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# Impact of Income Inequality on Health: Does Environment Quality Matter?

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## Abstract :

This paper examines the link between health indicators, environmental variables and income inequalities. Theoretically, all the mechanisms developed in the literature underline a negative impact of income inequality on health status. However, empirical studies find different results and the conclusions are far from a consensus. In this paper we investigate how environment degradation could be considered as a channel through which income distribution affects population health. We first develop a simple theoretical model based on Magnani (2000), in which relative income affects health status through the level of pollution abatement expenditures. Our econometric analysis shows that income inequalities negatively affect environmental quality and environment degradation worsens population's health. This negative effect of income inequalities on environment is mitigated by good institutions. We also show that income inequalities negatively affect health status. Another interesting result is that when environmental variables are taken into account, the level and the statistical significance of the coefficient of income inequality variable vanish. This confirms that environment quality is an important channel through which income inequalities affect population health. These results hold for air pollution indicators ($CO_2$ and $SO_2$) and water pollution indicator (BOD). It is also robust for rich and developing countries. Countries with high income inequalities may implement distributive policies in order to avoid its negative impact on health.


Keywords: health status, income inequality, environmental quality, instrumental variables method

JL classification: C13, D63, I1; Q5

# 1. Introduction

Population health is an important economic concern for many developing countries. It plays a crucial role in development process, since it constitutes a component of investment in human capital and workforce is the most abundant production factor in these countries. It constitutes also a major preoccupation for the international community, especially when it is considered as a public good. The importance given to health status could be illustrated through its relatively high weight among the Millennium Development Goals (MDGs), of which three are related to health preoccupations. It is therefore important to know the factors that influence population health in order to undertake suitable economic policy.

Rodgers (1979) is one of the first economists to consider income distribution as a determinant of health outcomes. He shows that income inequality influences health status not only in developed countries, but also in developing countries, opening the debate about the association between income distribution and health. Wilkinson (1992) reopens the debate by showing through eleven industrialized countries that income inequality is an essential determinant of health status. Even though major part of the studies on this topic confirm the negative effect of inequality on health, some authors reject this hypothesis and show that high inequality may be indifferent to health status or improve it (Pampel et Pellai 1986 ; Mellor et Mylio, 2001; Deaton, 2003).

All the mechanisms through which income distribution impacts health status developed in the literature show that an increase in inequality worsens population health. These mechanisms rely on the absolute and relative income hypothesis, psychosocial hypothesis and neo-materialism hypothesis as well. In this paper we add the environment as another mechanism through which income distribution could affect health status. During the past fifteen years, with the emergence of environmental concerns, many studies examine the association between income inequality and natural environment quality. But they found different results. On the one hand, some show that more inequality may improve environment quality (Scruggs, 1998; Ravallion et al., 2000). On the other hand, other studies underline the negative impact of inequality on environmental quality (Boyce, 1994; Torras & Boyce, 1998). If environmental quality is degraded by an increase in inequality, it may be a channel that reinforces the negative effect of the other mechanisms. But if it is improved by an increase in inequality, it maybe a mechanism that mitigates or cancels the negative effect predicted by the other mechanisms and justify the discrepancies between the findings.

Our results show theoretically and empirically that an increase in income inequality is associated to environmental degradation and environment quality is an important determinant of health status. This negative effect of income inequality on environment quality is mitigated by good institutions. When the effect of environment quality on health is taken into account, the effect of income distribution on health decreases and become less significant statistically. That is, an increase in inequality worsens population’s health via environmental degradation.

The rest of this paper is organized in four sections. Section 2 reviews the literature on the association between income distribution, environmental degradation and population’s health. In this section we explain why and how income inequality affects health before introducing the arguments that defend the association between income distribution and environmental quality. Section 3 develops a theoretical model in which income distribution affects health through environmental degradation. In section 4, we investigate empirically the effects of income distribution on health via environment quality. The last section concludes.

## 2. Literature review

The relationship between income inequality and population health has been investigated by many macroeconomic studies during the past 15 years. Scholars examine how and why income inequality affects health theoretically and empirically within and between nations. We will first review the traditional mechanisms, namely the ways income distribution affects population's health already developed in the literature. Then, we will explain how income inequality impacts health through environmental degradation.

### 2.1. Traditional effects of income inequality on health

Theoretically, four mechanisms are underlined, through which income inequality can harm directly population health (Mayer & Sarin, 2005).

The first mechanism is the absolute income hypothesis. In fact, income may be an important determinant of population health, since it allows them to buy better nutrition or medical care or reduces their stress. If the relationship between an individual income level and its health status is linear, an extra unit of income will have the same effect on health regardless of whether it goes to the rich or to the poor. In this case taking a unit of income from the rich and giving it to the poor will lower health status among the rich and raise it among the poor by exactly equal amounts, leaving the global health unchanged. The reality is that standard economic models predict that the health gains from an extra unit of income should diminish as income rises (Preston, 1975; Laporte, 2002; Deaton, 2003; Backlund et al., 1996; Babones, 2008), in other words, health should be a concave function of income. That is, a transfer of a unit of income from the rich to the poor might improve aggregate population's health status.

The second mechanism developed in the literature is the relative income hypothesis. The effect of economic inequality is likely to depend to some extent on the geographic proximity of the rich to the poor (Mayer & Sarin, 2005). In fact, if people assess their income by comparing themselves to their neighbours, the income of others can affect their health. The chronic stress provoked by this comparison may lower resistance to some diseases and cause premature death. For Wilkinson (1997), if individuals evaluate their well-being by comparing themselves to others with more income than themselves, increases in economic inequality will engender low control, insecurity, and loss of self esteem.

The third way developed in the literature through which income inequality may worsen population health is psychosocial hypothesis. Inequality can impact health through social comparisons by reducing social capital, trust and efficacy (Kawachi & Kennedy, 1997; Marmot & Bobak, 2000). According to Wilkinson (1996), income inequality worsens health because a low ranking in the social hierarchy produces negative emotions such as shame and distrust that lead to worse health via neuro-endocrine mechanisms and stress-induced behaviors such as smoking, excessive drinking, taking dangerous drugs, and other risky activities (Mayer & Sarin, 2005). Lynch et al. (2001) found weak associations between a variety of measures of the psychosocial environment, (distrust, belonging to organizations, volunteering, and efficacy), and infant mortality, but they found that economic inequality is strongly related to infant deaths.

Neo-materialism hypothesis is the fourth mechanism through which income inequality may harm health status. According to some authors defending this idea, income inequality affects health mainly through its effect on the level and the distribution of material resources (Coburn, 2000 and Lynch, 2000). This argument suggests that bad health could be the consequence of an increase in income inequality that reduces state spending on medical care, goods and services for the poor.

