Economic inequality and environmental degradation: An experimental study

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Abstract

This papers examines the relationship between economic inequality and environmental degradation from an experimental perspective. The experiment investigates the contribution to negative externalities in treatments with different wealth inequality. The experimental results show a positive relationship between inequality and contribution to negative externalities at the aggregate level. They also show a greater contribution to negative externalities of relatively deprived individuals. These results imply that economic inequality and relative poverty increase the pressure on the environment.

Keywords: wealth inequality, negative externality

1 Introduction

Over the last years, the analysis of the determinants of environmental quality has attracted considerable attention from scholars, policy-makers and international organizations involved in the fight against environmental degradation and climate change. The issue is particularly relevant in the developing world, where the welfare of many rural communities depends decisively on access to natural resources and on local environmental quality (WCED, 1987; World Bank, 2007; Barbier, 2010). Against this background, a relatively large body of research has been devoted during the last two decades to investigating the role played in this context by economic heterogeneity and inequality. Thus, following the study by Boyce (1994), various papers have examined empirically the effect of economic inequality on environmental quality using cross-country data in the framework of the environmental Kuznets curve literature. However, the results of these analyses are inconclusive. Some results show that a higher level of inequality is positively associated with a greater degree of environmental degradation (Torras and Boyce, 1998; Holland et al., 2009), while other findings suggest a negative correlation (Ravallion et al., 2000; Heerink et al., 2001). Likewise, there are cases where the observed link between economic inequality and environmental quality is not statistically significant (Clément and Meunié, 2010a,b).

This diversity of results may have to do with differences in the dependent variable used to capture the degree of environmental damage, the sample countries, the study period or the econometric methodology applied. In any case, the nature of these previous studies implies that their conclusions should be treated with caution. In particular, it is important to note that the findings of some of these papers may be affected by the presence of omitted-variable bias. Furthermore, this type of analysis is ultimately limited by the availability of cross-country data measuring inequality within the various countries, which may give rise to measurement error problems. Measurement error is always a concern in empirical analyses based on international comparisons of inequality data. In fact, few countries compile inequality data on a regular basis, and much of the available data are unreliable. Coverage tend to be uneven, particularly in the developing world, and and there are often relevant methodological differences among countries in the definition of key variables and the method of data collection, which makes it difficult to perform reliable international comparisons (Deininger and Squire, 1996; Atkinson and Brandolini, 2001). As is known, the presence of measurement error is potentially important from an econometric perspective. Nevertheless, the lack of suitable instruments for inequality implies that it is usually difficult to correct for this problem (Forbes, 2000).

In view of this, in the present paper we adopt an alternative approach to examine the relationship between economic inequality and environmental quality based on the evidence provided by a laboratory experiment. In a laboratory experiment, researchers create analogous, although stylized, scenarios that mimic real-life situations to obtain data in a controlled way and test the effect of variations in a specific factor while keeping all other constant (Roth, 1995). The employment of a laboratory experiment is especially useful in our context because, unlike the cross-country studies mentioned above, this approach allows us to investigate the various mechanisms concerning individual decisions that may explain in the final instance the link between economic inequality and environmental quality (Olson, 1965; Scruggs, 1998; Berthe and Elie, 2015).

To the best of our knowledge, only Cardenas et al. (2002) have examined to date the relationship between economic inequality and environmental quality using an experimental approach. These authors perform a field experiment in rural Colombia to explore the role that economic inequality plays in the provision of local environmental quality. In their experiment, participants can spend time collecting firewood in the local forest, an activity that reduces water quality, or can spend time in a market alternative. Economic inequality is introduced through unequal market wages among the participants. The results show better than Nash equilibrium outcomes, a general result in public good provision experiments (Leyard, 1995). At the aggregate level, the groups with unequal market wages put on average less pressure on local environmental quality than the groups with symmetric market returns, suggesting that economic inequality reduces environmental degradation. At the individual level, the high-wage players spend less time harvesting firewood than the poorer ones but the restrain necessary to achieve better that Nash equilibrium outcomes came largely from low-wage subjects.[1]

In the present paper we follow Cardenas et al. (2002) and use the contribution to a negative externality to introduce environmental quality in our experimental setting. However, in the contribution to the negative externality, we assume that all participants have the same capacity to generate environmental damage and the same opportunity cost of doing so. That is, in our case all participants have the same endowment and the same investment possibilities. This makes the design different from that of Cardenas et al. (2002) where participants have the same endowments but different investment possibilities. Therefore, in our paper economic heterogeneity is not introduced as endowment or wage inequality, as in Cardenas et al. (2002). Alternatively, in our analysis inequality is the result of the existence of differences in the wealth levels of the participants from the beginning of the experiment (Andreoni, 1995), which implies different wealth levels. We aim to test whether this wealth inequality affects the investment decisions of the participants.

We focus our attention on wealth inequality because this variable is clearly more appropriate than income or wage differences to capture the distribution of power within a society, which is key to explain the potential impact of economic heterogeneity and environmental quality (Boyce, 1994). In fact, there is abundant empirical evidence showing that in the real life wealth inequality is much greater than income or wage inequality (e.g. Piketty, 2014; Jones, 2015). Taking this into account, our approach

[1] Although as far as we are aware Cardenas et al. (2002) is so far the only paper on the effect of economic inequality on environmental quality based on an experimental approach, there are various contributions that use the experimental methodology to examine the impact of economic heterogeneity and inequality on the provision of public goods. See, for example, Isaac and Walker (1988), Buckley and Croson (2006) or Sadrieh and Verbon (2006).

allows us to investigate the effect of a controlled variation in wealth inequality on the contribution to the negative externality, thus complementing the macro data analysis described above with information on individual behaviour.

