THE RELATIONSHIP BETWEEN CO2 AND SULPHUR EMISSIONS AND INCOME: AN ALTERNATIVE EXPLANATION TO THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS

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Abstract

This analysis studies the role of those factors that are exogenous to the environmental Kuznets curve (EKC) model in causing a weakening in the correlation between GDP per capita and emissions (CO_2 and sulphur). The aim is to advance within the EKC research by scrutinizing both the historical experience of individual countries and the common features shared by those countries which have managed to reduce emissions (CO_2 and sulphur) whilst at the same time increasing GDP income levels. For this purpose, a graphic analysis is carried out.

JEL classification**:** Q56, O57
Key words: development, environment, Kuznets, world.

1.-Introduction.

The environmental Kuznets curve (EKC) hypothesis states that there is a positive relationship between environmental degradation and income, i.e. high income leads to greater degradation, up to a point at which incremental increases in income cause the curve to begin to slope downwards, implying improvements in the quality of the environment[1]. Then, the relationship between per capita income and environmental degradation may be graphically represented by an inverted-U curve.

The empirical studies that analyze the EKC hypothesis focus on estimating econometric models. The equation most often used is as follows (Ekins, 1997):

$$f(E_{it}) = \alpha_0 + \alpha_1 g_1(Y_{it}) + \alpha_2 g_2(Y_{it}^2) + \alpha_3 g_3(Y_{it}^3) + \alpha_4 g_4(Y_{it-a}^n) + \beta . B + \gamma t + \varepsilon_{it} \tag{1}$$

where E_{it} is the environmental indicator for the country i at the time t; α, β, γ are the parameters that must be estimated; Y_{it} is the per capita income for the country i at the moment in time t, where Y^n_{it-a} is a polynomial of the lagged income; B is a vector of other explanatory variables which might possibly include dummy variables in order to capture specific demographics, the geography or specific years; ε is the random disturbance; and

[1] Stern *et al* (1996), Ekins (1997), Barbier (1997), Stern (1998), Stagl (1999), Dasgupta *et al* (2002) and Stern (2004) offer an overview of the literature that is available within the field. Further, in 1997 the journal *Environment and Development Economics*, 2(4), dedicated a special edition to the issue, as did *Ecological Economics*, 25(2) in 1998

f(.) and *g(.)* are the functional forms that are predominantly, but not exclusively, logarithmic or lineal.

When this relationship is represented by an inverted-U shaped curve, the second step is to calculate the turning point (TP), that is, the per capita income at which a marginal change in the environmental indicator is zero.

Certain authors have cited EKC as a means of defending the existence of a direct positive causal relationship between economic growth and the quality of the environment, which in turn allows them to draw clear conclusions with respect to economic and environmental policy: This would seem to imply that the focus should be upon creating the competitive conditions that are required in order to guarantee continuous economic growth up to the point at which both economic and ecological objectives become attainable. Within this framework environmental policy would become unnecessary and, the imposition of such a policy would put a brake on economic growth as a primary objective.

It should be underlined that these conclusions are very simplistic and cannot be extrapolated directly from the EKC research. This is because the equation (1) is in its reduced form and, consequently, do not reveal whether or not environmental quality and economic growth are directly linked, or whether this relationship is indirect and comes about as a result of stricter environmental policy derived from higher income levels. This makes it difficult to obtain conclusions as to a direct causal relationship using these equations.

Moreover, it is most likely that the single global EKC model in its reduced version is a misspecification (Stern *et al*, 1996) given that it attempts to impose isomorphic EKCs on all of the countries and, therefore, a common TP for all of them.

Hence, in order to obtain robust conclusions as tools of policy design, the nexus between economic growth and environmental deterioration must be better analyzed.

