

Democratic Institutions and Environment Quality : Effect and Channel Transmissions

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KINDA Somlanare Romuald¹

Abstract

This paper aims at analysing the effect of democratic institutions on environment quality and at identifying channel transmissions. We use panel data from 1960 to 2008 for 122 countries and three modern econometric methods that are one-step GMM-System, two-step GMM-System and fixed effect estimators. Our results show that democratic institutions have opposite effect on environment quality: a positive direct effect on environment quality and a negative indirect effects through investments and income inequality. Indeed, democratic institutions attract investments that hurt environment quality. Moreover, as democratic institutions reduce income inequality, they also damage environment.

Resumé

L'article analyse l'effet des institutions démocratiques sur la qualité de l'environnement et identifie les canaux de transmission. L'analyse est conduite à partir d'un échantillon de 122 pays sur la période 1960-2008 et nous utilisons des techniques économétriques modernes que sont les estimateurs en effet fixe, en GMM System à une étape et à deux étapes. Nos résultats montrent que les institutions démocratiques ont un double effet sur la qualité de l'environnement : D'une part elles contribuent directement à une amélioration de la qualité de l'environnement. D'autre part elles la dégradent indirectement par l'intermédiaire des investissements et des inégalités de revenus. En effet, les institutions démocratiques augmentent les investissements et ceux-ci contribuent à augmenter la pollution. De même, en réduisant les inégalités de revenus, elles contribuent indirectement à une dégradation de la qualité de l'environnement.

Key words: Democratic institutions (043); Carbon dioxide (Q53); Panel data (C23); Income inequality (D31); Investments (E22)

¹ Member of CEDRES (Centre d'Etude, de Documentation et de Recherches en Economie Sociale), University of Ouagadougou (Burkina Faso). Ph-D student at CERDI (Centre d'Etude et de Recherche sur le Développement International), Université of Auvergne, Clermont Ferrand. Email : kindaromi@yahoo.fr
Somlanare_Romuald.Kinda@u-clermont1.fr

1. Introduction

Many environment problems can be explained by institutional failure and bad governance methods. At international level it is difficult to elaborate efficient and equity systems for environment resources management like oceans and climate warming. The Summit of Copenhagues (2009) put into in light real and enormous problems in international cooperation between countries for fighting climate warming. Though scientists reports emphasize that countries should act rapidly for reduce greenhouse effect gases responsable of climate warming. They also mention the huge challenge that international community must face, and specially democratic countries, to improve the situation.

In the analysis of the determinants of environment quality, political determinants received relatively less attention than economic factors. As shown in table (1), the simple correlation between an index of democratic instutions and environment quality is positive but weak over the period 1960-2008. Thus it comes as no surprise that literature on this topic finds mitigated results. Indeed, some authors find that democratic institutions favour environment protection whereas others conclude to a negative effect. On nineteen empirical studies (table (2)), six uncovers a negative association between democracies and environment quality, nine find a positive association and the remaining four are inconclusive. However, a limit of these papers is that they don't explicitly identify channel transmissions of democratic institutions on environment quality. Indeed, findings that democracy has a mitigated partial effect on environment quality may hide the fact that it entails both costs and benefits. Identifying and specifying the channel transmissions from democratic institutions to environment protection will allow a better understanding of environmental costs and benefits of democratic institutions.

This paper aims at analysing the effect of democratic institutions on environment quality and at identifying channel transmissions. The main contribution of this paper is that we identify and test some channels by which democratic institutions affect the environment quality. We identify and test two channel transmissions : income inequality and investments. We use panel data from 1960 to 2008 for 122 countries and three modern econometric methods that are one-step GMM-System, two-step GMM-System one step and fixed effect estimators. Our results show that democratic institutions have opposite effects on environment quality: a positive direct effect on environment quality and a negative indirect effect through

investments rate and income inequality. Indeed, democratic institutions attract investments that hurt environment quality. They also hurt environment quality because they reduce income inequality.

The plan of the paper is as follows. The next section outlines the arguments on the relation between democratic institutions and environment quality and discusses on previous empirical findings. In section 3, we identify potential channel transmissions between democratic institutions and environment quality. Section 4 derives estimating equations and shows empirical results and the last is devoted to the conclusion.

2. Effect of Democratic institutions on environment quality

The relation between democratic institutions and environment quality has been studied. Some authors conclude that democratic insitutions favour environment protection whereas others find negative effect.

2.1. Theoretical arguments

2.1.1. Democracy improves environment quality

According many authors, democracy is vertious and has a positive effect on environment quality. Payne (1995) argues that population, in democratic countries, are free to collect information about environment quality. They can express their preferences and put pressures on their governments. With democacy, citizens are more aware of environment problems (freedom of media). They can also express their preferences for environment (freedom of expression) and create lobbying groups (freedom of association). Political leaders are prompted (rights to vote) to implement environmental policies at national and international levels. McCloskey (1983) and Payne (1995) put on relief an important ability of democratic countries to satisfy people's environmental préférences and their will to commit themselves to international negotiations and agreements. Economics models (Page and Shapiro (1983)) about the link between public and political decisions suggest that when people is well informed about major problems, the latter are widely influenced. In autocratic regimes, populations cannot access information and create lobbying groups.

Deacon (1999) and Olson (1993) argue that political freedoms are in favour of environmental protection because non democratic regimes will under produce environment considered as a public good. According to them, autocratics regims are led by political elites who monopolize and hold large share of national incomes and revenues. The implementation

of rigorous environmental policies can lower the levels of production, income and consumption, which, in turn impose a higher cost on the elite in an autocracy than on the population whereas the marginal benefit is uniform for both elite and population. Elites in an autocracy are therefore relatively less pro-environment than people in democracy.

According to Acemoglu and Robinson (2006), in democratic countries, the majority of citizens have right to vote, to their preferences and the government is supposed to represent that in economic policies. As the preferences of median voter are important in democratic elections and its marginal cost of the implementation of environmental policies is lower than autocratic leaders, the adoption and implementation of environmental policies will prevail in democratic countries. The leaders in the preservation of biodiversity or fighting of climate change would be models for other countries.

