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Abstract

The Middle East and North Africa (MENA) countries are among the world's top emitters of CO2 and SO2 in per capita terms. The objective of this paper is to analyze whether investing in the democratic development of these countries is an effective tool to make the economic growth in this region more environmentally compatible. Arguing on the basis of the Environmental Kuznets Curve hypothesis and using panel data on the income-emission-democracy nexus, we find evidence that improvements in the democratic development of the MENA countries help to mitigate environmental problems. Our results clearly show, that the quality of democratic institutions has a greater influence on local environmental problems than on global environmental issues in the MENA region.

Keywords: democratic development; political institutions, environmental quality; MENA
JEL classification: Q56; Q58

1 Introduction

According to the Carbon Dioxide Information Analysis Center, six Middle Eastern countries ranked among the top 20 emitting nations based on CO2 per capita in 2007 (global ranking in parentheses): Qatar (1), Kuwait(2), United Arab Emirates (4), Bahrain (5), Saudi Arabia (14) and Oman (20).[1] Figure 1 shows the comparative position of the MENA region in terms of CO2 per capita from 1965 to 2005. It shows that MENA countries have had high records since 1965, exceeding the world average from 1995 onwards.

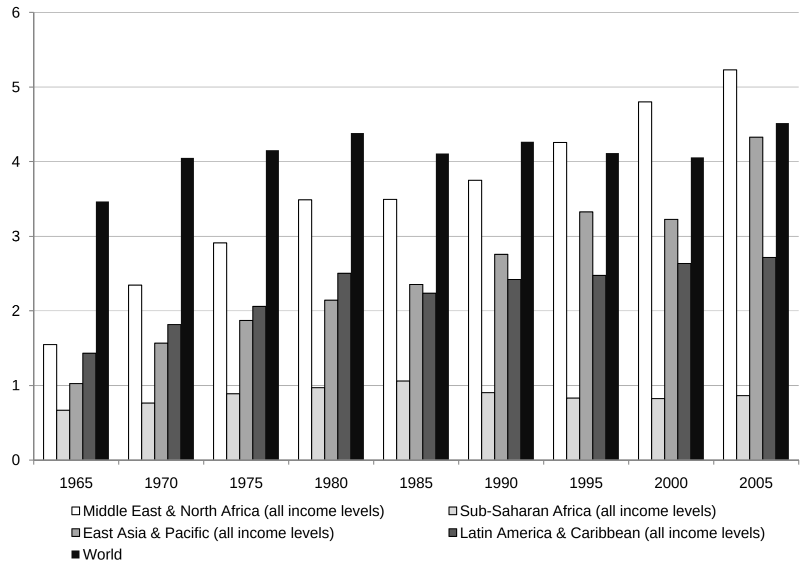

Figure 1: CO2 per capita (metric tons): comparative picture. Source: WDI (2011)

The MENA region has around 57% of the world's proven oil reserves and 41% of natural proven gas reserves. About 85% of all green house gas (GHG) emissions in this region come from energy production and consumption. The associated environmental problems are worsened through heavy subsidies on petroleum products which encourage excessive and inefficient use of fossil energy. According to the IEA (2008), energy subsidies in 20 largest non-OECD countries reached 310 billion US dollar in 2007. 11 countries out of the total of 20 countries in the world which subsidized the gasoline consumption were from the MENA region [Brown (2011)]. For example, fuel subsidies alone are 2 to 7.5 times larger than the public expenditures on health in Egypt, Morocco, and Yemen [WDI (2011)]. In 2007 the Iran was the largest fossil-fuel subsidizer in the world with $56 billion per year.[2] The under-pricing of oil products in the MENA region is significant. In 2008, for example, the gasoline price gaps between the price of gasoline in Algeria, Bahrain, Egypt,

[1] see http://cdiac.ornl.gov/trends/emis/top2007.cap

[2] Russia was the second largest subsidizer with $51 billion per year. China, Saudi Arabia, India, Venezuela, Indonesia, Egypt and Ukraine are the other large subsidizers, with annual subsidies in excess of $10 billion per year (IEA, 2008).

Iran, Kuwait, Libya, Qatar, Saudi Arabia and Yemen and the average world price of gasoline were 77, 90, 62, 58, 87, 97, 89, 95, and 81 percent per liter, respectively [WDI (2011)]. The massive subsidies distort the price system and lead to an inefficient allocation of resources. The high energy intensity of the production and the wasteful consumption of fossil fuels is a natural consequence of such subsidies. The existence of cheap energy hampers investments in clean technology and energy efficient means of transportation [see Ellis (2010) and von Moltke et al. (2004)]. The IEA (2010) emphasizes that phasing out fossil fuel subsidies is a crucial part of the climate change mitigation package for the MENA region.

Figures 2 and 3 show the carbon intensity of energy (emissions divided by energy use) and the energy intensity of GDP (energy use divided by GDP) in the MENA countries compared with other groups. The figures show that the MENA region produces the highest amount of energy consumption related emissions worldwide. Also the energy intensity of the production in the MENA has continuously increased since the 1980s, exceeding the global average from 2000 onwards. Moreover, MENA countries are experiencing one of the world's fastest growth rates in terms of

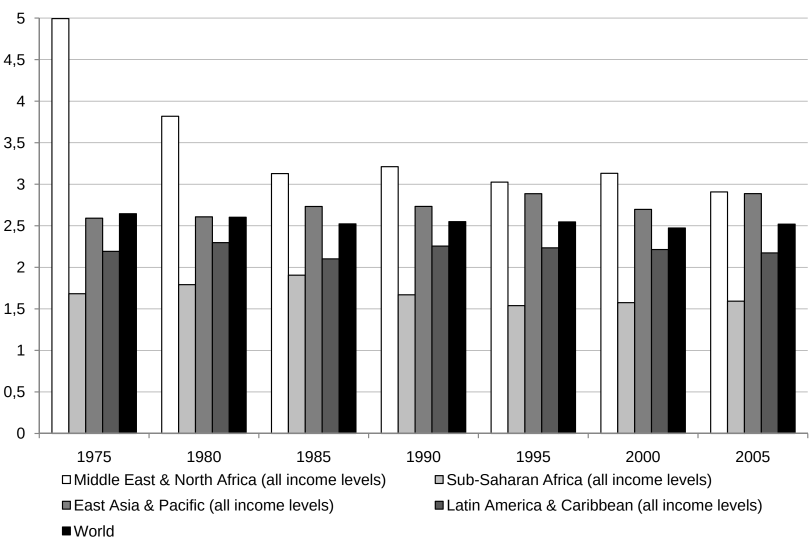

Figure 2: Carbon intensity of energy consumption (kg per kg of oil equivalent energy use), source: WDI (2011)

their consumption of fossil fuel products. During 1980-2000, their energy consumption has nearly tripled from 9 quads to 25 quads[3], reflecting an average annual increase of 5.1%[4]. In contrast to developed countries, most MENA countries are still on initial stages of industrial development, and a further rise in industrial production is expected. The increasing reliance on fossil fuel resources, the rapid growth of population in most parts of MENA countries as well as their high economic

[3] 1 Quad=10^{15} BTU. A BTU (British Thermal Unit) is the amount of heat necessary to heat one pound of water by 1 degree Fahrenheit.