If theoretically, all the arguments found in the literature indicate a negative impact of income inequality on health status, empirical findings are far from a consensus. Lynch et al. (2004) review 98 aggregate and multilevel studies to examine the associations between income inequality and health. They conclude that overall, there seems to be little support for the idea that income inequality is a major, generalizable determinant of population health differences within or between rich countries. Income inequality may, however, directly influence some health outcomes, such as homicide in some contexts. Mayer & Sarin (2005) review ten studies that use cross-sectional data to estimates the association between economic inequality and infant mortality. Eight (8) of these ten (10) use cross-national data and produce eleven (11) estimates. Nine (9) find that more unequal countries have higher infant mortality rates, and two (2) (Pampel & Pellai, 1986; Mellor& Milyo, 2001) find that more unequal countries have lower infant mortality rates than countries with less inequality. Wilkinson & Pickett (2006) compiled one hundred sixty eight (168) analyses in one hundred fifty five (155) papers reporting research findings on the association between income distribution and population health, and classified them according to how far their findings supported the hypothesis that greater income differences are associated with lower standards of population health. They find that for eighty seven (87) of these studies the coefficient of income inequality is always statistically significant with the correct sign. Forty four (44) present mixed results and thirty seven (37) no significant coefficient. They explain the divergence of empirical finding by the size of area, choice of control variables and don't find any explanation for some international studies.

We argue here that in addition to the traditional mechanisms through which income inequality degrades population's health, found in the literature, there exists at least another channel through which income inequality may affect health, namely environmental quality.

### 2.2. Income inequality and environment

A large body of research has reported strong associations between income inequality and environmental degradation: most theoretical arguments explain how income inequality may improve environmental quality.

First, income inequality can increase environment protection through individual preference toward environmental quality. In fact, for a given level of average income, greater inequality means not only higher incomes for the rich, but also lower incomes for the poor. Assuming that the income elasticity of demand for environmental quality is positive[2], and taking a unit of income from the poor and giving it to the rich increases the demand for environmental quality of the rich, but at the same time it decreases the demand of the poor. The net effect on environmental quality depends on whether the demand-income relation is linear, concave or convex (Scruggs, 1998; Boyce, 2003). If this relation is linear, the transfer will not have any effect on environmental quality since an extra unit of income will have the same effect on environmental demand regardless of whether it goes to the rich or to the poor. If the environmental demand is linked to income by a convex (concave) relation, the transfer of income from the poor to the rich will increase (decrease) environmental demand.

It is more convincing to assume that the wealthiest prefer more environmental quality than the poor for many reasons. First, economic theories suggest that the rich prefer less environmental degradation than the poor. This may be due to the fact that environmental quality is a superior good and demand increases faster than income (Baumol and Oates, 1988). This is one of the explanations behind the environmental Kuznets Curve (EKC) hypothesis (Grossman & Krueger, 1995). As argued by Scruggs (1998), greater demand for environmental protection

[2] This supposes that environmental quality is a normal good

among the wealthiest is also expected to result in a greater willingness and ability to pay for more environmental protection. In addition, wealth increases individuals' concern for the future, maybe because they expect higher life expectancies than the poorest or because it increases their concern for their children in the future. Another reason to explain why rich prefer more environmental quality is that environmental protests are usually composed of middle and upper classes, not the poor (Dalton, 1994).

Income inequality can also reduce environmental degradation through the marginal propensity to emit (MPE) as argue by Ravallion et al. (2000). According to these authors, each individual has an implicit demand function for carbon emissions since the consumption of almost every good implies some emissions either directly via consumption or indirectly via its own production. They call marginal propensity to emit (MPE) the derivative of this implicit demand function with respect to income. If poor people have a higher (lower) MPE than rich ones, a redistribution policy that reduces inequalities will increase (decrease) carbon emissions. One can assume that the poorests have higher MPE than wealthiests, first because less emission goods need high technology and are thus generally expensive. Therefore, the poorest cannot afford it. In addition, poor tend to use energy less efficiently than the rich, which entails a higher MPE (Ravallion et al., 2000).

If these arguments predict an improvement of environment quality channelled by income inequality, it is also largely argued by some authors that inequality may degrade environment rather than improving it.

Boyce (1994) is the first author to examine how income inequalities affect environmental degradation. He supports the hypothesis that greater inequality may increase environmental degradation and this for two reasons. First, he argues that a greater inequality increases the rate of environmental time preference for both poor and rich. In fact, when inequality increases, the poor tend to overexploit natural capital, because they perceive it as the only resource they have and the only source of income that can help them secure their survival. In addition, economic inequality often provokes political instability and risks of revolts. This leads rich people to prefer a policy that consists in exploiting the environment and investing the returns abroad rather than investing in the protection of local natural resources. Therefore, for Boyce an increase in inequality induces both rich and poor to degrade more their own environment. The second argument put forward concerns the power of the rich. Boyce (1994) argues that in a society with greater inequality, rich people are likely to have large political power and can heavily influence decisions on environmentally damaging projects. Such decisions are based on the competition between those who benefit from the environmentally degrading action and those who bear the costs of it. Boyce (1994) argues that rich people are generally the winners, while poor people tend to be the losers of the investments that have an ecological impact. Therefore, economic inequality favours the implementation of environmentally damaging projects and investments since it "reinforces the power of the rich to impose environmental costs on the poor" (Ravallion et al., 2000, p.6). Scruggs (1998) has criticized the hypotheses supported by Boyce. He states that the influence via cost-benefit analysis is based on two wrong assumptions. First, according to Scruggs, "evidence indicates that better off members of society tend to have higher environmental concern than those with lower income" (Scruggs, 1998, p.260). Moreover Boyce (1994) assumes that a democratic social choice criterion leads to higher environmental protection than a non-democratic decision process (i.e. a power-weighted social decision rule), while evidence suggests that this is not necessarily true.

Another theoretical argument to explain why more inequality leads to more degradation is developed by Borghesi (2000). He argues that "much of the theoretical environmental literature has stressed the need of cooperative solutions to environmental problems. In an unequal society this is more difficult to achieve than in an equal society since there are generally more conflicts among the political agents (government, trade unions, lobbies etc...) on many social issues. In this sense, greater inequality can contribute to increase environmental degradation" (Borghesi, 2000).

In addition to these arguments, some theoretical model supports the environmental degrading effect of income inequality. It is the case of Magnani (2000) who examines the impact of income distribution on public research and development expenditures for environmental protection. Through a model in which social decisions are determined by the preferences of the median voter, she hypothesizes that income inequality reduces pro-environmental public spending due to a "relative income effect," and higher inequality shifts the preferences of those with below-average income in favour of greater consumption of private goods and lower expenditure on environmental public goods.

Marsiliani and Renström (2000) have also recently investigated how income distribution affects political decisions on environmental protection. Through an overlapping-generations model, they show that the higher the level of inequality in terms of median-mean distance, the lower the pollution tax set by a majority elected representative. Therefore, inequality induces redistribution policies that distort economic decisions and lower production. Inequality may be negatively correlated with environmental protection as it leads to less stringent environmental policies.

It is a priori difficult to predict the effect of income distribution on environment quality theoretically even though degrading effect seems in our viewpoint more convincing. Let us see empirical findings.

Many authors have empirically studied the relation between income distribution and environment quality and their conclusions are quite not consensual. In appendix 1, we report nine (9) important papers and thirty one (31) studies on the association between income distribution and environment quality. Among these studies, ten (10) conclude that inequality improves environment quality, nine (9) find the opposite conclusion and twelve (12) don't find any significant association. Let explore some of them.