Congleton (1992) analyses the effect of political regimes (democratic or autocratic) on environmental policies. He supposes that temporal short horizon contributes to a weak regulation of environmental policies. As the consequences of environment degradation appear on the long term, political leaders can have myopia behaviour and under produce environment. Indeed, the short duration of electoral cycles incites political leaders to adopt economical politics favourable to their re-elections. It is difficult to implement policies and to impose to population who are also voters, a change of behaviour on problems which the consequences will be at the future.

2.1.2. Democracy hurts environment quality

Many authors think that democracy does not favour environment protection. The implementation of democratic institutions comes with individual freedoms. Desai (1989b) thinks that democracy doesn't protect environment because democracy is a factor of economic growth and prosperity, which hurt the quality of environment. Democracy is also correlated with factors such as property rights and social infrastructures that boost economic growth.

Firstly, Hardin (1968) worries about the management and overexploitation of environmental and natural resources. The property rights of environmental and natural resources (for example air, oceans, forests) are not well defined. This overexploitation is accelerated in democracies in which individuals have business and economic freedom.

Secondly, Paehlke (1996) thinks that the nature of environment and democracy are different. Environment is a global phenomena whereas democracy works on national and local levels. Consequently, environmental problems could not be resolved in an adequate and opportune way. For example, Heilbrunner (1974) supports the idea that global growth of population threatens environmental quality. Autocratic countries can restrain demographic dynamic while democratic countries must respect people freedoms.

Moreover, Dryzek (1987) notices that democracies are also economic markets wherein lobbying groups are very important. According to him, there are many countries where political leaders are influenced by lobbying groups and multilateral companies. Democracies are not considered as protecting environment quality as they are supposed to satisfy the preferences of markets and lobbying groups which aims at maximizing their economic profit that is not in favour of a better environment quality.

Finally, we think that when democracy is established, institutions becomes more complex and rigid. So, Olson (1982) and Midlarsky (1998) claim that lobbying groups are partially responsible for the rigidity of institutions in mature democracies. In other words, in mature and democratic countries, the supply of public goods could be reduced by an important number of lobbying groups which are less or not incited to take care of society interests. They can try to influence or to control legislative and administrative process. Consequently, public policies could be less favourable to environment quality when they are influenced by lobbying groups.

Theoretical arguments show that it's difficult to predict the impact of democratic institutions on environmental quality. Let us now turn to the empirical findings.

2.2. Empirical results

Congleton (1992) is one of the earliest scholars who explored the effect of political institutions on the willingness of governments to control environment quality. He uses ordinary least squares (OLS) regressions and finds that democratic countries have higher methane and Chlorofluorocarbon (CFC) emissions than autocratic countries. He also finds that they are more likely to sign the Vienna Convention and the Kyoto Protocol.

Contrary to him, Barret & Graddy (2000) use panel data (with generalized least squared and random effect) and conclude that political and civic freedoms reduce some pollutants (Sulfur dioxide) but have no effect on other pollutants (water pollution). Torras & Boyce (1998),

using the same data and OLS, also find that political and civic freedoms have a positive effect on air and water quality in least developing countries. Scruggs² (1998) finds that democracy has no effect on environment quality (dissolved oxygen, fecal coliform and particules emissions) but increases sulphur dioxide emissions.

Gleditsch & Sverdrup (2003) run simple bivariate correlations with Polity data and find that democracy is harmful for climate gases. Midlarsky (1998) runs multivariate OLS regressions and concludes that democracy increases carbon dioxide emissions and deforestation but protect land area.

Li & Reuveny (2006), using a large sample (between 105 and 143 countries), show that democracy (continuous and dichotomous variables) reduces environmental degradation (carbon dioxide emissions, nitrogen oxide, land degradation, deforestation, organic pollution in water). They also indicate that the effect of democracy varies in size across the five environmental indicators.

3. Democratic Institutions and environment quality : potential channel transmissions

In this section, we identify the potential transmission channels between democratic institutions and environment quality.

3.1. Democratic institutions and income inequality

An important characteristic of democracy is the right to vote. Indeed, an exclusion of an important part of population leads to a bias in political leaders's preferences. Many authors assert that an improvement of democratic institutions increases the possibilities of people to ask for a better distribution of income (Boix, 1998). As they are democratically elected, democratic leaders are incited to adopt redistribution policies such as minimum wage, prices subsidy and progressive taxation for the poor and middle classes. In other words, democratic process is supposed to reduce income inequality. On the contrary, autocratic leaders will tend to adopt policies that are in favour of the elite in powers and maintain consequently, they maintain income inequality.

Scully (1992) shows that countries where property rights and political openness exist, are less inequalitarian than countries where they aren't implemented. Using a transversal analysis for 126 countries over 1960-1998, Gradstein et al. (2001) show that the effect of

² He always uses Freedom House data.

democracy on income inequality depends on ideology that is the dominant religion in the country. So in Judeo-Christian societies, democracy is a factor of reduction of income inequality while it has no effect in Muslims and Confucian societies. In these countries, equity is a social value really important and income transfers are made in an informal way (family for example). Muller and Stratmann (2002) show that a high rate participation of citizens in the elections, affects the government policies, what tends to reduce income inequality. This income inequality reduction is made through income transfers or the size of government (spendings). Reuveny and Li (2003) also conclude that democracies have a positive effect on income distribution.

3.2. Democratic institutions and investments

In the analysis on the relation between democratic institutions and investments, there are two opposing trends. One concludes that democratic institutions reduce investments and the other one, they increase them.

According to Huntington and Dominguez (1975), in democracy, people have to choose between consumption and saving, but tend to be in favour of the latter. Indeed, democracy allows the median voter to redistribute the revenues in favour of the poor what reduces saving and investment. Some authors such as Alesina and Rodrik (1994) think that democracy can allow expropriation of physical capital by the median voter if his income is lower than average income or if he has greater political rights.