The experimental design is based on Andreoni (1995) and and Benito et al. (2014). As in these papers we use a linear game but, instead of being a repeated game, is a dynamic one. The traditional economic benchmarks, the Nash solution and the social solution, are independent of individual wealth and also are independent of wealth distribution. Furthermore, in our framework the Nash solution increases wealth inequality, while the social solution decreases wealth inequality.

The main results of our experiment show that at the aggregate level wealth inequality increases the degree of environmental degradation. Moreover, our analysis at the individual level reveals that the poorer individuals carry out higher contributions to the negative externality than the wealthier ones. This finding contrasts with the results obtained by Cardenas et al. (2002), but it is consistent with the arguments laid down by Olson (1965), who points out that the wealthier members in a group tend to contribute a larger share to the provision of a public good than their poorer counterparts (Bergstrom et al., 1986). This hypothesis suggests that the wealthier individuals will do more to protect environmental quality, which is in line with our experimental results.

The paper is organized as follows. Section 2 introduces the theoretical framework of our analysis. Section 3 describes the experimental design and procedure. Section 4 shows the main results. Finally, conclusions and future research are presented in section 5.

2 The game

2.1 Contribution to negative externalities

The present game is a dynamic version of the repeated game on negative externalities introduced by Andreoni and slightly modified by Benito et al. (2014). Besides being a dynamic version, the game is also modified to account for wealth inequality.

Assume a group of n members, $i = 1, ..., n$, each of which has an initial wealth W_{i0}. The initial wealth levels may differ among the group members. The group plays during T rounds the following game. At the beginning of each round, $t = 1, ..., T$, each participant receives an endowment e, equal for all the participants. Each participant can invest its endowment in two different projects, project A and project B. Project A yields a marginal revenue α_A while project B yields a marginal revenue α_B for the participant doing the investment. In addition, investment in project A by participant i has a marginal cost β for every group member (including subject i doing the investment). Therefore, investment in project A imposes costs on others, it generates an external cost or negative externality: the marginal private cost of project A is β, the marginal external cost of project A is $(n-1)\beta$ and then, the marginal social cost of project A is $n\beta$. Investment in project B has no cost.

Summarizing, $(\alpha_A - \beta)$ is the marginal private net benefit and $(\alpha_A - n\beta)$ is the marginal social net benefit from project A. Marginal private net benefit from project B is α_B and it is equivalent to marginal social net benefit from project B. We say that investment in project A is a *contribution to negative externalities.* Assuming that the whole endowment must be invested and assuming x_{it} is the contribution to the negative externality (investment in project A) of participant i, the income of participant i in round t, π_{it}, is straight forward.

$$\pi_{it} = (\alpha_A - \beta)x_{it} + \alpha_B\,(e - x_{it}) - \beta \sum_{j \neq i} x_{jt} \tag{1}$$

Or, equivalently,

$$\pi_{it} = \alpha_A x_{it} + \alpha_B\,(e - x_{it}) - \beta \sum_{i=1}^{n} x_{it} \tag{2}$$

From the individual point of view, we assume that, in any round t, investment in project A is more profitable than investment in project B which means that marginal private net benefit from project A is greater than marginal private net benefit from project B, $(\alpha_A - \beta) > \alpha_B$. From the social point of view, we assume that project B is better that project A, that is, marginal social net benefit from project A is smaller that marginal social net benefit from project B, $(\alpha_A - n\beta) < \alpha_B$. The payoff to i is increasing in i's contribution to negative externalities, x_{it}, and decreasing in other's contribution to negative externalities, $X_{-it} = \sum_{j \neq i} x_{jt}$. Likewise, aggregate or group payoff is a decreasing function of both, i's contribution to negative externalities and other's contribution to negative externalities. Isobenefit curves are depicted in figure 1.

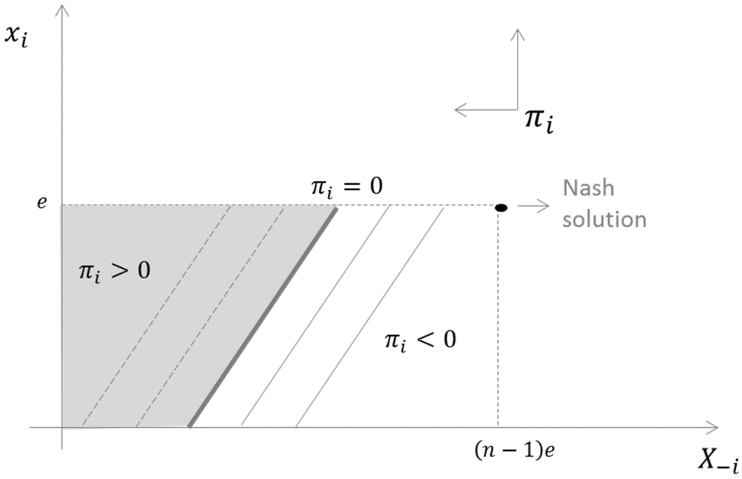
Individual payoff, whether positive or negative, adds to one's wealth at the end of each round. Thus, individual wealth may change with investment decisions and this may change average wealth and wealth distribution. Individual wealth in round τ is calculated as follows.

$$W_{i\tau} = W_{i0} + \sum_{t=1}^{\tau} \pi_{it} \tag{3}$$

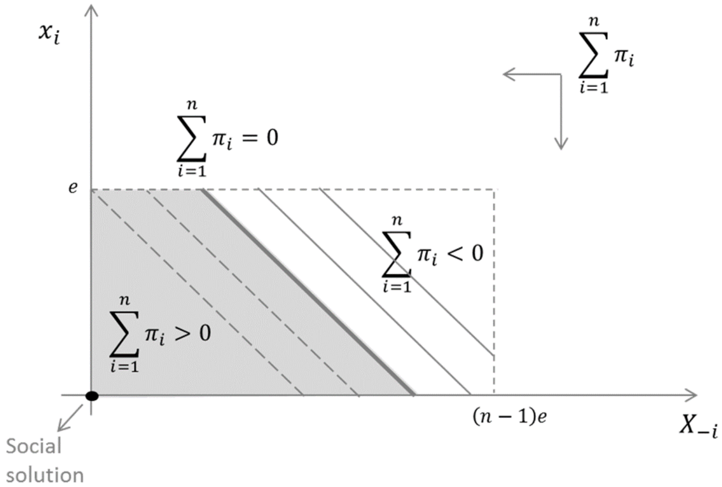
2.2 The benchmarks

Nash solution

Figure 1: Isobenefit curves



(a) Isobenefit curves for individual payoff.