Scruggs (1998) performs two cross-country empirical analyses to assess the effect of income inequality on the environment through pooled models. In the first one, four different pollutants (sulphur dioxide, particulate matter, fecal coliform and dissolved oxygen) are used as dependant variable in a panel of 22 up to 29 countries. The second investigation examines the impact of several variables on a composite index of environmental quality in a panel of 17 OECD countries. This index is constructed by combining five pollution indicators.

In the first case, he finds conflicting results: greater inequality improves environmental quality for one environmental indicator (particulates), whereas the opposite holds for the other indicator (dissolved oxygen). For the other indicators (sulphur dioxide, fecal coliform), the coefficients are not statistically significant. In the second analysis, income inequality decreases environmental degradation.

Through a panel of 42 countries in the period 1975-92, Ravallion et al. (2000) first estimate CO2 emissions as a cubic function of average per capita income and of population and time trend. They estimate their equation with fixed effect model and simple pooled model using ordinary least squares. They conclude that higher inequality within countries reduces carbon emissions. However, the impact of income distribution on the environment decreases at higher average incomes.

Borghesi (2000) performs an empirical analysis similar to that of Ravallion et al. (2000). He uses CO2 per capita as environmental variable and Gini from Deninger and Squire as income inequality indicator with a panel of 37 countries from 1988-1995. In the pooled OLS model, an increase in inequality lowers CO2 emissions, whereas it does not have a significant impact on CO2 emissions according to the FE model.

Magnani (2000) assessed the impact of inequality on R&D expenditures for the environment taken "as proxy for the intensity of public engagement in environmental problems" through pooled ordinary least squares and random effects estimations. Using a panel of 19 OECD countries in the period 1980-1991, he finds that higher inequality reduces environmental care, however, the effect is statistically significant at 5% level in the pooled ordinary least squares model only.

Using the principal components analysis, Boyce et al. (1999) estimate statistically a measure of inter-state variations in power distribution based on voter participation, tax fairness, Medicaid accessibility, and educational attainment levels. They find that income inequality, per capita income, race, and ethnicity affect power distribution in the expected directions. Inequality in power distribution is associated with lower environmental policies, and these in turn are associated with higher environmental stress. Both environmental stress and power inequality are associated with adverse public health outcomes.

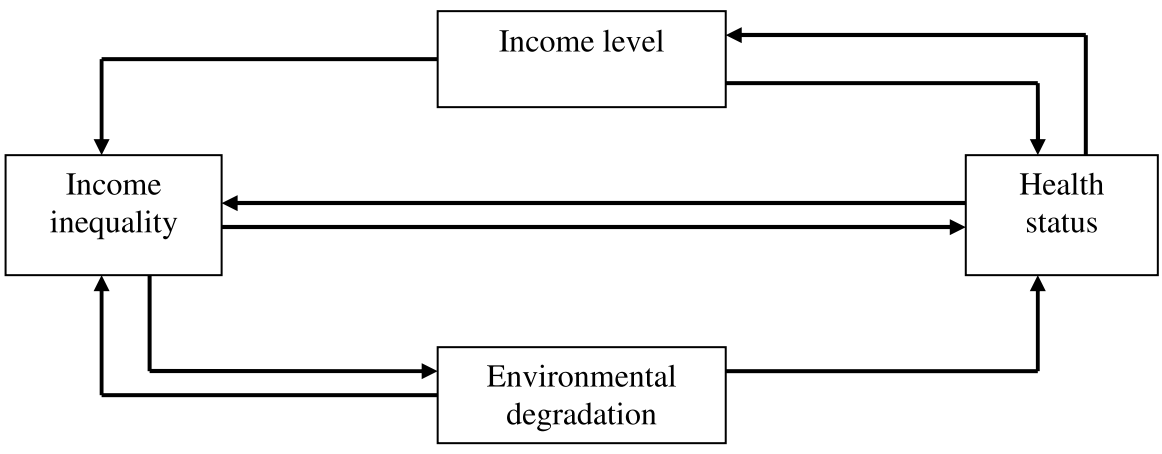
Torras and Boyce (1998) examine the effect of income distribution on a set of water and air pollution variables using the Global Environment Monitoring System (GEMS) data, Gini index, adult literacy rates and an aggregate of political rights and civil liberties.

With a OLS estimation, they obtain mixed results on the environmental impact of income inequality. The Gini coefficient is positive for some environmental indicators and negative for others.

It is also possible that more environmental degradation increases income inequality. In fact, environmental degradation in many ways affects the livelihood of the poor. The poorest are vulnerable to environmental degradation since they depend heavily on natural resources and have less alternative resource. They are also exposed to environment hazards and are less capable of coping to environmental risks (Dagusta and Mäler, 1994; World Bank, DFID, EC, UNDP, 2002). Furthermore, the rich are more capable of looking after themselves from environmental diseases than the poorest.[3]

This review explains the complexity of the relation between income distribution and environment. Figure 1 summarizes the relation linking income inequality and population's health.

Figure 1: Relations between Income level, Income Inequality, Ecological Degradation and Health




Source : author

[3] This is not the object of the present study.

## 3. The model

The purpose of this model is to assess theoretically how income inequality affects health status through the level of pollution abatement expenditures. It consists in the introduction of health variable in Magnani's model[4]. Let us assume an additively separable utility function for individual *i*:

$$U_i = c_i + \alpha_i h_i(Q) \tag{3.1}$$

Where $c_i$ is the level of consumption of a private good and $h_i$ is the health status of individual *i*. We consider health not merely as absence of illness or infirmity, but also as a state of complete physical, mental and social well-being. $h_i$ is positively linked to environment quality Q (a pure public good) and the effect of environment on health is the same for every individual *i* ($(\partial h_i)/(\partial Q) = k$). $\alpha_i$ is the contribution of health to *i*'s utility. It expresses also the preference for environment quality as in Magnani's model because if the contribution of health in individual *i*'s utility is high, he will prefer a better environment quality in order to improve his health. Furthermore, in this model, health is widely defined. The public good nature of $Q$ implies that environmental policy $E$ is necessary to solve market failure, that is $Q = Q(E)$, where $E$ is public expenditures for environmental care, and $Q'(.) > 0$. Environmental care is financed through taxation by a fraction $\tau y_i$ of individual income $y_i$ and we have: $E = Y(\tau - \tau^2/2)$, where $\tau$ is the environmental tax rate ($\tau \in (0,1)$) and $Y$ is the average income[5].
In this economy, individuals differ by personal income levels and income is distributed according to a unimodal function $f(y_i)$ where $y_i \in (0, y_H)$ and $y_H$ is the maximum level of personal income. Income inequality implies that the majority of the population has income below the average and $(y_m/Y) < 1$, where $y_m$ is the median income of the distribution $f(y_i)$.
We assume that $\alpha_i$, the preference for environment quality and the contribution of health to utility is positively correlated with the individual relative income $R_i = (y_i/Y)$. This assumption is crucial for our analysis. That is, $\alpha_i = \alpha_i(R_i)$ and $\alpha_i'(.) > 0$. The marginal rate of substitution between $c_i$ and $h_i$ depends on individual relative income. This assumption is supported by some theoretical and empirical studies (Ng and Wang 1993, Konrad 1996 and Magnani 2000).
The indirect utility function for the individual *i* can be written as:

$$V_i = (1-\tau) y_i + \alpha_i h_i \left[ Y(\tau - \tau^2/2) \right] \tag{3.2}$$