Consequently, we have chosen to follow the line proposed by Harbaugh *et al* (2002, p. 549): "Rather than trying to fit a universal, reduced-form, pollution-income relationship, it would be useful to know what common features are shared by pollutants and countries wherein emissions are decreasing and income is increasing". This suggested approach would facilitate the job of analysts in improving theoretical explanations and testing them, which, in turn, should help administrators produce more efficacious policy. Hence, our analysis attempts to make an advance within the field of EKC research by scrutinizing both the historical experience of individual countries and the common features shared by those countries which have managed to reduce pollution whilst at the same time increasing GDP income levels.

It must be pointed out that not all reductions in pollution are compatible with the EKC hypothesis even though the levels of per capita income are increasing. This occurs when the events that have given rise to dissociation between emissions and GDP are not linked to “typical characteristics of a developing and growing economy” (Vogel, 1999, p.26).

In this sense, Stern and Common (2001) and Díaz-Vázquez (2009) have suggested the possibility that factors exogenous to the EKC model have been more influent in counteracting the GDP-scale effect than factors related to income. This is essentially what this paper aims to explore.

2. – Aim of the Analysis.

This analysis focuses on determining the role of those factors that are exogenous to the EKC model in causing a transition in the relationship between per capita GDP and emissions. Transition is here defined as a change in the relationship by which the given variables go from demonstrating a strong positive correlation to one which is negative or simply weakly correlated.

The analysis focused upon the curve that arises if per capita GDP is traced on the x axis, and the environmental indicator, also used in per capita terms, is traced on the y axis. This graphic analysis attempts to achieve the following objectives:

a) To obtain a set of countries for whom it may be affirmed that there has been a transition towards the dissociation between the evolution of GDP and the environmental indicator.
b) To check for the possible existence of a systematic link between the onset of the transition and a specific level of income.
c) The detection of historical events, international agreements, policy measures, or other factors that might immediately precede or coincide with the start of the transition and which might also be identified as possible causes of said transition.
d) A comparison of what has occurred among different countries and their pollutants.

The essential mechanism used for the investigation carried out in this work involves the use of two environmental pressure indicators, those that are most commonly used in the EKC literature: the emissions of CO_2 and sulphur. The rationale for this choice was based on the fact that, there are long, complete sets of data that are readily available for both groups and that, although both pollutants have their origins in the combustion of fossil fuels, the environmental problems that they generate and their respective potential solutions are radically different since CO_2 produces climate change while sulphur produces acidification.

3. – Data.

The CO_2 emissions data come from the *Carbon Dioxide Information Analysis Center* (CDIAC) from the *Oak Ridge National Laboratory* (ORNL) in the *U.S. Department of Energy*. The CO_2 emissions data from the ORNL include the emissions derived from the combustion of solid, liquid and gaseous fossil fuels, gas flaring and the production of cement (Marland *et al*, 2002). The data are expressed in terms of thousands metric tons of carbon. The series of ORNL data was used since it provided the most comprehensive chronological data.

The sulphur emission data was taken from the Stern series (2003)[2] and was expressed in terms of metric tons of sulphur per year.

The GDP and population data was taken from the University of Groningen and the Conference Board (2002). The GDP data are expressed in millions of U.S. dollars at 1990 prices, converted using "Geary-Khamis" purchasing power parities. The population data has been expressed in thousands of individuals. GDP/POP is therefore, expressed in thousands of dollars per capita.

The samples used are the following:

OECD94 (22 countries): Australia, Austria, Belgium, Canada, Denmark, Spain, United States, Finland, France, Greece, Netherlands, Ireland, Italy, Japan, Norway, New Zealand, Portugal, United Kingdom, Germany, Sweden, Switzerland y Turkey.

Non-OECD (35 countries). A***frica***: Egypt, Ethiopia, Ghana, Kenya, Morocco, Niger, South Africa, Democratic Republic of the Congo. ***Asia***: Myanmar, China, Hong Kong, India, Indonesia, Philippines, South Korea, Sri Lanka, Taiwan, Thailand. ***East-Europe***: Bulgaria, Czechoslovakia, Hungary, Poland, USSR. ***Latin America***: Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela. ***Middle East***: Israel, Iran, Iraq, Saudi Arabia, Syria.