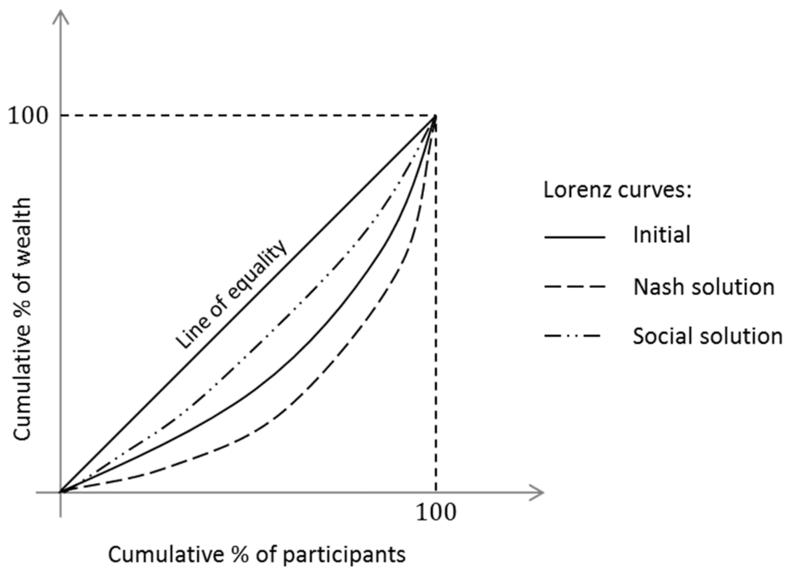
(b) Isobenefit curves for aggregate payoff

Taking into account that marginal private net benefit from project A is greater than marginal private net benefit from project B, $(\alpha_A - \beta) > \alpha_B$, by backward induction, the investment strategy that maximizes individual wealth, that is, the best response solution or the *Nash solution*, is full investment in project A ($x_{it} = e, \forall i, \forall t$), as can be seen in figure 1(a). Notice that the Nash solution does not depend on wealth distribution.

As endowments are equal among participants, each agent gets the same income from this strategy. According to equation (2), individual income in the Nash solution is $\pi_i^N = (\alpha_A - n\beta)e$. We assume a negative income from the Nash solution, that is, $(\alpha_A - n\beta) < 0$. Therefore, the Nash solution decreases individual (and average) wealth.

The Nash solution also affects wealth inequality. Assume that initial wealth is unevenly distributed and the Gini index is positive, $G_0 > 0$. This unequal wealth distribution can be represented geometrically by the Lorenz curve in figure 2 that shows what percentage of participants possess what percentage of group's wealth. When the group behavior meets the Nash solution, the wealth of each participant decreases and the Lorenz curve moves downwards (see doted line in figure 2), showing greater inequality. Hence, within the Nash solution, the Gini index increases. Therefore, the Nash solution not only decreases wealth, it also exacerbates inequality.[2]

Figure 2: Inequality consequences of the Nash and the social solutions



Social solution

By assumption, marginal social net benefit from project A is smaller than marginal social net benefit from project B. Therefore, using backward induction, the solution that maximizes aggregate payoff (and aggregate wealth), that is, the *social solution*

[2]If initial wealth is evenly distributed (the Gini index is equal to zero, $GI_0 = 0$), the Nash solution maintains this equal wealth distribution.

or efficient solution, is full investment in project B ($x_{it} = 0, \forall i, \forall t$), as can be seen in figure 1(b). As in the previous benchmark, this strategy is not affected by the initial distribution of wealth.

Individual income in any period is positive and equal for every participant (from equation 2, $\pi_i^S = \alpha_B e$). As in the previous benchmark, the social solution affects wealth and the distribution of wealth, but in the other way round. On the one hand, the social solution increases individual (and average) wealth. On the other hand, whenever initial wealth is unevenly distributed, $G_0 > 0$, an equal increase of wealth for all the participants moves upwards the Lorenz curve and the Gini index decreases (see figure 2). Therefore, the social solution increases wealth and reduces inequality.

3 Experimental design and procedure

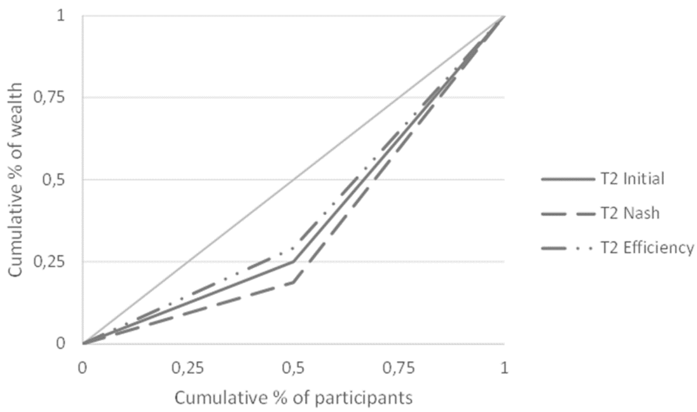
The game is played in groups of 4 individuals during 10 rounds. We implement three different treatments, all with the same parametrization except for initial wealth distribution. Looking at initial wealth, the three treatments have the same average wealth, 1000 points, but different initial wealth distribution. The initial wealth distribution in treatment 1 is $(1000, 1000, 1000, 1000)$. This treatment represents an equal wealth distribution and the initial Gini index is 0. In treatment 2, initial wealth distribution is $(500, 500, 1500, 1500)$ which corresponds to a Gini index 0.25. Treatment 3 also represents an uneven distribution of the initial wealth, $(500, 500, 500, 2500)$, being the Gini index 0.375. During the experiment, we refer to participants' wealth as "stock of points".