[4] http://www.eia.doe.gov/environment.html

growth pose a threat to mitigating climate change and air pollution in the near future. The important policy question is "whether economic growth should continue to be the main priority, with protection of the environment a secondary consideration to be addressed mainly in the future, or whether explicit policies to control environment degradation at the local, national and global level are urgently required today" [Barbier (1997)].

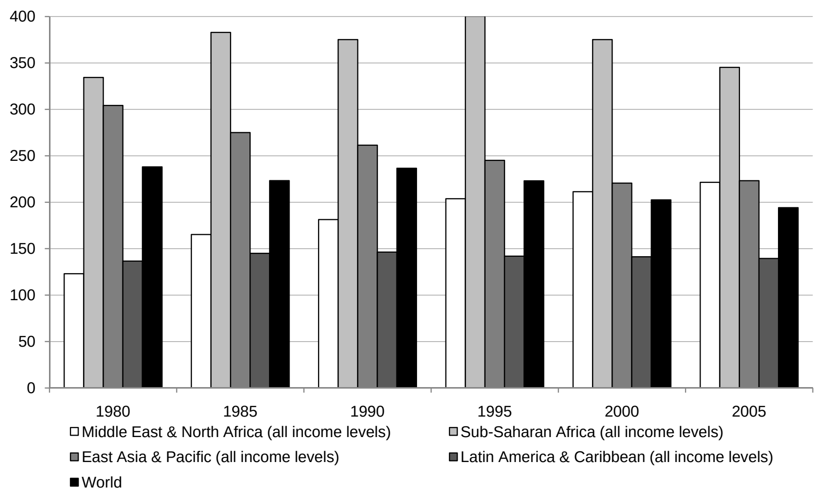

Figure 3: Energy intensity of GDP (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP), source: WDI (2011)

Recent studies based on the Environmental Kuznets Curve (EKC) hypothesis raise an important question with crucial implications for developing countries such as MENA: Should developing countries follow "the grow now, clean later" logic? The EKC hypothesis implies that developing countries will reach a turning point on their growth path. It is after this point that higher growth will accompany lower environmental degradation. However, as van Alstine and Neumayer have mentioned: "*Some developing countries will not reach this turning point for decades to come.*" [van Alstine and Neumayer (2008), p.57)]. Thus, it is important to keep in mind that economic growth by itself will probably not be the solution to environmental degradation in the near future.

A second distinguishing feature of MENA countries in comparison to developed countries is the stage of development of democratic institutions. In general, the political and democratic institutions in MENA countries are less developed. Many of the MENA countries are governed by autocratic regimes and the democratic participation of the people is rather low. This prevents the people from exercising their preference for environmental quality and may result in insufficient environmentally orientated policies. However, in the last two decades a number of MENA countries have significantly improved their democratic institutions. For example, Algeria improved its *Polity2* score from -8 in 1965 to -2 in 2005, Iran from -10 to 1.2 and Jordan from -9 to -2 for the same time span. More significantly, since the end of 2010 we are observing an ongoing political movement and revolutions in several countries in the MENA region known as the "Arab Spring". Some countries in the MENA region such as Egypt, Tunisia and Libya have begin to modernize their political structure and open themselves to democratic ideas. This modernization increases demand for more political engagement on the side of civil society. Tolba and Saab (2008) provide a comprehensive review of the future environmental challenges in the Arab world. The previous literature has shown that the relationship between environmental quality and economic development is not independent from political institutions that govern the process of policy making [see e.g. Farzin and Bond (2006) or Pellegrini and Gerlagh (2006)]. In particular, democracy and the associated freedoms seem to affect the level of environmental quality [Bernauer and Koubi (2009)]. Thus, our question is whether better democratic institutions can reduce the environmental hazard and how the impact depends on the level of countries' income.

This paper makes a contribution on two fronts: it demonstrates the important mediating effects of democratic institutions in reducing pollution as incomes rise, and it focuses on a set of highly polluting countries with great potential for growth in both income and quality of democratic institutions. The choice to study MENA countries has become even more salient due to political events since 2010. Our study for the case of the MENA region considers the two major air pollution indicators (SO2 and CO2 emissions) for a 25-year time period (1980-2005). SO2 is a well-known indicator of local pollution, while CO2 emissions are an indicator for global pollution. The largest sources of SO2 emission are fossil fuel combustion at power plants and other industrial units such as petroleum refineries, cement kilns, metal smelters and motor vehicles. We make use of a number of different subjective and objective indicators of democracy. We find evidence for the EKC hypothesis for both CO2 and SO2 emissions. Furthermore, we notice that increasing the quality of democratic institutions can moderate the increasing negative externalities of economic development for environment in the MENA region. The moderating role of political institutions is in particular valid for the case of local pollution (SO2). For global pollution (CO2), the democratic development of countries seems to play only a minor role. The improvement of democratic institutions and higher accountability of the government affect local environmental problems more significantly than global environmental issues.

The remainder of the paper is organized as follows: In the next section, we will briefly review the theoretical and empirical literature. Section 3 presents the data and empirical specification. The results are discussed in Section 4. Finally, Section 5 discusses the policy implications of our study.

2 Review of theoretical and empirical literature

2.1 Political institutions and pollution

Environmental quality is often seen as a normal good, if not a luxury good. This means that the income elasticity of demand for environmental quality is larger than zero or even than one.

If the income increases, the society pays more attention to the environmental quality [for more details, see e.g. Beckerman (1992)]. There are two different branches in the literature on the effects of democracy on the quality of environment. Some support positive environmental effects of democracy and higher quality of political institutions. It is argued that non-democratic regimes provide less public goods, including environmental quality [see Olson (1993), McGuire and Olson (1996), Lake and Baum (2001), de Mesquita et al. (2003) and Deacon (2009)]. Such systems are usually governed by small elites which redistribute income from their population to themselves. The costs of higher environmental standards are born excessively by the elite while the benefits are uniformly dispersed throughout the population. Thus, non-democratic regimes have little incentives to increase environmental standards. In democratic societies the median voter decides on environmental policies. The median voter has to bear lower costs for environmental policies than the economic and political elite. Hence, democratic regimes may have stricter environmental policies [see Bernauer and Koubi (2009)]. Democratic countries are usually richer economies as well. The supporters of the economic growth solution for environmental pollution point out the use of less pollution-intensive technology in production process in richer economies as one of the positive side-effects of growth on pollution [see Grossman and Krueger (1995)].

Some other studies point out to the environmental challenges within democratic systems. Hardin (1968) introduces "tragedy of commons", arguing that democracies are faced with over extraction of natural resources and higher environmental degradation because of the economic and business freedom of individuals. Paehlke (1996) discusses the relevance of democracy for local environmental problems and undermines its effectiveness for global and transnational pollution. Heilbronner (1974) shows that one of drivers of environmental degradation is increasing population. He argues that autocratic states can impose stricter control on the population growth than democratic systems. Role of industrial and business lobbies in democracies and their negative effects of the quality of environment are also mentioned by Dryzek (1987).

