INTRODUCING INSTITUTIONAL VARIABLES IN THE ENVIRONMENTAL KUZNETS CURVE (EKC): A LATIN AMERICAN STUDY

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Abstract:

Several studies have examined the relationship between environmental degradation and per capita income. However, most of them did not take into account institutional quality and just focused on macroeconomic determinants. The purpose of this paper is to fill this gap in the literature by assessing the effects on the Environmental Kuznets Curve (EKC) when institutional quality variables are introduced, especially those related to corruption and rent-seeking behavior.

This study considers 18 Latin American economies and panel data for 1998–2005. A standard reduced-form modeling approach with pool estimation was employed and, in order to introduce the heterogeneity of the different countries, three different models were estimated. The first model corresponds to the basic Environmental Kuznets Curve (Basic Model), the second model introduced a sets of additional economic variables (Extended Model Nº 1), and finally, the third one introduced institutional variables into the previous formulation (Extended Model Nº 2).

The expected results from this investigation lead us to support the EKC hypothesis while confirming the importance of improvements in political institutions and governance for better environmental performances in the region.

Key-Words: Environmental Kuznets Curve, Institutions, Corruption.

1.Introduction

The relationship between environmental degradation and economic growth has received increasing attention in recent years due to evident impacts of climate change on human economic activities and life quality.

A key policy objective of international efforts to mitigate adverse effects of global climate change is to reduce global CO_2 emissions. The success of these efforts depends on a large degree of commitment by major CO_2 producing nations to reach global emissions targets. This is the reason why it is so important to understand the main variables which impact over the CO_2 emissions.

Over the last years several studies used the Environmental Kuznets Curve (EKC) hypothesis to assess the impact of several economic variables on certain environmental indicators. The Environmental Kuznets Curve is a hypothesized relationship between several indicators of environmental degradation and per capita income. This model states that in the early stages of economic growth, degradation and pollution increases, but after achieving a certain level of per capita income this trend reverses (showing an inverted U-shape relationship).

The Environmental Kuznets Curve is a "reduced form" relationship in which the level of pollution is modeled as a function of per capita income without specifying the links between both of them. Grossman and Krueger (1995) characterize these missing links as "environmental regulations, technology and industrial composition"[1].

According to Deacon and Mueller (2004) there are four ways in which a nation's political system is linked to the way its natural resources and environmental assets are used:

1. When property rights related to resources are weak, competition can be wasteful and characterized by rent-seeking and violent conflict. The link to political systems shows up because ownership claims are most likely to be weak or ambiguous in countries where the rule of law is not well-established.
2. When a country's political system is unstable or non-representative, the individual's claim to a resource stock's future return can be rendered insecure. This reduces the payoff to natural resource conservation, leading to faster depletion of resource stocks.
3. When a country's natural resources or environmental services are capable of generating significant rents, but institutions of democratic governance and the rule of law are not well-established, corruption by government officials can encourage rent-seeking behavior, dissipating the benefits those resources or environmental services would otherwise confer.
4. The mix of private versus public good outputs produced by a nation's natural resources may be affected by its political system. When a country's government does not represent the interests of the entire population,

[1] For further references see Torras, M. and Boyce, J. (1998).

but rather acts on behalf of a select group, the use of resource stocks to provide public good amenities may be under-emphasized.

Creating property rights that provide incentives for efficient use of natural resources and environmental conservation requires that economic agents are able to cooperate and promote a State that is able to enforce rules in order to solve market failures and avoid opportunistic behavior. The ability to cooperate, promote and enforce rules, however, depends on the political.

This previous ideas will provide the starting point for this study. The main objective of this paper is to assess possible impacts of changes in institutional quality indices and income on the environment using the Environmental Kuznets Curve hypothesis for a sample of 18 Latin American countries.

This region was chosen because of the important contribution that natural resources and environmental services have on the productive structure of these countries. Furthermore, in this region several institutional performance indicators are considered fairly low compared to developed countries. Both characteristics explain why this region is one of the most interesting locations to analyze the potential impact of institutional improvements on environmental quality.

Previous studies have attempted to measure the impact of democracies on economic behavior; however, these studies focused their attention on measuring just a unique qualitative variable which is a democratic index[2] but little attention was given on the performance and effectiveness of these democracies (institutional quality).

