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Economic Growth, inequality and environment quality:

An empirical analysis applied to developing and transition countries

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Croissance économique, inégalité et qualité de l'environnement : une analyse empirique appliquée aux pays en développement et en transition

Résumé

Cet article a pour objectif d'analyser la relation qui prévaut entre les inégalités sociales et le degré de pollution. D'une part, il propose une revue de la littérature qui montre que d'un point de vue théorique, une diminution des inégalités a un effet indéterminé sur l'environnement. D'autre part, sur la base de ces discussions théoriques, nous proposons une analyse économétrique portant sur un échantillon de pays en développement et de pays en transition sur la période 1988-2003. Plus précisément, nous examinons l'effet des inégalités sur le degré de pollution locale (émissions de dioxyde soufre et pollution organique de l'eau) en intégrant l'indice de Gini dans la formulation de la courbe environnementale de Kuznets. Deux effets sont alors testés : (i) un effet direct des inégalités sur la pollution : (ii) un effet indirect par lequel les inégalités agit sur la pollution par l'intermédiaire de son influence sur le degré de libertés politiques.

Mots-clés : pollution ; inégalités ; courbe environnementale de Kuznets ; données de panel

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Abstract

This article aims at examining the relationship between social inequalities and pollution. On the one hand, it proposes a survey which shows that from a theoretical point of view, a decrease in inequality has an undetermined effect on environment. On the other hand, on the basis of these theoretical considerations, we propose an econometric analysis based on panel data for developing and transition countries during the period 1988-2003. More precisely, we examine the effect of income inequalities on the degree of local pollution (sulphur dioxide emissions and organic water pollution) by integrating Gini index in the formulation of environmental Kuznets curve. Then, two effects may be tested: (i) a direct effect of inequalities on pollution; (ii) an indirect effect by which the degree of inequality influence pollution by his negative impact on political freedoms.

Keywords: pollution; inequality; environmental Kuznets curve; panel data

JEL : **C23 ; Q01 ; Q53 ; Q5**

1 - Introduction

The globalization and intensification of environmental degradations induced by the contemporary mode of development question the long-term viability of the globalization process. The accumulation of wealth is today considered through the prism of its *sustainability*. The critics, in a more or less radical way, call into question the regulation mechanisms that govern the relations between economic systems and environment. The neo-classic authors pretend that the market remains the most efficient institution to integrate ecological constraints, on the double condition that these externalities are internalized and the technological progress is circulated. Heterodox economists dispute this optimist version of market failures, and wonder about the necessity to adopt another paradigm of economic development.

Nowadays the relationships between the human activities and their environment are approached through the concept of sustainable development (CMED, 1987). Its three pillars, economic, social and ecological, interact to lead the society on the path of a long-term viable growth. In order to determine the conditions of sustainability, most of the authors focus on the link-up between economic and environmental spheres. This paper aims at studying the consequences of the inclusion of the social relations' influence. Behind the impact of the GDP per capita, isn't it that the social and power inequalities play a prominent part regarding the evolution of the relations between environment and society?

Right in the heart of all paradigms of sustainable development, lies the question of long-term compatibility between economic growth and a reasonable use of the capacities of assimilation of our ecosystems and natural resources. In the standard approach, sustainability fosters a dependence link towards the per capita GDP growth. But as from the 1990's, some empiric studies put forward the idea that economic growth and respect of ecological constraints are compatible in the long run. Known as the Environmental Kuznets Curve (EKC), this analysis postulates that the impact of anthropogenic activities on natural environment obeys a differentiated dynamism according to the level of per capita income (Grosman and Krueger, 1994; Seden and Song, 1994; Shafik and Bandyopadhyay, 1992; World Bank, 1992). In a formal way, the relation between polluting emissions and the per capita GDP level takes the shape of an inverted-U curve.

The EKC concept thus postulates that there is a reversal threshold of the relation, beyond which the increase of wealth becomes compatible with an improvement of the societies' environmental performances. The variations of per capita GDP have an indirect effect on the pollution level, thanks to the combination of three structural effects:

> The *scale effect* expresses the impact of an increase of the economic activity. It estimates the additional quantity of pollution that would be generated if the intensity in GDP emissions would remain constant.
>
> The *composition effect* evaluates the consequences of sector-based mutations throughout the development process. First, the transition from a rural economy to an urban and industrial society aggravates the polluting rejects. Then, the decline in heavy energy-intensive industries as well as the emergence of the service sector, intensive in terms of technology and human capital, release the ecological constraint by exerting a lowering action on the GDP's emissions intensity.
>
> The *technological effect* estimates the decisive influence exerted by the organisational and scientific progress for the research linked to economic growth's sustainability. From a certain level of wealth, both State and enterprises have the human and financial means to incur consistent R&D amounts to promote innovations for a better ecological efficiency of the manufacturing processes.

Therefore, the existence of an EKC supposes that beyond a certain income per capita threshold, the two other effects more than make up for the scale effect.

One of the main critics towards EKC lies in its *deterministic* nature. If the wealthy economies manage to reduce their polluting emissions owing to their economic growth, then they become an example to be followed by the national models of capital accumulation in developing countries. Sustainability would then be a kind of sixth step of development, extending the Rostow model (Vivien, 2006). Several authors insist on the omission of explanatory variables for the pollutions level, whose effect would be to artificially curve the EKC. In this paper, we focus on the potential impact of inequalities. At international level, the theme of "pollution havens" is still the subject of controversy. If the Northern countries' environmental legislations go together with a relocation of their most polluting industries in developing countries (with less stringent standards) then the inverted-U curve looses its pertinence. It then becomes the result of the capacity of consumers issued from the wealthiest countries to put the burden of the pollutions resulting from production activities onto the populations who live in the less developed countries, instead of being the result of an effective improvement of the wealthiest economies (Mani and Wheeler, 1998; Rock, 1996 ; Stern *et al.*, 1996; Baumol and Oates, 1988). The development inequalities then have an upward influence on the ecological degradations in the poorest countries.

Within the framework of this paper, we analyse the effects of the introduction of inequalities variables in the EKC. This analysis presents a double perspective. On the one hand, it is a theoretical work aiming at identifying the economical, social and political mechanisms that could justify the nature of the relation between inequalities and environment. On the other hand, this work is completed by an empirical analysis that aims at examining the link between inequality and pollution over the 1988-2003 period for developing and transition countries. With this objective, the first part proposes a synthesis of the theoretical discussions about the relation between wealth inequalities and pollution. The second part describes the samples and data that are mobilized. Then, in a third part, several econometric investigations are proposed in order to highlight a few stylised facts about the relation between inequalities and two specific pollutants, *i.e.* the sulphur dioxide emissions and the water's organic pollution.

2 - Impact of inequalities on the environment: a critical analysis of the environmental Kuznets curve

The overall idea that we are submitting hinges on the representation of the groups of interest. The poor, being the main victims of *local* pollutions, have an immediate potential benefit from the reduction of environmental degradations. But the more non-egalitarian a country is, the least the poor is properly represented in both institutions and social compromises. Therefore, the most elitist countries should also be the ones with the lowest regulations regarding the relations between economy and environment. However, since the pollutants have multiple sources, they obey different dynamics and we thus think that there is no unique sequence, but, on the contrary, some indeterminacy about the concrete logics related to the links between inequalities and respect of the ecosystem.

