DEMOCRACY AND ENVIRONMENTAL QUALITY: ACCOUNTING FOR TRANSMISSION CHANNELS

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This paper contributes to the controversial literature on democratic institutions and environmental quality. Despite an extensive literature, studies have not focused on the transmission channels by which democracy affect environmental quality. Using panel data from 1960 to 2008 in 122 developed and developing countries, results are as follows: First democratic institutions have opposite effects on environmental quality: a positive and direct effect on environmental quality and a negative indirect effect through domestic investments and income inequality. Second, the positive effect of democracy on environmental quality is higher in developed countries than in developing countries.

Keywords: Democratic Institutions, Air Pollution, Panel Data, Income Inequality, Domestic Investments, Foreign Direct Investment (FDI), Trade
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1. INTRODUCTION

There is a presumption that institutions are determinants of economic development. The evidence suggests that rich countries are democratic, whereas many poor countries are not. Over the past two decades, the economic literature has analysed the link between institutional quality and economic performance. Two controversies are involved. First, several authors (Acemoglu et al., 2001; Glaeser et al., 2004; Hall and Jones., 1999) consider that institutions are the fundamental factor in explaining economic development. Indeed, they argue that the nature of property rights (Acemoglu and Johnson 2005), legal institutions (Levine, 1998) and labour market institutions (Besley and Burgess, 2004) have an effect on economic performance (production efficiency, investment, economic growth). However, other authors reject the primacy of institutions in economic development and highlight the importance of geography (Diamond, 1997; Sachs, 2003). According to them, geography[1] refers to the location,

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[1] It includes many elements, like a country's location in the world, climate, topography, natural resource endowments, size and population.

distribution and spatial organization of economic activities. Proximity to international markets reduces transport costs, improving the opportunities for countries to specialize in the activities in which they have comparative advantages and to access international technologies. Moreover, countries with a large population and agglomerations can have effective labour and product markets (Prager and Thisse, 2010). Firms can benefit from agglomerations because they are near to each other. They can access a large pool of suppliers, customers and labour, as well as benefiting from lower infrastructures costs. Consequently, Diamond (1997) and Sachs (2003) conclude that geography is the key determinant of economic development. A parallel stream of literature considers trade as a driver of income and productivity growth in the long term. Frankel and Romer (1999) show that trade has a positive effect on economic growth. They also show that their ability to trade is not entirely related to geographical factors but probably to institutions. Dollar and Kraay (2003) show that trade and institutions have a joint role in economic growth in the long term.

The emergence of natural resources and environmental protection often highlight institutional quality failure and poor governance methods. For instance, the institutional quality may influence the non-linear relationship between development and the environment. Bhattarai and Hammig (2001) and Culas (2007) find complementarity between the institutional factors and the environmental quality (forest sector policies). Moreover, Torras and Boyce (1998) show that pollution decreases with the quality of policies and institutions. At the international level, two additional problems appear. First, it is difficult to elaborate efficient and equitable systems for the management of local and global public goods (oceans and climate warming). Second, there are real and enormous problems in international cooperation between countries to protect global public goods fighting climate warming (the Summit of Copenhagen, 2009). Though scientists' reports emphasize that countries should act rapidly to reduce the greenhouse gases responsible for climate warming, they also mention the huge challenge that the international community must face, especially democratic countries, to improve the situation.

Political determinants deserve attention in the analysis of the drivers of environmental quality. Among the 40 highest carbon emitters internationally (cumulatively responsible for 91% of the total world emissions), the countries that have the best records are all democracies (Held and Hervey, 2010). The biggest polluters are also the countries with the highest scores for the quality of institutions. However, there is a correlation. Moreover, the literature on the link between democratic institutions and environmental quality has found mitigated results. Some authors (Barrett and Graddy, 2000; Bernauer and Koubi, 2009; Li and Reuveny, 2006) find that democratic institutions improve environmental protection, whereas others (Congleton, 1992) conclude a negative or no effect.

From these two apparent paradoxes, the aim of this paper is to analyse the effect of democratic institutions on environmental quality. The main contribution of this paper is that the transmission channels from democratic institutions to environmental quality are

explicitly modelled. We identify and test four channels (trade openness, domestic and foreign direct investments and income inequality). We use panel data from 1960 to 2008 for 122 countries and alternative econometric methods (one-step GMM system, two-step GMM system, fixed-effects estimator). The results suggest that democratic institutions have opposite effects on environmental quality: a positive direct effect on environmental quality and a negative indirect effect through domestic investments and income inequality. Indeed, democratic institutions attract domestic investments that harm the environmental quality. Moreover, as democratic institutions reduce income inequality, they also damage the environment. Moreover the positive effect of democratic institutions on environmental quality is higher in developed countries than in developing countries. Adding more control variables, alternative measures of democratic institutions and other econometric methods and strategies do not alter our main results.

The paper is organized as follows. The next section outlines the arguments on the relation between democratic institutions and environmental quality. In Section 3, we identify the potential transmission channels between democratic institutions and environmental quality. Sections 4 and 5 derive the estimating equations and present the empirical results, and the last Section is devoted to the conclusion.

2. EFFECT OF DEMOCRATIC INSTITUTIONS ON ENVIRONMENTAL QUALITY

According to the environmental economic literature, democratic institutions can have both virtuous and vicious effects on environmental quality. Democracy can be characterized by the effective existence of institutional rules that frame the power. The presence of institutions also enables citizens to express their expectations and choose political elites. It allows citizens to express their preferences for policies and social choices with respect to fiscal and distributional policies as well as to environmental ones. Democracy, however, allows freedom of association and lobbying groups, which do not always aim to implement better environmental practices.

2.1. Democracy and Environmental Preferences

2.1.1. Democracy and Environmental Consciousness

Populations are free to collect information about environmental quality in democratic countries. They can express their preferences and put pressure on their government. Citizens are more aware of environmental problems (freedom of media). They can also express their preferences for the environment (freedom of expression) and create lobbying groups (freedom of association). Political leaders are prompted (right to vote) to implement environmental policies at the national and international levels. McCloskey (1983) and Payne (1995) show the ability of democratic countries to satisfy

people's environmental preferences and their will to commit themselves to international negotiations and agreements. The economics models by Page and Shapiro (1983) suggest that when people are well informed about major problems, political decisions are more likely to be influenced. In autocratic regimes, populations cannot access information and create lobbying groups.

Acemoğlu and Robinson (2006) consider that, in democratic countries, the majority of citizens have the right to vote and thereby express their preferences. As the preferences of the median voter are important and the marginal costs of environmental policies' implementation are lower than in autocracies, the adoption and implementation of environmental policies will prevail in democratic countries.

Deacon (1999) and Olson (1993) argue that political freedoms favour environmental protection because non-democratic regimes will underproduce environmental public goods. Autocratic regimes are led by political elites who monopolize and hold large shares of the 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 less likely to adopt environmentally friendly policies. Deacon (2009) found that democratic governments implement more stringent environmental policies than autocratic governments.

2.1.2.   Effect of Democracy on Rent-seeking

Democratic institutions allow freedom of association and people's creation of lobbying groups to protect their own interests. Firstly, 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 environmental quality as they are supposed to satisfy the preferences of markets and lobbying groups that aim to maximize their economic profit, which does not favour a better environmental quality.