Section 1 of this paper briefly summarizes the theory behind the Environmental Kuznets Curve; Section 2 introduces main theories that tend to explain how institutions relate with environmental outcome and how rent-seeking behavior allocates resources in a different way than the social optimum desired level. Section 3 reviews the methodology used for the empirical analysis, and Section 4 presents the data sources and variables required to achieve the goals of this paper. Finally, Section 5 and Section 6 show the main empirical results and conclusions.

2.The environmental kuznets curve

Grossman and Krueger, among others, found that for a number of environmental variables, the relationship between per capita income and environmental degradation takes an inverted U-shaped form, this means that environmental quality initially worsens but ultimately improves with income. This apparent empirical relationship has been called the "Environmental Kuznets Curve" because of its similarity to the relationship between per capita income and income inequality first suggested by Simon Kuznets in 1955[3].

The Environmental Kuznets Curve hypothesis is intended to represent a long-term relationship between environmental impact and income. As Stern (2004) mentioned, the relationship between per capita income and environmental quality depends on *scale, composition and technology effects.*

As economic development accelerates, at the take-off stage, the rate of resource depletion begins to exceed the rate of resource regeneration, and waste generation increases in quantity and toxicity (*scale effect*). Therefore, we would expect environmental quality to worsen with income, as greater output generates more pollution.

On the other hand, environmental quality could improve with income if this scale effect were eclipsed by the combination of the two other effects. With increasing per capita income, the composition of output shifts among sectors which differ in their pollution intensity (for instance, the service sector may grow relative to the manufacturing sector), generating a "cleaner" economic structure (*composition effect*). Furthermore, several sectors of the economy may adopt less polluting technologies, either because of market driven technological advance or by government regulation (*technological effect*).

Therefore, at higher levels of development, structural change of the economy coupled with increased environmental awareness, enforcement of environmental regulations, better technology and higher environmental expenditures, leads to a gradual decline of environmental degradation as income increases.

Grossman and Krueger likewise speculated that the strongest link between income and pollution is, in fact, via an induced policy response and these policies are in turn induced by popular demand: As nations or regions experience greater prosperity, their citizens demand that more attention should be paid to the non-economic aspects of their living conditions. Therefore, richer countries would have relatively more stringent environmental standards and stricter enforcement of their environmental laws than the middle-income and poorer countries.

The public-good character of environmental quality means that, in fact, public demand is a requirement of an effective solution to a market failure. Implicit in such policy-based explanations of the Environmental Kuznets Curve, then, there is a theory of induced innovation: As per capita income rises, societies improve their abilities to redress market failure.

3.The importance of institutions to solve environmental problems

Payne (1995) has probably provided part of the most comprehensive theoretical treatise in favor of a positive impact of democracy on the environment. He argued that in democracies citizens are better informed about environmental problems (freedom of press) and can better express their environmental concerns and demands

[2] Most of these studies use the Freedom House index which measure if a country is more or less democratic following just the perception on Civil Liberties and Political Rights inside the country. For additional information about these studies see Bhattarai, M. and Hammig, M. (2001), Culas, R. (2007), Neumayer, E. (2002) and Robbins, P. (2000).

[3] For further references see Anand, S. and Kanbur, S. (1993).

(freedom of speech), which will facilitate an organization of environmental interests (freedom of association), which will in turn increase pressure on policy entrepreneurs operating in a competitive political system to respond positively to these demands (freedom of vote), both domestically as well as via international cooperation.

On the other hand, in non-democratic systems, governments are likely to restrict the access of their population to information, restrict the voicing of concerns and demands, and restrict the organization of interests and isolate them-selves from the citizen's preferences.

In other words, in democracies if citizens are concerned about environmental problems, this will eventually require policymakers to exhibit stronger environmental commitment to address these concerns and honors the demand for environmental protection measures.

However, democracies with emphasis on private property rights and individual liberty provide the opportunities for individuals and businesses to make full use of their potential to expand production and consumption, which, if not sufficiently counteracted by environmental regulation, will increase pressure on the environment. This means, that the quality of democratic regimens are in fact important to achieve sustainable growth.

However, while a good theoretical case can be made for a positive link between democracy and environment, there are a number of considerations pointing in the opposite direction[4]. The link between democracy and environment is therefore a complex one and there is still debate about it.