The optimal tax rate for individual *i* is obtained by differentiation of (3.2) with respect to $\tau$ and we have: $\tau_i^* = 1 - (1/\alpha_i k) R_i$. The marginal effect of relative income of individual *i* on his ideal tax rate is: $(\partial \tau_i^*)/(\partial R_i) = (-\alpha_i + \alpha_i' R_i)/(k\alpha_i^2) = (1/k\alpha_i)\left[-1 + (\partial \alpha_i/\partial R_i)(R_i/\alpha_i)\right]$. This effect is positive ($(\partial \tau_i^*)/(\partial R_i) > 0$) if the relative income elasticity of the preference for

[4] Magnani, E., Ecological Economics, 32 (2000) 431-443
[5] The functional form for public environmental protection is quite general and expresses environmental cost of public funds (Magnani 2000).

environmental care $\varepsilon_i$ is more than 1, or $(\partial\alpha_i/\partial R_i)(R_i/\alpha_i)>1$. For $\varepsilon_i$<1, the optimal tax rate for individual *i* is a decreasing function of relative income.
If we are in a democracy with majority voting system, the politician will maximize the indirect utility function of the median voter according to the median voter theorem. The optimal tax rate chosen by the economy will be that of the median voter and we have:

$$\tau^* = 1-(1/\alpha_m k)R_m \quad (3.3)$$

Where *m* is the index for the median voter. This equation (3.3) shows that the equilibrium level of environmental abatement expenditure is function of income distribution.

$$E^* = E^*(Y, y_m/Y) = Y(\tau^* - (\tau^*)^2/2) \quad (3.4)$$

And the marginal effect of income distribution on the optimal taxation rate is given by:

$$(\partial\tau^*)/(\partial R_m) = (-\alpha_m + \alpha_m^{'} R_m)/(k\alpha_m^2) = (1/k\alpha_m)\left[-1+(\partial\alpha_m/\partial R_m)(R_m/\alpha_m)\right] \quad (3.5)$$

Where $\alpha_m^{'} = (\partial\alpha_m)/(\partial R_m)$ is by assumption positive.
The marginal effect of income inequality $R_m$ on the optimal environmental public expenditure $E^*$ is given by:

$$(\partial E^*)/(\partial R_m) = Y\left[(\partial\tau^*)/(\partial R_m)\right]\left[1-\tau^*\right] \quad (3.6)$$

$\tau^* \in (0,1)$, therefore $1-\tau^* > 0$. The sign of $(\partial E^*)/(\partial R_m)$ only depends on the sign of $(\partial\tau^*)/(\partial R_m)$. Environmental public expenditure is an increasing function of income equality $R_m$ if $(1/k\alpha_m)\left[-1+(\partial\alpha_m/\partial R_m)(R_m/\alpha_m)\right]$>0 and this condition holds if the relative income elasticity of the preference for environment care of the median voter is greater than one ($(\partial\alpha_m/\partial R_m)(R_m/\alpha_m)>1$).

This result shows that income inequality affects negatively environmental public expenditure and therefore population's health.

## 4. Empirical analysis

### 4.1. Estimations

The analysis is subdivided into three steps. We examine, first, the impact of income inequality on environmental quality. Then, we study the association between environment quality and health status. Finally, we compare the effect of income distribution on population's heath in presence and in absence of environmental variables. The econometric relation between inequality and environment can be written as:

$$environment_{it} = \lambda_i + \beta EHII_{it} + \delta_k X_{kit} + \varepsilon_{it} \quad (4.1)$$

Where environment and EHII represent respectively the logarithm of environment quality and income inequality measure. $X_k$ is the matrix of the control variables. The country fixed effects are represented by $\lambda_i$ and $\varepsilon_{it}$ is the error term.

This equation could be estimated by the Ordinary Least Squares (OLS), but it is very likely that environmental degradation increases income inequality as explained in section 2. This potential simultaneity can be a source of endogeneity. Another source of endogeneity could arise from the measurement error of our inequality indicator. In order to solve this problem, we define as instrumental variable the dependency ratio and we estimate equation (4.1) with the Two Step Least Square (2SLS) method. As a proxy for demographic variable, age dependency ratio is an important determinant of income inequality because of its distributive effect and it is less convincing to ague that it affects directly environment quality. To control for the effect of income inequality depending on development level and institution quality, we progressively, add to equation (4.1), the interaction of income inequality with development level dummy and institution quality.

In the second model, health status is expressed as a function of environment quality and other explanatory variables.

$$Health_{it} = \eta_i + \gamma environment_{it} + \theta_k Z_{kit} + \omega_{it} \quad (4.2)$$

Where health represents health status measure and $Z_{it}$ is the matrix of the control variables. $\eta_i$ represents the country fixed effects and $\omega_{it}$ is the error term.

Equation (4.2) is estimated with standard fixed effects estimation.

The third model expresses health status as a function of income inequality with and without consideration of environmental variables. The coefficient of EHII must decrease with the addition of environmental variables if its effect is in part channelled by these variables.

$$Health_{it} = \phi_i + \psi EHII_{it} + \rho environment_{it} + \sigma_k Z_{kit} + \tau_{it} \quad (4.3)$$

This equation could be estimated by the Ordinary Least Squares (OLS), but it is very likely that population's health affects income inequality through productivity, education and other factors. This potential simultaneity can be a source of endogeneity. To solve for this problem, we estimate equation (4.3) with the Generalized Method of Moments (GMM system).

### 4.2. Data and variables

The data used in this paper cover the period 1970-2000 subdivided into 6 periods of 5 years and we retain for the basic regression 90 developed and developing countries (because of data availability). As health variable we use the logit of under five survival rate (LOGIT SURVIVAL). The under-five survival indicator is limited asymptotically, and an increase in this indicator does not represent the same performance when its initial level is weak or high. The best functional form to examine that is where the variable is expressed into a logit form, as Grigoriou (2005) underlined.

$\log it$ survival= $\ln(\frac{survival}{1-survival})$ .

Data on under five mortality rates are from the World Health Organization (WHO).

The environmental quality is represented by three variables: the carbon dioxide emission per GDP (CO2), the biological oxygen demand (BOD) both taken from WDI 2007 and the sulphur dioxide emission per GDP (SO2) from Stern (2005). For these variables, a higher value indicates more environmental degradation. CO2 and SO2 are air pollution indicators and BOD in a water quality indicator.