WORLD. Included all the OECD94 and non-OECD countries.

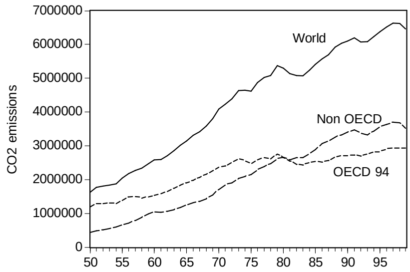
The time-frame used, for the sample and all of the variables, was 1950-1999. Given the availability of data for CO_2 emissions for USSR the period for this country was limited to 1950-1991. With respect to USSR's sulphur emissions the data is only available up until 1980.

The countries that were chosen contained 83% of the world's population in 1998, 94% of GDP, 87% of the emissions of CO_2 and 88% of the sulphur emissions.

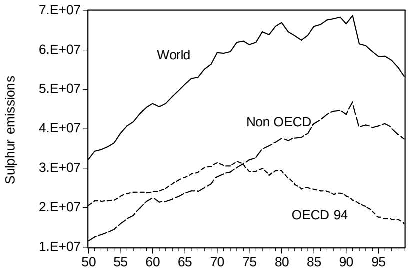
Figure 1 shows the evolution of the CO_2 and sulphur emissions. In the OECD94 sample, sulphur emissions begin to decline from 1973 onwards and CO_2 emissions tend to stabilize after 1979. In world and non-OECD, CO_2 emissions have tended to rise throughout the period, in contrast to sulphur emissions that begin to decline after 1990.

[2] This work explains how the data series were elaborated and indicates where they may be found i.e. at the following address: http://www.rpi.edu/~sternd/datasite.html see 23-9-2003. This paper has been subsequently published in Stern (2005).

Figure 1- CO_2 emissions (thousands of metric tons of carbon) and sulphur emissions (metric tons of sulphur) (*).



Source: CDIAC, Marland et al (2002)



Source: Stern (2003)

(*) In figure 1, the world emissions correspond to the total world emissions and not the total of the countries cited. The non-OECD emissions have been calculated as the difference between the world total and those of the OECD94 sample.

4.-Graphic Analysis

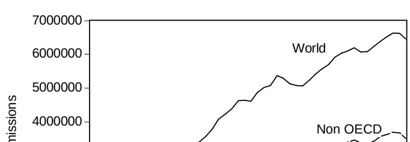
As previously indicated, this analysis is based on a study of the curve that is traced if and when per capita GDP is situated on the x-axis and the environmental indicator, also in per capita terms, on the y-axis. The objective of this procedure is, of course, to detect the factors that might have led to a transition in the relationship between GDP and the environmental indicator. Figures are available from Díaz-Vázquez and Cancelo (2008).

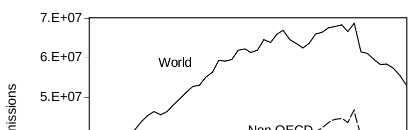
It should be stated, a priori, that the analysis is in per capita terms. Hence, all further mention of GDP, CO_2 or sulphur will refer to the variables per inhabitant unless otherwise specified.

4.1. - Graphic analysis of the CO_2-GDP relationship.