However this point of view is questioned by other authors who think that political institutions favour investments. Firstly, the establishment of a political democratic system requires a broad social consensus allowing the political process to be more stable and more efficient than autocratic regimes. Economic agents would also be more incited to invest in democratic countries than in autocratic countries wherein social consensus is low. Helliwel (1994), Pastor and Hilt (1993), Pastor and Sung (1995) conclude that democratic institutions have positive effect on private investments.

Moreover, democratic regimes are also politically stable so they attract investments. In political instability, economic agents consume more and reduce saving. Moreover, political instability is also a factor of uncertainty because it increases risks and/or perception of investment risks. Its reduces rights and safety of investors. Yi (2001) shows that political freedoms increase investments while uncertainty and political instability reduce them.

4. Empirical Analysis

4.1. Estimation method and empirical procedure

4.1.1. Empirical Procedure

The objective of the paper is to analyse the effect of democratic institutions on environment quality and also to identify potential channel transmissions. We think that one hand democratic institutions have direct effect on environment quality and other part, indirectly through income inequality and investments.

Our empirical procedure follows three steps. In first step, we estimate carbon dioxide per capita emissions on democratic institutions and control variables without channel transmissions. Control variables are from environment economic littérature and are determinants of carbon dioxide per capita emissions. There are income per capita, carbon dioxide per capita at the beginning of period, population growth and trade openness.

$$\text{Log}(e_{i,t}) = \alpha_i + \beta \text{Institutions} + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

With $e_{i,t}$ the average quantity of carbon dioxide per capita (in ton metric) in a country (i) at a year t ; $x_{i,t}$ are control variables without transmission channels; *Institutions* is our interest variable. The period is 1960 to 2008 and data are compiled in five-year averages. Our sample is made of 122 developed and developing countries.

In a second step, we include in the equation (1) the channel transmissions variables allowing democratic institutions to affect indirectly environment quality. There are income inequality and investments.

$$\text{Log}(e_{i,t}) = \alpha_i + \delta \text{Institutions} + \beta TC_{i,t}^j + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (2)$$

In a last step, we empirically test the effect of democratic institutions on each transmission channel.

$$TC_{i,t}^j = \alpha_i + \beta \text{Institutions} + \gamma_t + \varepsilon_{i,t} \quad (3)$$

With TC^j a vector of channel transmissions : income inequality and investments.

4.1.2. Econometric method

In order to estimate this model we use adequate econometric techniques. The panel data take into account transversal, temporal dimensions observed and unobserved heterogeneity of countries. It is inadequate to estimate equations (1) and (2) using respectively OLS (Ordinary Least Square), Fixed Effects (FE) and/or Random Effect (RE) because the former (OLS) doesn't take into account unobserved heterogeneity of countries and the latter (FE, RE) is inadequate for dynamic models. Indeed, the dependant variable is lagged and endogenous. We use the GMM-System (Generalized Method of Moment) from Arellano-Bond (1991), Arellano-Bover (1995) and Blundell-Bond (1998).

The GMM-System (Generalized Method of Moment) is a method that estimates a system of two equations: one equation in level and the other in first difference. In the first estimate, we use lagged variables in level of at least one period as instruments of the equation in first difference. It removes unobserved time invariant and unobserved individual characteristics. The conditions to be met are the error terms are uncorrelated and that explanatory variables are weakly exogenous. In the second estimate, we use variables in first difference lagged of at least one period as instruments of the equation in level.

To check the validity of results we use the standard Hansen test of over-identifying restrictions (where the null hypothesis is that the instrumental variables are not correlated with the residual) and the serial correlation test (AR(2), where the null hypothesis is that the errors exhibit no second-order serial correlation).

4.2. Determinants of carbon dioxide per capita emissions

We refer to the literature on environmental economics and identify determinants of carbon dioxide per capita emissions. There are income per capita, trade openness, population growth and carbon dioxide at the beginning of period.

Carbon dioxide per capita at the beginning of period.

In our opinion, we think that carbon dioxide per capita at the beginning of period can be an important determinant of current level of carbon dioxide per capita. It takes into account the inertia degree of pollution and time necessary to implement environment policies or to reduce air pollution.

Income per capita

The relation between income per capita and environment quality has been widely studied in literature. The debate focused on the existence and the pertinence of environmental Kuznets curve (EKC). EKC supposes that environment quality deteriorates initially with income per capita until an given level and improves. This hypothese has been validated for some pollutants such as sulfur dioxide, carbon monoxide, nitrogen oxides (Grossman and Krueger (1995), Selden and Song (1994), Shafik (1994), Suri and Chapman (1998) and Bimonte (2002). For other pollutants such as carbon dioxide, results are mixed or contradictory. Indeed, Holtz-Eakin and Selden (1995) don't validate the EKC while Schmalensee et al. (1998) do.

Trade openness

Grossman and Krueger (1995) decompose the effects of trade on environment into scale, technical and composition effects. The scale effect of trade measures the negative environmental consequences of scalar increases in economic activity. The technical effect is the positive environmental consequences of increases in income that call for cleaner production methods. The composition effect can have a positive or negative impact on the environment because it measures the evolution the economy towards a more or less appropriate productive structure. Thus, Antweiler and Ai (2001) conclude that trade reduced emissions of pollution of 43 countries over the period 1971-1996. Frankel and Rose (2005) also conclude that trade is favourable to the reduction of pollution. However, other authors such as Managi (2004) conclude that trade has a negative impact on carbon dioxide emissions.