There are empirical studies which have investigated the direct environmental effects of democracy. Grossman and Krueger (1995) find that non-communist countries have had a better environmental performance. Torras and Boyce (1998) show that higher levels of democracy increase the air and water quality, in particular in lower income countries. Barrett and Graddy (2000) also find a constructive effect of democracy on air pollution and insignificant effect on water pollution. Harbaugh et al. (2002) show that higher level of democracy has a negative and statistically significant effect on SO2 emission, controlling for other determinants of pollution. Bernauer and Koubi (2009) find a similar result. It is shown that democracies have higher commitments to international environmental agreements and more stringent environmental policies [Neumayer (2002), Fredriksen and Gaston (2000), and Fredriksson et al. (2005). Farzin and Bond (2006) find empirical evidence for a dampening effect of democracy on pollution. Binder and Neumayer (2005) examine the role of environmental non-governmental organizations, which exert stronger influence in democratic societies, and show that these civil organizations exert a statistically significant impact in the reduction of sulfur dioxide emission.

2.2 Economic determinants of pollution

The starting point for our empirical investigation of the emission-income-democracy nexus is the well known Environmental Kuznets Curve (EKC). The previous empirical results regarding the EKC are mixed, depending on the applied emission indicators, the included control variables and samples. Generally, the empirical results show three potential links between income and environmental degradation. These are depicted in Figure 4. In most studies, the basic empirical

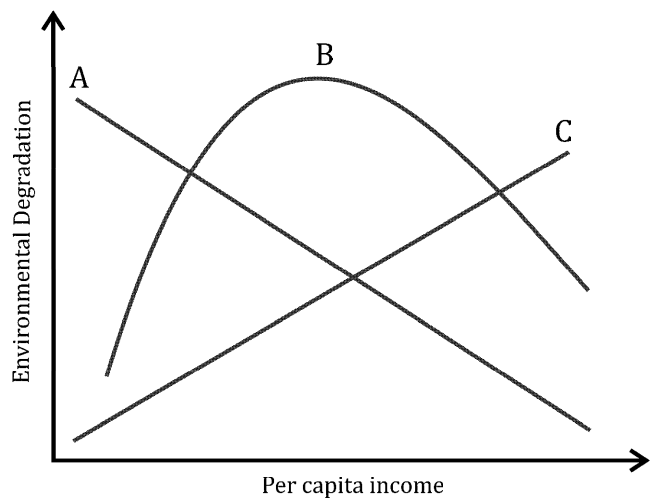

Figure 4: Environmental degradation and economic growth

specification is as follows:

$$ED_{i,t} = \alpha_0 + \alpha_1 GDP_{i,t} + \alpha_2 GDP_{i,t}^2 + \nu_i + \eta_t + \varepsilon_{i,t} \tag{1}$$

where, ED, is the environmental degradation (pollution indicator per capita), GDP is GDP per capita, ν and η control for country and time specific effects; i and t refer to countries and time periods. If the estimated α_1 is negative and significant and α_2 is not statistically significant, then we get line A in Figure 4. This means that increasing the income per capita reduces the environmental degradation. When the estimated α_1 is positive and significant and α_2 is not statistically significant, then we are at line C, e.g. increasing income will increase pollution as well. The most frequent outcome in previous literature is line B in Figure 4. In this case, the estimated α_1 is positive and significant and α_2 is negative and significant. Increasing the income per capita initially raises pollution up until a turning point. After this point, increasing income reduces the environmental degradation. The turning point can be calculated by taking the derivative in respect to y: $\bar{y} = (-\alpha_1/2 \cdot \alpha_2)$. The estimated turning points depend on what kind of pollutant the researchers study (see van Alstine and Neumayer (2008) for a survey).

Stern (2004) provides an excellent review of the EKC literature and criticizes the empirical studies of the EKC hypothesis. He raises some aspects which must be carefully re-examined in such studies: specification problems, major econometric weaknesses such as heteroscedasticity, omitted variable bias, and cointegration - related issues. For instance, the basic and common specification of EKC as presented in equation (1) does not control for interaction of GDP per capita and other policy indicators such as democracy. A higher quality of democratic institutions may transfer the turning point in Figure 4 to the left or make the slope of the curve flatter, reaching the turning point sooner or at lower economic costs. Another important question arises: Is the EKC relationship a quasi-automatic or policy-induced one [see Grossman and Krueger (1995)]? Policies such as secure property rights, the rule of law, better enforcement of contracts, effective environmental regulations, more political freedom and transparency, improved governance, the development of the financial sector and higher literacy can significantly affect the environmental quality [see, for example, Lopez and Mitra (2000), Bernauer and Koubi (2009), Pellegrini and Gerlagh (2006) and Farzin and Bond (2006)]. Indeed, the effect of growth on environment depends on the aforementioned policy indicators. For an extensive survey of related theoretical and empirical discussions about the EKC hypothesis, see Dinda (2004).

3 Data and empirical specification

As mentioned before, our research objective is to analyze the relationship between economic development, the stage of democratic development and environmental degradation in the MENA region. Our sample consists of 17 countries[5] during the period from 1980 to 2005. We take five years' average from the data to control for missing values and data heterogeneity, which yields five periods. The major benefit of using five years' average instead of yearly data is avoiding business cycles and reducing the effects of outliers, while capturing the time dimension of the panel. Table 4 in Appendix A provides a list of included countries.

To explore the income-pollution-institutions nexus in the MENA, we estimate the following log-linear specification:

$$log(ED_{i,t}) = \alpha_0 + \alpha_1 GDP_{i,t} + \alpha_2 GDP^2_{i,t} + \alpha_3 DQ_{i,t} + \alpha_4 (GDP_{i,t} \cdot DQ_{i,t}) + \alpha_5 Z_{i,t} + \nu_i + \eta_t + \varepsilon_{i,t} \quad (2)$$

where countries are indicated by i; time is indicated by t; ED is the local or global indicator of air emissions, GDP is real GDP per capita, DQ is the quality of democratic institutions, $(GDP \cdot DQ)$ is the interaction of real GDP per capita and the quality of institutions, Z is a vector of control variables which may affect the pollution including: *trade openness* (import+export divided by GDP), *urbanization* (share of urban population in total population), *population density*, *working age population* (between 15 and 64 years old), *energy intensity* (energy consumption divided by

[5] The MENA countries Iraq, Lebanon, Malta and Qatar are not included in the sample due to the limited availability of data.