Taking the work of Moomaw and Unruh (1997) as a starting point, this analysis has chosen to select those countries whose CO_2-GDP relationship trace a discontinuous transition, this trajectory giving rise to a relationship between both variables in which this changes from a strongly positive correlation to one which is negative or weak, i.e. those countries that Moomaw and Unruh characterise as type 1[3]. Even though in the work of Moomaw and Unruh all of the countries that fall into the type 1 category belong to the OECD, the additional information that is provided here for the enlargement of the sample

[3] Therefore the countries that fall outside the group are: those for whom this relationship is positive and increasing over the period, those that do not demonstrate a consistent relationship between the two variables and those countries in which emissions decrease as GDP rises.





period[4] has led us to partially modify the countries that are included in this group and, to draw a distinction between two sub-groups: a) Type 1 countries that belong to the OECD94 (type 1-OECD) and b) Type 1 Eastern Europe (type 1-EE). It was felt important to establish this distinction since the transition processes experienced by the countries belonging to each of the groups have different characteristics. These differences are explained below.

4.1.1- Type 1 countries OECD 94 (type 1- OECD).

All of the countries cited have at least one factor in common: they have experienced a discontinuous transition in the CO_2-GDP relationship due to the oil crises of the 1970's, a phenomenon which has been observed and recorded by Moomaw and Unruh. There is a markedly positive slope that characterises the CO_2 -GDP curve which levels off when the oil crises shocks occur, or even becomes negative[5] (see table 4). From Table 1 it can be seen that the type 1-OECD reach their maximum levels of per capita emissions for the period between the years 1970 and 1980. This occurs in such a way that, in spite of the fact that per capita GDP continues to grow throughout the rest of the period, the per capita emissions do not return to same levels as that of the given decade.

Only Finland and Denmark reach their maximum level of per capita emissions in 1996. However, if the graphs for these countries are analyzed in more detail, it can be seen that the breakage-point for Denmark with respect to the positive increasing relationship between emissions and per capita GDP, took place from 1970 onwards, and in Finland from 1980. In fact, the year 1970 represents for Denmark the second highest year in terms of per capita emissions after 1996. Finland undergoes a comparable process.

Table 1.- Maximum CO_2 emissions per head with the GDP per head and ratio CO_2/GDP

COUNTRY	YEAR OF MAXIMUM EMISSIONS PER HEAD (1)	CO_2 PER HEAD	GDP PER HEAD (1990 US$)	CO_2/GDP	YEAR OF MAXIMUM TOTAL EMISSIONS (1)
TYPE 1-OECD					
Germany	1979	3,83	15.333	0,25	1979
F.R. of Germany	1979	3,48	17.807	0,19	1973

[4] These authors use the per capita emissions of CO_2 from the CDIAC provided by the Oak Ridge National Laboratory and the real per capita GDP series (in 1985 U.S. dollars) from the Penn World Tables (Summers and Heston, 1991, 1994). Take these data for the period 1950-1992.

[5] It must be remembered that the choice of data for the classification of the countries was adopted while considering the variables in per capita terms. In spite of this, it has been observed that, with the exceptions of the USA and Canada, the transition which is observed in per capita terms remains observable when total values are used. The reverse is true of the two countries cited, their total emissions exhibit a sharp tendency to grow in line with GDP after the periods of crisis and far surpass the levels of emissions that are reached in the 1970's. It should further be underlined that, in the U.S.A., the per capita relationship also regains a clearly upward slope after the crisis, but without reaching the per capita levels that 1970's witnessed.

Austria	1979	2,28	13.449	0,17	1998
Belgium	1974	3,83	12.643	0,30	1974
Canada	1979	4,82	16.170	0,30	1997
Denmark	1996	3,77	20.399	0,18	1996
USA	1973	5,95	16.689	0,36	1999
Finland	1996	3,31	16.502	0,20	1996
France	1974	2,61	13.420	0,19	1979
Netherlands	1979	3,08	14.643	0,21	1979
Norway	1980	2,50	15.127	0,16	1999
United Kingdom	1971	3,23	10.937	0,30	1971
Sweden	1970	3,18	12.716	0,25	1970
Switzerland	1973	1,89	18.204	0,10	1973
		TYPE 1-EE			
Poland	1980	3,50	5.740	0,61	1987
Czechoslovakia	1978	4,47	7.761	0,58	1979
Hungary	1979	2,20	6.251	0,35	1979

(1) in the period 1950-1999.