3.1.Corruption as an institutional problem

All political regimens have faced corruption, even the most ancient ones. In democracies this problem takes increasing importance since it harms all the positive effects of this political system. In this sense, in the presence of corruption policymakers and public officers[5] take actions which are different from the social commitment they are working for.

For the purposes of this paper, corruption in natural resource and environmental management could be described using the definition of Robbins (2000) as "the use or overuse of community natural resources with the consent of a state agent by those not legally entitled".

It is expected that the more regulated an economy is and the larger the amount of resources administered by the government are, the higher will be the potential rents in the hands of public officials related to corruption. In this sense, public sector corruption serves the private interests of bureaucrats and criminals by taking away from citizens their rights to live in a clean environment, misallocating environmental resources, and diverting funds from conservation and preservation.

Fredriksson and Svensson (2003) established a model in which a producer lobby attempts to influence the incumbent government's environmental policy by offering prospective bribes (established as "political contributions"). In this model, the incumbent weighs bribes and the aggregate social welfare derived from the outcomes of environmental policies.

The model examines the incentives of an incumbent government and a single producer lobby group in a three-stage model. The predictions that emerge are that the effect of corruption on the stringency of environmental policy is conditional on the degree of political instability. Corruption reduces the stringency of environmental regulations, but the effect is reduced as the degree of political instability increase, therefore the incentive to offer a bribe is reduced when its expected return falls.

An increase in political instability has two opposing partial effects. First, bribery becomes less attractive for the producer lobby because the likelihood that the government remains in office throughout the policy implementation stage is reduced, and thus the bribe becomes less likely to pay off. This effect of instability is particularly pronounced when the level of corruption is high.

However, this previously mentioned effect is counterbalanced by the fact that the government now sees bribes as relatively more attractive[6]. The government is now less likely to be in office during the policy implementation stage, and thus the probability is lower that it will derive utility from its own policy choices. This effect of instability is strongest when the degree of corruption is low. The net impact of political instability on environmental policy thus depends on the level of corruption.

Another important contribution to the theoretical approaches regarding to the impact of corruption (or rent-seeking behavior) in environmental outcomes was introduced by López and Mitra (2000) that proposed a model were it is considered that the only goal of political parties is to repeat the rewards of holding office (win the elections).

Under the assumption of rent-seeking behavior, to the model assumes that the government maximizes a function which depends on its probability of being re-elected as well as on rents. As a conclusion for this model, the authors state the following proposition for a cooperative scenario:

"*If corruption takes the form of cooperative government-private sector interactions, then: (i) pollution levels will be above the socially optimal levels for any level of income; (ii) an inverted-U-shaped relationship*

[4] For further references see Leff (1964).

[5] Those in charge of enforcement of policies.

[6] Similar results than the theoretical model developed by Damania, R., Fredriksson, P. and List, J. (2003).

between income and pollution will exist; (iii) the turning point of the inverted U-shaped curve will occur at a higher per capita income (and higher pollution level) than in the socially optimal equilibrium".

On the other hand, in the case of a non-cooperative scenarios the authors state the following proposition:

"*If government corruption takes the form of a non-cooperative Stackelberg interaction between the government and the firm, with the latter as a leader, and payment functions are linear in output, then: (i) pollution is always above the social optimum for any level of per capita income; (ii) a turning point in the pollution per capita income relationship always exists as long as a turning point exists in the socially optimal pollution-income relationship, but such a point is likely to occur at a higher per capita income (and higher pollution level) than the socially optimal one*".

It is striking that, despite the assumed behavior of firms and government, these two scenarios derived results highly consistent. This means that irrespective of the type of interaction between the firm and the government, for any level of per capita income, pollution levels are always above the socially optimal level when corruption exists.

The authors also argued that unless economic growth process brings about a rapid reduction of corruption in developing countries, pollution will remain much higher in these countries than the levels reached in currently developed ones even when their per capita incomes were comparable.

Therefore, one of the main consequences of corruption is related to the fact that it leads to ecologically unsustainable resource use. This is the reason why governments should take into account the reduction of corruption as an alternative to reduce the negatives externalities produced by inefficient resource allocation.