2.1. An uncertain impact from an economic point of view

2.1.1. The position of the institutions in the stabilization of the usual behaviours towards environment

In the neo-classical paradigm, pollution is a public good that generates some markets externalities and failures. Therefore, there cannot be any spontaneous and universal movement behind the EKC. Public intervention is indispensable to stabilize behaviours and to let emerge some conventions for a sustainable development. Public policies are thus the essential factor, a mediator of the relation between the GDP per capita and the level of pollution. Generally speaking, the institutions and especially the State influence the movement of technical progress through the mobilization of regulating tools (norms, taxes or *ad hoc* market).

In their reference paper, Arrow *et al.* (1995) remind us that this curve is above all the result of action of authorities, instead of spontaneous dynamics. Similarly, according to Grossman and Krueger (1996, p. 120), "if environmental improvements are mediated by changes in government policy, then growth and development cannot be a substitute for environmental policy". However, the interests related to environmental uses are contradictory. The causes and consequences of certain polluting activities do not affect all the actors in the same way. The capital holders have an interest in carrying on production at the minimum cost. Most often, the victims are not these people, but rather the very users of a degraded ecosystem (dwelling, water consumption, etc.). Then, the public intervention depends on the representation of these groups.

Even though the ecological constraint is invested with an objective aspect, there is still a problem of *societal perception* of the ecological stakes. The spatial and temporal gap between the emission sources and a full understanding of the degradations explains the radical uncertainty in which the actors are. Furthermore, once the ecosystems' resilience is over, the phenomena are irreversible and prevent an efficient implementation of political management; there is no way back once environmental losses have incurred. Thus, the actors' behaviours must be guided by a *collective anticipation* of ecological risks. As for the spatial dimension, the local pollutions might lead to dynamics of land segregation, through which the wealthiest people can get away from deteriorated places while the poorest ones have no choice but to move in durably in polluted areas with cheaper rents.

2.1.2. The Power-weighted social decision rule

When it comes to polluting activities, Boyce (1994) formalizes the effects of power inequalities between winners and losers according to the pollution level[1]. The neoclassical theory suggests two ideal-type situations: the laissez-faire and the social optimality à la Coase. In the first case, the winners ignore the costs born by the victims and carry on their polluting activity until the point where the marginal benefits become null. The pollution level is then maximal. If the winners are forced to take into account the increasing marginal costs of the losers, then social optimality is reached when these costs equal the marginal benefits of the polluters. However, the existence of transaction costs leads to a practical result situated in between these two ideal-types.

Then, Boyce adds another angle to this dynamic: the power inequalities between winners and losers, defined 'as the ability to bear transaction costs'. The relations of strength then lead to the concrete formation of a compromise that strays from social optimum. Boyce calls this new decision rule the "*power-weighted social decision rule*" (PWSDR). According to the author, the PWSDR's direction is not indeterminate; in most cases the winners from degradations are the ones who have a greater relative power.

The power of a group is positively correlated to its level of relative wealth. Thus, the stronger the social inequalities are, the more the wealthiest people are able to maintain their interests. Yet, they are the ones who get the largest benefits from environmental deterioration. Rich people are thus at the source of a wider range of production and often consume goods that are more polluting (like big-engine cars for instance) than the ones used by poor people. Furthermore, they hold an overwhelming part of financial assets and thus capture the largest part of the producer surplus whose immediate interest is costs minimization, like a minimal undertaking of social costs. Boyce names this relation between wealth inequalities, power inequalities and pollution '*equality hypothesis*', reflecting the idea that a better social equality favours the preservation of environmental quality.

1 One can also refer to Boyce (2003, 2007).

Boyce identifies a few additional arguments that imply a negative influence of inequalities over the environment quality. First, the ecological irreversibility implies that a modification of power that favours the winners of degradations increases the long-term under-optimality of the pollution levels, but the opposite cannot work when the degradations have already happened and become irreparable. Second, the environment evaluation leads to a fictitious price, integrated in the price vector. However, price formation is influenced by the play of paying capacities, themselves depending on the initial distribution of wealth. The level of social inequalities is thus an additional channel of influence for the well-to-do classes. Likewise, the access to information is less performing for poor people and although they are the victims, they underestimate the impact of degradations. Besides, wealthy people have the ability to influence social compromises through the manipulation of information via marketing and media control. Third, rich people fear that social protest movements could put an end to their privileges. Such fear prompts them to increase their preference for the present (*i.e.* to overvalue the discount rate). They will thus increase the production level of polluting activities in order to maximize their current results, thus encouraging an increase of polluting emissions or a higher exploitation of natural resources.

Scruggs (1998) goes back on these theoretical developments to show that the whole of Boyce's architecture lies on the hypothesis that the wealthy people systematically prefer a degraded environment. She contests this idea by recalling that the literature suggests on the contrary that the quality of environment is a superior good whose demand increases faster than the income. Then, a non-egalitarian society should lead towards less environmental degradations[2]. Referring to the new paradigm of social modernization (Hofrichter and Reif, 1990), Scruggs asserts that there would be a threshold of average individual wealth beyond which the direction of the impact of inequalities on pollutions reverses. In the poorest countries, Boyce's assumption would be verified, but in the most developed countries, the inequalities would be in favour of environment preservation. She thus concludes that the relation between inequalities and ecological degradations cannot be one-to-one, but rather indeterminate. However, Scruggs only considers the debate through the terms of consumer's wealth, while the wealthiest classes are also the ones that have the largest interests in the production activities, and thus in the achievement of producer surplus (*cf. supra*).

2.1.3. Comments: the multiple influences of inequalities on environmental degradations

The debate between Boyce and Scruggs shows how complex the relation is between inequalities and environment. Such complexity is related to the multitude of underlying mechanisms that often act contradictorily.

The limits to growth

A key aspect of the debate is widely overlooked. If, at least in rich countries, the sustainability conditions imply the restriction of production growth for material goods, then the role of social inequalities appears from an angle that is wider than the direct impact of their dynamics on environmental quality. The emergence of an ecological constraint becomes an objective's limit enforced on the production scale, whose non-respect would inevitably create humanitarian disasters. All in all, the rich countries have reached a stage of undeniable opulence. But such material affluence remains relative. In Northern countries, a large proportion of individuals are still poor, and in Southern countries, the economies are far from reaching the levels of individual average wealth similar to that

2 The role of an increasing marginal utility of environmental quality is not as obvious as Scruggs would say. Indeed, even in this case, a wealthy consumer might be confronted with the necessity of comparing the usefulness of protecting any ecosystem and the opportunity cost of the renunciation to the buying of a polluting asset. For instance, a European whose financial assets allow him to spend holidays in the Maldives will have to give a very high marginal utility to the fight against climatic changes in order to give up the plane that would take him to this paradise place!

of Occident. Therefore, the stakes today lie more in the share of material wealth than in growth as such, since it has to stay within sustainable limits. Within the framework of our article, limited to the groups of Southern and transition countries, this primary acknowledgement can be used as our horizon line. Indeed, it demonstrates the inner limits of the current development in the North, a development that cannot be identically reproduced, from a quantitative point of view. This acknowledgement speaks in favour of a behaviour centred on the fair share of wealth, in order to minimize the need of growth. Besides, Sen (1981) supports this reasoning when he demonstrates that Indian famines occurred even though the granaries were full, because of the failure of the Indian redistribution system.

The scale effect of social inequalities reduction

The reduction of social inequalities can also put the ecosystems at a disadvantage. Indeed, the propensity to consume being a decreasing function to the income, a policy axed on incomes redistribution leads to a consumption increase that is more than proportional to the decrease of the riches' consumption. Moreover, the assets bought by middle class households might be of poorer quality, and more polluting. Such dynamics is especially true in transition countries, in which the middle class is fast increasing.