NOTE: GDP per head points are in real 1990 US dollars per inhabitant and the CO_2 emissions per head are in metric tons of carbon per inhabitant.

SOURCE: University of Groningen and Conference Board (2002), CDIAC (Marland et al, 2002), author´s calculation..

Table 2.- Weight of Nuclear energy into the total electricity production in 1986 (%)

France	69,8	Bulgaria	30,0
Belgium	67,0	F.R. of Germany	29,4
Sweden	50,3	Spain	29,4
Taiwan	43,8	Hungary	25,8
South Korea	43,6	Japan	24,7
Switzerland	39,2	Czechoslovakia	21,0
Finland	38,4	United Kingdom	18,4

SOURCE: García and Iranzo (1988, p. 171).

It is important to stress that, in most of the type 1-OECDs, the decline in per capita emissions is more intense during the economic stagnation phase which occurs after the 1979 oil shock.

It has also been shown that, confirming the analysis of Moomaw and Unruh, the shape of the curve for some of the type 1-OECD countries is closer to an inverted “V” shape than an inverted “U”. This would appear to indicate that there might be a sharp, swift reduction in these emissions. The most obvious cases are those of Belgium, France and Sweden. This sharp reduction may be explained by the fact that, as can be seen from table 2, it was precisely these three countries, the ones that rely most heavily on nuclear energy, which would seem to negate that this change in trajectory might be due to greater ecological sensitivity.

The case of Germany requires a specific explanation, given that the data that has been used was that which refers only to a united Germany. However, if the paths for East and West Germany are analyzed separately, it may be observed that, as one might expect, only West Germany is consistent with the performance typified by the type 1-OECD countries.

Finally, it should be underlined that the fact that per capita U.K. emissions in 1999 are lower than those for 1950 is exceptional.

4.1.2. - Type 1 Eastern European Countries (type 1-EE).

The countries that have been chosen within this group are: Poland, Czechoslovakia and Hungary. These countries were not included by Moomaw and Unruh among type 1. These authors observed that, in general, in those countries that were regulated under the umbrellas of planned economies, the per capita emissions fell as and when per capita GDP fell. The additional information that the enlargement of the time period analyzed provides, leads to the conclusion that, at the very least the three countries that have been selected have experienced transitions with respect to their CO_2-GDP, although the characteristics of these countries are somewhat different from those of the type 1-OECD.

There are two principal conclusions that may be gleaned from the analysis. Firstly, the oil crisis, particularly the second oil "shock", also set off a reaction leading to a transition with respect to CO_2-GDP, which has its parallel in the type 1-OECD. This phenomenon may be observed for the cases of Czechoslovakia and Hungary. These countries reach their maximum level of emissions in the years 1978 and 1979 respectively. Further from these dates onwards, up until 1989, the per capita emissions become more stable or decline, whilst per capita GDP continues to grow. In the case of Poland, this "first" transition is not observable given that, in this particular country, the emissions are very closely linked to the growth of GDP during this period, that is, there is a decrease which coincides with a fall in per capita GDP after the oil crisis which subsequently gives way to a recovery as production itself recovers.

Secondly, the effect of the oil crisis was exacerbated by the subsequent sharp contraction in economic activity within the Eastern European countries between 1989 and 1993. In this second shock, the emissions initially diminish as per capita GDP diminishes. However the result of adding together two effects has been that when per capita production has begun to recover, it has done so with levels of emissions that are far lower than those of previous decades and, the curve that represents the CO_2-GDP relationship has not managed to regain an upward slope. Thus, the economic phase of contraction and restructuring might be deemed to be a "second" CO_2-GDP transition for the type 1-EE countries (but the first for Poland)[6].