GDP) and a *time trend* variable to control for a common technological progress (see Panayotou (1997) for a similar approach). Unlike cross-sectional analysis, the advantage of panel data is that they allow controlling for individual heterogeneity and reducing the risk of biased results. We allow for country (ν_i) and time (η_t) specific effects. The former captures unobservable time-invariant country characteristics, while the latter captures shocks common to all countries. We always present the results for pooled OLS estimations, country and time fixed and random effects with heterogeneity-robust standard errors. The pooled OLS provides only a first idea of how the data are correlated without controlling for country and time fixed effects. In fixed effects estimations, what we measure is the "within" effects of income and democracy on pollution indicators, namely the impact of changes in income, democracy and their interaction term on changes in levels of pollution within countries. To control for the persistency in dependent variable, we also control for the lag of dependent variable. Using lag of dependent variable calls for a different estimation method, e.g., GMM. In addition, we present a number of robustness tests using different measures of the quality of democratic institutions.

3.1 Dependent variables

We use indicators of both local and global air pollution. For the local pollutants, the most appropriate indicator is sulfur dioxide (SO2). SO2 is one of the criteria pollutants[6] and is used by the World Bank, OECD and other international organizations as an indicator for air quality. One of the important aspects of this pollutant is its controllability by the local governments through effective regulation and alternative production techniques. This pollutant (SO2) in industrial countries mainly stems from electricity generation, whereas in developing countries it comes from the burning of diesel fuels. The source of information for the amount of SO2 is Smith et al. (2011). They have provided new estimates for the global and regional anthropogenic sulfur dioxide emissions. SO2 emissions are estimated annually for the following sectors: coal combustion, petroleum combustion, biomass combustion, shipping bunker fuels, metal smelting, natural gas processing and combustion, petroleum processing, pulp and paper processing, other industrial processes, and agricultural waste burn. The final estimated SO2 is the sum of SO2 emissions from above mentioned categories. We use the logarithmic form of SO2 per capita in this study.

The second indicator of air quality is carbon dioxide (CO2). In contrast to SO2, this pollutant is a global problem. The most important contributor to CO2 and total greenhouse gas (GHG) emissions is the fossil fuel consumption. The Intergovernmental Panel on Climate Change (IPCC) 2007 report shows that the long-observed trend in the reduction of CO2 emission intensity per unit of GDP reversed in 2000. "*This means that, with world economic growth the strongest it has been in decades, global CO2 emissions are growing faster than at any time since 1970.*" [Bacon and Bhattacharya (2007), p.1]. The source of data for CO2 emissions (metric tons per capita in

[6] Carbon Monoxide (CO), Nitrogen Oxide (NO2), Ozone (O3), particulate matter (PM10 and PM2.5), and Lead (Pb) are other criteria pollutants.

logarithmic form) is WDI (2011). According to the World Bank definition, carbon dioxide emissions (CO2) are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during the consumption of solid, liquid, and gas fuels and gas flaring. Thus, CO2 emission is calculated primarily through the amount of energy consumption.

3.2 Independent variables

One of the robust determinants of environmental quality is the economic development, measured by the level of GDP per capita. In accordance with the previous literature, we expect that higher economic development leads to higher energy consumption and thus more environmental pollution. However, on the basis of the EKC hypothesis, it is possible that after a specific income threshold, higher development leads to better quality of environment. It is argued that in this early phase of development and growth, the governments pay more attention to meeting the basic needs of people and addressing the major economic problems such as unemployment and inflation. In the initial stages of development, environmental quality is then a luxury good. However, upon reaching a turning point, it changes to a normal good. People in higher developed countries demand a more environmental-friendly production and cleaner environment. The existence of such a non-linear relationship between economic development and environmental quality has been extensively studied in previous literature [see e.g. Dinda (2004)]. The source of GDP per capita is the WDI (2011). Therefore, we use the level and squared transformations of real GDP per capita to test the EKC hypothesis that there is an inverted U-shaped relationship between real GDP per capita and environmental pollution, ceteris paribus:

H1: Following the EKC hypothesis the GDP per capita has an increasing effect on emission ($\alpha_1 > 0$). After the turning point, higher growth will reduce emission ($\alpha_2 < 0$).

The second important variable which is of our main interest in this paper is the quality of democratic institutions. Panayotou (1997) emphasizes that the quality of policies and institutions can significantly reduce environmental hazards at low income levels and expedites improvements at higher income levels. In other words, better institutions can help flatten the EKC. More specifically, Panayotou (1997, p.469) mentions that: "... *the removal of distortionary subsidies and introduction of more secure property rights over resources and pollution taxes (or other efficient instruments) to internalize externalities, are expected to reduce the environmental price of economic growth.*". Bromley (1989) defines institutions as "*Rules and conventions of society that facilitate coordination among people regarding their behavior*"[Bromley (1989), p.22]. North (1990) presents the most cited definition of institutions: "*Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction.*" [North (1990), p.3]. One important question is how to incorporate these various dimensions into a measure of institutions.

We report the results of pollution-income analysis, controlling for other key determinants of pollution including interaction of income with three measures of the quality of democratic institutions, e.g. the *Polity2* index, the *Vanhanen* index of democracy and the Freedom House *civil liberty* indicator. The *Polity2* index from the Polity IV project [Marshall, Gurr and Jaggers (2009)] has been widely used in the literature as a proxy for political openness and democracy. We have rescaled this index to the range from 0 to 1, where higher scores mean higher levels of democracy. In contrast to the *Polity2* index which is a subjective measurement of democracy, the *Vanhanen* index of democracy is an objective measure of political competition and participation [see Vanhanen (2000)]. This index combines two basic dimensions of power balance − competition and participation − measured as the percentage of votes cast for parties other than the largest one (competition) multiplied with the percentage of the population who actually voted in the election (participation). This product is divided by 100 to form an index that in principle could vary from 0 (lowest level of political openness) to 100 (highest level of political openness). As a robustness check, we also report the results using the Freedom House *civil liberty* indicator which were rescaled to the range from 0 to 1 where higher scores mean lower civil liberties. Our hypotheses regarding the institutional quality is:

H2: The effect of income on emission depends on the quality of democratic institutions. We expect that increasing GDP per capita and improving the institutions at the same time reduces environment pressures ($\alpha_4 < 0$).

Another important aspect of environmental development is the degree of globalization of a country and its international trade and investment connections. Cole (2004) suggests that *trade openness* may reduce pollution because the countries may find greater access to environmentally friendly technologies. However, the opposite effect can also occur. Based on the "Pollution Haven Hypothesis", developed countries may export their dirty industries such as petrochemical and cement industries to those developing countries with lower environmental standards. In such a scenario, higher trade openness may increase the local and international environmental problems. To test the puzzling effect of trade openness on environment, we use the share of imports and exports in total GDP as a standard proxy for *trade openness* from WDI (2011).