Second, when a democracy is established, institutions become more complex and rigid. Therefore, Olson (1993) claims 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 that are less or not incited to take care of the society's interests. They can try to influence or to control the legislative and administrative process. Consequently, public policies could be less favourable to environmental quality when they are influenced by lobbying groups.

2.1.3. *Geographical Aspects of Democracy: Local or Global Governance*

The government's decision to ratify environmental treaties may be affected by the level of democracy. By allowing citizens to be informed about environmental problems (freedom of media), to express their preferences for the environment (freedom of expression) and to create lobbying groups (freedom of association), democracy increases the probability that the government will ratify international or regional environmental treaties. Neumayer (2002) confirms that democratic countries sign and ratify more multilateral environmental agreements[2] than autocratic ones. Moreover, environmental lobbying groups may influence the probability of environmental treaties' ratification. Using panel data for 170 countries, Fredriksson et al. (2007) show that governments are more responsible to environmental lobby groups and the effect increases with the level of government corruption. However, Fredriksson and Ujhelyi (2006) find that environmental lobby groups raise the probability of environmental treaty ratification, but the effect decreases with the number of individual or collective government units (the president, the prime minister, the chambers of parliament, the majority party or the government coalition parties).

Paehlke (1996) thinks that the nature of the environment and that of democracy differ. The environment is a global phenomenon, whereas democracy works on national and local levels. Consequently, environmental problems could not be resolved in an adequate and opportune way. For example, Heilbronner (1974) supports the idea that the global population growth threatens environmental quality. Autocratic countries can restrain the demographic dynamic, while democratic countries must respect people's freedoms. In democratic countries, governments are accountable to people. They often avoid compliance with multilateral actions and decisions if this weakens their relationship with their electorate. There is an exception when strong democratic governments can control the multilateral game.

2.2. Democracy and Property Rights

Some authors believe that democracy does not favour environmental protection. The implementation of democratic institutions comes with individual freedoms. Desai (1998) thinks that democracy does not protect the environment because democracy is a factor in economic growth and prosperity, which damages the quality of the environment. Democracy is also correlated with factors such as property rights and social

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[2] The author uses several measures: (1) the signing and ratification of multilateral environmental agreements (MEAs); (2) the membership of environmental intergovernmental organizations (EIOs); (3) the extent to which the reporting requirements for the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) are met; (4) the percentage of a country's land area under protection status; (5) the existence of a National Council on Sustainable Development (NCSD) in a country; and (6) the availability of environmentally relevant information concerning a country.

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

This argument is rejected by authors who focus on the institutional and ideational features of democratic institutions. Democracies are more likely to comply with environmental agreements because they respect the rule of law. Weiss and Jacobson (1999) argue that democratic countries respect economic freedom and, therefore, have market economies that, in turn, improve environmental protection. Barrett and Graddy (2000) conclude that political and civic freedoms reduce some pollutants (sulphur dioxide) but have no effect on other pollutants (water pollution). Torras and Boyce (1998) also find that political and civic freedoms have a positive effect on air and water quality in developing countries.

3.   TRANSMISSION MECHANISMS

Our main argument in this paper is that the previous arguments linking democracy may not have a direct effect on environmental quality. It is more likely that democracy's effects on environmental quality are channelled by policies implemented by democratic governments. First, democratic transition often entails political and economic liberalization, thereby enhancing the business environment. For instance, economic liberalization often leads to increases in trade openness. Moreover, it may contribute to countries' attractiveness and thus favours either foreign direct or domestic investments. Second, democracy produces political competition among parties, which makes the redistribution of income a most salient issue. In this section, we discuss the transmission channels of democratic institutions.

3.1.   Domestic and Foreign Direct Investments

The degree of democratization may affect the accumulation of domestic and foreign direct investments (FDI). In theory, democratic institutions can favour investments in several ways. First, 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 where the social consensus is low. Moreover, democratic regimes are politically stable, so they attract FDI. In political instability, economic agents consume more and reduce their saving. Second, political instability is also a factor of uncertainty because it increases risks and the perception of investment risks and may reduce the rights and safety of investors. Feng (2001) shows that institutions lead to improved property rights and political freedoms, which in turn

increase domestic investments and FDI, while uncertainty and political instability reduce them.

The relationship between investments (domestic and Foreign Direct) and environmental quality has been analysed. According to Brock and Taylor (2010), a high investment rate leads to a high physical capital stock in a regular state and increases the carbon dioxide per capita emissions during the transitional dynamic. Concerning the effect of FDI on pollution, one major debate is about the pollution haven hypothesis (PHH), which assumes that developing countries attract polluting industries to engage in FDI by taking advantage of the lower environmental standards. Similarly to trade openness, Grossman and Krueger (1995) consider that FDI can affect environmental quality through the scale effect, the technique effect and the composition effect. The scale effect is related to the effect on environmental degradation as a consequence of an increase in economic output due to the expansion of FDI. The composition effect means that FDI can have an impact on environmental degradation by changing the industrial structure of the economy. The technique effect considers that FDI favours the development, diffusion and transfer of clean technologies, which improve environmental quality.

3.2. Trade Openness

Democracy (political freedom) can influence environmental quality through trade openness. Indeed, protectionist policies can be adopted in autocratic regimes because they benefit only a few producers (or political elites) at the expense of the majority of people (or consumers). By reducing the price of imported goods and increasing their incomes, democracy may incite people, as represented by the median elector, to choose trade policy and openness. Several authors such as Grossman and Krueger (1995), Antweiler et al. (2001) have shown that trade affect environmental quality.

3.3. Income Inequality

An important characteristic of democracy is the right to vote. Indeed, the exclusion of an important part of the population leads to a bias in political leaders' preferences. Many authors assert that an improvement in democratic institutions increases people's possibilities to ask for a better distribution of income (Boix, 2003). As they are democratically elected, democratic leaders are incited to adopt redistribution policies, such as minimum wage, price subsidies and progressive taxation for the poor and middle classes. In other words, the democratic process is supposed to reduce income inequality. On the contrary, autocratic leaders will tend to adopt policies that favour the elite in power; consequently, they maintain income inequality. Li and Reuveny (2006) and Scully (1992) find that democracies have a positive effect on income distribution.

The effect of income inequality on environmental quality has been analysed by many scholars. Magnani (2000) and Koop and Tole (2001) find that income inequality tends to

exacerbate pollution and deforestation, respectively. Developing theoretical arguments from political economy, Boyce (1994) assumes that income inequality increases environmental degradation through the rate of time preference. He supposes that income inequality reduces the awareness of environmental quality for both rich and poor. Indeed, the poor would overexploit natural and environmental resources because of their survival motivation. Moreover, because income inequality and the polarization of resources increase and exacerbate conflicts (violence, social trouble), rich people can prefer a policy of overexploiting the environment and natural resources and investing the returns abroad. Torras and Boyce (1998) assume that political power is highly correlated with income inequality. In unequal societies, those (the rich) who benefit from environmental degradation are more powerful than those (the poor) who bear the cost. Therefore, a cost–benefit comparison predicts environmental degradation. Borghesi (2006) argues that the implementation of environmental policies is likely with social consensus. It is easier to gain this consensus in an equal society than in an unequal society with conflicts among political agents and social instability.