A differentiated impact of inequalities according to the pollutant's type

Environmental degradations have many sources, and thus the impact of inequalities cannot be systematically the same. For instance, environmental amenities such as natural parks are a common asset with the characteristics of a superior good. On the other hand, the location of urban wastes processing plants rather obeys the logics of land segregation, according to the intensity of degradations. The spatial pollution scale affects the ability of wealthy people to protect themselves from degradations. The more localized the effects of a pollutant are, the more one can expect an aggravating impact of social inequalities. Similarly, the split between acts of production and consumption have an influence on the inequalities impact and its direction (Khanna and Plassmann, 2004).

The technological progress potential

The technological ability to adopt production methods with lower pollution is also a strategic variable. If such option can be reached, wealthy households will be in a position to buy less polluting, but more expensive products. Then, the inequalities can have a positive impact on environment quality because they increase the demand for such innovating products.

Societal perception

The social and power inequalities act directly on the development of societal perception. As we earlier reminded, the poorest categories are also very often the ones who are head-on affected by micro-pollutions. Therefore, they are the best "informed" about environmental violations, especially when pollutions affect vital ecological services such as drinking water consumption. But within the public institutions, the more the mechanisms to defend the most vulnerable are weak the more the wealth distribution is distorted in favour of the riches. Their economic interests are not properly relieved and this asymmetry is also present in their environmental interests. Since the wealthiest individuals have a stronger ability to protect themselves from local pollutions (or to "feel" protected), there is a chance that the society underestimates environment violations. This reasoning applies without the necessity to express the assumption that the wealthiest groups are inevitably in favour of environment degradations.

Survival activities and access inequalities

The impact of inequalities on environment also has several sources, and thus several consequences. Social inequalities are at the source of a direct interest for the most vulnerable people in deteriorating their environment because of survival motivations. They might indeed have no other choice but to make an excessive withdrawal on the natural endowments of their ecosystems in order to draw some minimum incomes. Deforestation linked to the cultivation of new lands or smuggling of protected species can be, if not encouraged, at least not constrained by public authorities to minimize the risk of protest movements. The effects of inequalities on living conditions can be amplified by some feedbacks like a pathogen impoverishment of the services issued from degraded ecosystems. Such sequence concerns before and above all the poorest countries. A direct effect of inequalities on the ecosystems is generated by access inequalities, especially in developing countries. For example, if a territory only has a limited access to safe drinking water, it is in principle the poorest ones who will be the most affected by water rationing. If the governance fails to take properly into account the interest of the poorest people, the construction of infrastructures dedicated to an improvement of the drinking water supply might fall very short. Easterly (2001) stresses that inequalities are one of the main causes of the freeze of the development process, one thing that, in return, perpetuates the unsustainable pressures on the ecosystems related to survival activities.

The risk of a growth's acceleration that would annihilate the control of its content

The aggravating impact of inequalities is also found in the interest of authorities in non-egalitarian countries to accelerate the rhythm of wealth creation (in order to compensate strong inequalities). This refers to the ability or to the will of public institutions to create some institutional conditions that would favour a strong economic growth in order to keep their political legitimacy. The EKC scale effect is thus amplified and accordingly the environment is quickly deteriorated. Indeed, the faster the economic growth is, the least possible it is to control the very content of this growth, and therefore its ecological effects. An exemplary case of these noxious dynamics is China.

Power inequalities relieved by democracy?

Lastly, the supposed superiority of certain democratic configurations to better take into account the interest of the most vulnerable is also often considered in economic literature. The interests of each social group are better taken into account in nations with free elections, thanks to the voter status of each actor. The State, through its governing people, thus takes a better care of the needs of the poorest. The ecological problems are thus managed in a more voluntaristic way. However, we would like to qualify this optimism (although we do not aim at fundamentally questioning it). First, in configurations where challenges are badly perceived because they have not yet occurred, a large majority of these groups can find an interest in carrying on polluting activities without constraining them (for example, in order not to reduce the employment in these industries). There are then little chances that the political power takes the risk of imposing some unpopular measures, even though there is proper information from the scientific community. Furthermore, in certain Western countries (USA for example), social inequalities are very high and the positive effect of the democratic work on the environmental performances might then be threatened. Lastly, the cultural imagination of these mass consumption societies is often in direct conflict with the necessity to restrict the activity of polluting industries. In a market economy, the necessity to keep on expanding the outlets finds one of its solutions in the permanent creation of new needs. Such dynamics often contradict the "self-restriction" requirement in goods demand. For instance, the number of vehicles must be reduced to fight climatic changes, but the current trend is the opposite, even though a few marginal improvements are being done (decrease in the vehicles' fuel consumption). Moreover, through social representations, the inequalities probably intensify these difficulties because the poorest people tend to mimic the ostentatious behaviours of the riches. This is even more pertinent when one knows that the poorest people can only afford the lowest products in terms of quality, and therefore the most polluting ones (an aggravating factor on the EKC scale effect). In the end, some powerful contradictions might exist between the beneficial effect of a democratic system on ecological performance and the logics of a market economy.

2.2. Empirical findings

There is quite an abundant empirical literature on the relation between environment and inequalities. The present survey is restricted to the main articles that deal specifically with the Environmental Kuznets Curve and the impact of inequalities.

Torras and Boyce (1998) were the first authors to analyze these issues. In this conflict of interest between net winners and losers, the public authorities judge according to the respective efficiency of the representation within the institutions of both these groups. Yet, according to the PWSDR, the winners group owns a stronger negotiation power. In their analysis, Torras and Boyce thus try to demonstrate that the inequalities interact with the per capita GDP level, raising the EKC reversal threshold. Indeed, according to Kuznets himself, power inequalities, underlying a same level of income dispersion, are all the more high that the GDP per capita is weak, something the authors call the 'Kuznets unsung hypothesis'. They then estimate the equation that links the pollution level to a vector of control variables, to the level of GDP per capita and to the negotiation power. This latter is approximated by the Gini index, the literacy rate and an indicator of civil rights and political freedom[3]. They mostly mobilize data issued from the GEMS database for the pollutant concentrations during the 1977-1991's period in 18-52 cities out of 19-42 countries according to the type of pollution. After having estimated the regressions without inequality variables and having noticed that the results are similar to the Grossman and Krueger (1995) ones, they include them by adding a dummy that marks the membership of the group of either poor or rich countries. Then the coefficients loose their significance. All in all, the inequalities have a significant upwards impact on pollution, especially for the poorest countries. In other words, the weaker the per capita GDP level is, the more the social and power inequalities have an influence on the degradation of the environmental quality, thus confirming the 'Kuznets' unsung hypothesis'.

Scruggs (1998) tests the '*equality hypothesis*', according to which a reduction of inequalities improves the environment. The observations that are utilized come from two distinct databases: the United Nations GEMS base on water (dissolved oxygen and faeces) and air (SO_2 and particles concentrations) quality and a sample only made of 17 industrial democracies. The results go towards an indeterminacy of the direction of the impact of inequalities on ecological degradations. In the first set of regressions, only the indicators of dissolved oxygen and particles are significantly correlated with the Gini index. Moreover, the expected sign is only observed with the first indicator. In the second set, the results are also ambiguous, since the inequalities variables are not significant (except for a particular regression, and yet the sign goes towards a positive impact of inequalities on the environmental quality) and the GDP per capita acts contrarily to the EKC dynamics.