The role of demographic variables such as *population density* and the share of urban population in total population (*urbanization*) have been investigated in the literature as well. On the one hand, urbanization may add to the environmental pollution as it leads to a raise in public and private transportation resulting in higher fossil fuel consumption [Panayotou (1997)]. Moreover, a higher degree of urbanization often implies a higher density of the means of production, having a further negative impact on the quality of the environment [Cole and Neumeyer (2003). On the other hand, the negative consequences of urbanization might be mitigated by its own effects as it may stimulate networking activities among different groups of people and environmental NGOs, forcing governments to impose stricter environmental controls and standards on pollution

Table 1: Summary statistics

	Observations	Mean	Std. Dev.	Minimum	Maximum
log(CO2 per capita)	102	1.42	1.24	-1.00	4.00
log(SO2 per capita)	96	-10.69	1.01	-13.99	-8.84
GDP per capita	93	6677.17	8373.55	442.14	41403.83
Polity2 (rescaled)	99	0.24	0.28	0.00	1.00
civil liberty (rescaled)	99	0.75	0.16	0.29	1.00
Vanhanen index	102	4.13	8.90	0.00	36.74
energy intensity	77	0.22	0.11	0.09	0.77
trade openness	94	80.66	36.09	13.25	219.24
urbanization	102	64.33	20.11	15.48	98.24
population density	102	87.64	168.13	1.53	957.84
pop 15-64	102	57.30	6.71	46.33	76.81

intensive industrial units. Urbanization also provides a unique opportunity for people to access politicians and policy makers, which may be not the case in a country with a higher share of the rural population [Torras and Boyce (1998), Rivera-Batiz (2002) and Farzin and Bond (2006)]. It is, however, unlikely that the benefits of urbanization outweigh its negative consequences. The second demographic variable is *population density*. It is often emphasized that a high population density leads to an unsustainable exploitation of the environment [Hilton and Levinson (1998)].

The age structure of population, in particular the working age population (15-64 years old), can have an effect on the environmental degradation. Some scholars refer to the positive role of this part of the population in reducing pollution, while some others oppose this view. Farzin and Bond (2006) have explained these different views on the effects of age composition on environmental quality. They point out, for example, that young people can bear more risks of environmental pollution compared to the older part of population. The youngers have a higher option value of waiting for future improvements in environmental quality. Older people feel the health problems of pollution more directly and are willing to put higher pressures on the government for stricter environmental regulation. Older people also may have more spare time to participate in local NGOs, supporting environmentally-friendly policies by the government. Thus, on the basis of Farzin and Bond argument, we expect that a higher share of the working age population on total population (*pop 15-64*) increases the environmental degradation.

Finally, one of the main characteristics of the MENA countries is the significant amount of fossil fuel subsidies. Higher energy subsidies lead to higher reliance on energy inputs for production. This increases the *energy intensity* of production, measured by the share of energy consumption in GDP.

Appendix A presents data descriptions, transformations and sources. Table 1 shows descriptive statistics of our main variables.

4 Results

4.1 Main results

We have specified the model in log-linear form, which is commonly used in the EKC literature [see e.g. Binder and Neumayer (2005) or Bernauer and Koubi (2009)]. We present the results of estimations for pooled OLS (Pooled OLS); country and time fixed OLS (C&T FE), country random and time fixed effects GLS (C&T RE) and system GMM with heteroscedasticity robust standard errors at country level. For the case of CO2 and SO2 emissions, the Hausman test shows that we cannot accept the null hypothesis of no systematic differences between fixed and random effects at 10% level (p-values: 0.03 and 0.08, respectively). The rejection of null hypothesis for the case of CO2 and SO2 models means that individual effects are correlated with the other regressors in the models and thus a random effect model produces biased estimators, violating one of the Gauss-Markov assumptions; so a fixed effect model is preferred.

Table 2 shows the results of the income-pollution-democracy nexus using the *Polity2* index as a measure of the quality of political institutions. Regardless of method of estimation, we can see a robust evidence for the EKC hypothesis (see H1) for the case of CO2 and SO2 emissions. There is an inverted U-shaped relationship between income per capita and global and local pollution in the MENA region, controlling for other demographic, economic and political factors. Regarding our second variable of interest namely moderating role of democracy (*Polity2*), we have noticed a highly statistically significant negative interaction term between Polity and income for the case of SO2 emission. The moderating role of democracy in income-pollution is not statistically different from zero in the case of global pollution (CO2).[7] This empirical finding is in line with the theoretical argument of Farzin and Bond (2006). According to their argument, at rather lower income per capita levels and by increasing income inequality "it is the environmental preferences of the poor (i.e., abatement of local pollution), and not those of the rich (reduction of global pollution), that dominates the state's environmental policy." Democratization (as measured by within country changes in our democracy measure in fixed effects regressions) provide an opportunity for the masses in the MENA region to pressure the government for better policy making and regulations in the local environment. Sound democratic institutions stimulate a flow of information regarding health risks of pollutants and its consequences and facilitate mobilization and expression of public demands for cleaner environment. Control of local air pollution as a public good is more respected within democracies than within autocracies [see Congleton (1992) and Deacon (2009)].

[7] Table 5 in Appendix B shows the results of the estimations without considering the quality of democratic institutions.

Table 2: Pollution-Income-Institutions: using *Polity2* index

	Dep. variable: log(CO2 per capita)				Dep. variable: log(SO2 per capita)			
	Pooled OLS	C&T FE	C&T RE	GMM	Pooled OLS	C&T FE	C&T RE	GMM
GDP	0.00019***	0.00013***	0.00015***	0.00008**	0.00019***	0.00022***	0.00021***	0.00013***
	(5.24)	(4.72)	(4.64)	(2.53)	(4.89)	(6.97)	(6.82)	(4.48)
GDP^2	-2.72e-09***	-1.49e-09***	-1.86e-09***	-1.45e-09***	-2.59e-09***	-2.58e-09***	-2.61e-09***	-1.73e-09***
	(-3.69)	(-3.50)	(-3.48)	(-2.99)	(-4.50)	(-4.80)	(-5.56)	(-3.65)
trade	-0.00517**	0.00097	0.00078	-0.00182	-0.00345	0.00068	-0.00358	-0.00032
	(-2.45)	(0.44)	(0.62)	(-1.13)	(-1.27)	(0.26)	(-1.34)	(-0.12)
urbanization	0.01825***	-0.01330	0.0034754	0.00580	0.02313***	0.02840***	0.02040***	0.01037
	(3.59)	(-1.60)	(0.63)	(1.35)	(5.27)	(3.12)	(2.72)	(1.64)
pop density	0.00056**	-0.00040	-0.00003	0.00030	0.00046	0.00358***	0.00151***	0.00100*
	(2.57)	(-0.63)	(-0.08)	(0.94)	(1.42)	(3.78)	(3.75)	(1.91)
pop 15-64	-0.02300	0.03052	0.02752*	0.01274	-0.06041***	-0.06695	-0.09678***	-0.05126***
	(-1.19)	(1.53)	(1.76)	(0.79)	(-3.00)	(-1.66)	(-3.73)	(-3.93)
energy/GDP	2.86873***	1.42428	1.81352**	—	-0.29396	2.39523**	1.37862	-0.73095
	(3.12)	(1.58)	(2.21)		(-0.33)	(2.13)	(1.37)	(-1.03)
$Polity2$	0.15852	0.30818	-0.17641	-0.15363	0.80010*	0.45820	0.98276*	0.85778**
	0.43	(1.12)	(-0.67)	(-0.25)	(1.83)	(0.70)	(1.94)	(2.70)
$Polity2 \cdot GDP$	-0.00009***	0.000012	-0.00002	-0.00003	-0.00012***	-0.0000968**	-0.00012**	-0.00010***
	(-2.97)	(0.33)	(-0.77)	(-0.68)	(-3.31)	(-2.19)	(-3.39)	(-3.34)
$time$	0.05747	0.03074	0.00587	—	0.07823*	0.02482	0.12978	0.00993
	(1.29)	(0.56)	(0.19)		(1.89)	(0.23)	(2.12)	(1.56)
dep. variable$_{t-1}$	—	—	—	0.58881***	—	—	—	0.48681***
				(4.25)				(4.08)
Obs.$^{a)}$	76 (17)	76 (17)	76 (17)	76 (17)	76 (17)	76 (17)	76 (17)	76 (17)
R^2	0.93	0.66	0.87	—	0.81	0.63	0.77	—
$AR(2)^{c)}$	—	—	—	0.203	—	—	—	0.673
$Hansen^{c)}$	—	—	—	0.861	—	—	—	0.882
$diffHansen^{c)}$	—	—	—	0.932	—	—	—	0.901