Income inequality is measured by the Gini coefficient taken from the database created by Galbraith and associates and known as the University of Texas Inequality Project (UTIP) database. It contains two different types of data on inequality: the UTIP-UNIDO and the EHII indexes. The EHII (that we use here) is an index (ranging from 0, low inequality to 1, high inequality) of Estimated Household Income Inequality and is built combining the information in the Deninger and Squire (D&S) data with the information in the UTIP-UNIDO data. The other variables used are gross domestic product per capita (GDPCAP), population density (POPDENS), fertilizer use (FERTILIZER), foreign direct investment (FDI), dependency ratio (DEPENDENCY) and trade openness (OPEN), all taken from WDI 2007 and primary school enrolment (SCHOOL) from Barro and Lee (2000).

Appendix 2 summarizes the characteristics of the important variables. This table shows the mean, the minimum, the maximum, the standard deviation and the coefficient of variation of each variable. These statistics are completed by appendix 3 which presents the correlation between important variables. These statistics are confirmed by appendix 7, which displays the statistical relation between EHII and environmental variables. These relations are just a simple correlation and don't take into account the influence of other variables. The econometrical section will solve for this.

### 4.3. Results

#### 4.3.1. Income inequality and environment

The results obtained from equation (4.1) for the whole sample of developed and developing countries (the relation between inequality and environment quality), are reported in table 1. The column 1 of this table shows the results when the logarithm of carbon dioxide emission per GDP (CO2) is used as environmental variable. The environmental Kuznets Curve (EKC) hypothesis is verified, since the coefficient of the logarithm of GDP per capita (GDPCAP) is positive and statistically significant, and the coefficient of its square (GDPCAPSQ) is negative and also significant. In this column, the coefficient of inequality variable (EHII) is positive and statistically significant at 5%, showing that an increase in income inequality worsens environmental quality.

Columns 2 and 3 summarize the results when sulphur dioxide emission per GDP (SO2) and the biological demand (BOD) are respectively used as environmental variables. The important results remain unchanged, namely, income inequality is an important cause of environment degradation, except for SO2 where the coefficient of inequality is not statistically significant.

We estimated again equation (1) by adding as additional variable, the interaction between income inequality and economic development level dummy to assess the differential effect of income inequality depending on development level. The results obtained are summarized in the first three columns (1, 2 and 3) of appendix 4. The relationship between income inequality and environment is confirmed for CO2 in the first column. In this column, the coefficient of the interaction term is negative and statistically significant. This result shows that income inequality increases CO2 emission but the effect is higher in developed countries. For SO2 emission in column (2), only the coefficient of the interaction term is statistically significant and positive showing that income inequality increases SO2 emission only in developing countries. Finally for BOD in column (3), we have not any effect.

To take into account the role played by institutions quality on the inequality effect, we add as additional variable, the interaction between institution and inequality. The results are presented in the last three columns (4, 5 and 6) of appendix 4. These results show that good institutions mitigate the negative effect of income inequality on environment quality, but this effect is only significant statistically for SO2 emission in column (5).

Table 1: Impact of income inequality on environment quality:

| | 2SLS FIXED EFFECTS ESTIMATIONS | | |
|---|---|---|---|
| | DEPENDENT VARIABLES | | |
| INDEPENDENT VARIABLES | (1) CO2 | (2) SO2 | (3) BOD |
| EHII | 4.405** | 2.819 | 9.580* |
| | (2.387) | (0.673) | (1.736) |
| GDPCAP | 0.969*** | 3.479*** | 1.893** |
| | (2.653) | (4.218) | (2.298) |
| GDPCAPSQ | -0.0723*** | -0.253*** | -0.164*** |
| | (-3.220) | (-4.977) | (-3.192) |
| POPDENS | -0.130 | -0.870** | -1.366*** |
| | (-0.859) | (-2.522) | (-2.888) |
| SCHOOL | 0.108 | 1.574*** | 0.125 |
| | (0.643) | (4.120) | (0.325) |
| FERTILIZER | 4.52e-05* | 0.000177*** | 0.000166** |
| | (1.786) | (3.033) | (2.205) |
| INSTITUTION | -0.00104 | -0.00976*** | -0.00491 |
| | (-0.801) | (-3.290) | (-1.587) |
| FDI | -0.317 | -0.878 | -0.327 |
| | (-0.708) | (-1.019) | (-0.370) |
| OPEN | -0.0778 | -0.150 | -0.165 |
| | (-0.896) | (-0.764) | (-0.814) |
| CONSTANT | -3.895** | -28.95*** | -16.40*** |
| | (-2.411) | (-7.976) | (-4.550) |
| Observations | 367 | 367 | 365 |
| NB countries | 86 | 86 | 88 |

***significant at 1%, **significant at 5%, *significant at 10%. t-statistics enter parenthesis. Income inequality (EHII) is instrumented by dependency ratio. The first step estimation results are presented in appendix 5.

### 4.3.2. Environment and health

The effect of environmental quality on health status (equation 4.2) is estimated with standard fixed effects model and the results are reported in table 2. Column 1 presents the results when environment quality is measured by CO2 emission. All the explanatory variables have expected sign and are statistically significant, except the primary school enrollment lagged (SCHOOL(1)) which is not statistically significant. GDP per capita lagged (GDPCAP(1)) and immunization rate (IMDPT) improve the survival rate while fertility rate (FERT) and environment quality (BOD) degrades it. The negative and significant coefficient of CO2 shows that air pollution worsens health status as expected in the literature review. Columns 2 and 3 shows the results when SO2 and BOD are respectively used as environmental indicators. All these columns underline the negative effect of air and water pollution on population's health.

Table 2: Impact of environment quality on health

| INDEPENDENT VARIABLE | OLS FIXED EFFETS ESTIMATION Dependent variable: logit of under five survival rate (1) | (2) | (3) |
|---|---|---|---|
| GDPCAP(-1) | 0.396*** | 0.290*** | 0.282*** |
| | (6.223) | (3.640) | (3.883) |
| IMDPT | 0.502*** | 0.474*** | 0.532*** |
| | (5.710) | (5.195) | (5.632) |
| SCHOOL(-1) | -0.310 | -0.206 | -0.441 |
| | (-1.206) | (-0.779) | (-1.532) |
| FERT | -0.202*** | -0.178*** | -0.153*** |
| | (-5.933) | (-4.835) | (-4.343) |
| CO2 | -0.223* | | |
| | (-1.949) | | |
| SO2 | | -0.209*** | |
| | | (-8.060) | |
| BOD | | | -0.237*** |
| | | | (-4.711) |
| CONSTANT | 0.340 | -3.056*** | -2.073*** |
| | (0.582) | (-4.711) | (-3.088) |
| Observations | 434 | 429 | 373 |
| NB countries | 97 | 96 | 93 |

***significant at 1%, **significant at 5%, *significant at 10%. t-statistics enter parenthesis.

#### 4.3.3. Income inequality, environment and health

The effects of income inequality on health status with and without consideration of environment variables (equation 4.3) are summarized in table 3. Column (1) of this table presents the results without consideration of environment quality. Each variable has the expected sign. Income inequality affects negatively and significantly population health. In the other columns (2, 3 and 4) of this table, we introduce environment quality in the model. All the environmental variables affect negatively health status. In addition, the introduction of environmental variables decreases the level and the statistical significance of the coefficient of income inequality variable in each column. This confirms the channel role played by environmental quality concerning the effect of income distribution on population health.