Population growth

Many authors analyse the effect of growth and the level of population on environment quality. According to National Academy of science (NAS, 1992), "The more people there are in the world, the greater is the demand put on resources to provide food, energy, clothing and shelter for them. All these activities necessarily involve emissions of greenhouse gases". Newell & Marcus show there is a "nearly perfect" correlation (99,8%) between world population growth and growing concentration of carbon dioxide over the period 1958-1983. Holdren (1991) and Harisson (1994) use mathematical formula to find a contribution of population growth to greenhouse gas emissions. They conclude that population growth is responsible for 40% (36%) of the increase in energy consumption (annual emissions growth) respectively. However Lutz (1993) found that population growth has a small role in industrial carbon

dioxide emissions. They also show that population growth rate has a positive effect on pollution.

Investments

According to Brock&Taylor (2004), a high investment rate leads to high physical capital stock at regular state and increases carbon dioxide per capita emissions during transitional dynamic. Investments are the motor of economic growth. Foreign and domestic investments allow countries to access international markets, trade, new technologies and competences. However these opportunities can differ with countries development.

In some countries, investments are directed towards building, services and manufacturing sectors. In other countries, they are directed towards natural resource sectors in particular, oil firms, wood companies, big consumers of energy and thus pollutants. For example in Africa, 65% of direct foreign investments go to the natural resources sector. The expected effects are a rise of employment, a rise of taxes, a rise of revenues for the states and the reduction of poverty. These countries can also be less sensitive to environmental problems. In the same way, the weakness of infrastructures, particularly roads, strongly increases the use of energy and consumption of polluting resources.

Income inequality

Many scholars such as Boyce (1994), Marsiliani& Renström (2000), Borghesi (2000) have analysed the effect of income inequality on environment quality. Some authors conclude that income inequality favours environment protection whereas others find negative effect.

Firstly Boyce (1994) develops theoretical arguments that income inequality increases environment degradation through the rate of time preference and the benefit-cost analysis of environmentally degrading activities. As to the first point, Boyce (1994) thinks that income inequality reduces awareness of environment quality for both rich and poor. The poor would overexploit natural and environmental resources because of survival motivation. Similarly, rich people will not also protect the environment quality. Income inequality increases and exacerbates conflicts in income distribution and political instability. The polarization of resources and incomes causes violence and social trouble. This leads rich people to prefer a policy of overexploiting the environment and natural resources and investing the returns abroad.

Secondly, political power is highly correlated to income inequality. Rich people are likely to have political power and to influence environmental policies. The implementation of

environmental policies are based on cost-benefit analysis ie the competition between people who benefit from the environment destruction and those who bear the cost of it. Therefore Boyce (1994) concludes that income inequality affects the distribution of power and allows people who benefit from activities that degrade the environment (the rich) to impose environmental cost on the losers.

Thirdly, Borghesi (2000) argues that the implementation of environmental policies is likely with social consensus. It is easier to get this consensus in an equal society than in an unequal society with conflicts among political agents and social instability.

Several empirical studies have found that income inequality degrades environmental quality. Magnani (2000) finds that reductions in pollution are more likely if a country's economic growth is accompanied by improvements in income equality. In a study of tropical countries, Koop and Tole (2001) conclude that inequalities of income and landownership tend to exacerbate deforestation. Mikkelsen *et al.* (2007) and Holland *et al.* (2009) find income inequality to be a statistically significant predictor of biodiversity loss.

However other scholars think that income inequality may have no effect or improve environment quality.

Firstly Ravallion *et al.*(2000) claim that the impact of income distribution on environmental degradation depends on the marginal propensity to emit (MPE). According to them, each agent has an implicit demand function for air pollution (carbon dioxide) since the consumption of every good pollute the environment quality either directly (via consumption) or indirectly (via its production). If the poor have a higher (lower) MPE than the rich a reduction of income inequality will increase (reduce) pollution emissions respectively. One can't say a priori which of these two effects will happen. On the one hand, the poor may consume goods with more pollution than the rich. On the other hand they can use energy more efficiently than the rich. Therefore the effect of income inequality is not clear and depends on whether the marginal propensity to emit increases or decreases as income grows. In other words it depends on the second derivative of the the pollution-income function.

Secondly, Boyce (2003) shows that income distribution affects the demand for environmental quality. At any given level of average income, an increase in income inequality means the rich become more rich and the poor more poor. He supposes that the environment is a normal good ie the income elasticity of demand for environmental quality is positive. An increase in income inequality increases the demand for environmental quality of the rich and decreases the demand of the poor. The net effect on demand for environmental quality is ambiguous and is function of the shape of the demand-income relation. If the relation is linear or demand for

environmental quality increases with income at a constant rate, an increase in income inequality will have no effect on the demand for environmental quality. If the demand-income relation is convex (concave) income inequality reduces (improves) environmental quality.

4. 3. Overview of the Data

The time period under study is 1960-2008 for 122 developed and developing countries. Our panel data are time period corresponding to five-year averages (1960-1964, 1965-1969,...). The data on carbon dioxide per capita, investments, trade openness, population growth and income per capita are from World Development Indicators (2008). Those on democratic institutions and income inequality come from Polity IV (2008) and Texas Inequality Project (UTIP 2008) database.

The carbon dioxide per capita emissions are measured in metric ton per capita and are estimated from the combustion of fossil energies, cement industries in the liquid, solid or gas form. Trade openness and investment correspond respectively to the share of the sum of (exports and imports) and investments in gross domestic product (GDP).

As democratic institutions, we chose the index of polity(2), which is a score obtained by differencing of the index of democracy and index of autocracy on a scale going from +10 (democracy) to -10 (autocracy). The indicator of democracy is characterized by the effective existence of institutional rules framing of the power and the presence of institutions enabling citizens to express their expectations and choose political elites. The autocracy is characterized by the absence or the restriction of political competition, economic planning and control. The exercise of the power is slightly constrained by institutions and the leaders are only selected within a “political elite”.

Income inequality is a GINI coefficient. It comes from Texas Inequality Project (UTIP 2008) database. We use EHII (Estimated Household Income Inequality) variable that is an index ranging from 0 (no inequality) to 1 (perfect inequality) and is based on database of Deninger and Squire (D&S) and UTIP-UNIDO.