Ravallion et al. (2000) claim that the impact of income inequality on environmental degradation depends on the marginal propensity to emit (MPE). Based on the Keynesian concept of marginal propensity to consume (MPC), the argument assumes that the poor may have a higher MPC than the rich. Indeed the poor may consume goods with more pollution than the rich because environmentally friendly goods need high technology and are expensive for them. In addition, according to Ravallion et al. (2000), the poor tend to use energy less efficiently than the rich. Therefore, a reduction on income inequality (through an increase in the income of the poor to catch up the rich) will increase energy consumption and pollution emission. In other words an increase in income inequality tends to improve environmental quality. Several authors (Ravallion et al., 2000 ; Heerink et al., 2001; Hübler, 2017) have shown that income inequality improve environmental quality.

The previous sections have analysed the effect of democratic institutions on environmental quality and identified the potential transmission channels. This section describes the empirical method, the econometric specifications and the data set.

3.4. Empirical Model

We rely on Brock and Taylor's (2010) Green solow model, which establishes convergence in air pollution. We augment the model and take into account the role of democratic institutions. The baseline model is written as follows:

$$log\big(e_{i,t}\big) = \alpha_i + \rho log\big(e_{i,t-1}\big) + \delta_1 DI_{i,t} + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t}, \qquad (1)$$

with $e_{i,t}$ the level of environmental quality in country (i) in period t. The time

coverage extends from 1960 to 2008 and the data are compiled in five-year averages.[3] Our sample is made up of 122 developed and developing countries. $DI_{i,t}$ is a measure of democratic institutions. $X_{i,t}$ are control variables without transmission channels. Derived by Brock and Taylor (2010) and the literature, they are lagged emissions per capita, population growth and income per capita. δ_1 in equation (1) identifies the effects of democratic institutions on environmental quality. Because equation (1) does not include potential transmission channels, δ_1 captures the total effect of democratic institutions.

The transmission channels are modelled as having an additive effect on environmental quality in equation (2):

$$log\big(e_{i,t}\big) = \alpha_i + \rho log\big(e_{i,t-1}\big) + \delta_2 DI_{i,t} + \beta TC_{i,t}^j + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t}. \tag{2}$$

$TC_{i,t}^j$ is the vector of potential transmission channels: foreign direct investments (FDI), trade openness, income inequality and domestic investments.

δ_2 in equation (2) captures the direct effect of democratic institutions on environmental quality. The indirect effect, which passes through the transmission channels, may be derived as the difference between the total effect (δ_1) and the direct effect (δ_2).

Moreover, what is important in the identification of the transmission channels is to have a significant relationship between democratic institutions and transmission channels on one hand and a significant relationship between transmission channels and environmental quality in another hand. We therefore empirically test the effect of democratic institutions on each transmission channel (equation 3):

$$TC_{i,t}^j = \alpha_i + \beta Institutions + \gamma_t + \varepsilon_{i,t}. \tag{3}$$

It is inadequate to estimate equations (1) and (2) using either fixed effects (FE) or random effects (RE) because the lagged dependent variable is one of the regressors. Therefore, results will be biased (Nickell, 1981). We thus rely on GMM system estimators (Generalized Method of Moments) following Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). The GMM system (Generalized Method of Moments) 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. This removes unobserved time-invariant and unobserved individual characteristics. The conditions to be met are that the error terms are uncorrelated and that the explanatory variables are weakly exogenous. In the second estimate, we use variables in first differences lagged of at least one period as instruments of the equation in level. To

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[3] We average our variables on five-year period because democratization is a long-term process.

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

3.5. Sources and Description of the Variables

The data on carbon dioxide per capita, domestic and foreign direct investments, trade openness and population growth are from the World Development Indicators (2010). Those on democratic institutions, income inequality, sulphur dioxide per capita and education come respectively from Polity IV (2008), the Texas Inequality Project (UTIP 2008) database, David Stern (2004) and Barro and Lee (2012). The definitions, sources and descriptive statistics of the variables are in Appendices 1 and 2.

3.5.1. Environmental Quality

In the absence of a single measure of environmental quality, many indicators have been used in the literature as a proxy for environmental quality. For the purpose of our study, we use two pollutant variables. These are carbon dioxide (CO_2) per capita and sulphur dioxide (SO_2) per capita. The choice of CO_2 as an environmental indicator is based on two reasons. Firstly, data on carbon dioxide emissions are available for longer time series than any other pollution indicator. Secondly, at the global level, CO_2 is an immediate cause of greenhouse gas, responsible for global warming and climate change. Moreover, carbon dioxide emissions contribute to global warming more than any other greenhouse gas. At the domestic level, while CO_2 by itself does not pose any immediate health hazard to human beings, it is usually a by-product of increased industrial activity, which, in the absence of stringent regulation, can be a source of toxic emissions and particulates that pose environmental concerns.

Contrary to carbon dioxide emissions, sulphur dioxide is a local pollutant. It is widely regarded as one of the most prominent forms of air pollution worldwide, since it has direct and visible effects on human health, ecosystems and the economy (Konisky, 1999). SO_2 has negative effects on the human body. It causes acid rain, which damages forests, lakes, buildings, cultural objects and agricultural production. It also reduces visibility, from light mist to dense grey smog.

3.5.2. Democratic Institutions

As democratic institutions, we chose the index of polity (2) from Polity IV, which is a score obtained by differencing the index of democracy and index of autocracy on a scale from +10 (democracy) to -10 (autocracy). The indicator of democracy is characterized by the effective existence of institutional rules framing the power and the presence of institutions enabling citizens to express their expectations and choose

political elites. Autocracy is characterized by the absence or the restriction of political competition, economic planning and control. The exercise of power is slightly constrained by institutions and the leaders are only selected within a "political elite".

4.   RESULTS

4.1.   Baseline Results

Columns (1) and (3) of Table 1 show that democracy improves environmental quality. Coefficients is -0.00995 (-0.0243) and significant at 10% (1%), respectively, for CO_2 and SO_2 respectively These results are similar to those of previous authors, such as Bernauer and Koubi (2009) and Li and Reuveny (2006), who conclude that democratic institutions improve environmental quality.

Table 1.   Effect of Democratic Institutions on Environmental Quality

Dependent variable	Log of carbon dioxide emissions per capita		Log of sulphur dioxide emissions per capita	
	(1)	(2)	(3)	(4)
Lagged emission per capita (log)	0.972***	0.908***	1.086***	1.102***
	(0.0352)	(0.0923)	(0.0700)	(0.0726)
Democratic Institutions	-0.00995*	-0.0300***	-0.0243***	-0.0240**
	(0.00592)	(0.0107)	(0.00905)	(0.00959)
Population growth	0.0111	-0.0362	0.0608**	0.0645**
	(0.00908)	(0.0294)	(0.0286)	(0.0271)
Income per capita (log)	0.00563	-0.0120	-0.0156	-0.0152
	(0.00849)	(0.0340)	(0.0119)	(0.0107)
Democratic Institutions* parlementary		0.0252		0.0146
		(0.0168)		(0.0144)
Democracy*assembly elected		0.0492**		-0.0104
		(0.0210)		(0.0102)
Intercept	0.0987***	0.253***	1.276	1.498*
	(0.0268)	(0.0709)	(0.855)	(0.893)
Observations	867	800	800	800
Countries	121	120	104	104
AR(1)	0.01	0.004	0.02	0.03
AR(2)	0.464	0.550	0.24	0.308
Hansen Test	0.18	0.42	0.12	0.46
Instruments	12	18	20	18

Notes: * significantly at 10%; ** at 5%; *** at 1%. The study period is 1960-2000 and 1960-2008 for sulphur dioxide emissions and carbon dioxide emissions and emporal dummies are included.