Note: robust t-statistics are in parentheses. Constant term is included (not reported). ***, **, * refer to significance at 1%, 5%, and 10% level. C&T FE and C&T RE mean country and time fixed effects and random effects, respectively. a) The number of included cross-sections are in parentheses, b) one-step system GMM, c) the value reported for the *Hansen* test is the p-value for the null hypothesis of instrument validity. The *diff Hansen* reports the p-value for the validity of the additional moment restrictions required by the SYS-GMM. The values reported for $AR(2)$ are the p-values for second order autocorrelated disturbances in the first difference equations.

These results suggest that the countries may reduce the local environmental burden of economic development by investing in their democratic institutions and providing more political transparency, accountability of the government and necessary tools for free express of demands by the citizens. In other words, "growth now, clean later" strategy can convert to "growth and clean now" by paying attention to democratic institutions.

Looking at our control variables, we notice a highly statistically significant and increasing effect of urbanization on local pollution (SO2), while the effect on global pollution (CO2) is not statistically significant. The urban population has typically more pollution intensive behavioral patterns such as higher use of personal cars, motor cycles and buses. In the MENA, the average urban population growth and share of urban population in total population from 1960-2010 was 4% and 51%, while the same figures for an average country in world reached 2% and 41%, respectively [WDI (2011)]. This rapid urban population growth rates increases local environmental problems such as air and water pollution. The same increasing effect is also observed from population density in the MENA region on local pollution but no significant effect on global pollution. The average of annual growth rate in population density of the MENA countries from 1960-2010 was 2.61% which was higher than average world for this period (1.65%). In contrast to our expectations, we find empirical evidence for the negative (decreasing) effect of higher share of working age population on local air pollution in the MENA. As argued by Farzin and Bond (2006), the younger part of population are more vocal about their environmental preferences. They have better networking capabilities and resources and therefore can have more effective participation in environmental regulation process through environmental pressure groups or green NGOs. Energy intensity, measured as energy consumption per GDP has a stronger role to increase global pollution (CO2) in the MENA region. One of the main characteristics of this region is significant subsidies on energy products and under pricing of petroleum products, leading to higher energy waste and inefficiencies. Average figure of carbon intensity (CO2 emission per 1000 US$ of GDP) from 1970-2008 in the MENA region was 1.43 which was higher than average world for the same period (0.96).

Following Tamazian and Rao (2010), we also estimate the one-step system GMM models [Arellano and Bover (1995) and Blundell and Bond (1998)], using 2 lags of potential endogenous variables (lag of pollution indicators, GDP per capita and its square)[8]. The System GMM estimator combines the first differenced equation and levels equation to estimate the model, employing both lagged levels and differences as instruments. In the models with endogenous regressors, the use of too many instruments could result in biased estimates. To avoid this problem, we restrict the number of lags used as instruments to 2 periods. The validity of the employed set of instruments is examined through the Hansen and Diff-Hansen statistics. The calculated probability under the Hansen test shows the validity of instruments while the Diff-Hansen reports the probability values for the validity of the additional moment restrictions. The GMM results in Table 2 confirm the validity of the EKC hypothesis for both CO2 and SO2 pollution in the MENA region. We also notice that our main hypothesis on the moderating role of political institutions is only valid for the case of local pollution (SO2) in this region. This finding is intuitive. It is expected that improvement in democratic institutions and higher accountability of the government affect local environmental problems more significantly than global environmental issues. One of the main obstacles to reducing CO2 as a main source of global pollution is the free riding behavior among countries. The free riding behavior is less likely for the case of SO2 pollution which is a main local emission indicator. Thus, investing in political institutions is rewarding in the case of local environmental issues.

To get a better picture of the size and interpretation of effects, we calculate the marginal effects of one standard deviation increase in GDP per capita variable at different levels of *Polity2* index on the logarithm of SO2 emission per capita. For illustration, we use coefficients of GMM model in Table 2. Using equation 2, we calculate these marginal effects.

$$\frac{\partial log(ED)}{\partial GDP} = (\alpha_1 + 2 \cdot \alpha_2 \cdot GDP + \alpha_4 \cdot DQ) \cdot std(GDP) \tag{3}$$

The results are presented in Table 3.[9] Given an average level of GDP per capita (6912 USD), a

[8] Higher pollution may increase the pressure on the governments to increase the tax rates on polluting industries and stricter environmental regulations. These environmental taxes and regulation may increase the production costs and reduction of profit margin of industrial units. Finally, the overall output in the economy can be affected by pollution. Apart from this possible reverse feedback, the lagged dependent variable which is now included to control for the persistency of pollution indicators may be correlated with error term. Thus, we treat these variables as endogenous in our GMM estimations.

[9] We present the marginal impact of increasing one standard deviation in GDP per capita at different levels of Polity index for (log)SO2 emission per capita only. The interaction term is not statistically significant for the case of (log)CO2 emission per capita.

one standard deviation increase in real GDP per capita at the minimum level of Polity index (0, e.g., Saudi Arabia) raises SO2 emissions per capita by 85%, respectively. This impact could be reduced to 6% in the case of maximum level of Polity (1, e.g., Israel). Given a minimum level of GDP per capita (442 USD, e.g., Yemen), a one standard deviation increase in the GDP per capita at the mean level of Polity index amplifies SO2 emission per capita by 108%. The less developed countries of the MENA region can reduce the negative externality of their economic growth by investing in their political institutions. For example, if Yemen with the minimum level of GDP in the MENA region could increase its democratic institutional quality to the level of Israel or Turkey, then the marginal impact of economic growth on SO2 emission could reduce to 29%.

Table 3: Marginal effects of GDP per capita on log(SO2pc)

Marginal effects of...	one std. increase in *GDP* on log(CO2pc)		
	min *GDP*	mean *GDP*	max *GDP*
min *Polity2*	1.33	1.10	-0.64
mean *Polity2*	1.08	0.85	-0.89
max *Polity2*	0.29	0.06	-1.68

Note: one standard deviation (std.) of GDP per capita (*GDP*) is 8373.55 USD.