However, the majority of empirical studies go in the direction of a negative impact of inequalities on the environmental quality. Boyce *et al.* (1999) thus get some results in 50 USA states, in accordance with the 'equality hypothesis'. Gawande *et al.* (2001) study the relation between the location of toxic wastes sites and the income level of United States households. They clearly demonstrate that, behind the EKC look, hides in fact the financial ability of the wealthy households to get away from pollution sources. When getting richer, individuals tend to try to move away from polluting places rather than influence the public policies in favour of a significant decrease of toxic wastes. Mikkelson *et al.* (2007) concludes that the inequalities increase the number of endangered species[4]. Gates *et al* (2007) underline a significant and indirect relation between social inequalities and ecosystems preservation through their negative impact on political freedom. Furthermore, inequalities

3 They apply OLS, which, in our view, appears to restrict their results, panel data methods being more relevant.
4 They also find a U-shaped curve with GDP per capita, an inverse EKC-type curve.

also have a direct negative relation with the percentage of land holding the status of protected natural parks and with the quality of available information on environmental conditions.

3. Data

In order to test the relation between inequalities and environmental quality, we mobilize an 83 countries sample, comprising 67 developing countries and 16 transition countries (CEEC and ex-soviet republics) for which we have observations throughout the 1988-2003 period. The database presents a panel structure and thus allows to capture the heterogeneity among countries through the introduction of some effects that are specific to the individuals and to capture temporal dynamics through the introduction of some effects that are specific to the years.

Because there are no composite indicators of environment quality, two pollution variables are taken into account, with the requirement of only referring to local pollutants. First, the data on sulphur dioxide (SO_2) emissions spring from the ASL database and its update proposed by David Stern for the 1990's and 2000's (ASL and Associates, 1997; Stern, 2005). They are expressed in kg per capita. Second, the observations on water organic pollution are taken from the World Bank *World Development Indicators 2007* and are expressed in kg per worker.

Inequality data, grasped by the Gini index, come from the *World Income Inequality Database* of the *World Institute for Development Economics Research* (WIDER). This database gathers about 5000 observations taken from multiple sources and graded according to their quality. Whenever possible, we retained high quality observations that are homogeneous in terms of measurement unit and covered population. However, these inequalities' data raise two difficulties. First, they present a problem of comparability because the households surveys used to estimate the distribution of the standard of living are based on distinct sampling methods and also because the indicator of the standard of living that is utilized is not homogeneous among countries[5]. Second, the data on inequalities are very parsimonious. This is why the panel is not balanced. Indeed, out of 1328 theoretical observations (67 countries and 16 years), we only have 412 observations for the Gini index.

To take the political situation into account, we turn to the political rights index built each year by the non-governmental organization *Freedom House*. It particularly measures the extent of political freedom according to four criteria: (i) the extent of freedom in electoral processes, (ii) the pluralism, (iii) the citizen's participation in political life, (iv) the governments' functioning. Taking these criteria into account, the indicator grades the countries according to the extent of their political freedom, grade 7 corresponding to a very restrained level of political rights and grade 1 to a democratic regime. All other explanatory variables used in the analysis (the GDP per capita expressed in constant dollars of 2000, the literacy rate, and the share of energy exports in total exports) are taken from the *World Development Indicators*.

4. Results

4.1. Environmental Kuznets curve

In order to test the validity of the EKC, we retain a three degree polynomial form for the relation between the pollution level and the GDP per capita. Moreover, because of the double dimension of the data (individual and temporal), we resort to linear panel models, that is, the fixed effects model and the random-effects model, by integrating both individual and temporal effects[6]. The expression of the fixed effects model is given by:

5 For comparability problems, please refer to Deiniger and Squire (1996, 1998)

6 For technical aspects related to these two models, refer to Baltagi (1995).

$$POL_{it} = \beta_1 GDPh_{it} + \beta_2 GDPh_{it}^2 + \beta_3 GDPh_{it}^3 + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

With *POL* as the pollution level and *GDPh* as the per capita GDP. The fixed effects are constants to be estimated that are specific to the countries (α_i) and to the years (λ_t) and that capture the influence of non-observable characteristics, respectively constants along the time and constants between individuals. The fixed effects model estimator is the least squares with dummy variables estimator (LSDV) which is equivalent to the ordinary least squares (OLS) applied to the individual averages deviation model. The expression of the random-effects model is given by:

$$POL_{it} = \alpha + \beta_1 GDPh_{it} + \beta_2 GDPh_{it}^2 + \beta_3 GDPh_{it}^3 + u_i + v_t + \varepsilon_{it} \quad (2)$$

Here, both individual and temporal effects are supposed to be random (u_i). And, taking into account a particular form of self-correlation of the wastes, the model is estimated through the generalized least squares (GLS).

Tables 1a and 1b respectively present the results for SO_2 emissions and for water organic pollution. The explanatory capacity of the models is satisfactory for transition countries, but rather limited for developing countries as well as for the sample as a whole. We must also precise that the Chow test implemented for the fixed-effects model confirms the relevance of these two sub-samples, no matter the pollutant considered. The Hausman test that enables to choose between the fixed-effects model and the random-effects model produces some contradictory results according to the sample and pollutant. However, in four cases out of six, a random-effects model will be preferred.

As for sulphur dioxide emissions, we excluded the cubic term of GDP per capita from the regressions because of its non-significance. All in all, it seems that the relation between SO_2 emissions and GDP per capita takes the shape of a U-inverted curve, in accordance with the EKC hypothesis. The turning point is relatively high (between USD 7,700 and USD 7,900 according to the models) and more or less corresponds to the Chile or Russia’s average level of development over the given period. The implementation of distinct estimations for developing and transition countries shows that the relation is not stable. The EKC seems to be validated in the ex-socialist countries. But this result requires more attention. Indeed, with the exception of Macedonia, one notes a decrease of SO_2 emissions in all transition countries[7] in the considered period. For example, the SO_2 emissions per capita have decreased by 88% in the Czech Republic, by 70% in Hungary and by 57% in Bulgaria. How can we then justify the increasing part of the relation? This increasing part is related to the inter-individual variability (between countries) of the GDP per capita and emissions, while the decreasing part would rather be related to the inter-temporal variability and traduce the decrease of emissions as time goes by. Therefore, the observed EKC is artificial in a certain way, because of the confusion between inter-temporal and intra-temporal dimensions. As for the developing countries, the estimations show the absence of a significant quadratic relation between the SO_2 emissions per capita and the GDP per capita. However, when one excludes the squared GDP per capita, one notes the existence of an increasing linear relation that is significant from a statistical point of view. This linear relation is confirmed by the scatter plot found in annexes (Chart A2) and the value of the linear correlation coefficient (significant and positive). In other words, the developing countries might have not yet reached the threshold that marks the transition to a phase of decreasing emissions, in accordance with the EKC.

7 For SO_2, emissions, the group of transition countries is exclusively made out of CEEC, since there is no available data for the ex-soviet republics.

Table 1a: Regression results for the determinants of SO2 emissions, fixed-effects model (FEM) and random-effects model (REM).

	Whole sample		Developing countries		Transition countries	
	FEM (1)	REM (2)	FEM (1)	REM (2)	FEM (1)	REM (2)
Constant		**-8,4564**		2,8239		**-46,8553**
		-3,10***		*1,30*		***-2,14*****
GDPh	**0,0091**	**0,0080**	0,0010	**0,0011**	**0,0230**	**0,0216**
	9,27***	***9,90******	*1,42*	***1,67****	***4,73******	***4,82******
GDPh²	**-5,85E-07**	**-5,10E-07**	6,39E-08	6,09E-08	**-1,34E-06**	**-1,25E-06**
	-9,90***	***-9,75******	*1,27*	*1,29*	***-5,57******	***-5,52******
N	957	957	836	836	121	121
R²	0,0999	0,0998	0,0726	0,0726	0,2545	0,2544
Hausman test	1,21 (0,2721)		0,04 (0,8327)		0,53 (0,4654)	
Chow test			1,63 (0,0011)***			
Turning point	7778	7843			8582	8640

Figures in parentheses are t-ratios for regression coefficients and significance level for the Hausman and Chow tests.
*** statistically significant at 1% level; ** statistically significant at 5% level; * statistically significant at 10% level.