The first column of table 1 correlates carbon dioxide per capita with the explicative variables such as democratic institutions, income inequality, Investments, income per capita, population growth and trade. The signs of these correlations are consistent with our priors. For example carbon dioxide per capita emissions are positively correlated with investments, democratic institutions and negatively with income inequality, income per capita and population. The second column contains the correlations between democratic institutions and variables such as channel transmissions (income inequality and investments). Analysing the democratic

institutions- channel and channel –carbon dioxide per capita correlations together (column 1 and column 2), we have an outline of the direction of channel effects. Indeed democratic institutions are positively correlated with investments and investments are positively correlated with carbon dioxide per capita implying that democratic institutions is positively correlated with carbon dioxide per capita positively through investment. The same analysis can be made with income inequality. However to confirm or reject correlation results, it is better to estimate our equations and control for other determinants of carbon dioxide per capita emissions.

Table 1 : Correlation matrix for variables

| | C02/ capita | Democratic Institutions | Income Inequality | Investment | Income /capita | Population | Trade |
|----------------------------|----------------|----------------------------|-------------------|------------|-------------------|------------|--------|
| C02/ capita | 1.0000 | | | | | | |
| Democratic Institutions | 0.2787 | 1.0000 | | | | | |
| Income Inequality | -0.2577 | -0.3898 | 1.0000 | | | | |
| Investment | 0.1153 | 0.0492 | 0.2643 | 1.0000 | | | |
| Income/ capita | -0.0050 | -0.0235 | -0.0256 | 0.2497 | 1.0000 | | |
| Population | -0.1364 | -0.5537 | 0.4609 | -0.1123 | -0.0255 | 1.0000 | |
| Trade | 0.1468 | 0.0406 | -0.0338 | 0.2648 | -0.0742 | -0.0922 | 1.0000 |

Source : Author

4.4. Résultats

Table (4) shows results of equation (1) estimated by GMM-System. An improvement of democratic institutions contributes to a reduction of carbon dioxide per capita. The effect is high (-0,015) and significant at 5%. These results are similar to previous studies that conclude that democratic institutions improve environment quality. There are also robust with the inclusion of control variables such as income per capita, population growth and trade openness. Trade openness and income per capita have positive effect on air pollution.

Table4 : Effect of Democratic institutions on Carbon dioxide per capita emissions

| Log of carbon dioxide per capita emissions GMM-System | |
|---|--------------------|
| Log of initial carbon dioxide per capita | 0.936 (5.09)*** |
| Log of Democratic Institutions | -0.015 (2.01)** |
| Log of income per capita | 0.01 (0.14) |
| Population growth | -0.015 (0.42) |
| Log of Trade openness | 0.08 (1.13)* |
| Constant | 0.23 (0.90) |
| Observations | 887 |
| Number of countries | 122 |
| AR (1) | 0.001 |
| AR(2) | 0.464 |
| Hansen Test | 0.18 |
| Number of instruments | 12 |

NB: * significatif à 10%; ** at 5%; *** at 1%. The study period is 1960-2008. Temporal dummies are included.

Table (5) shows results of equation (2) estimated by GMM-System. We estimate the effect of democratic institutions on carbon dioxide per capita emissions, control variables including channel transmissions : investments and income inequality.

Table5 : Effect of democratic institutions on environment quality

| Log of carbon dioxide per capita emissions (One step GMM-System) | (1) | (2) | (3) |
|---|--------------------|---------------------|---------------------|
| Log of initial carbon dioxide per capita | 0.936 (5.09)*** | 0.59 (3.15)*** | 0.903 (19.83)*** |
| Log of Democratic Institutions | -0.015 (2.01)** | -0.043 (2.83)*** | -0.198 (2.11)** |
| Log of income per capita | 0.01 (0.14) | 0.015 (1.04) | -0.019 (2.07)** |
| Population growth | -0.015 (0.42) | -0.175 (1.76)* | -0.025 (0.67) |
| Log of Trade openness | 0.08 (1.13)* | 0.156 (1.32) | 0.119 (1.01) |
| Log of investment | | 0.80 (2.84)*** | 0.495 (2.85)*** |
| Inégalité de revenus | | | -0.021 (2.32)** |
| Constant | 0.23 (0.90) | -2.57 (1.38) | -0.238 (0.28) |
| Observations | 887 | 823 | 577 |
| Number of countries | 122 | 122 | 117 |
| AR (1) | 0.001 | 0,006 | 0,01 |
| AR(2) | 0.464 | 0,67 | 0,10 |
| Hansen Test | 0.18 | 0,27 | 0,28 |
| Number of instruments | 12 | 19 | 27 |

NB: * significatif à 10%; ** at 5%; *** at 1%. The study period is 1960-2008. Temporal dummies are included.

Column (2) shows results of equation (2). Investments have a positive and significant effect on carbon dioxide per capita emissions. Indeed, a 1% increase in investment contributes to carbon dioxide per capita by 0,80%. Investments are also an important factor of air pollution. The coefficient of democratic institutions is increased between column (1) (-

0,015) and (-0,043) in table (5). In column (3), we include income inequality in estimation. Results indicate that an increase of income inequality reduces pollution emissions. The inclusion of investments and income inequality improve the magnitude and the significance of the coefficient of democratic institutions on carbon dioxide per capita emissions.

Results also indicate that democratic institutions have both direct and indirect effect on environment quality. Indeed, an increase of magnitude and coefficient of democratic institutions (column (1) to column (3)) would indicate that they have a partial effect through investments and income inequality. It would also be very important and interesting to test the existence of these two potential channel transmissions.