Marginal revenue from project A is $\alpha_A = 3$, marginal revenue from project B is $\alpha_B = 1$ and marginal private cost of project A is $\beta = 1$. This implies a marginal social cost of project A equal to 4. Endowment in each round is 20 points and participants decide simultaneously and individually how many points they want to invest in project A. The rest of the endowment points are automatically invested in project B. At the end of each round, each participant receives summary information about investment decisions and consequences in that round: own investment in project A, average investment in project A, individual income from that round, stock of points of each participants (including own stock of points) and average stock of points (average wealth) of the group.

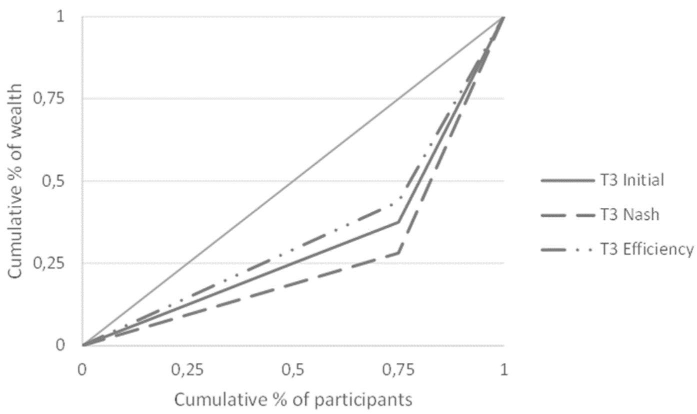
The benchmarks in these three treatments are the same: in the Nash solution $x_{it} = 20, \forall i$ and in the Social solution $x_{it} = 0, \forall i$. Individual income in the Nash solution is -20 and individual income in the social solution is 20 (see figure 4, that represents the isobenefit curves). The consequences for wealth distribution differ among treatments. The evolution of the Gini index under these solutions are summarized in figure 3 where we have depicts the initial Lorenz curve and the Lorenz curves in round 10 following the Nash or the social solution. It is worth mentioning that the Gini index may increase by 25% in treatment 2 and 3 in the Nash solution and may decrease by 17% in treatment 2 and 3 in the social solution. There is no change in the Gini index in treatment 1.

We run three different sessions, one per treatment, that were conducted using the z-tree program (Fischbacher,1999) at Lineex, an experimental lab located in Valencia. There were 32 participants (8 groups) per treatment which make a total of 96 participants. In the instructions, we include 6 examples of possible investment situation in order to make clear to participants the structure of the game. This examples are indicated with a dot in figure 4. Subjects were told that, at the end of the experiment, the points would be exchanged for cash at a prespecifed exchange rate. Each session lasted around one hour and the average earnings per subject amounted to about XX Euros.

Figure 3: Wealth distribution in treatments 2 and 3.

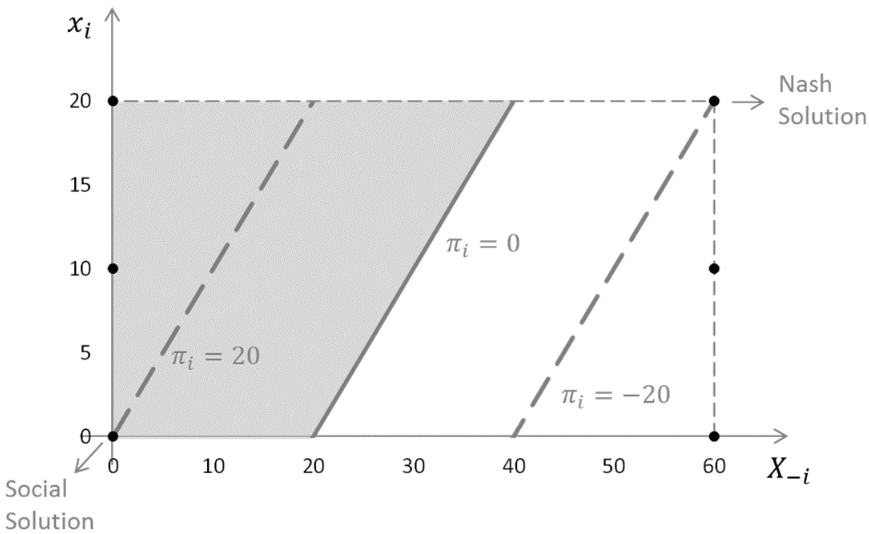


(a) Treatment 2



(b) Treatment 3

Figure 4: Isobenefit curves for the three treatments



4 Results

We begin by studying whether the contribution decisions depend on the initial level of wealth inequality within the various groups. To that end, we examine the density functions of the distribution of the contribution decisions in the three treatments. We address this issue by means of non-parametric techniques, thus avoiding the lack of generality and flexibility associated with parametric methods. The non-parametric approach does not require specifying any particular functional form beforehand, though a method to smooth the data must be selected. An immediate option is to use histograms, the oldest and best-known non-parametric density function estimator (Stangor, 2011). Histograms are useful to describe certain data characteristic, but they present several limitations.[3] For this reason, in our analysis we complement the information provided by histograms with a kernel density estimator, which has the advantage of being independent of the choice of origin (corresponding to the location of the bins in a histogram) (Wand and

[3]For example, the problem of how to define the origin and length of each interval, and the possibility of improving the accuracy and efficiency of the estimates (Silverman, 1986).