Table 1b: Regression results for the determinants of organic water pollution, fixed-effects model (FEM) and random-effects model (REM).

	Whole sample		Developing countries		Transition countries	
	FEM (1)	REM (2)	FEM (1)	REM (2)	FEM (1)	REM (2)
Constant		**0,3084**		**0,2447**		**0,4441**
		29,18***		***24,77******		***15,33******
GDPh	**-6,96E-05**	**-5,02E-05**	**-1,41E-05**	**-1,64E-05**	**-1,37E-04**	**-1,23E-04**
	-11,44***	***-10,24******	***-2,66******	***-3,75******	***-9,72******	***-9,29******
GDPh²	**7,38E-09**	**5,47E-09**	**1,67E-09**	**1,87E-09**	**1,64E-08**	**1,53E-08**
	9,92***	***8,36******	***2,67******	***3,38******	***8,27******	***7,96******
GDPh³	**-2,40E-13**	**-1,82E-13**	**-5,60E-14**	**-6,18E-14**	**-6,21E-13**	**-5,91E-13**
	-8,67***	***-7,17******	***-2,52*****	***-3,04******	***-7,13******	***-7,00******
N	785	785	589	589	196	196
R²	0,1887	0,1893	0,1179	0,1279	0,3279	0,3402
Hausman test	28,95 (0,0000)***		0,62 (0,4325)		8,42 (0,0037)***	
Chow test			1,74 (0,0002)***			
Turning point						
Min	7352	7116	6082	6443	6814	6373
Max	13148	12921	13799	13730	10792	10886

Figures in parentheses are t-ratios for regression coefficients and significance level for the Hausman and Chow tests.
*** statistically significant at 1% level; ** statistically significant at 5% level; * statistically significant at 10% level.

The relation between water organic pollution and development level is different since it takes the shape of an inverted-N curve that goes against the EKC 's predictions. Furthermore, this relation seems to be stable because it is observed for both transition and developing countries. However, the final decreasing part of the relation does not really mean anything since there are only two countries (South Korea and Czech Republic) presenting some average levels of GDP per capita greater than the curve's maximum (situated around USD 13,000). The concept of a development level beyond which the water pollution would decrease is likely, but this threshold is high and only concerns a few countries of the sample. Therefore, the relation between water pollution and development level rather takes the shape of a U curve as far as our sample is concerned.

Finally, the relation between environment deterioration and GDP per capita depends on the pollutant and on the group of considered countries. Like Gates *et al.* (2002) and He *et al.* (2007), we defend the idea that the relation between pollution and development level depends on factors that are related to the social and political situation.

4.2. Pollution, inequalities and political rights

It is advisable to test the hypothesis according to which the relation between pollution and wealth level cannot be understood without taking into account the social and political dimensions. Therefore, we first integrate the degree of inequalities (measured by the Gini index) in the previous regressions, in accordance with the following equation related to the random-effects model:

$$POL_{it} = \alpha + \beta_1 GDPh_{it} + \beta_2 GDPh_{it}^2 + \beta_3 GDPh_{it}^3 + \beta_4 GINI_{it} + u_i + v_t + \varepsilon_{it} \quad (3)$$

Secondly, we introduce the political situation, captured by the political rights index *(POLIT) :*

$$POL_{it} = \alpha + \beta_1 GDPh_{it} + \beta_2 GDPh_{it}^2 + \beta_3 GDPh_{it}^3 + \beta_4 GINI_{it} + \beta_5 POLIT_{it} + u_i + v_t + \varepsilon_{it} \quad (4)$$

Lastly, in order to test the interaction between inequality and the extent of political freedom, we take into account a differentiated effect of the Gini index, depending on whether the country present a democratic regime (political rights index from 1 to 3) or an authoritarian one (political rights index above 3). The equation of the random-effects model is then given by:

$$POL_{it} = \alpha + \beta_1 GDPh_{it} + \beta_2 GDPh_{it}^2 + \beta_3 GDPh_{it}^3 + \beta_4 (GINI*DEM)_{it} + \beta_5 (GINI*DIC)_{it} + u_i + v_t + \varepsilon_{it} \quad (5)$$

With *DEM* and *DIC* two dummy variables respectively indicating whether the political regime of the country is rather democratic or authoritarian, at the considered date. We only present the estimations of the random-effects models, respectively for SO_2 emissions (table 2a) and water pollution (table 2b).

Table 2a: Regression results for the determinants of SO2 emissions, random-effects model

	Whole sample			Developing countries			Transition countries		
	(3)	(4)	(5)	(3)	(4)	(5)	(3)	(4)	(5)
Constant	0,6208	-7,1245	-1,9341	-0,5999	-1,0385	-0,2399	1,4036	-18,9184	0,1258
	0,10	*-1,14*	*-0,34*	*-0,13*	*-0,21*	*-0,05*	*0,05*	*-0,78*	*0,01*
GDPh	**0,0086**	**0,0089**	**0,0084**	0,0014	0,0015	0,0014	**0,0164**	**0,0142**	**0,0141**
	7,52*	***8,15****	***7,82****	*1,24*	*1,26*	*1,16*	***3,35****	***3,41****	***3,33****
GDPh²	**-5,90E-07**	**-6,12E-07**	**-5,94E-07**	3,53E-08	3,34E-08	3,64E-08	**-1,02E-06**	**-9,33E-07**	**-9,12E-07**
	-7,87*	***-8,84****	***-8,59****	*0,38*	*0,36*	*0,39*	***-4,25****	***-4,60****	***-4,39****
Gini	**-0,2261**	-0,1286		0,0552	0,0554		**-0,9655**	-0,1035	
	-1,90*	*-1,20*		*0,65*	*0,65*		***-1,95****	*-0,22*	
Political freedoms		0,7212			0,0796			**2,5576**	
		1,60			*0,23*			***1,89****	
Gini_democracy			-0,1448			0,0669			-0,5653
			-1,35			*0,78*			*-1,35*
Gini_dictature			-0,1658			0,0411			-0,5625
			-1,51			*0,48*			*-1,23*
N	310	307	307	228	228	228	82	79	79
R²	0,2417	0,2917	0,2701	0,0830	0,0840	0,0876	0,3747	0,4924	0,4417
Turning point	7288	7271	7071				8039	7610	7730

Figures in parentheses are t-ratios for regression coefficients.
*** statistically significant at 1% level; ** statistically significant at 5% level; * statistically significant at 10% level.