Table 3: Impact of income inequality and environment quality on health

| | GMM System estimation results | | | |
|---|---|---|---|---|
| | Dependent variable: logit of under five survival rate | | | |
| Independent variables | (1) | (2) | (3) | (4) |
| GDPCAP | 0.799*** | 0.774*** | 0.766*** | 0.495** |
| | (11.98) | (11.14) | (11.68) | (2.455) |
| IMDPT | 0.547*** | 0.550*** | 0.585*** | 0.500*** |
| | (4.678) | (4.646) | (5.112) | (4.090) |
| SCHOOL | 0.180 | 0.482 | 0.230 | 0.264 |
| | (0.650) | (1.579) | (0.856) | (1.469) |
| FERT | -0.125*** | -0.147*** | -0.119*** | -0.226*** |
| | (-3.535) | (-4.147) | (-3.591) | (-3.527) |
| EHII | -1.400** | -1.200* | -1.302** | -1.103 |
| | (-2.144) | (-1.709) | (-2.067) | (-1.133) |
| CO2 | | -0.217** | | |
| | | (-2.050) | | |
| SO2 | | | -0.0498** | |
| | | | (-2.175) | |
| BOD | | | | -0.224* |
| | | | | (-1.746) |
| CONSTANT | -3.109*** | -2.916*** | -3.901*** | -3.243*** |
| | (-3.600) | (-3.248) | (-4.675) | (-2.614) |
| Observations | 360 | 359 | 357 | 354 |
| NB countries | 90 | 89 | 88 | 90 |
| Sargan OID test (p.value) | 0.12 | 0.34 | 0.10 | 0.25 |
| AR(2) | 0.58 | 0.63 | 0.69 | 0.56 |

***significant at 1%, **significant at 5%, *significant at 10%. t-statistics enter parenthesis.

## 5. Conclusion

The purpose of this paper was to investigate the effect of income distribution on health which passes through environmental quality. Theoretically, we show that environment degradation could be consider as a channel through which income inequality affects population health in addition to the direct mechanisms found in the literature. This effect could reinforce the negative effect of income inequality on health.

Empirically, we show through an econometric analysis that income inequality affects negatively environmental quality and environment degradation worsens population's health. This negative effect of income inequality on environment quality is mitigated by good institutions. Another interesting result is that income inequality affects negatively health status and in presence of environmental variable, the level and the statistical significance of the coefficient of income inequality variable decrease. This confirms that environment quality is an important channel through which income inequality affects population health. These results hold for air pollution indicators (CO2 and SO2) and water pollution indicator (BOD). It is also robust for rich and developing countries.

As policy implication, our results mean that income inequality is bad for health and environment, and countries with high income inequality may implement distributive policy in order to avoid its negative impact on health.

Next studies could extend our finding is taking it again at individual level (microeconomics). Another way to extend this article is to verify it conclusions for other environmental and inequality variables.

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# Appendices:

Appendix 1: literature review

| study | year | inequality variable | environment measure | effect of inequality | | data | estimator | review | other covariates |
|---|---|---|---|---|---|---|---|---|---|
| | | | | effect | sig. Level | | | | |
| Clément and Meunie | 2008 | gini WIDER | SO2 emission | impr. | 10% | 83 developing and transition countries in 1988-2003 | OLS | Cahiers du GREThA n° 2008-13 | GDP, $GDP^2$, $GDP^3$ |
| | | | BOD emission | degr. | 1% | | | | |
| Herring, N., Mulatu A. and, Bulte E. | 2001 | gini index | access to safe water, access to sanitation, and deforestation | degr. | 1% | 16-country sample of sub-Saharan African countries | pooled | Ecological Economics 38, 359–367 | GDP, $GDP^2$ |
| | | | carbon dioxide emissions, nitrogen depletion, and phosphorus depletion | impr. | 1% | | | | |
| | | | sulfur dioxide and particulate concentrations | impr. | NO | | | | |
| Borghesi | 2000 | Gini (Deninger and Squire) | CO2 per capita | impr. | 1% | panel of 37 countries from 1988-1995 | OLS pooled model | NOTA DI LAVORO 83.2000 | GDP, $GDP^2$, $GDP^3$, Population density, industry share. |
| | | | | degr. | NO | | fixed effects | | |
| Marsiliani and Renström | 2000 | ratio of households ranked at top 90th percentile to the median household | sulfur, Nitrogen oxides and carbon dioxide | degr. | 1% | two panels of 7 and 10 industrialized countries over 1978-1997 | simple OLS | CentER working paper n.2000-34 | GDP |
| | | | | | | | ML | | |
| | | | | impr. | | | fixed effects | | |
| Magnani | 2000 | quintiles 1 / quintiles 4 | Public R&D expenditure for environmental protection | degr. | 10% | 17 developed countries | fixed effects & random effects | Ecological Economics 32 (2000) 440 431–443 | GDP, $GDP^2$, Time trend |
| | | gini | | | NO | | | | |

| study | year | inequality variable | environment measure | effect of inequality | | data | estimator | review | other covariates |
|---|---|---|---|---|---|---|---|---|---|
| | | | | effect | sig. Level | | | | |
| Ravallion M., Heil M., Jalan | 2000 | gini index | CO2 per capita emission | impr. | 5% | panel of 42 countries in the period 1975-92 | fixed effects & pooled OLS | Oxford Economic Papers, *52*:651-669 | GDP, GDP², Population |
| Boyce et al. | 1999 | power inequality | environment policy | degr. | 1% | 50 US states in 1990's | OLS | Ecological Economics 29 (1999) 127–140 | manufacturing share, urbanization and population density |
| Scruggs L.A. | 1998 | Gini (Deninger and Squire) | sulfur dioxide | impr. | 1% | 25–29 countries for 3 periods: 1979–1982, 1983–1986 and 1987–1990 | OLS pooled model | Ecological Economics 26 (1998) 259–275 | Democracy, Income, Industrialize site, periode |
| | | | particulate matter | impr. | NO | | | | |
| | | | fecal coliform | degr. | NO | | | | |
| | | | dissolved oxygen | degr. | 1% | | | | |
| Torras and Boyce | 1998 | gini (low income) | Sulfur dioxide | degr. | 1% | 287 stations in 58 countries | OLS | Ecological Economics 25 (1998) 147–160 | GDP, GDP², GDP³, literacy rate, right |
| | | | Smoke | degr. | 1% | | | | |
| | | | Heavy particles | impr. | 1% | | | | |
| | | | Dissolved oxygen | impr. | 1% | | | | |
| | | | Fecal coliform | impr. | NO | | | | |
| | | | Safe water (%) | degr. | 1% | | | | |
| | | | Sanitation (%) | degr. | NO | | | | |
| | | gini (high income) | Sulfur dioxide | impr. | 1% | | | | |
| | | | Smoke | impr. | NO | | | | |
| | | | Heavy particles | degr. | NO | | | | |
| | | | Dissolved oxygen | degr. | NO | | | | |
| | | | Fecal coliform | impr. | 1% | | | | |
| | | | Safe water (%) | degr. | NO | | | | |
| | | | Sanitation (%) | degr. | NO | | | | |