4.Methodology

The main goal of this work is to test if institutional variables are explanatory variables of environmental performance. Therefore, an appropriated econometric technique would be needed to assess the relationship between performance of those governments perceived as less connected with society needs and more corrupt and an environmental quality indicator.

Several previous empirical studies use cross-country data to measure, among other factors, the relationship between income and environmental degradation[7]. However, these models implicitly assumed that a common structure exists across all countries at a certain period.

In recent years it has been possible to obtain statistics that combine cross-sectional data observed for a considerable time sized period; this is one of the reasons that explain the increase of researches and economic studies which use panel data methodology.

Comparing the information provided by a panel with the information given by only cross-sectional or time series sample, some differences can be found that help to identify the main advantages that, from the econometric modeling point of view, the use of this information combined offers.

The first advantage of panel data is that it provides more information, more variability, less collinearity among variables, more degrees of freedom and more efficiency; all of these elements are the main limitations of many studies which used cross-sectional or temporal information only.

A second advantage of this methodology is related to the fact that panel data suggest that individuals, families, businesses, states or regions analyzed are heterogeneous. The cross-sectional data only (or just cannot) control the temporal heterogeneity, this means that there is the risk of not taking into account all the information and the final results could be a biased parameter.

A third advantage of panel data methodology is that it allows a more precise analysis of the dynamics of adjustment of economic variables. These concepts are difficult to measure in cross-section and time series analysis separately[8].

Due to all this reasons, this paper will use panel data methodology following standard approaches in the existing Environmental Kuznets Curve literature. Given that the dataset used in this paper have a reduce amount of temporal dimensions, long run effects will not be capture in an adequate way by fixed and random effect models. Therefore, the use of panel data (pool estimation) with the introduction of specific economic variables (additional explanatory variables) is the best way to model the differences in behavior across countries[9].

The methodology proposed in this paper involves the estimation of three models:

- **BASIC MODEL**: This model is established by regressing CO_2 emission on GDP per capita and GDP per capita squared. This specification enables the estimation of the Environmental Kuznets Curve in its purest form.
- **EXTENDED MODEL N° 1**: This model considers additional explanatory variables that should allow the assessment of the effect on the Environmental Kuznets Curve of economics variables which might capture cross-country differences.

[7] The initial empirical studies on EKC used this type of econometric analysis.

[8] For further references see Balestra, P. and Nerlove M. (1966).

[9] For further information see Nilsson (2008).

- **EXTENDED MODEL N° 2**: This model includes institutional quality indexes as additional explanatory variables on the EXTENDED MODEL N° 1 in order to assess the impact of these variables on the Environmental Kuznets Curve.

Under the hypothesis of no correlation between the exogenous variable and the individual effect, the panel data models can be estimated directly by ordinary least squares (OLS). However, the main problem in this is that the model error generates a high probability of autocorrelated and heteroscedastic behavior, with a consequent impact on the efficiency property of the estimator[10]. Therefore the need for a general estimation (because the variance-covariance matrix is no longer a scalar matrix) rises.

In this sense, White[11] supplied a method to correct asymptotic variance estimator that was applied to the panel models by means of the econometric software (E-Views).

Finally, it should be addressed that complete panels of data could not be obtained for all countries in the dataset. This is a common problem with panel data and can be corrected by using balanced panel estimation methods.

5. Data

Our data sources are several international institutions such as the World Bank (WB[12]), Food and Agriculture Organization of the United Nations (FAO), Freedom House, International Monetary Fund (IMF) and the Economic Commission for Latin-American and the Caribbean (ECLAC).

The dependent variable under consideration is carbon dioxide (CO_2) emissions (measured in metric tons per capita) which are those stemming from the burning of fossil fuels and the manufacture of cement. The dataset for CO_2 emissions is composed of measurements for several Latin American countries between the years 1998 to 2005. The following table shows the list of countries included in the estimation[13] and the codes which identify these countries in each institution from where the data was taken.