The economic literature considers that democracy differs in the form of democratic government. These differences may affect the protection of the environment. Recent research on the provision of public goods argues that the form of government is an

important factor in environmental protection. Persson et al. (2000) consider that a presidential system would underproduce public goods because legislative coalitions are unstable and leaders promote the allocation of spending to powerful minorities. The parliamentary system would increase spending on public goods and satisfy the majority of voters. However, Bernauer and Koubi (2009) and Mesquita et al. (2005) show that the presidential system would produce more public goods (prosperity, peace, transparency, political rights, civil liberties, sulphur dioxide emissions) than the parliamentary system. We include in our analysis an index of the type of democratic system. There are three dichotomous variables: a) president, which takes the value of 1 for presidential democracies and 0 otherwise; b) assembly elected, which takes the value of 1 for assembly-elected presidential democracies and 0 otherwise; c) parliamentary, which takes the value of 1 for parliamentary democracies and 0 otherwise. The results[4] (columns 2 and 4, Table 1) suggest that presidential democracies seem to be the best system to protect environmental quality (carbon dioxide per capita and sulphur dioxide per capita).

4.2.   Disentangling the Indirect Effect of Democratic Institutions

We now examine the transmission mechanisms by which democracy may influence environmental quality. In section 3, we identify four potential channels (foreign direct investments (FDI), trade openness, income inequality and domestic investments).

Tables 2 and 3 show the results of equation (2). First, column (2) of Tables 2 and 3 indicate that an increase in income inequality reduces air pollution emissions. These results are similar to those of scholars (Ravallion et al., 2000; Heerink, et al., 2001; Hübler, 2017) and are compatible with the marginal propensity to emit approach. As income inequality increases, the poor will reduce energy consumption and carbon-intensive energy goods, which in turn decreases environmental quality (carbon dioxide and sulphur dioxide emissions per capita).

Second column (3) of Tables 2 and 3 show that domestic investments decrease environmental quality. Final columns (4) and (5) conclude that foreign direct investments (FDI) and trade have no effect on environmental quality.

The inclusion of income inequality and domestic investments in the regression improves the magnitude of the coefficients of democratic institutions (columns (3), (4) and (6)). The results indicate that democratic institutions have a positive effect on environmental quality. This direct effect (column 6) of democratic institutions is higher than the total effect (column 1). Moreover, the increase in the magnitude and coefficient of democratic institutions (column (1) and column (6)) may indicate that democratic institutions have partial effects through investments and income inequality.

To be sure that they are really channels through which democratic institutions affect

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[4] We include in the baseline regression two of three dichotomous variables.

environmental quality, we empirically test[5] the effect of democratic institutions on domestic investments and income inequality.

Table 2. Effect of Democratic Institutions on CO2 taking into account Transmission Channels

Dependent variable	Log of carbon dioxide emissions per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged carbon dioxide per capita (log)	0.972***	0.984***	0.810***	1.064***	1.033***	0.862***
	(0.0352)	(0.0687)	(0.0711)	(0.0317)	(0.0684)	(0.0491)
Democratic Institutions	-0.00995*	-0.0276***	-0.0275***	-0.0179*	-0.0128**	-0.0481*
	(0.00592)	(0.00762)	(0.0101)	(0.00994)	(0.00601)	(0.0257)
Population growth	0.0111	0.0209***	0.111**	0.0272***	0.0114	-0.0545
	(0.00908)	(0.00731)	(0.0430)	(0.00910)	(0.0116)	(0.0370)
Income per capita (log)	0.00563	-0.00378	-0.0133	-0.0143*	0.00751	-0.0383
	(0.00849)	(0.00892)	(0.0132)	(0.00778)	(0.0148)	(0.0294)
Income Inequality		-0.0230***				-0.0275***
		(0.00800)				(0.0101)
Investments (log)			0.351*			0.406**
			(0.205)			(0.162)
FDI (log)				0.0170		-0.0153
				(0.0328)		(0.0835)
Trade (log)					0.0473	0.0501
					(0.165)	(0.111)
Intercept	0.0987***	1.075***	-0.564	0.0778***	-0.0825	-0.513
	(0.0268)	(0.338)	(0.639)	(0.0279)	(0.644)	(0.686)
Observations	867	627	733	634	788	577
Countries	121	111	119	120	120	117
AR(1)	0.01	0.00	0.01	0.004	0.01	0.01
AR(2)	0.464	0.87	0.30	0.550	0.869	0.92
Hansen Test	0.18	0.13	0.53	0.42	0.11	0.44
Instruments	12	14	17	18	15	15

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2008.

Table 4[6] shows the results of equation (3). Columns (1) and (2) show that democratic institutions have a positive effect on investments. Our results are similar to those of Feng (2001), Pastor and Hilt (1993) and Pastor and Sung (1995), who conclude that political freedoms (democratic freedoms) attract investments. Columns (3) and (4)

[5] Some authors report bivariate regressions (Mo, 2001; Pellegrini and Gerlagh, 2006) and others include additional determinants (Papyrakis and Gerlagh, 2004).

[6] Moreover, we check the robustness of our results by including in the regressions additional independent variables. For the investments equation, we take into account income per capita, inflation, credit available in the private sector and corruption. For the income inequality equation, we include income per capita, lagged income inequality.

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. First, 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 coups d'état (Figueroa, 1996). Second, Acemoğlu and Robinson (2006) show that income inequality strongly reduces the consolidation of democracies. One argument is that it facilitates and allows the redistribution of incomes in favour of the poor and disadvantages the rich people in power. The burden of democracy on the elites increases in the income gap between them and the citizens. They would have an incitative to destabilize the democracy. Latin America is an example showing that income inequalities do not allow democracy to consolidate. The estimation results are biased. To solve the problem of endogeneity, we use the GMM system, allowing us to instrument democratic institutions with lagged variables. Columns (5) and (6) conclude that democratic institutions reduce income inequality. Thus, democracy allows the poor to obtain more resources through income redistribution. The result is similar to those of previous studies (Boix, 2003; Mueller and Stratmann, 2003). The reduction of income inequality may be partially explained by income transfers or by government size (expenditure).