Jones, 1995).[4]

Figure 5 shows the results obtained when these non-parametric methods are used to estimate the density functions of the distribution of the contribution decisions in the three treatments. As can be seen, the external shape of the distribution is similar in the three cases, particularly in the last period. In order to confirm this visual impression, we performed several two-sample Kolmogorov-Smirnov tests of equality of distributions.[5] Table 1 reveals that the results of these tests do not allow us to reject the null hypothesis of equality of distributions in any case, thus confirming that there are no statistically significant differences in contributions to the negative externality among the three treatments. This result suggests that the initial level of wealth inequality within the various groups does not significantly affect contribution decisions.

Table 1: Kolmogorov-Smirnov tests.

	Period 1	Period 5	Period 10
Treatments 1 and 2	0.125	0.125	0.156
	(0.968)	(0.968)	(0.838)
Treatments 1 and 3	0.094	0.219	0.094
	(0.999)	(0.434)	(0.999)
Treatments 2 and 3	0.125	0.219	0.125
	(0.968)	(0.434)	(0.968)

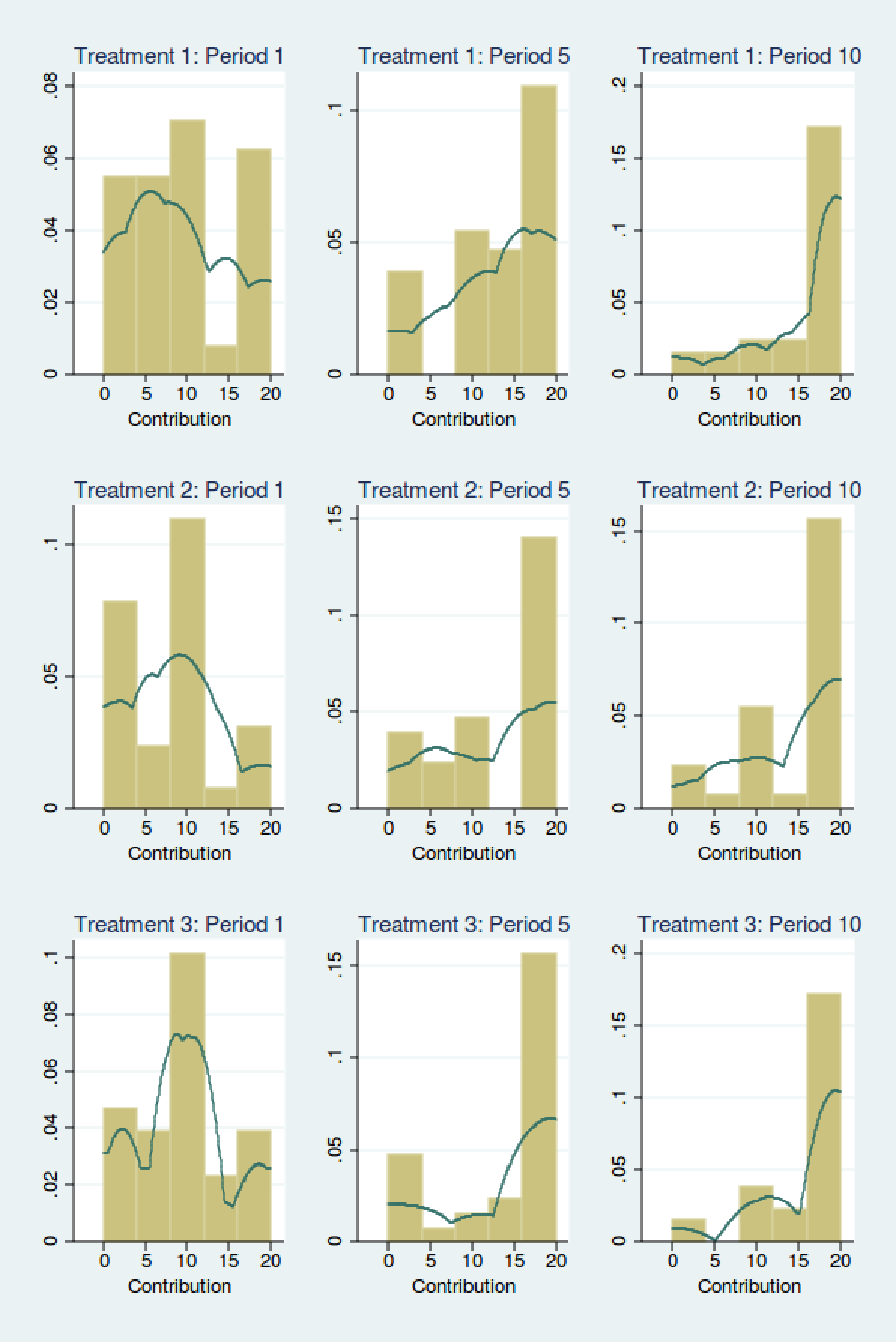
Notes: p-values in parentheses.

Figure 5 also shows that contributions to the negative externality are on average below the Nash prediction but above the efficient level in all treatments and periods. Nevertheless, this does not imply that the initial situation remains stable over time. In particular, regardless of the treatment considered, our estimates reveal that the density located at the upper end of the distribution increased throughout the various periods,

[4]Specifically, the Epanechnikov kernel function was used, while the smoothing parameter was determined according to Silverman (1986, p.48).

[5]Given the relatively reduced sample size, the p-values of the Kolmogorov-Smirnov test were obtained by modifying the asymptotic p-value by using a numerical approximation technique.