TABLE N° 01
SET OF LATIN AMERICAN COUTRIES

Country	COD FAO	COD WB	COD IMF
Argentina	9	ARG	213
Bolivia	19	BOL	218
Brasil	21	BRA	223
Colombia	44	COL	233
Costa Rica	48	CRI	238
Chile	40	CHL	228
Ecuador	58	ECU	248
El Salvador	60	SLV	253
Guatemala	89	GTM	258
Honduras	95	HND	268
México	138	MEX	273
Nicaragua	157	NIC	278
Panamá	166	PAN	283
Paraguay	169	PRY	288
Perú	170	PER	293
República Dominicana	56	DOM	243
Uruguay	234	URY	298
Venezuela (República Bolivariana de)	236	VEN	299

The panel includes a wide range of macro-level information on socioeconomic characteristics of countries. The variables are shown in the following table which contains the definition and an explanation of those variables.

TABLE N° 02
EXPLANATORY VARIABLES

[10] For further references see Breusch, T., Mizon, G. and Schmidt, P. (1989).
[11] For further information about these tests see Arcarons, J. and Calonge, S. (2008).
[12] World Development Indicators Online Database.

[13] Not all Latin American countries could be included in this study due to lack of an appropriate dataset for all the relevant variables related to the purpose of the research.

CODE	VARIABLE	UNIT	SCALE	SOURCE
VAI	Voice and Accountability Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
PSI	Political Stability & Absence of Violence/Terrorism Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
GEI	Government Effectiveness Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
RQI	Regulatory Quality Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
RLI	Rule of Law Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
CCI	Control of Corruption Index	Index	Ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.	World Bank
POP	Total Population	Hab.	1000 hab.	FAO
GDP	Gross domestic product, current prices	U.S. dollars (Billions)	Billion of US$	IMF
GDPPC	Gross domestic product per capita, current prices	U.S. dollars		IMF
GDPPCPPP	Gross domestic product based on purchasing-power-parity (PPP) per capita GDP	Current international dollar		IMF
UNEMP	Average annual unemployment rate	Percentage		CEPAL
RURP	Rural Population	Hab.	1000 hab.	FAO
RURPR	Rural Population	% of total population		FAO
EXDBT	External Debt	US$	Millions of US$	CEPAL
INF	Inflation	Percentage	Data for inflation are averages for the year, not end-of-period data.	IMF
CO2	CO2 Emissions per capita	metric tons per capita		World Bank

Per capita Gross Domestic Product (GDPPC) is used as a proxy for the per capita income of a country. Additional country specific data is gathered in order to control possible influences of these national characteristics in explaining CO_2 emissions.

For the purpose of this work a set of recent institutional indexes constructed by the World Bank[14] is used in order to assess the main characteristics a democracy should have through aggregate indicators. Even though this institution estimates indicators related to six dimensions of governance, three of them: PSI (Political Stability and Absence of Violence/ Terrorism Index), VAI (Voice and Accountability Index) and CCI (Control of Corruption Index) are of main interest for the purpose of this paper.

5.Empirical finding

The estimation of the so called "Basic Model" results from regressing CO_2 emission (our environmental variable) on GDP per capita (GDPPC) and GDP per capita squared (GDPPC^2). This specification allows the estimation of the Environmental Kuznets Curve in its purest form.

The Basic Model estimation gave the expected results with expected sign and statistically significance of both coefficients which led to confirm the quadratic form of the Environmental Kuznets Curve in its traditional theoretical formulation.

Even though the countries in the sample came from the same region (Latin America) some heterogeneity across them should be expected. Therefore, the "Extended Model" is used then to assess the impact on the Environmental Kuznets Curve when additional explanatory variables (which might capture cross-country differences) are included.

For the Extended Model two different versions were estimated: (i) "Extended Model Nº 1" will include the basic Environmental Kuznets Curve formulation and a set of additional economic variables; (ii) "Extended Model Nº 2" includes a set of institutional variables taken into the previous model in order to assess the impact of government performance on the Environmental Kuznets Curve.

The following table shows the estimation results for the three models:

[14] The governance indicators reflect the statistical compilation of responses on the quality of governance given by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries, as reported by a number of survey institutes, think tanks, non-governmental organizations, and international organizations.