Table 3.   Effect of Democratic Institutions on SO2 Quality taking into account Transmission Channels

Dependent variable	Log of sulphur dioxide emissions per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged sulphur dioxide per capita (log)	1.086***	0.856***	1.027***	1.157***	1.027***	0.931***
	(0.0700)	(0.0260)	(0.0978)	(0.0714)	(0.165)	(0.0626)
Democratic Institutions	-0.0243***	-0.0664**	-0.0840*	-0.0296***	-0.0264*	-0.133***
	(0.00905)	(0.0323)	(0.0458)	(0.0106)	(0.0140)	(0.0354)
Population growth	0.0608**	-0.0152	0.0666**	0.0641**	0.0670**	0.0758***
	(0.0286)	(0.0246)	(0.0269)	(0.0311)	(0.0270)	(0.0229)
Income per capita (log)	-0.0156		-0.00584	-0.0219*	0.00175	-0.00161
	(0.0119)		(0.0147)	(0.0120)	(0.0175)	(0.00543)
Income Inequality		-0.00662**				-0.0327***
		(0.00319)				(0.00924)
Investments (log)			0.161**			0.303***
			(0.0762)			(0.0774)
Trade (log)				-0.0306		-0.0618
				(0.0628)		(0.0489)
FDI (log)					-0.0265	-0.00578
					(0.0903)	(0.0173)
Intercept	1.276	-1.236***	0.0173	2.266**	0.446	-0.970
	(0.855)	(0.274)	(1.359)	(0.979)	(2.042)	(0.900)
Observations	800	577	692	744	590	423
Countries	104	104	102	103	104	90
AR(1)	0.02	0.03	0.07	0.03	0.001	0,01
AR(2)	0.24	0.30	0.42	0.308	0.316	0,15
Hansen Test	0.12	0.26	0.57	0.46	0.23	0,24
Instruments	20	21	12	18	20	19

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2000.

Table 4.   The Effect of Democratic Institutions Transmission Channels

	Investments (log)		Income inequality			
	(1)	(2)	(3)	(4)	(5)	(6)
Democratic Institutions	0.0310*	0.0394**	0.123***	0.0661*	-0.549**	-0.315***
	(0.0186)	(0.0189)	(0.0341)	(0.0348)	(0.233)	(0.0738)
Income per capita (log)		0.0969**		-2.556***		-0.300**
		(0.0412)		(0.582)		(0.151)
Population growth		0.0434**		-0.103		-0.119
		(0.0186)		(0.198)		(0.526)
Constant	2.900***	2.012***	41.33***	65.79***	41.34***	45.45***
	(0.0448)	(0.407)	(0.424)	(5.433)	(0.640)	(1.781)
Observations	674	671	735	683	735	683
R-squared	0.045	0.067	0.234	0.252		
Countries	122	122	125	122	125	122
AR(1)					0.041	0.001
AR(2)					0.482	0.152
Hansen test					0.41	0.102
Instruments						9

4.3.   Robustness Checks

How robust are these results to alternative tests? First, we take into account the importance of economic development. Second, we include more control variables (legal structure and security of property rights, corruption) to check the pertinence of the transmission channels (income inequality and domestic investments). Third, alternative measures of democratic institutions are added to the equations. Fourth, an alternative econometric method (two-step GMM system) is applied.

4.3.1.   The Importance of Economic Development

Our results conclude that democratic institutions have a positive direct effect on environmental quality. However, an important characteristic of democratic institutions is that their levels differ according to economic development. These results may be biased and explained by the quality of democratic institutions in developed countries. Table (5) indicates that democratic institutions in both groups have a direct positive effect on environmental quality. More interestingly, the direct effect of democratic institutions on environmental quality in developed countries is higher than that in developing countries. This can be explained by the fact that the quality of democratic institutions is better in developed countries than in developing countries. Another result is that the direct positive effect of democratic institutions is higher for sulphur dioxide per capita than for carbon dioxide per capita in developed countries and in developing countries. These results can be explained by the fact that sulphur dioxide emissions are a local pollutant, contrary to carbon dioxide, which is a global pollutant.

4.3.2. Adding More Control Variables

A common characteristic of democratic institutions is that they can promote (generally) economic freedom. Aixalá and Fabro (2009) and Lawson and Clark (2010) provide evidence that economic institutions are related to a country's level of political institutions, because on one hand the institutions that affect environmental performance (through economic growth) are distinct from the institutions of representative democracy and on the other hand economic institutions can be affected by democratic institutions. Moreover, some authors, such as Pellegrini and Gerlagh (2006) show that studies analysing the relationship between democratic institutions and environmental quality may be biased when they do not take into account the level of corruption. Because these two variables are highly correlated, the individual estimation of the effects of democratic institutions overemphasizes its importance (coefficient). They conclude that democratic countries do not protect environmental quality when they are corrupt. We control for property rights, law and order and corruption in Table 6. The results are not affected by the inclusion of these variables.

Table 5. Effect of Democratic Institutions on Environmental Quality According to Economic Development

Dependent variable	Log of carbon dioxide per capita		Log of sulphur dioxide per capita	
	Developing	Developed	Developing	Developed
	(1)	(2)	(3)	(4)
Lag emissions per capita (log)	0.872***	0.983***	0.697***	0.697***
	(0.0460)	(0.200)	(0.111)	(0.114)
Democratic Institutions	-0.0348**	-0.0659***	-0.107**	-0.187**
	(0.0143)	(0.02487)	(0.0478)	(0.0798)
Population growth	0.00811	-0.0604	0.114*	-0.0900
	(0.0515)	(0.0445)	(0.0614)	(0.0564)
Income per capita (log)	0.0272	0.3895**	0.0256	0.4083**
	(0.0365)	(0.1891)	(0.0197)	(0.2048)
Income Inequality	-0.0318***	-0.0215*	-0.05796*	-0.02108*
	(0.0091)	(.01257)	(0.03329)	(0.01239)
Investments (log)	0.527***	0.514***	0.691***	0.191*
	(0.184)	(0.192)	(0.1084)	(0.110)
Trade (log)	-0.158	-0.266	0.0769	0.0710
	(0.170)	(0.221)	(0.0882)	(0.0814)
FDI (log)	-0.00493	-0.0392	0.0233	0.0144
	(0.0405)	(0.0383)	(0.0318)	(0.0285)
Intercept	-0.132	0.129	-3.196*	-2.920
	(1.226)	(0.972)	(1.751)	(1.757)
Observations	378	171	280	143
Countries	78	27	66	24
AR(1)	0.001	0.09	0.03	0.22
AR(2)	0.13	0.32	0.47	0.26
Hansen Test	0.44	0.70	0.60	0.31
Instruments	17	17	18	17

Notes:* significantly at 10%; ** at 5%; *** at 1%. The study period is 1960-2000 and 1960-2008 for sulphur dioxide emissions and carbon dioxide emissions.

Table 6. Effect on Democratic Institutions on Environmental Quality: More Control