Figure 5: Histograms and kernel density estimates.



thus indicating that the contributions to the negative externality tend to raise over time. This pattern is illustrated clearly in the average contributions shown in Figure 6, which suggests that the implication of agents in activities generating negative externalities increases over the ten periods, thus amplifying its adverse consequences on environmental quality.[6] In any case, a Kruskal-Wallis test shows that the differences among the average contributions in the three treatments are not statistically significant ($\chi^2 = 1.307$, p-value $= 0.520$). In other words, we cannot reject the hypothesis that the three treatments have the same underlying distribution, which is in line with the information provided by Figure 5 and Table 1.[7]

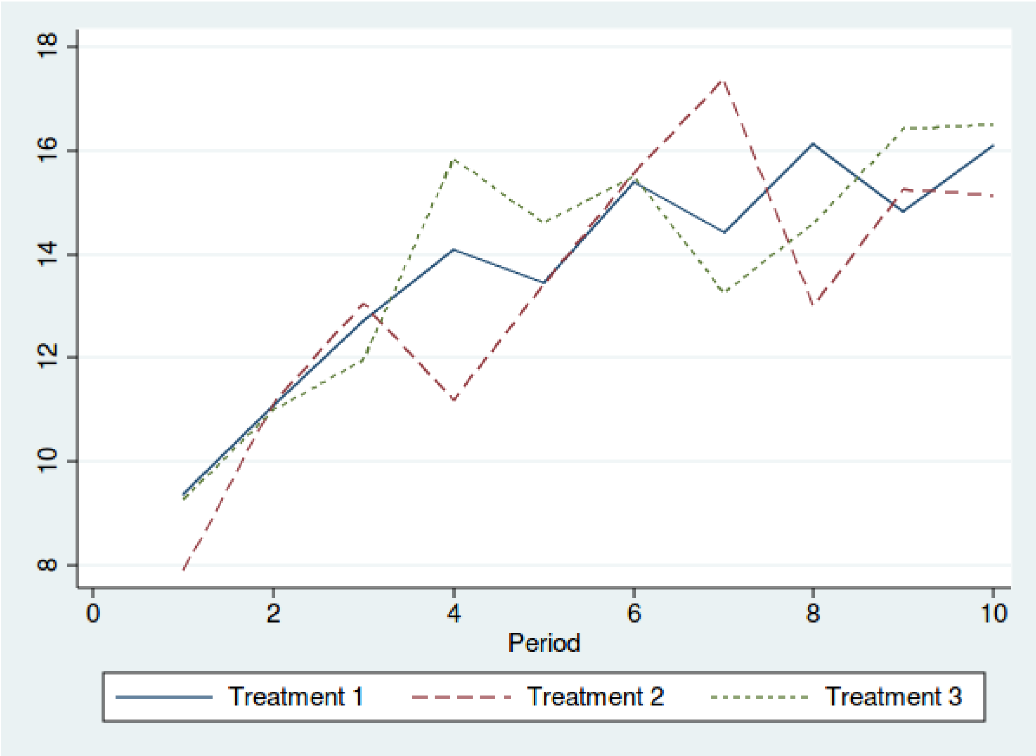
According to the arguments laid down in section 2, the individual decisions influence directly on the mean and dispersion of wealth within the various groups. In view of this, Figure 7 shows the evolution of average wealth and wealth inequality within the various groups. To quantify the level of wealth inequality, we calculate the Gini index for the different groups over the study period. As can be seen in Figure 7, the evolution of average wealth and wealth inequality is very similar in the three treatments. Specifically, the average wealth decreased in all cases in comparison with the situation at the beginning of the experiment. In turn, the level of wealth inequality within the various groups increased steadily throughout the ten periods, regardless of its initial level. The tendencies observed in Figure 7 are consistent with the results obtained when fitting a simple time trend by least-squares.

As mentioned in the introduction, the main aim of the paper is to investigate the relationship between the contribution decisions and the degree of wealth inequality within the various groups. As a first insight on this link, Figure 8 shows the relationship be-

[6] It is interesting to note that this finding resembles the general result observed in linear public good experiments, where average contribution lies between full-contribution (efficient prediction) and zero-contribution (Nash prediction) following a decreasing trend with repetition (towards the Nash prediction). See, for example,...

[7] This conclusion is confirmed whether we resort to the Mann-Whitney-U test to perform a comparison by pairs among the three treatments.

Figure 6: Average contributions to the negative externality.