In order to finalize the analysis of the CO_2-GDP trajectory in the type 1 countries, it should be concluded that, when the disparities in the per capita incomes of the chosen countries are taken into account at the precise time at which the transition was taking

[6] The evolution of the relationship between total emissions and GDP in these countries is very similar to that set out for per capita variables

place[7], that, historical events (the oil crisis and the restructuring of Eastern Europe) have led more surely to a CO_2-GDP related transition than the mere fact of achieving a given threshold per capita income level. Further, it should be underlined that these transition processes are linked to periods of profound economic crisis.

4.2.-Graphic analysis of the sulphur-GDP relationship

Among the objectives of this analysis is the comparison of the sulphur-GDP with the CO_2-GDP trajectory[8]. To this end, the type 1-OCDE countries and the type 1-EE which are referred to in the analysis are those which have been classified into these groups in the analysis of the CO_2-GDP relationship.

Table 3.- Maximum sulphur emissions per head with the GDP per head and ratio S/GDP

COUNTRY	YEAR OF MAXIMUM EMISSIONS PER HEAD (1)	SULFUR PER HEAD	GDP PER HEAD (1990 US$)	S/GDP	YEAR OF MAXIMUM TOTAL EMISSIONS (1)
COUNTRIES TYPE 1-OECD					
Germany	1964	51,21	9.709	5,72	1985
Austria	1957	36,93	5.716	6,46	1957
Belgium	1980	42,04	14.467	2,91	1980
Canada	1951	123,04	7.686	16,01	1974
Denmark	1980	44,12	15.227	2,90	1980
USA	1969	69,41	15.179	4,57	1973
Finland	1980	61,09	12.948	4,72	1980
France	1980	29,80	15.103	1,97	1980
Netherlands	1956	25,37	7.468	3,40	1970
Norway	1977	18,61	13.357	1,39	1977
United Kingdom	1955	76,60	7.826	9,79	1955
Sweden	1980	29,54	14.936	1,98	1980
Switzerland	1951	12,92	9.684	1,33	1974
COUNTRIES TYPE 1-EE					
Poland	1985	57,79	5.664	10,20	1985
Czechoslovakia	1979	100,87	7.790	12,95	1982
Hungary	1964	95,86	4.390	21,84	1964

(1) Period 1950-1999.
NOTE: GDP per head points are in real 1990 US dollars per inhabitant and the sulphur emissions per head are in metric tons of carbon per thousand inhabitants.

[7] See Table 1. Taking into consideration the graphic analysis, the year in which emissions reached maximum levels may be considered to be the point at which the transition in the type 1 countries began to take place ("first" transition in Czechoslovakia and Hungary), with the notable exceptions of Denmark, Finland and Poland. It may be observed that the range in per capita income oscillates between 6,251 dollars in 1990 in Hungary and 18,204 in Switzerland

[8] It should be remembered that the work of Moomaw and Unruh (1997) was limited to analyzing what occurred in the case of CO_2 emissions

SOURCE: University of Groningen and Conference Board (2002), Stern (2003) , author´s calculation.

From the sulphur-GDP curve the following conclusions may be gleaned:

First, given identical economic circumstances, the reductions in sulphur emissions have been much more acute, and prevalent in more countries than when looking at those for carbon. This result is consistent with the fact that the effects of the sulphur emissions are more local in nature, thus favouring the adoptions of measures aimed at reducing this type of emissions.

Second, and as in the case of CO_2-GDP, there is no specific per capita level of GDP that marks the outset of the process of transition with relation to the sulphur-GDP (see table 3).

Third, and as previously expounded, the changes in the CO_2-GDP are linked to specific historical events, the economic crisis of the 1970's and the fall of the Berlin wall. However, the transitions with relation to sulphur-GDP are not necessarily linked to these events. The situations are more noticeably divergent in this particular case. This can be verified by looking at the considerable differences in the dates in which these countries reach their maximum sulphur emissions per inhabitant (see table 3). In consequence, it might be deduced that the specific conditions or characteristics of each given country are significantly influential.