TABLE N° 03
ECONOMETRIC RESULTS

Dependent Variable: CO2 Emissions
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

	BASIC MODEL		EXTENDED MODEL N° 1		EXTENDED MODEL N° 2	
INDEPENDENT VARIABLE						
	Coefficient	**t-Statistic**	**Coefficient**	**t-Statistic**	**Coefficient**	**t-Statistic**
Constant	0.036332	0.759852	0.053741	0.836159	-0.571314	-4.08082***
GDPPC	0.000839	17.44645***	0.000908	18.64481***	0.0007	10.93161***
GDPPC^2	-4.57E-08	-7.154299***	-7.37E-08	-9.084384***	-3.49E-08	-3.012249***
RURP			-2.89E-05	-4.003441***	-5.35E-05	-7.85784***
EXDBT			1.12E-05	9.053483***	1.04E-05	9.940891***
INF			6.30E-06	1.031276	0.007472	6.27357***
UNEMP			-0.249857	-0.900385	0.244624	0.321209
CCI					-0.501422	-3.302914***
CCI^2					0.745271	9.907683***
PSI					-0.104618	-1.779556***
VAI					-0.238984	-15.97884***
GEI					0.607658	2.679024***
RQI					-0.105945	-1.185813
RLI					-0.273657	-2.378383***
WEIGHTED STATISTICS						
R-squared	0.666314		0.748843		0.768356	
Adjusted R-squared	0.664879		0.745378		0.739676	
F-statistic	464.2624***		216.1635***		26.79089***	
UNWEIGHTED STATISTICS						
R-squared	0.413158		0.459292		0.6513	

* Significance at 10%
** Significance at 5%
*** Significance at 1%

The introduction of additional explanatory variables into the Basic Model estimation gave also expected results since the expected sign and statistically significance of the coefficients related to GDPPC and GDPPC squared (GDPPC^2) still leads to confirm the quadratic formulation of the Environmental Kuznets Curve.

However, it is important to point out that the coefficients from the additional explanatory variables were those expected by theory. The coefficient of RURP (rural population rate) confirms the idea that countries which focus their productive activities on the rural sector have less use of labor factor on their industrial sector (the pollutant sector). Moreover, the expected sign of EXDBT (external debt) also confirms the idea that countries with higher levels of external debt have more resources to increase their production possibilities and, therefore, increase pollution.

On the other hand, in the case of unemployment (UNEMP), even though previous empirical studies on Environmental Kuznets Curve showed a statistical significance of the coefficient of this variable, we cannot confirm the statistical relevance of this variable.

It is important to highlight that due to the inclusion of additional explanatory variables, the statistical significance of the variable INF (inflation) is different in the two versions of the Extended Model. This could be explained by the fact that in Extended Model Nº 1 relevant explanatory variables (institutional variables) were omitted which could generate a bias in the estimation and led to accept the null hypothesis of no significance. The positive relationship between inflation rates and CO_2 emissions could be explained by the fact that higher inflation rates in the short run[15] do have an impact on production.

Regarding to institutional variables, five of the six coefficients of these variables included in the model were statistical significant. The first main result that should be pointed out is the statistical significance of a quadratic relationship between pollution (CO_2 emissions) and corruption (measured by the CCI variable) as López

[15] Given that the dataset do not have an extensive temporal dimension range, the results obtained do not capture long-run effects.

and Mitra proposed. This means that countries that make higher efforts to control corruption in the public administration tend to improve their environmental quality.

On the other hand, results did not support the idea proposed by Fredriksson and Svensson[16]. This could be explained by the fact that, even though corruption control and political stability in the region are not as good as in other developing regions, the level of political instability should not be considered as extremely high as the theoretical model propose by these authors. Furthermore, results showed that an increase in the political stability in the region have a statistically positive effect over environmental quality which could be explained by the fact that governments with less instability are more concerned on the efficiency of their policies (including environmental policies).

Econometric estimation also helped to support the proposition of Payne which argued that democratic governments citizens can express better their environmental concerns and demands, which will in turn increase pressure on policy entrepreneurs (operating in a competitive political system) to respond positively to these demands. To test this hypothesis the variable VAI (Voice and Accountability Index) was introduced as an explanatory variable and results showed an expected negative significant sign which means that countries which have strengthen their democratic mechanisms of representation tend to improve their environmental quality.

In developing countries the need of increasing production in order to develop and promote employment is the main concern of public authorities. Even though, this does not mean that countries in the region are not concerned about environmental quality, the weight of these policies is not equal to those related to economic growth promotion. In this sense, the results for the variable GEI showed that an improvement in government effectiveness should be related to efficiency in the allocation of resources (which would lead to an increase in factors productivity) and, therefore, to an increase in production which increases also pollution.