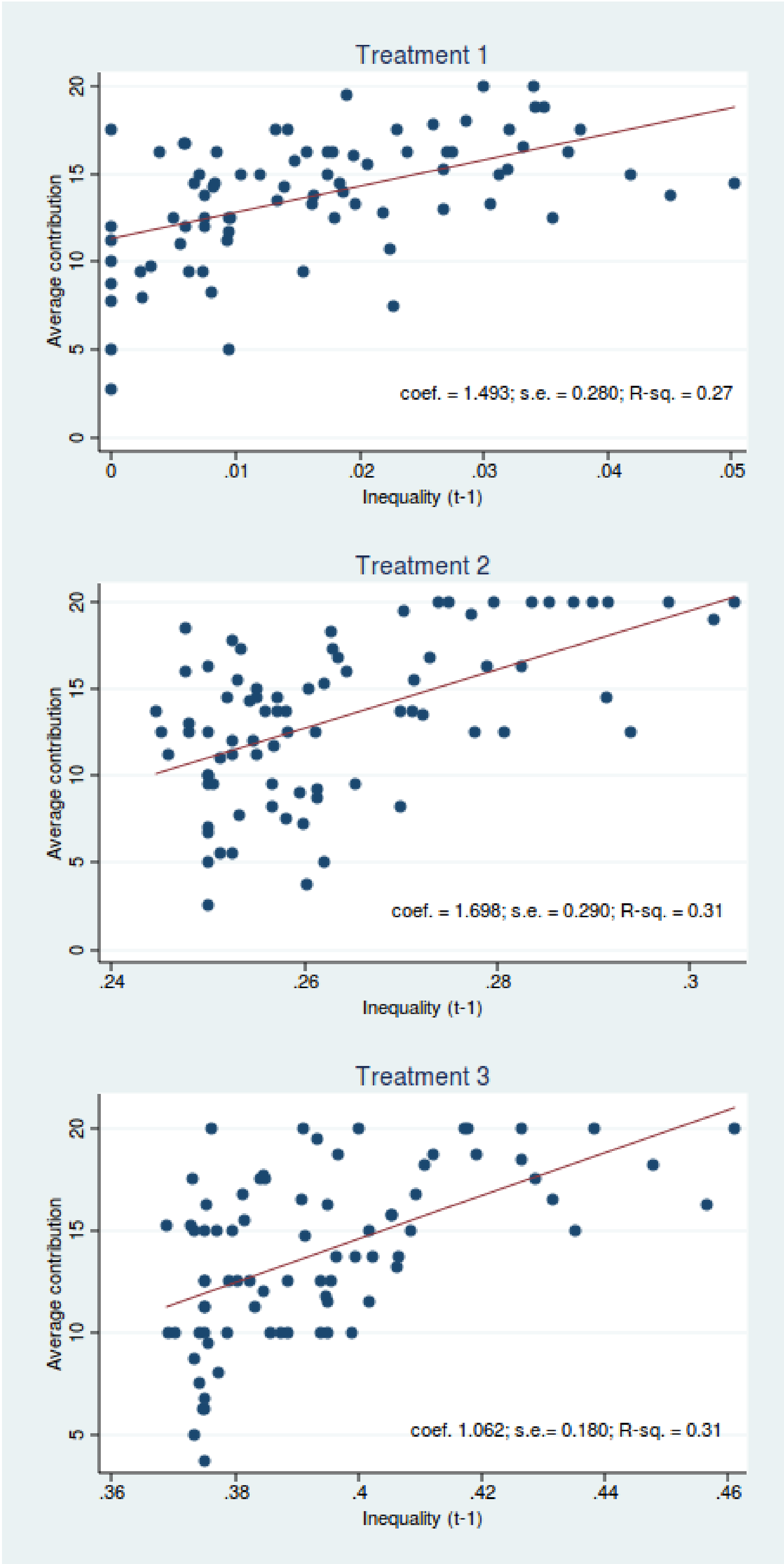
tween the average contribution of the various groups and their level of wealth inequality in the previous period. The different scatter plots show the existence of a positive association between both variables in the three treatments. The relationship is statistically significant in all cases, and the Gini index alone explains a share of the variation in the average contribution ranging between 27% (treatment 1) and 31% (treatments 2 and 3). Accordingly, this preliminary evidence seems to suggest that the average contribution to the negative externality is higher in those situations characterized by greater levels of wealth inequality.

Figure 7: Average wealth and average inequality.

Nevertheless, the results in Figure 8 should be interpreted with caution, as omitted variables can seriously affect our perception of how wealth inequality shapes contribution decisions. For this reason, we now carry out a more appropriate statistical analysis on this issue. To that end, we estimate a fixed effects model in order to explain the variation in the average contributions of the different groups. This type of specification is particularly useful in our context because the fixed effects allows us to control for unobserved heterogeneity across groups, thus minimizing any omitted variable bias (Wooldridge, 2002). Furthermore, unlike random effects models, fixed effects models do not require that unobservable effects are uncorrelated with the control variables (Baltagi, 2001; Hsiao, 2003). This latter assumption does not hold in our case, which implies that the random effects estimator would not be consistent in this context. In addition to the Gini index, we include in the model the average wealth of the various groups. Taking into account the literature on the environmental Kuznets curve (e.g. Grossman and Krueger, 1995; Stern, 2004; Gassebner et al., 2011), we also investigate the possible existence of a non-linear relationship between the average wealth and the dependent variable. To do this, we consider an alternative specification of the model including the square of average wealth. All the control variables just described are lagged one period in order to avoid any simultaneity bias. The model also incorporates a time trend to examine whether contribution decisions are affected by time evolution.

Table 2 presents the results obtained when different versions of the fixed effects model are estimated using robust standard errors clustered at the group level. The first two columns of the Table show the estimates when we do not distinguish among treatments. Focussing on the aim of the paper, the main finding is that the coefficient of the Gini index in the previous period is positive and statistically significant, which implies that higher levels of wealth inequality within the various groups are associated with greater average contributions to the negative externality. It is interesting to note that this finding is consistent with the empirical evidence provided among others by Torras and Boyce (1998) or Holland et al. (2009), who find in their cross-country analyses that inequality exerts a positive effect on environmental degradation. Columns 3-8 of Table 2 show the results obtained when the model is estimated separately for the three treatments. Interestingly, the observed relationship between within-group inequality and average contribution does not hold for the first treatment. Regarding this

Figure 8: Average wealth and average inequality.



point, it should be recalled that in this treatment the group members are characterized by having initially the same individual wealth, which gives rise to comparatively lower levels of inequality than in the remaining treatments during the ten periods considered (Figure 7). By contrast, Table 2 reveals that the coefficient of the Gini index is positive and statistically significant in the two treatments with positive levels of inequality at the beginning of the experiment (treatments 2 and 3). In both cases the magnitude of the coefficients is very similar, although Figure 7 indicates that there are considerable differences in the level of inequality registered in the two treatments.

With respect to the remaining control variables, the estimates in Table 2 show that the average wealth is positive and significantly correlated with the dependent variable in all cases. However, our findings do not support the existence of a non-linear relationship between this variable and average contribution. In turn, the results for the time trend confirm the increasing tendency in the contributions to the negative externality observed in Figures 5 and 6.

In order to complement these results, we now examine the determinants of contribution decisions at the individual level using again a fixed effects model. Here we are interested mainly in the relationship between the relative situation of individuals in comparison with the remaining members of the group, and their contribution to the negative externality. To investigate this issue, we calculate for each individual the relative deprivation index proposed by Yitzhaki (1979), which measures the cumulative difference between an individual's wealth and those with greater wealth within its group divided by the group size (Ref. ???). The Yitzhaki's relative deprivation index is especially attractive in our context, as the group average of this measure is equal to the Gini index (Yitzhaki, 1979; Hey and Lambert, 1980). Taking into account our previous findings, we also control for the average wealth within each group, the Gini index and a time trend. Furthermore, the model is estimated using robust standard errors adjusted for intra-group correlation.