Table 2b: Regression results for the determinants of organic water pollution, random-effects model

Variables	Whole sample			Developing countries			Transition countries		
explicatives	(3)	(4)	(5)	(3)	(4)	(5)	(3)	(4)	(5)
Constant	**0,2554**	**0,2699**	**0,2613**	**0,2104**	**0,2160**	**0,2091**	**0,6276**	**0,6068**	**0,5880**
	10,56***	***10,62******	***11,21******	***10,93******	***10,90******	***10,89******	***9,53******	***8,56******	***8,77******
GDPh	**-5,18E-05**	**-4,04E-05**	**-4,09E-05**	**-2,18E-05**	**-2,26E-05**	**-2,22E-05**	**-1,70E-04**	**-1,43E-04**	**-1,45E-04**
	-5,78***	***-4,53******	***-4,58******	***-2,97******	***-3,08******	***-3,03******	***-8,01******	***-6,20******	***-6,14***
GDPh²	**6,74E-09**	**5,29E-09**	**5,36E-09**	**3,06E-09**	**3,09E-09**	**3,07E-09**	**2,05E-08**	**1,75E-08**	**1,78E-08**
	5,13***	***4,11******	***4,17******	***3,05******	***3,08******	***3,06******	***7,46******	***5,82***	***5,82******
GDPh³	**-2,70E-13**	**-2,19E-13**	**-2,22E-13**	**-1,17E-13**	**-1,17E-13**	**-1,17E-13**	**-7,68E-13**	**-6,72E-13**	**-6,81E-13**
	-4,82***	***-4,03******	***-4,09******	***-2,90******	***-2,90******	***-2,90******	***-6,99******	***-5,59******	***-5,62******
Gini	**0,0011**	4,41E-04		**7,12E-04**	**7,58E-04**		**-0,0018**	**-0,0025**	
	2,82***	*1,17*		***2,22*****	***2,35*****		***-2,14*****	***-2,91******	
Political freedoms		-0,0022			-0,0013			-0,0049	
		-1,25			*-1,18*			*-1,32*	
Gini_democracy			5,91E-04			**8,13E-04**			**-0,0021**
			1,56			***2,44*****			***-2,47*****
Gini_dictature			3,51E-04			**7,33E-04**			**-0,0025**
			0,92			***2,28*****			***-2,97******
N	259	254	254	160	160	160	99	94	94
R²	0,2857	0,2717	0,2893	0,0823	0,1235	0,1162	0,4166	0,4652	0,4704
Turning point									
Min	6021	6224	6215	4990	5182	5106	6578	6578	6491
Max	10621	9879	9881	12445	12425	12387	11217	10783	10935

Figures in parentheses are t-ratios for regression coefficients.
*** statistically significant at 1% level; ** statistically significant at 5% level; * statistically significant at 10% level.

When referring to the estimations for SO_2 emissions, it appears that the Gini index has a negative effect significant at the 10% level on the degree of emissions for the whole sample [model (3)]. In other words, a high degree of inequalities would be associated to a reduction of emissions. However, when introducing the variable of political freedom, the Gini index looses its significance [model (4)]. Likewise, we do not get any significant result when taking into account the interaction between inequalities and extent of political rights [model (5)]. For the developing countries sample, the models have a weak explanatory power and the results are unconvincing since no variable (including the GDP per inhabitant) is statistically significant. For transition countries (only CEEC for SO_2 emissions), the models have a better specification since the R^2 are systematically greater than 0.35. When the inequality degree is the only integrated one, it has a negative effect significant at the 10% level on SO_2 emissions [model (3)]. In other words, an inequality increase would favour the reduction of emissions. But this result needs to be carefully examined. The reforms aimed at providing the transition towards a market economy have indeed resulted in a deep social upheaval, notably characterized by an outburst of inequalities, while they were moderate in the former system (Milanovic, 1998). It is also true that this increase of inequalities went together with a reduction of the SO_2 emissions. But in our point of view, there is no causal relation between the evolution of the social context and the evolution of the emissions. The decrease of sulphur dioxide emissions is mainly explained by two factors, separate from the social context. First, this improvement is linked to the 1990's economic crisis marked by a collapse of the industrial production. In second place, the increase of political rights related to the setting up of democratic regimes in most of the CEEC, as well as the perspectives of joining the European Union, did favour the emergence of environmental matters that were totally ignored under socialist regimes. Therefore, in a certain way, the correlation between inequalities and SO_2 emissions that has been underlined is misleading and certainly cannot identify any causality. This thesis is confirmed by model (4), since the impact of inequalities on SO_2 emissions disappears when the indicator of political freedom is introduced. It becomes significant and positive, indicating that an increase of political rights (decrease of the indicator of political rights) is favourable to a decrease of sulphur emissions.

For the organic water pollution, the estimations display a positive effect of inequalities, significant at the 1% level, for the whole sample [model (3)]. But this significant impact disappears as soon as political freedoms are introduced in the regressions [models (4) and (5)]. Therefore, all in all, the effect of inequalities on water pollution is uncertain. For developing countries, the impact of inequalities is highly significant and the positive sign of the coefficient related to the Gini index indicates that a high degree of wealth inequalities prejudices the water quality [model (3)], in accordance with Boyce's thesis (1994). The results also indicate that this effect is not constrained by the political system. Indeed, the introduction of an effect differentiated from the Gini index according to the political situation (democracy or dictatorship) does not modify the positive influence of the Gini index [model (5)]. For transition countries, the logics are strictly opposite, since the impact of inequalities on water pollution is negative and separate from the political system. Yet, when calculating a simple linear correlation coefficient, a positive correlation between inequalities and water pollution is observed. In other words, a high degree of inequalities would be associated to an important level of water pollution. Actually, the nature of the relation between pollution and inequalities is modified when one takes into account the level of wealth (GDP per capita). Once controlled by the level of wealth, an unequal distribution of wealth favours a reduction of the water pollution.

In the end, the nature of the relation between pollution and inequality seems to be constrained by the pollutant and the group of observed countries. As for the SO_2 emissions, it looks like the level of wealth exerts a stronger effect than its distribution. But the inequalities have a fundamental effect on water pollution. In developing countries, they reinforce the degree of water pollution, according to Boyce's hypothesis, while the relation is opposite in transition countries, once controlled by the level of wealth.

4.3. Instrumental variables techniques

It is important to discuss the relevance of an indirect effect of inequalities on environmental degradations through the channel of politics. Along the same lines as Gates *et al.* (2002), we make the assumption that a high degree of wealth inequality, because it takes part to the degradation of political rights, would have an adverse effect on environment. More precisely, we propose to call up the techniques of instrumental variables on panel data by instrumenting the indicator of political freedoms with the Gini index (to test the indirect effect), the part of fuel exports in total exportations and the literacy rate. The point is actually to apply the two-stage least squares estimator to the fixed-effects model.

The estimations are reported in table 3a for SO_2 emissions and table 3b for water pollution. Taking into account the limited number of observations in transition countries (less than 60), the estimations where only implemented for the whole sample and developing countries. What's more, for the latter, no significant result was obtained since there is no significant variable, even in terms of GDP per capita. On the other hand, the estimations call several comments for the global sample.

Table 3a: Regression results for the determinants of SO2 emissions, fixed-effects model with instrumental variables

	Whole sample		Developing countries	
	(1)	(2)	(1)	(2)
GDPh	**0,0072**	**0,0072**	0,0038	0,0056
	3,11*	***3,02****	*1,07*	*0,51*
GDPh²	**-4,56E-07**	**-4,58E-07**	-6,48E-08	-1,60E-07
	-3,54*	***-3,44****	*-0,28*	*-0,23*
Gini		0,0973		0,5275
		0,3		*0,37*
Political freedoms	**2,7101**	3,5122	4,6253	19,1712
	1,71*	*1,11*	*0,77*	*0,44*
N	212	212	170	170
R^2	0,1112	0,1415	0,0587	0,0781
Turning point	7895	7860		

The index of political freedoms is instrumented with the Gini index, the share of fuel exports in total exportations and the literacy rate.
Figures in parentheses are t-ratios for regression coefficients.
*** statistically significant at 1% level ; ** statistically significant at 5% level ; * statistically significant at 10% level.