In short, our empirical evidence shows that the MENA countries can moderate the negative side-effects of their economic growth by improving their democratic institutions. The moderating effects of higher quality of political institutions are more visible in the case of local pollution (SO2 emission) at the average and lower income.

4.2 Robustness

In Table 6 in Appendix B, we use the objective *Vanhanen* index of political openness instead of the subjective *Polity2* index for robustness. It is important to see if our main results are sensitive to a specific measure of political institutions quality indicator. As we can see in Table 6, our main results hold. CO2 and SO2 emission increases with income up to a turning point, falling with higher development beyond the turning point. Similar to our previous models with *Polity2* index, the EKC hypothesis is supported by data in all models (pooled OLS, fixed and random effects) for both CO2 and SO2 emission indicators. The interaction of *Vanhanen* index and income is negative in all models but is statistically significant for the case of SO2 emission in fixed and random effects. For the case of CO2 emission, the interaction term is only significant when we use the pooled OLS. Controlling for the fixed effects, it becomes insignificant. Again this is similar to our previous finding using the *Polity2* index. Quality of democratic institutions matters for the local pollution in the MENA region rather than global and transboundary pollution problems.

Effects of other control variables are as expected. Higher *urbanization* leads to more local pollution (SO2). The same increasing effect on local pollution can be observed from higher *population density*. Urbanization and population density intensifies transportation and consumption fossil fuels which has a direct effect on local pollution. Of course urbanization increases CO2 emission, mainly due to higher energy consumption. As in previous models with the *Polity2* index, we find a consistent negative (decreasing) effect of working age population on local population. Finally, higher energy intensity is a robust driver of CO2 emission in the MENA region.

Tables 7 in Appendix B presents the results for the income-pollution-democracy nexus using the Freedom House civil liberties indicator. The Freedom House measures the freedom concept on a survey basis, concentrating on two major concepts: political rights and civil liberties. By political rights, they mean "*free participation in the political process such as the right to vote freely for distinct alternatives in legitimate elections, compete for public office, join political parties and organizations, and elect representatives who have a important impact on public policies and are accountable to the electorate*". Civil liberties include the freedom of express, and rule of law. The survey focused on real world rights and freedoms of citizens. Thus, the survey gives more attention to the implementation of legal rights in practice. Civil liberties scores vary from 1 to 7. Higher scores mean less freedom.[10] We only report the results for the civil liberty measure (cl) since both measures are highly correlated (0.85). In Table 7 we notice strong evidence for the EKC hypothesis for both CO2 and SO2 emission indicators in all models. The level of income per capita is positive for the case of SO2 models, but the estimated coefficients are insignificant at conventional level. However, the squared term of income for the case of SO2 models has an expected negative sign and is significant in all models. The sign of interaction of civil liberty and GDP per capita has an expected sign (positive) and is statistically significant in random effects for the case of CO2. Recall that higher cl means lower civil freedom. Thus, those countries that lack civil freedom bear a larger environmental burden by economic development.

5 Conclusion

A number of MENA countries are among the top emitting nations based on CO2 and SO2 per capita all over the world. MENA countries have one of the fastest growth rates in consumption of fossil fuel products and it is expected that the reliance on fossil fuel resources will increase further in future. At the same time, there is an increasing openness in the political environment of the MENA countries recently known as Arab Spring. Higher political rights and civil liberties can facilitate the public demand for more attention to the quality of environment among others. The further economic and democratic development may both have crucial implications for the degree of environmental burden in the MENA region. The main objective of this paper is to study the mechanism through which economic development feeds the local and global pollution and the role of democratic institutions in this process. We use panel data covering the period from 1980 to 2005 for 17 countries. Arguing on the basis of an Environmental Kuznets Curve, we analyze the income-emission-democracy nexus considering the two major air pollution indicators CO2 and SO2

[10] More details can be seen at: www.freedomhouse.org.

and a number of different subjective and objective indicators of democracy.

The empirical findings of this study suggest that improving the quality of democratic institutions can mitigate the negative external effects of economic growth in the MENA region. The moderating role of political institutions is in particular valid for the case of local pollution (SO2). For global pollution (CO2), the democratic development of countries seems to take only a minor role. The improvement of democratic institutions and higher accountability of the government affect local environmental problems more significantly than global environmental issues. These results are robust, as we use different subjective and objective indicators of democracy such as the *Polity2* index, *Vanhanen* democracy indicators and the *civil rights* indicators by the Freedom House. In addition, we find evidence for the Environmental Kuznets Curve (EKC) hypothesis for the local emission indicator as well as for the global emission indicator. Since the MENA countries are among the top emitters in per capita terms worldwide, these results have important policy making implications. These countries may benefit from both economic prosperity and environmental quality through investing in their political institutions and being accountable to their own electorates.

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A List of included countries

Table 4: Sample Countries

Algeria, Bahrain, Djibouti, Egypt, Iran, Israel, Jordan, Kuwait, Libya, Morocco, Oman, Saudi Arabia, Syrian, Tunisia, Turkey, United Arab Emirates, Yemen

Data description and sources

SO2pc: log of Sulfur dioxide emission divided by the number of total population (Gg sulfur dioxide emissions per capita). Source: Smith et al. (2011).

CO2pc: log of CO2 emission per capita (metric tons per capita), Source: WDI (2011).

GDPp.c.: GDP per capita in constant prices of 2000 USD. Source: WDI (2011).

trade openness: the sum of exports and imports divided by total GDP. Source: WDI (2011).

urbanization: share of urban population in total population. Source: WDI (2011).

pop density: Population density is midyear population divided by land area in square kilometers. Source: WDI (2011).

pop15-64: the percentage of the total population that is in the age group 15 to 64. Source: WDI (2011).

polity2: Polity score, scaled so that it ranges from 0 to 1 with higher values indicating better democratic institutions. Polity is defined as the difference between democracy and autocracy scores. Source: Marshall, Gurr and Jaggers (2009).

vanhanen: Vanhanen democracy index. Higher levels of this index reflect more competition of political parties and the participation of the voters in election. Source: Vanhanen (2000).

cl: civil liberty score, scaled so that it ranges from 0 to 1 with higher values indicating lower levels of civil liberty. Source: Freedom House (www.freedomhouse.org).