4.4.1. Effect of democratic institutions on channel transmissions

Our results seem to indicate that democratic institutions have both direct and indirect effect through income inequality and investments on environment quality. In this section, we test the existence of these two channel transmissions. In equation (3.a & 3.b) respectively, we estimate democratic institutions on income inequality and investments.

$$\text{Income Inequality}_{i,t} = \alpha_i + \beta_1 \text{Institutions}_{i,t} + \gamma_t + \delta X_{i,t} + \varepsilon_{i,t} \quad (3.a)$$

$$\text{Investment rate}_{i,t} = \alpha_i + \beta_2 \text{Institutions}_{i,t} + \delta X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (3.b)$$

With $X_{i,t}$: income per capita, population growth and trade openness.

Column (1) of table (6) shows result of equation (3.a) estimated with fixed effects (FE) method. Democratic institutions have a positive effect on investments. Our results are similar with Yi (2001) who conclude that political freedoms (democratic freedoms) attract investments.

Similarly, column (2) shows results of equation (3.b) estimated with fixed effects (FE). Results show that democratic institutions have a positive effect on income inequality. However we suspect an inverse relation (endogeneity problem) between income inequality and democratic institutions. Firstly, income inequality increases and exacerbates conflicts in income distribution and political instability. The polarization of resources and incomes causes violence and social trouble. This situation can allow illegal activities, protest movements and coup d'Etat (Figueroa, 1996). Secondly, Acemoglu and Robinson (2006) show that income inequality reduce strongly the consolidation of democracies. One argument is that it facilitates and allows a redistribution of incomes in favour of the poor and disfavour of rich in power.

The burden of democracy on the elites is increasing in the income gap between them and citizens. They would have an incitative to destablize democracy. Latin America is an example wherein income inequalities do not allow democracy to consolidate. Estimation results is biased. To solve the problem of endogeneity, we use GMM-System allowing us to instrumente democratic institutions with lagged variables.

Column (3) conclude that democratic institutions reduce income inequality. Thus democracy allows the poor to get more resources through income redistribution. Result is similar with authors such as Boix (1998), Muller and Stratmann (2002). Muller and Stratmann (2002) show that a better participation of citizens in elections (from 40% to 80%) reduces income inequality (Gini Index) in 10%. The reduction of income inequality is explained by income transfers or by government size (expenditure).

Table 6 : Democratic Institutions and channel transmissions

| | Log of investment (1) FE | Income Inequality | |
|--------------------------------|-----------------------------|----------------------|--------------------|
| | | (2) FE | (3) GMM System |
| Log of Democratic Institutions | 0.037 (1.90)* | 0.380 (1.26)* | -1,29 (-2,31)** |
| Log of income per capita | 0.075 (1.81)* | -2.274 (3.51)*** | -0,385 (2.19)** |
| Population growth | 0.059 (3.24)*** | -0.047 (0.23) | 1.760 (4.18)*** |
| Log of Trade openness | 0.290 (7.09)*** | 0.529 (0.85) | 4.978 (1.73)* |
| Constant | 1.014 (2.50)** | 60.348 (10.22)*** | 25.297 (2.12)** |
| R-squared | 0.15 | 0.25 | |
| Observations | 662 | 663 | 663 |
| Number of countries | 122 | 122 | 122 |
| AR (1) | | | 0,18 |
| AR(2) | | | 0,23 |

| | |
|-----------------------|------|
| Test Hansen | 0,13 |
| Nombre of instruments | 11 |

NB: * significatif à 10%; ** at 5%; *** at 1%. The study period is 1960-2008. Dummy variables are included.

Results indicate that democratic institutions have a positive (negative) effect on investments and income inequality respectively. Democratic institutions also affect environment quality indirectly through investments and income inequality.

Indeed, democratic institutions attract investments that hurt carbon dioxide per capita emissions. We can conclude that democratic institutions increase pollution emissions through investments. Similarly, democratic institutions hurt environment quality because they reduce income inequality. Then democratic institutions have opposite effect on environment quality: a positive direct effect on environment quality and negative indirect effects through investments and income inequality. In other words, on one hand democratic institutions improve environment quality and other part, they hurt it through income inequality and investments.

4.4.2. The importance of economic development

According to economic development, democratic institutions and environment quality (air pollution) are different. In this section, we distinguish two groups of countries that are developing countries and developed countries and analyse the effect of democratic institutions on environment quality. The results shown in columns (1) and (2) of table (7) indicate that democratic institutions in both groups have a direct negative effect on environment quality. The direct effect of democratic institutions on environment quality in developed countries is higher than in developing countries. This can be explained by the fact that the quality of democratic institutions are better in developed countries than in developing countries.

4.4.3. Sensitivity analysis

4.4.3.1. The environmental kuznets curve

Estimations show that income per capita reduces carbon dioxide per capita emissions. We test the existence of environmental kuznets curve by including the squared income per capita. Results (column 3, table7) conclude that the hypothese of environmental kuznets curve isn't verified.

Table (7) : Effect on democratic institutions on environment quality (sensitivity tests)

| Log of carbon dioxide per capita (One step GMM-System) | (1) Developing Countries | (2) Developed Countries | (3) | (4) |
|--|-----------------------------|----------------------------|---------------------|---------------------|
| Log of initial carbon dioxide | 0.836 (15.06)*** | 1.056 (5.21)*** | 0.905 (20.01)*** | 0.887 (20.45)*** |
| Log of Democratic Institutions | -0.189 (1.92)** | -0.252 (3.92)*** | -0.204 (2.16)** | -0.152 (2.17)** |
| Log of income per capita | -0.020 (1.54) | -0.017 (0.52) | -0.047 (1.90)* | -0.015 (1.90)* |
| Population growth | -0.049 (1.68)* | -0.080 (1.72)* | -0.028 (0.73) | -0.016 (0.64) |
| Log of Trade openness | 0.227 (1.61) | -0.321 (1.56) | 0.106 (0.93) | 0.083 (0.82) |
| Log of investment | 0.553 (2.57)** | 0.698 (2.47)** | 0.491 (2.81)*** | 0.494 (3.15)*** |
| Income inequality | -0.011 (2.22)** | -0.018 (1.70)* | -0.021 (2.32)** | -0.018 (2.20)** |
| Income per capita squared | | | 0.002 (1.14) | |
| Form of democratic government | | | | 0.027 (0.71) |
| Constant | -1.231 (1.30) | -0.571 (0.76) | -0.048 (0.05) | -0.401 (0.55) |
| Observations | 406 | 171 | 577 | 568 |
| Number of codepays | 90 | 27 | 117 | 115 |
| AR(1) | 0.001 | 0.09 | 0.01 | 0.01 |
| AR(2) | 0,13 | 0.32 | 0.10 | 0.12 |
| Hansen Test | 0,44 | 0.70 | 0.27 | 0.22 |
| Number of instruments | 17 | 17 | 18 | 23 |

NB: * significatif à 10%; ** at 5%; *** at 1%. The study period is 1960-2008. Temporal dummies are included.