Dependent variable	Log of carbon dioxide emissions per capita					Log of sulphur dioxide emissions per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged emissions per capita (log)	0.862***	1.042***	0.906***	1.150***	0.931***	1.075***	0.986***	1.096***
	(0.0491)	(0.0786)	(0.127)	(0.0862)	(0.0626)	(0.108)	(0.266)	(0.157)
Democratic Institutions	-0.0481*	-0.0342*	-0.0445*	-0.0327***	-0.133***	-0.127**	-0.138**	-0.125*
	(0.0257)	(0.0198)	(0.0231)	(0.00924)	(0.0354)	(0.0576)	(0.0617)	(0.0703)
Population growth	-0.0545	0.0864*	0.0109	-0.00161	0.0758***	0.130	-0.0180	0.0101
	(0.0370)	(0.0466)	(0.0653)	(0.0314)	(0.0229)	(0.111)	(0.0340)	(0.0356)
Income per capita (log)	-0.0383	0.0358	0.0285	-0.0644	-0.00161	-0.0498	-0.00151	0.00392
	(0.0294)	(0.0568)	(0.0420)	(0.0438)	(0.00543)	(0.0303)	(0.0147)	(0.00743)
Income Inequality	-0.0275***	-0.0186**	-0.0120*	-0.0187**	0.0153*	-0.0196**	-0.0234*	-0.0274**
	(0.0101)	(0.00922)	(0.00699)	(0.00926)	(0.00919)	(0.00852)	(0.0129)	(0.0119)
Investment (log)	0.406**	0.656***	0.675***	0.558**	0.303***	0.641***	0.404**	0.366***
	(0.162)	(0.178)	(0.197)	(0.241)	(0.0774)	(0.141)	(0.177)	(0.124)
FDI (log)	-0.0153	0.00247	0.0515	-0.00313	-0.00578	0.00763	0.00852	-0.00945
	(0.0835)	(0.0417)	(0.0570)	(0.0979)	(0.0173)	(0.0205)	(0.0278)	(0.0197)
Trade (log)	0.0501	-0.136	0.0913	-0.232	-0.0618	-0.0385	-0.127	-0.0334
	(0.111)	(0.142)	(0.190)	(0.209)	(0.0489)	(0.0744)	(0.193)	(0.0761)
Law and order		0.00771				0.00175		
		(0.0795)				(0.0175)		
Property rights			-2.535				2.374	
			(9.743)				(19.84)	
Corruption				-0.0306				-0.232
				(0.0628)				(0.183)
Intercept	-0.513	-1.563**	-1.287	0.0722	-0.970	0.0161	-0.809	2.413
	(0.686)	(0.613)	(1.002)	(1.268)	(0.900)	(1.496)	(0.883)	(3.055)
Observations	577	373	506	373	423	309	390	309
Countries	117	105	95	105	90	83	82	83
AR(1)	0.01	0.00	0.00	0.003	0,01	0.001	0.036	0.022
AR(2)	0.92	0.75	0.20	0.119	0,15	0.868	0.405	0.857
Hansen test	0.44	0.27	0.13	0.258	0,24	0.664	0.679	0.115
Instruments	15	18	26	16	19	24	27	26

Notes: * significantly at 10%; ** at 5%; *** at 1%. The study period is 1960-2000 and 1960-2008 for sulphur dioxide emissions and carbon dioxide emissions.

4.3.3. *Alternative Measures of Democratic Institutions*

In the literature, many measures of democratic institutions have been used. They can be divided into two categories: dichotomous and continuous indicators. We use two alternative measures of democratic institutions from Cheibub et al. (2010) and Vanhanen (2003). The index of democratic institutions (Cheibub et al., 2010) is a dichotomous indicator (chga) that is coded 1 if a democracy and 0 otherwise. A regime is considered a democracy if the executive and the legislature are directly or indirectly elected by popular vote, multiple parties are allowed, there is de facto existence of multiple parties outside the regime front, there are multiple parties within the legislature and there has been no consolidation of incumbent advantage (e.g. unconstitutional closing of the lower house or extension of the incumbent's term by postponing subsequent elections). Transition years are coded as the regime that emerges in that year.

Table 7.   Democratic Institutions and Carbon Dioxide per Capita: Alternative Measures of Democracy

Dependent variable	Log of carbon dioxide per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged carbon dioxide per capita (log)	0.963***	0.824***	0.911***	0.938***	0.862***	0.895***
	(0.0587)	(0.0725)	(0.0520)	(0.0857)	(0.180)	(0.0404)
Democracy (chga)	-0.0185**	-0.127***	-0.121**	-0.0190**	-0.0277**	-0.251**
	(0.00740)	(0.0266)	(0.0469)	(0.00883)	(0.0112)	(0.0988)
Population growth	0.00120	-0.0397	-0.00840	-0.0130	0.0125	-0.0196
	(0.00400)	(0.0495)	(0.0157)	(0.0317)	(0.0177)	(0.0337)
Income per capita (log)	0.0141	-0.0177	-0.0264	0.00906	0.0265	0.0662
	(0.0135)	(0.0247)	(0.0295)	(0.0201)	(0.0394)	(0.0754)
Income Inequality		-0.0239**				-0.0173**
		(0.0100)				(0.00838)
Investments (log)			0.457***			0.585***
			(0.113)			(0.153)
Trade (log)		0.188		-0.133		0.129
		(0.163)		(0.164)		(0.113)
FDI (log)					-0.0609	-0.0274
					(0.0807)	(0.0253)
Intercept	0.0635	0.636	-1.158***	0.611	-0.0406	-1.027*
	(0.0441)	(0.460)	(0.346)	(0.616)	(0.117)	(0.614)
Observations	848	600	725	780	633	569
Countries	120	119	118	119	119	116
AR(1)	0.001	0.01	0.22	0.00	0.00	0.00
AR(2)	0.13	0.10	0.42	0.98	0.20	0.45
Hansen Test	0.11	0.29	0.31	0.12	0.59	0.20
Instruments	19	17	14	22	19	12

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2008.

Table 8.   Democratic Institutions and Sulphur Dioxide per Capita: Alternative Measures of Democracy

Dependent variable	Log of Sulphur dioxide per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Sulphur dioxide per capita (log)	1.200***	0.890***	0.842***	0.700***	0.756***	1.074***
	(0.0735)	(0.0447)	(0.0729)	(0.118)	(0.121)	(0.0982)
Democracy (chga)	-0.0452***	-0.133*	-0.189**	-0.0541***	-0.0579***	-0.295**
	(0.0156)	(0.0738)	(0.0908)	(0.0141)	(0.0126)	(0.111)
Population growth	-0.0923	-0.0145	0.0224	-0.0581	-0.0222	0.0148
	(0.0580)	(0.0412)	(0.0543)	(0.0401)	(0.0344)	(0.0325)
Income per capita (log)	-0.0736	-0.0326	-0.0260	-0.0543	-0.0375	-0.0626
	(0.0499)	(0.0404)	(0.0312)	(0.0418)	(0.0545)	(0.0526)
Income Inequality		-0.0335**				-0.0215**
		(0.0156)				(0.00918)
Investments (log)			0.327**			1.176***
			(0.161)			(0.359)
Trade (log)				0.188		0.00140
				(0.127)		(0.0372)
FDI (log)					0.0485	-0.0107
					(0.0570)	(0.0356)
Intercept	2.844***	-0.466	-2.347**	-3.634**	-2.296*	-2.034*
	(0.936)	(0.402)	(0.917)	(1.625)	(1.350)	(1.035)
Observations	793	584	681	736	576	540
Countries	103	99	101	102	102	100
AR(1)	0.014	0.061	0.018	0.008	0.034	0.017
AR(2)	0.456	0.439	0.905	0.466	0.246	0.805
Hansen Test	0.358	0.338	0.423	0.312	0.783	0.634
Instruments	15	24	24	24	13	12

Note: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2000.