Table 3b: Regression results for the determinants of organic water pollution, fixed-effects model with instrumental variables

	Whole sample		Developing countries	
	(1)	(2)	(1)	(2)
GDPh	-1,40E-05	-1,16E-05	-1,71E-05	-1,63E-05
	-0,51	-0,37	-0,70	-0,67
GDPh²	3,20E-09	2,94E-09	2,88E-09	2,74E-09
	1,04	0,85	1,06	1,02
GDPh³	-1,63E-13	-1,54E-13	-1,14E-13	-1,08E-13
	-1,52	-1,28	-1,23	-1,18
Gini		5,80E-04		4,04E-04
		0,65		0,89
Political freedoms	**0,0137**	**0,0174**	0,0037	0,0031
	2,63***	**2,15****	0,18	0,15
N	178	178	125	125
R^2	0,2231	0,3805	0,2180	0,2694

The index of political freedoms is instrumented with the Gini index, the share of fuel exports in total exportations and the literacy rate.
Figures in parentheses are t-ratios for regression coefficients.
*** statistically significant at 1% level ; ** statistically significant at 5% level ; * statistically significant at 10% level.

First, for SO_2 emissions, the EKC keeps its significance. And the political situation has a significant effect at the 10% level. More precisely, a worsening of the political situation, influenced by a high degree of inequalities, would favour an increase of SO_2 emissions. However, this indirect effect of inequalities on SO_2 emissions disappears when the Gini index is introduced (this index is supposed to capture the direct effect). All things considered and according to our previous conclusions, the inequalities seem to have a limited effect on SO_2 emissions, since they are above all related to the level of wealth rather than its distribution.

The results look more convincing with water pollution. The estimations highlight an indirect effect at the 1 to 5% level, depending whether the direct effect of inequality is integrated or not. The inequalities thus have an impact on the organic water pollution, in accordance with Boyce's equality assumption (1994). Furthermore, the per capita GDP polynomial looses its significance when taking into account this indirect effect. This seems to confirm the idea that the relation between water pollution and wealth is probably affected by a bias of omitted variables. This relation seems to be conditional on the degree of inequalities and its interaction with the political situation. Therefore, if we consider that poor people are the most affected ones by water pollution, it is likely that in a context of strong social inequalities and constrained political freedoms, these people do not have the possibility of asserting their interest in the preservation of water quality.

5 - Conclusion

This paper aimed at discussing the potential interactions between the social and environmental dimensions of sustainability. In this respect, we examined the role of wealth inequalities in the pollution process. From a theoretical point of view, the impact of social inequalities on pollution seems indeterminate because of multiple and contradictory mechanisms. Although Boyce (1994, 2003, 2007) asserts that inequalities affect the environment because they reinforce the power inequalities (to the benefit of the wealthiest people), Scruggs (1998) questions this analysis by showing that it rests on a particularly questionable assumption according to which the wealthiest individuals systematically prefer a degraded environment.

The econometric analysis made out of a sample of transition and developing countries have shown that the relation between inequality and pollution is not universal. It depends on both the pollutant and the context that are analysed. Regarding sulphur dioxide emissions, our investigations indicate that, in accordance with the hypothesis of environmental Kuznets curve, they depend above all on the level of wealth (GDP per capita), rather than on its distribution. In other words, the inequalities would only have a limited influence on SO_2 emissions. On the other side, the role of inequalities on the organic water pollution is strong. In developing countries, a high degree of inequalities is thus associated with important water pollution. Furthermore, this inequalities' impact is first expressed indirectly, through their impact on the political variable (indirect effect), thus confirming Boyce's equality hypothesis (1994). Therefore, wealth inequalities, because they reinforce power inequalities and lead to a deterioration of political freedoms, also reinforce water pollution.

Bibliography

Arrow, K. *et al.* 1995, "Economic Growth, Carrying Capacity and the Environment", *Science*, vol. 268, pp. 520-521.

ASL and Associates 1997, *Sulfur Emissions by Country and Year*, Report n° DE96014790, US Department of Energy, Washington DC.

Baltagi, B.H. 1995, *Econometric Analysis of Panel Data*, John Wiley & Sons, Chichester.

Baumol, W.J., Oates, W.E. 1988, *The Theory of Environmental Policy*, Cambridge University Press, 2ème éd., New York.

Boyce, J.K. 1994, "Inequality as a Cause of Environmental Degradation", *Ecological Economics*, vol. 11, pp. 169-178.

Boyce, J.K. 2003, "Inequality and Environmental Protection", *Political Economy Research Institute Working Paper*, n° 52.

Boyce, J.K. 2007, "Is Inequality Bad for the Environment?", *Political Economy Research Institute Working Paper*, n° 135.

Boyce, J.K., Klemer, A.R., Templet, P.H., Willis, C.E. 1999, "Power Distribution, the Environment and Public Health: A State-level Analysis", *Ecological Economics*, vol. 29, pp. 127-140.

CMED 1987, *Our Common Future*, Oxford University Press, Oxford.

Deininger, K., Squire, L. 1996, "Measuring Income Inequality: a New Data-base", *World Bank Economic Review*, vol. 10(3), pp. 565–591.

Deininger, K., Squire, L. 1998, "New Ways of Looking at Old Issues: Inequality and Growth", *Journal of Development Economics*, vol. 57(2), pp. 259-287.

Easterly, W. 2001, *Inequality does Cause Underdevelopment*, Mimeo, World Bank Washington D.C.

Gates, S., Gleditsch, N.P., Neumayer, E. 2002, *Environmental Commitment, Democracy and Inequality*, World Development Report 2003, Background Paper, World Bank.

Gawande, K., Berrens, R., Bohara, A. 2001, "A Consumption-based Theory of the Environmental Kuznets Curve", *Ecological Economics,* vol. 37, pp. 101-112.

Grossman, G.M., Krueger, A.B., 1994, "Economic Growth and the Environment", *NBER* Working Paper, n° 4634.

Grossman, G.M., Krueger, A.B. 1996, "The Inverted-U: What does it Mean?", *Environment and Development Economics*, vol. 1, pp. 119-122.

He, J., Makdissi, P., Wodon, Q. 2007, *Corruption, Inequality and Environmental Regulation*, Cahiers de Recherche de l'Université de Sherbrooke, n° 07-13, Université de Sherbrooke.

Hofrichter, J., Reif, K. 1990, "Evolution of Environmental Attitudes in the European Community", *Scandinavian Political Studies*, vol. 13, pp. 119-146.

Khanna, N., Plassmann, F. 2004, "The Demand for Environmental Quality and the Environmental Kuznets Curve Hypothesis", *Ecological Economics*, vol. 51, pp. 225-236.

Mani, M., Wheeler, D. 1998, "In Search of Pollution Havens ? Dirty Industry in the World Economy, 1960-1995", *Journal of Environment and Development,* vol. 7, pp. 215-247.

Mikkelson, G. M., Gonzalez, A., Peterson, G. D. 2007, "Economic Inequality Predicts Biodiversity Loss", *Plos One*, vol. 2(5).

Milanovic, B. 2002, "True World Income Distribution, 1988 and 1993: First Calculation Based on Household Surveys Alone", *Economic Journal*, vol. 112, pp. 51-92.

Rock, M. 1996, "Pollution Intensity of GDP and Trade Policy: can the World Bank be Wrong?", *World Development*, vol. 24(3), pp. 471-479.

Sen, A. 1981, *Poverty and Famines*, Clarendon, Oxford.

Scruggs, L.A. 1998, "Political and Economics Inequality and the Environment", *Ecological Economics*, vol. 26, pp. 259-275.

Selden, T., Song, D. 1994, "Environmental Quality and Development: is there an EKC for air Pollution ?", *Journal of Environmental Economics and Management,* vol. 27, pp. 147-162.

Shafik, N., Bandayopadhyay, S. 1992, *Economic Development and Environmental Quality: Time Series and Cross-Country Evidence*, Background Paper for the World Development Report 1992.