Finally, the impact of public policies on the environmental quality should not only be considered by the amount of laws or directives given, but also by the way governments make this regulation accomplish its goals (this is what institutional economists usually call "enforcement"). The variable RLI (rule of law index) tried to capture this effect obtaining a statistical significant negative effect on environmental quality which means that improvement in the enforcement capacity of governments would lead to less CO_2 emissions as Deacon and Mueller suggested.

5.1.Comparative analysis

An important characteristic to analyze on the Environmental Kuznets Curve is related to the estimated turning point of the model and how it changes with additional explanatory variables. The following table shows the results of the turning points of the three models.

TABLE N° 04
ENVIRONMENTAL KUZNETS CURVE TURNING POINT

	Basic Model	Extended Model N° 1	Extended Model N° 2
Turning Point (US$)	9,256	6,058	10,109

The inclusion of economic variables into the basic Environmental Kuznets Curve (Extended Model Nº 1) does have an important impact on the turning point which reduced its value in approximately 35% compared to Basic Model. On the other hand, a different outcome was obtained in the Extended Model Nº 2 which showed a relative smaller difference with the Basic Model but a relatively higher difference with the Extended Model N° 1.

The estimation of the Environmental Kuznets Curve with only economic variables (Extended Model Nº 1) gave biased estimators which would explain the big difference in the value of the turning point. Therefore, the inclusion of additional explanatory variables related to institutional performance would help to correct the bias and reach better results.

In order to test if the turning points obtained belong to a reasonable range, the estimations were compared to a survey[17] of several empirical studies which attempted to estimate the Environmental Kuznets Curve[18]. It is important to mention that all these studies have differences between each other due to the use of different measures of environmental damages, regions and explanatory variables, therefore, all these results should be taken as relative values.

TABLE N° 05

[16] That argued that when political instability increases, bribery becomes less attractive for lobbies (because of the likelihood that the government remains in office) that seeks to change environmental policies.

[17] For further references see Almeida,E. and Sabadini,T. (2009), Bhattarai,M. and Hammig, M. (2001), Brajer et al. (2008), Lee et al. (2010), and Selden et al. (1994).

[18] In order to give an accurate comparative perspective only those studies which used GDP per capita for their estimation were taken into account.

SURVEY OF EMPIRICAL ESTUDIES

Source	Author	Region	Period	Dependant Variable	Additional Explanatory Variables	Turning Point
Almeida and Sabadini	Moomaw and Unhruh (1997)	16 countries	1950-1992	CO2 Emissions	none	$12,813
Almeida and Sabadini	Agras and Chapman (1999)	34 countries	1971-1989	CO2 Emissions	Trade variables and temporally lagged dependent variable	$13,630
Almeida and Sabadini	Dijkgraaf and Vollebergh (2001)	OECD countries	1960-1997	CO2 Emissions	none	$15,704 and $13,959
Almeida and Sabadini	Almeida and Sabadini	167 countries	2000-2004	CO2 emissions	Cubic GDP per capita, KPt Kyoto Protocol dummy, Sum of imports and exports (over total GDP by country), energy consumption and population	US$ 10,193.68 and US$ 13,484.85
Bhattarai and Hammig	Bhattarai and Hammig (2001)	Latin America (20 countries)	1972-1991	Deforestation rate	Political institution index (WRI), black market foreing exchange rate, external debt, population, rural population, change in cerial yield index	$ 6,600
Brajer, Mead and Xiao	Brajer, Mead and Xiao (2008)	China (128 cities)	1990–2004	SO2 Emission	Time trend	$ 7,793
	Brajer, Mead and Xiao (2008)	China (128 cities)	1990–2004	SO2 Emission	Time trend, dummy for coast zone and dummy for cities in the north	$ 6,766
	Brajer, Mead and Xiao (2008)	China (128 cities)	1990–2004	SO2 Emission	Time trend, GDP cubic	$ 4,765
	Brajer, Mead and Xiao (2008)	China (128 cities)	1990–2004	SO2 Emission	Time trend, GDP cubic, dummy for coast zone and dummy for cities in the north	$ 4,429
Lee, Chiu and Sun	Lee, Chiu and Sun (2010)	97 countries	1980-2001	Water Polution	GDP cubic, trade and population and lagged dependant variable	$ 13,956
Selden and Song	Selden and Song (1993)	30 countries	1973-1975, 1979-1981, 1982-1984	SO2 Emission	Population density and period effects dummies	$ 10,292 (1985 US Dollars)
	Selden and Song (1993)	31 countries	1973-1975, 1979-1981, 1982-1985	SO2 Emission	period effects dummies	$ 10, 681 (1985 US Dollars)
	Selden and Song (1993)	32 countries	1973-1975, 1979-1981, 1982-1986	CO2 Emission	Population density and period effects dummies	$ 15,741 (1985 US Dollars)
	Selden and Song (1993)	33 countries	1973-1975, 1979-1981, 1982-1987	CO2 Emission	period effects dummies	$ 19,092 (1985 US Dollars)