The results of the regression analysis at the individual level are shown in Table 3. As can be observed, the coefficient of the relative deprivation index is positive and statistically significant in all cases. This implies that those individuals in worse relative situation in the previous period carry out higher contributions to the negative externality, which contrasts with the results obtained by Cardenas et al. (2002) in their field experiment. However, our finding is consistent with the arguments laid down by Olson (1965) who points out that the wealthier members in a group tend to contribute a larger share to the provision of a public good than their poorer counterparts (Bergstrom et al., 1986). This hypothesis suggests that the wealthier individuals will do more to protect environmental quality, which is in line with the information provided by Table 3. It is important to note that this result is obtained in the three treatments, although the impact of the relative deprivation index is greater in those situations with higher levels of within-group inequality (treatments 2 and 3). The average wealth and the time trend continue to be positive and statistically significant, confirming our previous findings in Table 2. Nevertheless, the Gini index is not statistically significant in any of the regressions when we control for the relative deprivation index.

5 Conclusions

The literature on development economics has considered poverty and economic inequality as both a consequence and a cause of environmental degradation. In this paper, an experimental analysis allows us to disentangle a little bit these complex round trip relationships. We have analyzed economic inequality as a cause of environmental degradation. Therefore, the experimental design has been constructed in other to control by average wealth and potential environmental damage.

Economic inequality has been introduced as wealth inequality and environmental degradation as contribution to negative externalities. The results show that economic inequality is relevant when taking decisions related with the environment at the aggregate and at the individual level. On the one hand, the average level of wealth inequality within a group, measured using the Gini index, increases the pressure on the environment. On the other hand, the results show that relatively deprived individuals put more pressure on the environment than their wealthier counterparts.

It is interesting to link these results with the arguments of Olson (1965) on the provision of public goods. Olson analyzes the provision of public goods with heterogeneous individuals (with different size or interest in the collective action). In such context, the largest members bear a disproportionate share of the burden of providing the public good. Similarly, our results show that, in the contribution to a public bad (environmental degradation), wealthier individuals restrict more their contribution, that is, they have a lower share on the environmental pressure.

It is also worth mentioning a possible link of this results with environmental policy. The main result of this experiment shows that greater wealth inequality within groups increases environmental pressure. Bridging the gap between experimental studies and their application to reality, this result opens the possibility to use wealth distribution within a group or society as an environmental policy instrument to control environmental degradation.

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Table 2: Determinants of average contributions to the negative externality: Regression analysis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inequality (t-1)	1.198***	1.180***	1.264	1.164	1.387**	1.387**	1.422**	1.388*
	(0.254)	(0.254)	(0.786)	(0.810)	(0.483)	(0.483)	(0.596)	(0.616)
Average wealth (t-1)	0.093***	-0.400	0.134***	-0.683	0.053**	0.048	0.142***	-1.229
	(0.020)	(0.470)	(0.028)	(0.404)	(0.015)	(0.942)	(0.039)	(0.690)
Average wealth squared (t-1)		0.000		0.000*		0.000		0.001*
		(0.000)		(0.000)		(0.000)		(0.000)
Time trend	0.883***	0.927***	1.206***	1.379***	0.539*	0.539*	1.115***	1.278***
	(0.188)	(0.236)	(0.319)	(0.382)	(0.253)	(0.256)	(0.147)	(0.126)
Constant	-109.422***	125.661	-126.141***	258.435	-78.124***	-75.886	-186.748**	463.836
	(22.365)	(218.959)	(28.348)	(190.354)	(13.976)	(455.472)	(59.445)	(331.819)
Treatment	All treatments	All treatments	Treatment 1	Treatment 1	Treatment 2	Treatment 2	Treatment 3	Treatment 3
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.398	0.402	0.570	0.587	0.325	0.325	0.428	0.463
Groups	24	24	8	8	8	8	8	8
Observations	240	240	80	80	80	80	80	80

Notes: Robust standard errors clustered at the group level in parentheses. * Significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Table 3: Determinants of indiviuals contributions to the negative externality: Regression analysis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Relative deprivation index (t-1)	0.816***	0.751***	0.461*	0.388*	0.903**	0.834**	1.047***	0.983**
	(0.158)	(0.170)	(0.220)	(0.187)	(0.260)	(0.265)	(0.278)	(0.309)
Inequality (t-1)		0.448		0.879		0.558		0.437
		(0.292)		(0.679)		(0.416)		(0.692)
Average wealth (t-1)	0.082***	0.093***	0.127***	0.134***	0.042*	0.053***	0.123***	0.142***
	(0.019)	(0.020)	(0.031)	(0.028)	(0.021)	(0.015)	(0.021)	(0.038)
Time trend	0.951***	0.883***	1.436***	1.206***	0.642**	0.538*	1.138***	1.115***
	(0.183)	(0.187)	(0.267)	(0.315)	(0.237)	(0.250)	(0.138)	(0.145)
Constant	-90.415***	-109.448***	-119.392***	-126.125***	-54.909**	-78.329***	-153.628***	-186.512**
	(20.060)	(22.247)	(31.913)	(27.964)	(20.064)	(13.763)	(28.014)	(58.732)
Treatment	All treatments	All treatments	Treatment 1	Treatment 1	Treatment 2	Treatment 2	Treatment 3	Treatment 3
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.162	0.164	0.191	0.195	0.152	0.154	0.183	0.185
Individuals	96	96	32	32	32	32	32	32
Observations	960	960	320	320	320	320	320	320

Notes: Robust standard errors clustered at the group level in parentheses. * Significant at 10% level, ** significant at 5% level, *** significant at 1% level.