm shift in the way environmental issues are analyzed from an economic perspective and in the choice of the relevant factors to be considered.

Several caveats limit the interpretation of our results beyond their context and create the bases for further research. First, we use an imperfect measure of trust, which is collected only occasionally. Second, we provide an aggregated result, but we are not able to disentangle the ways that lead trust to be effective in reducing emissions. Third, we do not assess the net effect of trust, which should encompass also the growth-driven impact on emissions. Fourth, it is still largely unexplained how policymakers can affect trust and social values, although some reviewed contributions started to target the issue.

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Tables

Table 1: Dependent and independent variables: summary statistics

Variable	**Unit**	**Mean**	**Std Dev**	**Min.**	**Max.**	**N**
Greenhouse gas emissions per capita	10^3 tons of CO_2 equivalent	0.011	0.004	0.004	0.035	539
Real GDP per capita	Euros of 2000	19747.18	12622.49	1218.981	71428.57	438
Trust	Share of positive answers	0.352	0.148	0.099	0.68	340
Manufacturing	Share of GDP	0.197	0.056	0.075	0.453	460
Trade openness	Share of GDP	0.494	0.250	0.165	1.764	484
Energy consumption per capita	10^3 tons of oil equivalent	0.004	0.002	0.002	0.014	538

Source: Own computations. See Table 4 for data sources.

Table 2: Empirical results based on model (1), (2) and (3)

	Greenhouse gas emissions			Energy consumption
	Model (1)		Model (2)	Model (3)
	(1)	(2)	(3)	(4)
Trust	-0.269** (0.114)	-0.242** (0.110)	0.022 (0.744)	-0.321*** (0.101)
Real GDP per capita	-0.023** (0.011)	0.088*** (0.033)	-0.070*** (0.024)	0.192*** (0.030)
Manufacturing	1.414*** (0.240)	2.241*** (0.344)	1.106*** (0.238)	1.384*** (0.317)
Trade	-0.210*** (0.068)	-0.569*** (0.115)	-0.440*** (0.076)	-0.157 (0.105)
Energy consumption	-	-	0.821*** (0.054)	-
Constant	-4.045*** (0.152)	-5.080*** (0.333)	0.805* (0.446)	-7.171*** (0.307)
Country fixed-effects	Yes	Yes	Yes	Yes
Observations	257	197	197	197
Countries	29	20	20	20
Within-R^2	0.277	0.287	0.694	0.327
R^2	0.970	0.970	0.987	0.983

Source: Own computations.

Notes: Standard errors in parentheses.

*,** and ***: significance at the 90%, 95% and 99% confidence levels, respectively.

The dependent variable is greenhouse gas emissions per capita, in logs. Panels are unbalanced.

Columns (2) to (4) do not include transition economies.

Table 3: Robustness tests for model (1)

	Greenhouse gas emissions			
	(1)	(2)	(3)	(4)
Trust	-0.242	* (0.140)	* (0.146)	** (0.091)
Real GDP per capita	0.088	** (0.035)	** (0.039)	* (0.044)
Manufacturing	2.241	*** (0.297)	*** (0.376)	*** (0.490)
Trade	-0.569	*** (0.095)	*** (0.100)	*** (0.122)
Constant	-5.080	*** (0.363)	*** (0.384)	*** (0.438)
Standard errors	-	White	Bootstrap	Driscoll-Kraay

Source: Own computations.

Notes: Column (1) provides the coefficients of column (2) in Table 2.

Remaining columns show standard errors (in parentheses) as defined in the table.

Driscoll-Kraay standard errors are estimated with default lags, T=18.

*,** and ***: significance at the 90%, 95% and 99% confidence levels, respectively.

Panels are unbalanced. Transition economies are excluded.

Table 4: Data source

Variable	Database	Eurostat table	Measure	Unit
Greenhouse gas emissions	Eurostat	env_air_gge	Greenhouse gas emissions	10^3 of tons of CO_2 equivalent
GDP per capita	Eurostat	nama_gdp_c	Gross domestic product at current prices	Euro per inhabitant
Trust	World Values Survey	-	Most people can be trusted	Percentage of positive answers
Manufacturing	Eurostat	nama_gdp_c/ sbs_na_2a_mil	Manufacturing, value added	Percentage of GDP
Imports	Eurostat	nama_exi_c	Imports at current prices	Percentage of GDP
Exports	Eurostat	nama_exi_c	Exports at current prices	Percentage of GDP
Energy	Eurostat	nrg_100a	Gross inland energy consumption	$10^3$of tons of oil equivalent
Population	Eurostat	demo_pjan	Population on January 1^{st}	Number of persons
Deflator	Eurostat	teina110	GDP deflator	Index (2000=100)

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