From the previous table we can appreciate the results obtained by other authors that do not vary considerably from the results of the three models estimated, therefore, we can consider that these turning points belong to a reasonable range.

5.2.The impact of institutions on environmental quality

This section attempts to analyze how do changes in institutional performance indexes affect environmental quality through simulations based on the results obtained for the Extended Model Nº 2. The econometric analysis revealed that, even though five of these variables obtained a coefficient value statistically different from zero, not all of these variables have the same impact over environmental quality. In this sense, the most important variables that should be considered given the magnitude of their impacts on CO_2 emission are CCI (Control of Corruption Index) and GEI (Government Efficiency Index).

Even though the theories of Fredriksson and Svensson (related to the impact of political instability on environmental outcome) and Payne (which related voice and accountability performance of the governments with better environmental policies) where considered statistically significant, the relative impact on environmental outcome of institutional improvement related to this variables is very low.

On the other hand, referring to corruption control (CCI), it is important to mention that the impact of this variable in each of the 18 countries analyzed depends on the relative allocation that each country has (measured by CCI index). Since the variable showed a quadratic form, an improvement of 0.1 units on CCI would leave to higher impact on environmental quality for the most corrupt countries than for less corrupt ones.

Governments do have an idea of the main benefits of improving institutional performance on economic growth; however, few studies have attempted to measure how these improvements affect environmental quality. This impact should be considered in policy assessment (additional social benefits from institutional reforms) and as a main decision variable when resources from international cooperation are allocated since this decision would not only benefit the country that receives cooperation, but also the entire planet that would benefit from the reduction in CO2 emissions.

6.Conclusions

The objective of this paper is to assess the impact of institutional quality on environmental outcome. Results supported the Environmental Kuznets Curve hypothesis for CO_2 emissions by means of three econometric models for a panel of 18 Latin American countries. Therefore, the existence of an inverted U-shaped relationship between per capita CO_2 emissions and per capita gross domestic product is confirmed. Furthermore, the results showed the potential relevance of improvement in institutional performance in the reduction of global amount of emitted dioxide carbon.

The final model selected (Extended Model Nº 2) was considered as the most appropriate to explain the Environmental Kuznets Curve theory since it corrected the bias generated by the omission of relevant explanatory variables. Even though the risk of omitted variables cannot be excluded for this estimation, the specification of the model follows closely the theory applied to the Environmental Kuznets Curve relationship and, therefore, this risk is reduced.

The main contribution of this research is related to the fact that institutional variables (that measure government performance) do have statistical significance and, therefore, should be taken into account in future researches.

Lack of corruption control and other institutional weaknesses affect government's concerns and control of environmental quality, both with important implications to environmental degradation. Therefore, institutional reforms that lead to improve quality of government performance would also lead to environmental improvements.

The Environmental Kuznets Curve does not indicate that countries can simply grow out of environmental problems, but the understanding of the relationship between income and pollution can contribute to policy making. Therefore, the results of this research should be considered in public policy assessment as additional social benefits from institutional improvement.

Moreover, as some developed countries and international institutions help developing countries to improve institutional quality, the impacts on environmental performance should also be considered as a social benefit to take into account when resources from international cooperation are allocated into developing countries. Furthermore, international cooperation not only would benefit the receptor country but also the entire world, since it will improve environmental quality worldwide.

In sum, economic growth does not guarantee the cure for the world's environmental problems. Proper institutional performances do have a fundamental role in the reduction of greenhouse gases emission in the world.

7.References

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