B Further results

Table 5: Pollution-Income

	Dep. variable: log(CO2 per capita)			Dep. variable: log(SO2 per capita)		
	Pooled OLS	C&T FE	C&T RE	Pooled OLS	C&T FE	C&T RE
GDP	0.00015***	0.00012***	0.00015***	0.00013***	0.00016***	0.00013***
	(3.16)	(5.57)	(6.18)	(4.23)	(4.18)	(3.40)
GDP^2	-2.24e-09**	-1.51e-09**	-1.83e-09***	-1.98e-09***	-2.02e-09***	1.65e-09**
	(-1.82)	(-2.78)	(-4.10)	(-3.11)	(-3.61)	(-2.51)
trade openness	-0.00346	0.00058	0.00033	-0.00245	0.00085	-0.00297
	(-1.56)	(0.29)	(0.30)	(-0.85)	(0.42)	(-1.16)
urbanization	0.0110*	-0.0115	0.00225	0.0172***	0.0366***	0.0263***
	(1.80)	(-1.65)	(0.46)	(3.68)	(4.00)	(4.44)
pop density	0.00004	-0.00020	-0.00001	-0.00004	0.00372***	0.00127***
	(0.08)	(-0.29)	(-0.03)	(-0.09)	(5.11)	(3.12)
pop 15-64	0.00076	0.0378**	0.0292**	-0.0314	-0.0533	-0.0735***
	(0.04)	(2.39)	(2.21)	(-1.53)	(-1.68)	(-2.90)
energy / GDP	4.535***	1.762*	2.082***	0.950	2.164*	1.108
	(3.98)	(2.09)	(2.98)	(1.04)	(1.80)	(0.99)
time	0.00515	0.0178	-0.0074	0.0343	-0.0249	0.0871
	(0.14)	(0.44)	(-0.27)	(0.70)	(-0.29)	(1.38)
Obs.	79 (17)	79 (17)	79 (17)	79 (17)	79 (17)	79 (17)
R^2	0.89	0.73	0.84	0.76	0.67	0.70

Note: robust t-statistics are in parentheses. ***, **, * refer to significance at 1%, 5%, and 10% level. C&T FE and C&T RE mean country and time fixed effects and random effects, respectively. a) The number of included cross-sections are in parentheses.

Table 6: Pollution-Income-Institutions: using Vanhanen index

	Dep. variable: log(CO2 per capita)			Dep. variable: log(SO2 per capita)		
	Pooled OLS	C&T FE	C&T RE	Pooled OLS	C&T FE	C&T RE
GDP	0.00020***	0.00014***	0.0016***	0.00016***	0.00021***	0.00018***
	(5.36)	(6.37)	(4.65)	(5.50)	(8.79)	(6.16)
GDP^2	-2.97e-09***	-1.53e-09***	-2.00e-09***	-2.37e-09***	-2.61e-09***	-2.31e-09***
	(-3.55)	(-3.86)	(-3.54)	(-5.27)	(-6.12)	(-4.51)
trade openness	-0.0044*	0.00065	0.00080	-0.00312	0.000299	-0.00335
	(-1.94)	(0.36)	(0.69)	(-1.25)	(0.11)	(-1.13)
urbanization	0.0159**	-0.0146*	-0.00065	0.0223***	0.0278***	0.0225***
	(2.77)	(-1.92)	(-0.10)	(4.30)	(2.98)	(2.87)
pop density	0.00046*	-0.0002	0.00001	0.00029	0.00356***	0.00138***
	(1.95)	(-0.33)	(0.06)	(0.90)	(4.51)	(3.19)
pop 15-64	-0.0258	0.0362**	0.0255	-0.0471**	-0.0673*	-0.0925***
	(-1.43)	(2.23)	(1.42)	(-2.37)	(-1.98)	(-3.65)
energy / GDP	3.079***	1.781*	2.019**	-0.376	2.784**	1.415
	(3.06)	(2.09)	(2.14)	(-0.40)	(2.54)	(1.29)
vanhanen	0.00676	0.0138***	0.00696	-0.00274	0.0159	0.0186
	(0.53)	(4.17)	(1.19)	(-0.10)	(1.46)	(1.32)
$vanhanen \cdot GDP$	-2.46e-07**	-2.10e-07	-7.75e-07	-1.37e-06	-2.55e-06***	2.78e-06***
	(-2.66)	(-0.32)	(-1.47)	(-0.92)	(-3.47)	(-3.48)
time	0.0541	0.0186	0.0113	0.0633	0.0227	0.151****
	(1.16)	(0.41)	(0.17)	(1.36)	(0.23)	(2.10)
Obs.	78 (17)	78 (17)	78 (17)	78 (17)	78 (17)	78 (17)
R^2	0.92	0.75	0.84	0.79	0.70	0.74

Note: robust t-statistics are in parentheses. ***, **, * refer to significance at 1%, 5%, and 10% level. C&T FE and C&T RE mean country and time fixed effects and random effects, respectively. a) The number of included cross-sections are in parentheses.

Table 7: Pollution-Income-Institutions: using civil liberty index of Freedom House

	Dep. variable: log(CO2 per capita)			Dep. variable: log(SO2 per capita)		
	Pooled OLS	C&T FE	C&T RE	Pooled OLS	C&T FE	C&T RE
GDP	0.00013***	0.00013	0.00010***	0.00006	0.00012	0.00005
	(4.68)	(1.35)	(3.00)	(1.32)	(1.52)	(0.89)
GDP^2	-2.32e-09***	-1.48e-09**	-1.67e-09***	-2.10e-09***	-1.92e-09***	-1.60e-09***
	(-4.94)	(-2.35)	(-3.59)	(-4.14)	(-3.50)	(-2.90)
trade openness	-0.00111	0.00089	0.00113	-0.0032	0.00168	-0.00229
	(-0.68)	(0.48)	(1.06)	(-1.00)	(0.80)	(-0.88)
urbanization	0.0167***	-0.00941	0.00636	0.0183***	0.0421***	0.0292***
	(4.43)	(-1.24)	(1.16)	(3.42)	(4.41)	(3.95)
pop density	0.000011	-0.00006	-0.00006	0.000145	0.00400***	0.00137***
	(0.55)	(-0.07)	(-0.30)	(0.32)	(6.19)	(3.09)
pop 15-64	0.0105	0.0422**	0.0319**	-0.0434*	-0.0457	-0.0846***
	(0.95)	(2.35)	(2.47)	(-2.02)	(-1.56)	(-3.38)
energy / GDP	2.246***	2.042	2.159**	0.698	2.916**	1.238
	(3.26)	(2.12)**	(2.50)	(0.77)	(2.65)	(1.10)
cl	1.651***	0.308	0.795***	-0.619	0.646	-0.540
	(3.06)	(0.95)	(3.14)	(-0.64)	(1.01)	(-0.77)
$cl \cdot GDP$	0.00003	8.10e-06	5.67e-05**	0.00011	5.39e-05	0.00011
	(0.80)	(0.08)	(2.40)	(1.42)	(0.56)	(1.59)
time	-0.0380	-0.00322	0.00737	0.0518	-0.0706	0.11300
	(-1.49)	(-0.07)	(0.17)	(1.10)	(-0.94)	(1.43)
Obs.	79 (17)	79 (17)	79 (17)	79 (17)	79 (17)	79 (17)
R^2	0.94	0.73	0.91	0.78	0.69	0.70

Note: robust t-statistics are in parentheses. ***, **, * refer to significance at 1%, 5%, and 10% level. C&T FE and C&T RE mean country and time fixed effects and random effects, respectively. a) The number of included cross-sections are in parentheses.