4.4.3.2. The form of democratic system

We find that democratic institutions have a direct positive effect on air quality. In democratic institutions there are different forms of government : presidential and parliamentary. Does the form of democratic government affect environment quality ? Indeed recent research on the provision of public goods such as environment argues that the form of government in democratic political systems is an important factor. Persson et al. (2000) think that presidential system would underproduce public goods because legislative coalitions are unstable and leaders promote the allocation of spending to powerful minorities. Parliamentary system would increase spending on public goods and satisfy the majority of voters. However, Bueno de Mesquita et al. (2003) develop selectorate theory and show that presidential system would produce more public goods (prosperity, peace, transparency, political rights, and civil liberties) than parliamentary system. Results are mixed for public goods such as such as education, health care, social security, and foreign policy. Bernauer & Koubi (2008) also find that presidential system reduce sulfure dioxide emissions more than parliamentary system. We include in our analysis a index of the type of democratic system. It is a trichotomous variable that takes the value of 0 for presidential democracies ; 1 for assembly-elected president democracies and 2 for parliamentary democracies.

Results (column 4, table7) indicate that the form of democratic system have no effect on environment quality. Results are robust.

4.4.3.3. Econometric method

For estimations, we used one-step Generalized Method of Moments (GMM-system). We re-estimate our equations using two step GMM-system because two step GMM-system estimator is more efficient than one-step GMM-system estimator even if their standards errors can be severely downward biased in small sample. This potential bias is solved by the method of correction (Windmeijer (2005)) of covariance matrice in finite sample. Results are in table 4. We note that results (column8) are similar with those obtained by one-step GMM estimator and are robust.

Table 8 : Effect of Democratic institutions on environment quality

| Log of carbon dioxide per capita (Two step GMM-System) | (1) | (2) | (3) |
|---|---------------------|---------------------|---------------------|
| Log of initial carbon dioxide per capita | 0.816 (7.62)*** | 0.998 (14.57)*** | 0.912 (19.84)*** |
| Log of Democratic Institutions | -0.393 (3.54)*** | -0.222 (2.22)** | -0.13 (2.34)** |

| | | | |
|--------------------------|-------------------|--------------------|--------------------|
| Log of income per capita | 0.021 (1.16) | -0.004 (0.32) | -0.017 (1.70)* |
| Population growth | -0.080 (1.75)* | -0.010 (0.28) | -0.031 (0.99) |
| Log of Trade openness | 0.119 (1.19) | 0.022 (0.20) | 0.129 (1.13) |
| Log of investment | | 0.527 (3.50)*** | 0.443 (2.72)*** |
| Income inequality | | | -0.020 (2.29)** |
| Constant | 0.459 (0.92) | -1.001 (1.82)* | -0.137 (0.18) |
| Observations | 887 | 823 | 577 |
| Number of countries | 122 | 122 | 117 |
| AR (1) | 0,01 | 0,01 | 0,008 |
| AR(2) | 0,72 | 0,94 | 0,11 |
| Hansen Test | 0,13 | 0,27 | 0,30 |
| Number of instruments | 14 | 23 | 17 |

NB: * significatif à 10%; ** at 5%; *** at 1%. The study period is 1960-2008. Dummy variables are included.

Alternative empirical tests show that results are not affected by the inclusion of income per capita squared, the form of democratic government and the use of two-step GMM-system. Democratic institutions have opposite effect on environment quality: a positive direct effect on environment quality and negative indirect effects through investments and income inequality. In other words, on one hand democratic institutions improve environment quality and other part, they hurt it through income inequality and investments.

5. Conclusion

This paper aims at analysing the effect of democratic institutions on environment quality and at identifying channel transmissions. We use panel data from 1960 to 2008 for 122 countries and three modern econometric methods that are one-step GMM-System, two step GMM-

System and fixed effect estimators. Our results show that democratic institutions have opposite effect on environment quality: a positive direct effect on environment quality and negative indirect effects through investments rate and income inequality. Indeed, democratic institutions attract investments that hurt carbon dioxide per capita emissions. We can conclude that democratic institutions increase pollution through investments. Similarly, democratic institutions hurt environment quality because they reduce income inequality. In other words, on one hand democratic institutions improve environment quality and other part, they hurt it through income inequality and investments.

Results are robust with alternative econometric method such as two-step GMM-system and the inclusion of variables such as income per capita squared, the form of democratic government. The positive effect of democratic institutions show they allow people to more conscious of environmental problems. Democratic institutions are also responsive to the demand of people by reducing income inequality and increasing investments that favour economic growth. The negative effect on environment quality through income inequality and investments put highlights some important factors explaining free riding behaviour of some democratic countries. Our empirical analysis also indicates that democracy don't "works" through the form of democratic government: controlling for the form of democratic government, democratic institutions have a direct positive impact on environment quality. Our results suggest policy implications. They suggest an improvement of democratization process in countries (specially developing countries) allowing a high awareness of people. Countries should also find ways to reduce the indirect negative impact of democratic institutions on environment quality (for example the implementation of ecologically appropriate investments).