Table 9. Democratic Institutions and Carbon Dioxide per Capita: Alternative Measures of Democracy

Dependent variable	Log of carbon dioxide per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged carbon dioxide per capita (log)	1.008***	0.912***	0.811***	0.717***	0.749***	0.985***
	(0.0297)	(0.0698)	(0.0712)	(0.0969)	(0.114)	(0.102)
Democracy (van_index)	-0.0105*	-0.0273***	-0.0279***	-0.0138***	-0.00728	-0.0561**
	(0.00567)	(0.00887)	(0.00953)	(0.00486)	(0.00584)	(0.0269)
Population growth	0.0162**	-0.0937	-0.00707	-0.00921	-0.0331	0.0333
	(0.00751)	(0.0632)	(0.0195)	(0.0246)	(0.0393)	(0.0890)
Income per capita (log)	-0.00395	0.0137	-0.0382	-0.0188	0.0130	0.0634
	(0.00724)	(0.0138)	(0.0275)	(0.0272)	(0.0285)	(0.0424)
Income Inequality		-0.0315***				-0.0343***
		(0.0114)				(0.0124)
Investments (log)			0.414***			0.517***
			(0.154)			(0.158)
Trade (log)				0.440		-0.542
				(0.276)		(0.504)
FDI (log)					-0.0301	0.162
					(0.0766)	(0.133)
Intercept	0.150***	1.987***	-1.086**	-1.607	0.281	1.761
	(0.0376)	(0.443)	(0.461)	(1.049)	(0.184)	(2.384)
Observations	847	580	724	779	632	460
Countries	120	107	118	119	119	110
AR(1)	0.00	0.00	0.01	0.22	0.003	0.001
AR(2)	0.92	0.53	0.12	0.42	0.86	0.53
Hansen Test	0.44	0.14	0.29	0.31	0.329	0.400
Instruments	15	19	17	14	15	17

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2008.

Table 10. Democratic Institutions and Sulphur Dioxide per Capita: Alternative Measures of Democracy

Dependent variable	Log of Sulphur dioxide per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged sulphur dioxide per capita (log)	1.034***	1.070***	1.083***	0.912***	1.084***	0.717***
	(0.0773)	(0.0685)	(0.0501)	(0.0628)	(0.0972)	(0.0709)
Democracy (van_index)	-0.00867*	-0.0646**	-0.0566**	-0.0166***	-0.0147**	-0.116*
	(0.00495)	(0.0303)	(0.0277)	(0.00458)	(0.00601)	(0.0591)
Population growth	-0.0620	-0.0419	-0.0408	-0.0290	-0.0153	-0.0163
	(0.0388)	(0.0460)	(0.0665)	(0.0448)	(0.0595)	(0.0327)
Income per capita (log)	-0.0127	-0.0418	-0.0102	0.0646***	-0.00269	0.0391*
	(0.0110)	(0.0451)	(0.0133)	(0.0213)	(0.00916)	(0.0219)
Income Inequality		-0.0217**				-0.0181**
		(0.00988)				(0.00872)
Investments (log)			0.542***			0.527***
			(0.183)			(0.164)
Trade (log)				0.0105		0.137
				(0.0677)		(0.259)
FDI (log)					-0.0131	-0.0482
					(0.0466)	(0.0364)
Intercept	0.736	1.133	-0.293	-0.730	1.227	-4.488***
	(0.889)	(0.773)	(0.893)	(0.847)	(1.214)	(1.386)
Observations	792	583	683	551	588	420
Countries	103	99	101	97	103	89
AR(1)	0.000	0.003	0.026	0.006	0.024	0.005
AR(2)	0.181	0.118	0.129	0.518	0.473	0.992
Hansen Test	0.195	0.723	0.228	0.149	0.66	0.212
Instruments	64	27	14	22	23	38

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2000.

The second measure of democracy, developed by Vanhanen (2003), is a composite (continuous) indicator. It combines two basic dimensions of democracy – competition and participation – measured as the percentage of votes not cast for the largest party (competition) times the percentage of the population that actually voted in the election (participation). It varies from 0 (no democracy) to 100 (full democracy). Tables 7, 8, 9 and 10 show that democratic institutions always have positive (direct) and indirect impacts on environmental quality (SO2 and CO2).

4.3.4. Alternative Econometric Methods[7]

We re-estimate our equations using the two-step GMM system because the two-step GMM-system estimator is more efficient than the one-step GMM-system estimator even if the standards errors can be severely downward biased in a small sample. This potential bias is solved by the method of correction (Windmeijer, 2005) of a covariance matrix in a finite sample. The results are displayed in Tables 11 and 12. We note that the results are similar to those obtained by the one-step GMM estimator and are robust.

Table 11.   Effect of Democratic Institutions on Environment Quality with Two Step GMM-System

Dependent variable	Log of carbon dioxide emissions per capita					
GMM System Two Step	(1)	(2)	(3)	(4)	(5)	(6)
Lagged carbon dioxide per capita (log)	0.712***	0.847***	0.837***	1.055***	1.106***	0.898***
	(0.217)	(0.0760)	(0.0761)	(0.0288)	(0.0729)	(0.0567)
Democratic Institutions	-0.0186*	-0.0463**	-0.0322**	-0.0192*	-0.0148*	-0.0746**
	(0.0107)	(0.0232)	(0.0133)	(0.0105)	(0.00858)	(0.0302)
Population Growth	-0.0521	-0.0146	-0.0115	-0.0259	-0.0485	-0.0219
	(0.0499)	(0.104)	(0.0222)	(0.0240)	(0.0301)	(0.0348)
Income per capita (log)	-0.0186	0.0166	0.000465	0.0132	-0.0118	-0.0468
	(0.0180)	(0.0234)	(0.00838)	(0.0326)	(0.0144)	(0.0376)
Income inequality		-0.0126*				-0.0181*
		(0.00751)				(0.0102)
Investments (log)			0.380***			0.414**
			(0.133)			(0.165)
FDI (log)				0.0108		0.0313
				(0.0307)		(0.0394)
Trade (log)					0.108	0.127
					(0.202)	(0.135)
Intercept	0.0794	1.669***	-0.945**	0.0733**	-0.334	-0.752
	(0.0563)	(0.594)	(0.402)	(0.0289)	(0.795)	(0.742)
Observations	867	589	742	634	788	577
Countries	121	108	119	120	120	117
AR(1)	0.003	0.01	0.003	0.008	0.008	0.032
AR(2)	0.73	0.96	0.13	0.11	0.234	0.114
Hansen Test	0.13	0.21	0.35	0.29	0.400	0.615
Instruments	23	23	19	17	19	12

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2008.

[7] We apply the approach of the residuals generated regressors (Gomanee et al., 2005) to identify the transmission channels. We find similar results (available on request).

Table 12. Effect of Democratic Institutions on Environment Quality with Two Step GMM-System

Dependent variable GMM System Two Step	Log of carbon dioxide emissions per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged sulphur dioxide per capita (log)	1.073***	0.871***	1.060***	1.100***	0.950***	0.941***
	(0.0696)	(0.0263)	(0.0693)	(0.0705)	(0.160)	(0.0717)
Democratic Institutions	-0.0273***	-0.0566*	-0.0825*	-0.0340***	-0.0270***	-0.143***
	(0.00761)	(0.0330)	(0.0462)	(0.00937)	(0.00720)	(0.0452)
Population Growth	-0.0633	-0.0608	-0.0434	-0.0567	-0.0266	0.0596
	(0.0405)	(0.0467)	(0.0341)	(0.0437)	(0.0421)	(0.0581)
Income per capita (log)	-0.0116	-0.0839	-0.00887	-0.0132	0.00781	-0.00211
	(0.0145)	(0.0728)	(0.0121)	(0.0142)	(0.0189)	(0.00789)
Income inequality		-0.00576*				-0.0250**
		(0.00327)				(0.00977)
Investments (log)			0.128*			0.356***
			(0.0768)			(0.106)
FDI (log)				-0.0384		-0.0163
				(0.0636)		(0.0250)
Trade (log)					-0.0542	-0.0776
					(0.0838)	(0.0701)
Intercept	1.109	-1.122***	0.533	1.628*	-0.447	-1.022
	(0.865)	(0.276)	(1.002)	(0.950)	(2.014)	(1.008)
Observations	800	577	692	744	590	423
Countries	104	104	102	103	104	90
AR(1)	0.007	0.040	0.011	0.009	0.015	0.049
AR(2)	0.288	0.218	0.239	0.285	0.181	0.157
Hansen Test	0.153	0.212	0.197	0.772	0.259	0.719
Instruments	19	11	18	20	19	27

Notes: * significant at 10%; ** at 5%; *** at 1%. The study period is 1960-2008.