In spite of these factors, in the majority of the type 1 countries, the dates of the oil crisis signal a change in the trajectory of sulphur-GDP and, specifically, this occurs after 1979 when there is a significant reduction in emissions. However, in contrast with the case of CO_2 (that is, the oil crises generally entail a transition from high levels of correlation between the two variables to a relationship which is negative or weakly correlated), there is found to be a greater diversity of situations with respect to the sulphur-GDP trajectory, both before and after the dates of the oil crises (see table 4):

- *From a clearly positive slope to one which is either weak or indeed negative:* Denmark, the USA, Finland, Norway, Switzerland and Czechoslovakia.
- *From a correlation that is positive but low, there is a sulphur-GDP curve which is clearly downward sloping:* Belgium, France and Switzerland.
- *The downward slope becomes much more pronounced:* Austria, Netherlands and Hungary. This group may also be deemed to hold Canada, given that it provides a negative correlation between the sulphur emissions and GDP before 1973, although it is not possible to assert that curve maintained a negative tendency until this year. In fact, in this country, the emissions fall considerably in the 1950's but, subsequently rise a little until 1973.
- *With no outstanding effect:* The United Kingdom and Germany. In the United Kingdom, the sulphur-GDP relationship is represented by a sharply negative slope throughout practically the whole of the period and this does not become more intense after the oil crisis. With respect to Germany, it should be remembered that the data used is that which belongs to a united Germany. This

makes it very likely that there are hidden trajectories that are different for Western and Eastern Germany, as is the case for carbon.

Although the analysis has indicated that 1979 is a key year for the sulphur-GDP relationship, in the majority of the type 1 countries, it cannot be deduced that the energy crises have been the main driving force behind this trajectory. This is because, in the case of sulphur, signing the 1979 Convention on Long-range Transboundary Air Pollution and the pacts agreeing to certain obligatory reductions adopted in 1985 in the Helsinki protocol may have had an effect. All of the type 1 countries signed the convention. Of these, only the USA, The United Kingdom and Poland failed to sign the 1985 protocol.

Further, as with the CO_2-GDP scenario, sulphur-GDP in the type 1-EE countries are affected by the economic changes suffered after the fall of the Berlin wall, in such a way that the subsequent economic recuperation did not involve a contingent increase in emissions, but rather, these emissions continued to fall.

Finally, it should be underlined that some of the countries that were not selected as type 1 countries because their GDP-CO_2 emissions were on the increase, enjoyed a stage in which their sulphur-GDP curve tended to turn downwards: Japan (from 1970), Israel (from 1973), Italy (from 1974), Ireland (from 1979), Spain (from 1980), Egypt (from 1982), Taiwan (from 1989), South Korea (from 1990), Greece (from 1992)[9] and Hong Kong (from 1993).

Table 4.- Correlations between emissions per head and GDP per head.

	CO_2-GDP			Sulphur-GDP		
	1950-1973	1974-1999	1980-1999	1950-1973	1974-1999	1980-1999
Type 1-A						
Germany	0,95	-0,76	-0,79	0,73	-0,73	-0,83
Austria	0,98	-0,04	0,60	-0,45	-0,95	-0,91
Belgium	0,93	-0,69	-0,42	0,52	-0,91	-0,85
Canada	0,95	-0,72	-0,53	-0,40	-0,91	-0,82
Denmark	0,97	-0,26	-0,06	0,61	-0,82	-0,95
USA	0,94	-0,14	0,65	0,72	-0,94	-0,93
Finland	0,98	0,15	0,39	0,94	-0,85	-0,79
France	0,99	-0,86	-0,74	0,14	-0,92	-0,86
Netherlands	0,99	-0,30	0,03	-0,18	-0,90	-0,88
Norway	0,97	-0,33	-0,47	0,83	-0,93	-0,90
United Kingdom	0,57	-0,66	-0,40	-0,93	-0,95	-0,91
Sweden	0,98	-0,89	-0,82	0,23	-0,90	-0,87
Switzerland	0,99	-0,59	-0,27	0,01	-0,85	-0,92
Type 1-B						
Czechoslovakia	0,98	0,12	0,39	0,96	-0,04	0,18
Hungary	0,97	0,42	0,62	0,73	0,19	0,51
Poland	0,98	0,03	-0,09	0,99	-0,22	-0,33
Type 2						
AFRICA						
Egypt	0,77	0,96	0,93	-0,25	0,61	-0,66