Stern, D.I., Common, M.S., Barbier E.B. 1996, "Economic Growth and Environmental Degradation: the EKC and Sustainable Development", *World Development*, vol. 24(7), pp. 1151-1160.

Stern, D.I. 2005, "Global Sulfur Emissions from 1850 to 2000", *Chemosphere*, vol. 58, pp. 163-175.

Torras, M., Boyce, J.K. 1998, "Income, Inequality and Pollution: a Reassessment of the Environmental Kuznets Curve", *Ecological Economics*, vol. 25, pp. 147-160.

Vivien, D. 2006, *Le développement soutenable*, La découverte, Repères, Paris.

World Bank 1992, *World Development Report*, World Bank.

Table A1: Mean values of dependant and independent variables (1988-2003)

	SO_2 emissions[1]	Water pollution[2]	GDP per cap.[3]	Gini	Politics[4]
Asia	**4,612**	**0,162**	**3614,9**	**0,375**	**4,26**
Bangladesh	0,5318	0,1585	1373,2	0,306	2,94
Cambodia	1,1787	0,1497	1576,3	0,463	6,00
China	8,0655	0,1381	2937,1	0,368	6,94
India	2,8263	0,1967	2017,6	0,309	2,5
Indonesia	1,8261	0,1800	2737,5	0,333	5,31
Korea, Rep	-	0,1231	13380,0	0,335	2,00
Lao	0,5027	-	1286,1	0,340	6,75
Malaysia	6,1847	0,1216	7286,6	0,479	4,63
Mongolia	19,3226	0,185	1440,4	0,321	2,81
Pakistan	3,6925	0,1791	1778,9	0,377	4,38
Philippines	3,7988	0,1889	3795,0	0,440	2,31
Sri Lanka	1,2155	0,1805	2930,4	0,349	3,44
Thailand	9,1758	0,1744	5799,5	0,437	2,69
Viet Nam	1,1049	-	1633,6	0,362	6,94
Middle East and North Africa	**7,072**	**0,189**	**4232,6**	**0,391**	**5,16**
Algeria	5,1882	0,243	5262,2	0,377	5,69
Egypt	4,6415	0,1918	3121,1	0,330	5,69
Iran	9,6123	0,1587	5363,9	0,432	5,94
Jordan	12,4528	0,1817	4060,1	0,395	4,44
Morocco	4,5258	0,1703	3487,4	0,393	4,88
Tunisia	12,3346	0,1514	5456,3	0,406	5,81
Turkey	6,3578	0,1772	5908,4	0,417	3,44
Yemen, Rep	1,4648	0,2526	768,8	0,364	5,38
Afrique Subsaharienne	**5,974**	**0,234**	**1962,3**	**0,456**	**4,76**
Burkina Faso	1,4720	0,2154	955,2	0,457	5,00
Burundi	0,5079	0,2423	763,9	0,376	6,44
Cameroon	2,0825	0,2321	1905,4	0,457	6,37
Côte d'Ivoire	1,6541	0,2238	1600,5	0,398	5,94
Djibouti	3,0317	-	2173,1	0,447	5,19
Ethiopia	1,2045	0,2211	782,5	0,405	5,31
Ghana	0,9208	0,1737	1785,0	0,354	3,94
Guinea	1,8508	-	1869,5	0,529	6,13
Kenya	1,3010	0,2364	1060,7	0,477	5,63
Lesotho	-	0,1699	2409,2	0,606	4,31
Madagascar	1,4830	0,2706	846,7	0,458	2,88
Malawi	0,7932	0,2803	542,3	0,557	4,13
Mali	2,6503	-	745,0	0,453	3,19
Mauritania	4,8120	-	1882,9	0,425	6,25
Mauritius	3,5068	0,1574	8197,6	0,379	1,25
Mozambique	2,8735	0,2762	717,2	0,435	4,13
Niger	1,5874	0,3038	730,8	0,427	5,06
Nigeria	3,5067	0,1905	844,1	0,469	5,44
Senegal	2,0745	0,3240	1375,7	0,456	3,56
South Africa	40,4940	0,1767	8842,6	0,579	2,63
Swaziland	-	0,2647	4109,1	0,555	6,00
Tanzania	1,8430	0,2518	514,4	0,342	5,13
Uganda	1,0010	0,2588	1003,2	0,473	5,31
Zambia	51,8547	0,2296	850,1	0,516	4,31
Zimbabwe	7,3978	0,1994	2576,9	0,531	5,50

Table A1 (following): Mean values of dependant and independent variables (1988-2003)

	SO_2 emissions	Water pollution	GDP per cap.	Gini	Politics
Latin America	**11,585**	**0,231**	**5563,2**	**0,514**	**2,49**
Argentina	5,3485	0,2126	11045,2	0,490	1,94
Bolivia	4,9876	0,2377	2238,8	0,601	1,75
Brazil	6,5807	0,1941	6860,8	0,591	2,38
Chile	91,9979	0,2316	7777,5	0,550	2,31
Colombia	2,9077	0,1971	5888,3	0,559	3,25
Costa Rica	2,8036	0,2118	7267,0	0,483	1,00
Dominican Republic	5,2976	-	5425,8	0,501	2,38
Ecuador	6,0418	0,2526	3325,9	0,582	2,31
El Salvador	2,6117	0,1952	4195,2	0,510	2,56
Guatemala	2,1353	0,2699	3731,1	0,563	3,38
Honduras	2,9587	0,2151	2841,1	0,553	2,56
Jamaica	18,4621	0,2889	3517,2	0,415	2,00
Mexico	13,2596	0,1944	8251,8	0,525	3,25
Nicaragua	3,7350	-	2873,0	0,463	3,44
Panama	6,6014	0,2912	5373,7	0,566	2,69
Paraguay	2,0081	0,2757	4381,8	0,548	3,88
Peru	15,5098	0,2014	4423,0	0,486	3,63
Trinidad and Tobago	13,9399	0,2553	8036,0	0,407	1,44
Uruguay	10,3873	0,2477	8031,3	0,436	1,25
Venezuela	13,8790	0,2075	5879,8	0,461	2,37
Transition countries	**33,645**	**0,170**	**6611,1**	**0,298**	**3,14**
Albania	5,9074	0,1955	3113,9	0,289	4,13
Armenia	-	0,2064	2318,2	0,381	4,08
Azerbaijan	-	0,1562	2787,7	0,362	5,85
Bulgaria	85,5807	0,1461	6200,7	0,329	2,50
Croatia	11,4495	0,1617	8643,9	0,257	3,31
Czech Republic	52,0943	0,1328	14493,8	0,221	1,00
Hungary	35,5842	0,1597	11599,3	0,238	1,63
Kyrgyz Republic	-	0,1622	1712,8	0,381	4,92
Lithuania	-	0,1677	8754,3	0,313	1,15
Macedonia	25,7148	0,1714	5833,4	0,354	3,50
Moldova	-	0,3139	2018,6	0,336	3,31
Poland	32,7720	0,1580	8918,5	0,311	1,75
Romania	22,7584	0,1004	6297,9	0,289	3,56
Russian Federation	-	0,1683	7659,4	0,400	4,19
Slovak Republic	27,9719	0,1409	10456,0	0,249	1,64
Ukraine	-	0,1558	5717,9	0,282	3,44
Whole sample	**11,026**	**0,199**	**4201,0**	**0,410**	**3,87**

Notes: (1) kg per capita; (2) kg per worker; (3) constant US dollars 2000, PPP; (4) the political freedoms index grades the countries according to the extent of their political freedom, grade 7 corresponding to a very restrained level of political rights and grade 1 to a democratic regime.

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