5. CONCLUSION

This paper analyses the effect of democratic institutions on environmental quality and identifies transmission channels. The main contribution of this paper is to identify and test some channels, which are income inequality, investments, foreign direct investments (FDI) and trade. We use panel data from 1960 to 2008 for 122 countries and apply alternative econometric methods (one-step GMM system, two-step GMM system, fixed-effect estimators). The results are as follows. First democratic institutions have opposite effects on environmental quality: a positive direct effect on environmental quality and a negative indirect effect through domestic investments and income inequality. Indeed, democratic institutions attract investments that harm environmental quality. Similarly, democratic institutions damage environmental quality because they reduce income inequality. Second the nature of democratic institutions (presidential, parliamentary) is conducive to environmental quality. In an older democracy, political leaders favour the provision of visible environmental goods (SO_2). Final, the positive effect of democratic institutions on environmental quality is higher in developed countries than in developing countries. Thus, the democratic process in the first group of

countries has increased their awareness of the environmental protection. Results are robust to an alternative econometric method (two-step GMM system), the inclusion of additional control variables (legal structure and security of property rights, corruption) and alternative measures of democratic institutions. The positive effect of democratic institutions shows that they allow people to be more conscious of environmental problems. Democratic institutions are also responsive to the demands of people by reducing income inequality and increasing investments that favour economic growth. The negative effect on environmental quality through income inequality and investments highlights some important factors explaining the free-riding behaviour of some democratic countries.

Our results suggest policy implications. They suggest that an improvement of the democratization process in countries (especially developing countries) favours environmental quality through a high level of awareness of people for environmental protection. In addition international community and Non Governmental Organizations (NGO) should promote environmental campaigns in presidential democracies, which seem to be the best system to protect environmental quality.

To dampen negative effects that emanate from domestic investments, countries should promote green investments (for instance renewable energies). In addition, policymakers should ensure that distributive policies (induced by democratic institutions) do not translate into environmental degradation.

APPENDICES

Table A1.   Descriptive Statistics

	Average	Standard Dev	Min	Max
Carbon dioxide per capita	4.04	6.69	0	76.16
Sulfur dioxide per capita	0.000018	.0000384	2.94e-08	0.000647
Democracy (Polity 2)	0 .32	7.33	-10	10
Income inequality	41.58	6.67	21.82	62.32
Investment rate	21.37	7.486702	2.53	86.79
Foreign Direct Investments	2.627364	4.507913	-13.26511	62.26394
Trade openness	67.83	41.55648	2.35	466.31
Income per capita	5147.74	7842.89	83.50	53653.35
Population rate	1.87	1.54	-20.36	11.80
Property rights	12.34949	4.311884	1.94496	20.83041
Corruption	2.929675	1.394834	0	6
Law and Order	3.501834	1.510063	0	6
Democracy (Van index)	10.95214	12.80848	0	45.42
Democracy (chga)	0.4108145	0.478568	0	1

Table A2.   List of Countries in the Sample

Albania	Botswana	Ecuador	India	Morocco	Liberia	P New Guinea	Syria
Algeria	Central African Republic	Egypt, Arab Rep. Eritrea	Ireland	Mauritania	Libya	Poland	Tanzania
Argentina	Canada	Spain	Iran, Islamic Rep	Moldova	Lesotho	Portugal	Thailand
Armenia	Chile	Ethiopia	Israel	Madagascar	Sudan	Paraguay	Tonga
Australia	China	Finland	Italy Kuwait	Mexico	Switzerland	Romania	Trinidad Tobago
Austria	Cote d'Ivoire	Fiji	Jamaica	Macedonia, FYR	Russian	Russian	Tunisia
Azerbaijan	Cameroon	France	Jordan	Malta	Norway	Rwanda	Turkey
Belgium	Congo, Rep.	Gabon	Japan	Myanmar	Nepal	Saudi Arabia	Uganda
Burundi	Colombia	United Kingdom	Kenya	Mongolia	New Zealand	Senegal	Ukraine
Benin	Cape Verde	Ghana	Kyrgyz Republic	Mozambique	Oman	Singapore	Uruguay
Bangladesh	Costa Rica	Greece	Korea, Rep.	Mauritius	Pakistan	El Salvador	United States
Bulgaria	Croatia	Guatemala	Kuwait,	Malawi	Panama	Suriname	Sweden
Bahrain	Cyprus Czech Republic	Honduras	Sri Lanka	Malaysia	Peru	Slovak Republic	Venezuela, RB
Burkina-Faso	Germany	Haiti	Lithuania	Namibia	Guinea	Slovenia	South Africa
Bolivia	Denmark	Hungary	Luxembourg	Nigeria	Qatar	Sweden	Zambia
Brazil	Togo	Indonesia	Mali	Netherlands	Philippines	Swaziland	Zimbabwe

Table A3.   Variables Definitions and Sources

Variables	Definitions	Sources
Sulfur dioxide per capita	Sulphur dioxide emission per GDP	David Stern (2005)
Carbon dioxide per capita	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	WDI (2010)
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 (2008)
Democracy (van)	This index combines two basic dimensions of democracy – competition and participation – measured as the percentage of votes not cast for the largest party (Competition) times the percentage of the population who actually voted in the election (Participation). It varies from 0 (no democracy) to 100 (full democracy).	Vanhanen (2011)
Democracy (chga)	Coded 1 if democracy, 0 otherwise. A regime is considered a democracy if the executive and the legislature is directly or indirectly elected by popular vote, multiple parties are allowed, there is de facto existence of multiple parties outside of regime front, there are multiple parties within the legislature, and there has been no consolidation of incumbent advantage.	Cheibub, Gandhi and Vreeland (2009)
Form of democratic government	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.	The logic of Political Survival Data Source
Foreign Direct Investments Investments	It is the net inflows in current US$ (% of Foreign Direct investments) Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.	WDI (2010)
Trade openness	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	
Population growth	Annual population growth rate (%).	
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) (2008)
Property rights	Legal structure and security of property rights	Fraser (2008)
Income per capita	Gross Domestic Product per capita	WDI (2010)
Corruption	Indicator of corruption as reported by international consultants. Scaled from 0 to 6, higher values denote less corruption	ICRG
Law and order	Law and Order are assessed separately, with each sub-component comprising zero to three points. The Law sub-component is an assessment of the strength and impartiality of the legal system, while the Order sub-component is an assessment of popular observance of the law. Thus, a country can enjoy a high rating – 3 – in terms of its judicial system, but a low rating – 1 – if it suffers from a very high crime rate of if the law is routinely ignored without effective sanction.	ICRG

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