Appendix 2: descriptive statistics

| | MEAN | MINIMUM | MAXIMUM | COEF. VAR. | STAND. DEV. | NB. OBS. |
|---|---|---|---|---|---|---|
| LOGIT SURVIVAL | 2.988 | 0.672 | 5.293 | 0.406 | 1.214 | 478 |
| CO2 | 0.448 | 0.020 | 2.255 | 0.747 | 0.335 | 436 |
| BOD | 2.34e-06 | 2.29e-07 | 0.00002 | 1.034 | 2.42e-06 | 369 |
| SO2 | 8.18e-09 | 5.64e-12 | 2.99e-07 | 3.320 | 2.72e-08 | 485 |
| EHII | 0.417 | 0.266 | 0.642 | 0.147 | 0.061 | 485 |
| GDPCAP | 6280 | 122.6 | 36160 | 1.261 | 7922 | 485 |
| SCHOOL | 0.304 | 0 | 0.93 | 0.889 | 0.271 | 485 |
| IMDPT | 0.710 | 0.012 | 0.99 | 0.350 | 0.249 | 351 |
| FERT | 3.997 | 1.18 | 8.494 | 0.492 | 1.968 | 485 |
| POPDENS | 98.713 | 1.567 | 951.97 | 1.265 | 124.89 | 485 |
| FERTILIZER | 1681.06 | 0.896 | 37358 | 2.201 | 3700.6 | 485 |

Appendix 3: correlations between important variables

| | LOGIT SURVIVAL | CO2 | BOD | SO2 | EHII | GDPCAP | SCHOOL | IMDPT | FERT | POPDENS |
|---|---|---|---|---|---|---|---|---|---|---|
| LOGIT SURVIVAL | 0.94* | | | | | | | | | |
| LIFE EXPECT | 0.30* | 1.00 | | | | | | | | |
| CO2 | -0.45* | 0.01 | 1.00 | | | | | | | |
| BOD | -0.19* | 0.06 | 0.20* | 1.00 | | | | | | |
| SO2 | -0.62* | -0.17* | 0.13* | 0.11* | 1.00 | | | | | |
| EHII | 0.81* | 0.17* | -0.47* | -0.14* | -0.61* | 1.00 | | | | |
| GDPCAP | -0.86* | -0.29* | 0.33* | 0.12* | 0.52* | -0.63* | 1.00 | | | |
| SCHOOL | 0.64* | 0.17* | -0.20* | -0.03* | -0.30* | 0.44* | -0.59* | 1.00 | | |
| FERT | -0.90* | -0.30* | 0.32* | 0.22* | 0.57* | -0.68* | 0.84* | -0.61* | 1.00 | |
| POPDENS | 0.17* | -0.01 | 0.12* | -0.11* | -0.11* | 0.11* | -0.12* | 0.05 | -0.25* | 1.00 |
| FERTILIZER | 0.40* | 0.02 | -0.11* | -0.08* | -0.27* | 0.41* | -0.31* | 0.25* | -0.32* | 0.12* |

*significant at 10%.

Appendix 4: Development level and institution conditional impact of inequality on environment

| INDEPENDENT VARIABLES | DEPENDENT VARIABLES (2SLS FIXED EFFECTS ESTIMATIONS) | | | | | |
|---|---|---|---|---|---|---|
| | DEVELOPMENT LEVEL | | | INSTITUTION QUALITY | | |
| | (1) CO2 | (2) SO2 | (3) BOD | (4) CO2 | (5) SO2 | (6) BOD |
| EHII | 12.14*** | -7.513 | 5.685 | 6.481** | 15.10 | 14.17* |
| | (3.576) | (-0.892) | (0.652) | (2.410) | (1.405) | (1.955) |
| (EHII)x(DEV_LEVEL) | -9.984*** | 13.31* | 5.757 | | | |
| | (-3.149) | (1.698) | (0.723) | | | |
| (EHII)x(INSTITUTION) | | | | -0.129 | -0.778* | -0.247 |
| | | | | (-1.290) | (-1.929) | (-1.169) |
| GDPCAP | 1.606*** | 2.623** | 1.523 | 0.930** | 3.276** | 1.775** |
| | (3.649) | (2.412) | (1.427) | (2.344) | (2.059) | (2.097) |
| GDPCAPSQ | -0.118*** | -0.192*** | -0.138** | -0.0686*** | -0.230** | -0.154*** |
| | (-4.178) | (-2.734) | (-1.993) | (-2.807) | (-2.343) | (-2.909) |
| POPDENS | -0.0352 | -0.995*** | -1.477*** | -0.162 | -1.016 | -1.484*** |
| | (-0.240) | (-2.735) | (-2.931) | (-0.963) | (-1.500) | (-2.927) |
| SCHOOL | 0.161 | 1.506*** | 0.0934 | 0.285 | 2.570*** | 0.442 |
| | (0.958) | (3.616) | (0.225) | (1.239) | (2.832) | (0.916) |
| FERTILIZER | 5.00e-05** | 0.000171*** | 0.000173** | 6.27e-05** | 0.000254** | 0.000199** |
| | (1.971) | (2.689) | (2.168) | (1.996) | (2.087) | (2.350) |
| INSTITUTION | -0.00313** | -0.00700* | -0.00386 | 0.0556 | 0.334* | 0.104 |
| | (-2.097) | (-1.890) | (-1.036) | (1.267) | (1.875) | (1.118) |
| FDI | -0.295 | -0.846 | -0.350 | -0.0841 | -0.995 | -0.407 |
| | (-0.666) | (-0.908) | (-0.369) | (-0.164) | (-0.597) | (-0.446) |
| OPEN | -0.0770 | -0.154 | -0.175 | -0.133 | -0.376 | -0.242 |
| | (-0.895) | (-0.724) | (-0.804) | (-1.275) | (-0.940) | (-1.098) |
| CONSTANT | -6.442*** | -25.52*** | -14.92*** | -4.806** | -34.81*** | -18.03*** |
| | (-3.367) | (-5.415) | (-3.241) | (-2.481) | (-4.449) | (-4.447) |
| Observations | 367 | 367 | 365 | 367 | 367 | 365 |
| NB countries | 86 | 86 | 88 | 86 | 86 | 88 |

***significant at 1%, **significant at 5%, *significant at 10%. t-statistics enter parenthesis. Income inequality (EHII) is instrumented by dependency ratio; (EHII)x(DEV_LEVEL) is instrumented by the interaction between dependency ratio and development level dummy and EHII INSTITUTION is instrumented by the interaction between dependency ratio and institution variable. The first step estimation results are presented in appendix 5.