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List of countries included in the sample

Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Belgium, Burundi, Benin, Bangladesh, Burkina-Faso, Bulgaria, Bahrain, Bolivia, Brazil, Botswana, Canada, Central Africa, Chile, China, Cote d'Ivoire, Cameroun, Congo, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Germany, Denmark, Ecuador, Egypt, Eritrea, Ethiopia, Spain, France, Finland, Fiji, Gabon, Ghana, Greece, Guatemala, Honduras, Haiti, Holland, Hungary, Indonesia, India, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Liberia, Libya, Luxembourg, Lesotho, Lithuania, Macedonia, Mexico, Madagascar, Mali, Mauritania, Malawi, Malaysia, Morocco, Moldova, Mongolia, Mozambique, Myanmar, Nigeria, Netherland, New Zealand, Niger, Nicaragua, Nepal, Norway, Pakistan, Panama, Peru, Philippines, New Guinea, Guinea, Poland, Portugal, Paraguay, Qatar, Romania, Russia, Rwanda, the United Kingdom, Saudi Arabia, Senegal, Sri Lanka, Sierra Leone, El Salvador, Sudan, Syria, Sweden, Switzerland, Tanzania, Togo, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, the USA, Uruguay, Venezuela, South Africa, Zambia, Zimbabwe.

Table 1 : Correlation matrix for variables

| C02/ capita | Democratic Institutions | Income Inequality | Investment | Income /capita | Population | Trade |
|----------------|----------------------------|-------------------|------------|-------------------|------------|-------|
|----------------|----------------------------|-------------------|------------|-------------------|------------|-------|

| | | | | | | | |
|-------------------------|---------|---------|---------|---------|---------|---------|--------|
| C02/ capita | 1.0000 | | | | | | |
| Democratic Institutions | 0.2787 | 1.0000 | | | | | |
| Income Inequality | -0.2577 | -0.3898 | 1.0000 | | | | |
| Investment | 0.1153 | 0.0492 | 0.2643 | 1.0000 | | | |
| Income/ capita | -0.0050 | -0.0235 | -0.0256 | 0.2497 | 1.0000 | | |
| Population | -0.1364 | -0.5537 | 0.4609 | -0.1123 | -0.0255 | 1.0000 | |
| Trade | 0.1468 | 0.0406 | -0.0338 | 0.2648 | -0.0742 | -0.0922 | 1.0000 |

Source : Author

Table2 : Papers studying the effect of democracy on environment quality

| Authors | Environment indicators | Results | Sample |
|-------------------------|--|-----------|---|
| Congleton (1992) | Methane per capita | + | 118 countries for 1989 |
| | CFC per capita | + | |
| Midlarsky (1998) | CO2 per capita | + | 98 countries i for 1990 |
| | soil erosion by water | + | 97 countries for the 1980s, |
| | % of annual deforestation | + | 77 countries from 1981 to 1990 |
| | % of protected land area | + | 100 countries in 1993 |
| | freshwater availability | No effect | 97 countries in 1990 |
| | the level of soil erosion by chemicals | No effect | 97 countries during the 1980s. |
| Barrett & Graddy (2000) | sulfur dioxide per capita | - | a pooled sample of countries for about 33 years |
| | water pollution | No effect | 45 countries for about 29 years. |
| Torras and Boyce (1998) | Air pollution (SO2, smoke, particulate emissions) | - | Samples of 19–42 countries from 1977 to 1991 |
| | Water pollution (dissolved oxygen, fecal coliform, access to safe water, and access to sanitation) | - | 58 countries from 1977 to 1991 |
| Scruggs (1998) | water pollution and particulate emissions | No effect | 148–185 sites in 24 countries three periods (1979–1982, |

| | | | |
|----------------------------------|---|---|--|
| | | | 1983–1986, and 1987–1990) |
| | SO2 emissions | - | |
| Gleditsch and Sverdrup (2003) | CO2 per capita | - | 108 countries in 1990 |
| Li & Reveuny (2006) | land degradation | - | 105 countries in the 1980s. |
| | Carbon dioxide emissions | - | 143 countries from 1961 to 1997 |
| | NOx emissions | - | 118 countries in 1990, time series cross sectional |
| Bernauer & Koubi (2009) | sulfur dioxide (SO ₂) concentrations | - | 42 countries from 1971 to 1996 |

Table3: Descriptive statistics

| | Average | Standard dev | Min | Max |
|---------------------------|----------------|---------------------|------------|------------|
| Carbon dioxide per capita | 4,04 | 6,69 | 0 | 76,16 |
| Democratic Institutions | 0 ,32 | 7,33 | -10 | 10 |
| Investment rate | 21,37 | | 2,53 | 86,79 |
| Income Inequality | 41,58 | 6,67 | 21.82 | 62,32 |
| Trade openness | 67,83 | | 2,35 | 466,31 |
| Population growth rate | 1,87 | 1,54 | -20,36 | 11,80 |
| Income per capita | 5147,74 | 7842,89 | 83,50 | 53653.35 |

Source: WDI (2008), Polity IV, University of Texas Inequality Project (UTIP) database (2008) and author

Table 9 : Définition and data sources

| Variabes | Définitions | Source de données |
|---------------------|---|--------------------------|
| Emissions of carbon | Carbon dioxide per capita (metric ton per | |

| | | |
|---------------------------------|---|--|
| dioxide per capita | capita) | Word Development Indicators (2008) |
| Emissions per capita initial | Carbon dioxide per capita at the beginning of each period | |
| Investment rate | Investment/PIB | |
| Trade openness rate | $(\text{Exportations} + \text{Importations}) / \text{Gross Domestic Product}$ | |
| Population growth rate | Population growth rate | |
| Democratic institutions | Combined score of democracy and autocracy on a scale going from -10 to 10. (- 10) large represents a big autocracy and 10, large democracy | Polity IV |
| Income Inequality | EHII (Estimated Household Income Inequality) variable is an index ranging from 0 (no inequality) to 1 (perfect inequality) | University of Texas Inequality Project (UTIP) database (2008) |