Appendix 5: First step estimation results

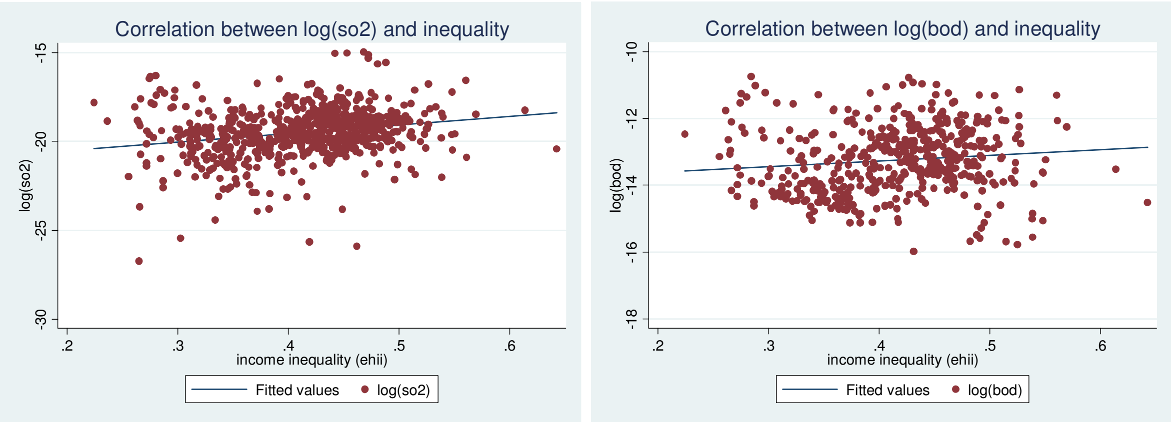
| | DEPENDENT VARIABLES (FIRST STEP ESTIMATIONS) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| INDEPENDENT VARIABLES | EHII | (EHII)x(DEV_LEVEL) | (EHII)x(INSTITUTION) |
| GDPCAP | -0.146*** | -0.096* | -1.644 |
| | (-2.99) | (-1.93) | (-0.94) |
| GDPCAPSQ | 0.0079*** | 0.0048 | 0.085 |
| | (2.63) | (1.53) | (0.77) |
| POPDENS | 0.047*** | 0.035*** | 0.531 |
| | (3.46) | (2.63) | (1.13) |
| SCHOOL | 0.0023 | 0.015 | 1.528 |
| | (0.08) | (0.56) | (1.56) |
| FERTILIZER | -8.14e-06** | -6.06e-06* | -0.000022 |
| | (-2.48) | (-1.93) | (-0.20) |
| INSTITUTION | 0.0003 | 0.000058 | 0.521*** |
| | (1.54) | (0.29) | (13.73) |
| FDI | 0.063 | 0.044 | 2.284 |
| | (0.88) | (0.64) | (0.91) |
| OPEN | 0.0036 | -0.0026 | -0.332 |
| | (0.25) | (-0.19) | (-0.67) |
| DEPENDENCY | -0.003*** | 0.00024 | -0.020 |
| | (-3.24) | (0.18) | (-0.54) |
| (DEPENDENCY)x(DEV_LEVEL) | | -0.0042*** | |
| | | (-2.66) | |
| (DEPENDENCY)x(INSTITUTION) | | | -0.0018** |
| | | | (-2.04) |
| Observations | 367 | 367 | 367 |
| NB countries | 86 | 86 | 86 |

***significant at 1%, **significant at 5%, *significant at 10%. t-statistics enter parenthesis.

Appendix 6: data characteristics and sources

| VARIABLES | CHARACTERISTICS | SOURCES |
|---|---|---|
| LOGIT SURVIVAL | logit of survival rate (log survival/log(1-survival)) | WHO |
| LIFE EXPECT | modified life expectancy (-log(80-life expectancy)) | WDI 2007 |
| CO2 | carbon dioxide emission as ratio of GDP | WDI 2007 |
| BOD | biological oxygen demand as ratio of GDP | WDI 2007 |
| SO2 | sulfur dioxide emission as ratio of GDP | Stern 2004 |
| EHII | Estimated Household Income Inequality | University of Texas Inequality Project (UTIP) database |
| DEPENDENCY | Population under 15 and above 65 | WDI 2007 |
| INSTITUTION | Political institution quality | Polity IV |
| GDPCAP | Gross Domestic Product per capita | WDI 2007 |
| SCHOOL | Primary school enrollment | WDI 2007 |
| IMDPT | Immunization rate | WDI 2007 |
| FERT | fertility rate | WDI 2007 |
| POPDENS | population density | WDI 2007 |
| FERTILIZER | fertiliser use | WDI 2007 |

Appendix 7: Correlation between income inequality and environment quality




Source: Author

Appendix 8: Country list

| World bank code | country | | World bank code | country |
|---|---|---|---|---|
| ARG | Argentina | | JOR | Jordan |
| AUS | Australia | | JPN | Japan |
| AUT | Austria | | KEN | Kenya |
| BDI | Burundi | | KOR | Korea, Rep. |
| BEL | Belgium | | KWT | Kuwait |
| BEN | Benin | | LBR | Liberia |
| BGD | Bangladesh | | LKA | Sri Lanka |
| BOL | Bolivia | | LSO | Lesotho |
| BRA | Brazil | | MEX | Mexico |
| BWA | Botswana | | MOZ | Mozambique |
| CAF | Central African Republic | | MUS | Mauritius |
| CAN | Canada | | MWI | Malawi |
| CHL | Chile | | MYS | Malaysia |
| CHN | China | | NIC | Nicaragua |
| CMR | Cameroon | | NLD | Netherlands |
| COG | Congo, Rep. | | NOR | Norway |
| COL | Colombia | | NPL | Nepal |
| CRI | Costa Rica | | NZL | New Zealand |
| CYP | Cyprus | | PAK | Pakistan |
| DEU | Germany | | PAN | Panama |
| DNK | Denmark | | PER | Peru |
| DOM | Dominican Republic | | PHL | Philippines |
| DZA | Algeria | | PNG | Papua New Guinea |
| ECU | Ecuador | | POL | Poland |
| EGY | Egypt, Arab Rep. | | PRT | Portugal |
| ESP | Spain | | PRY | Paraguay |
| FIN | Finland | | RWA | Rwanda |
| FJI | Fiji | | SEN | Senegal |
| FRA | France | | SLE | Sierra Leone |
| GBR | United Kingdom | | SLV | El Salvador |
| GHA | Ghana | | SWE | Sweden |
| GMB | Gambia, The | | SWZ | Swaziland |
| GRC | Greece | | SYR | Syrian Arab Republic |
| GTM | Guatemala | | TGO | Togo |
| HND | Honduras | | THA | Thailand |
| HTI | Haiti | | TTO | Trinidad and Tobago |
| HUN | Hungary | | TUN | Tunisia |
| IDN | Indonesia | | TUR | Turkey |
| IND | India | | UGA | Uganda |
| IRL | Ireland | | URY | Uruguay |
| IRN | Iran, Islamic Rep. | | USA | United States |
| ISL | Iceland | | VEN | Venezuela, RB |
| ISR | Israel | | ZAF | South Africa |
| ITA | Italy | | ZMB | Zambia |
| JAM | Jamaica | | ZWE | Zimbabwe |