[9] Further, in Greece, the positive slope of the curve becomes much more gentle after the mid eighties.

ASIA						
China	0,79	0,93	0,90	0,74	0,84	0,75
South Korea	0,95	0,99	0,99	0,91	0,36	-0,18
Hong Kong	0,97	0,87	0,72	-0,90	0,77	0,50
India	0,96	0,98	0,98	0,93	0,94	0,92
Indonesia	0,85	0,95	0,95	-0,04	0,95	0,92
Sri Lanka	0,57	0,91	0,90	0,52	0,75	0,80
Thailand	0,98	0,98	0,98	0,95	0,96	0,95
Taiwan	0,99	0,97	0,96	0,68	0,31	-0,43
LATIN AMERICA						
Chile	0,95	0,88	0,96	-0,47	0,77	0,75
Colombia	0,87	0,88	0,81	0,52	0,49	0,20
MIDDLE EAST						
Israel	0,97	0,95	0,99	0,96	0,12	0,30
OECD94						
Australia	0,98	0,97	0,97	0,65	0,46	0,37
Spain	0,99	0,78	0,81	0,97	-0,67	-0,91
Greece	0,99	0,97	0,96	0,97	0,81	0,49
Ireland	0,97	0,95	0,94	0,79	-0,29	-0,23
Italy	0,99	0,87	0,90	0,98	-0,94	-0,90
Japan	0,99	0,77	0,93	0,97	-0,81	-0,67
Portugal	0,99	0,99	0,98	0,73	0,87	0,80
Turkey	0,98	0,97	0,97	0,94	0,88	0,86

Source: Author´s calculations. Data from: University of Groningen and Conference Board (2002), CDIAC (Marland *et al*, 2002) and Stern (2003).

5. Conclusions.

The guiding light for this analysis has been the study of those specific cases in which the emissions-GDP relationship has followed an inverted-U trajectory. This strategy aimed to discover whether or not these cases were consistent with the suppositions that underlie the EKC hypothesis, in short whether the intentional and non-intentional events that might have given rise to dissociation between the two variables are systematically linked to growing, developing economies.

The results of this study indicate that, there is no threshold income level beyond which there is a general reduction on the pressure exerted on the environment. On the contrary, historical events and economic crises would seem to have been more clearly linked to environmental transitions rather than the attainment of a given developmental threshold. Specifically, from the analysis presented here it is revealed that the events that provoke the CO_2-GDP transition, that is, the oil crisis of the 1970’s and the transition of the Eastern European economies, are not systematically linked to a specific phase of development and do not even respond to environmental factors.

With respect to sulphur, the results are more ambiguous, given that, on the one hand, not all of the countries begin the transition at the same time. On the other, while 1979 seems to be the year in which there is a generalized fall in emissions in many of the OECD94 countries, this may be somewhat misleading given that this was the year in which both the second oil crisis and the signing of the Convention on Long-range

Transboundary Air Pollution took place, hence making it difficult to assess their impact on emissions. Therefore, it would appear to be more complex to detect a common given event capable of explaining the dissociation and, as a consequence, it is also difficult to determine the role of income levels within the process as a motor of the demand for improved environmental conditions.

In spite of this, there is no level of per capita income beyond which there begins to be dissociation in terms of sulphur-GDP and, given the greater heterogeneity of this scenario, other factors might be affecting the results. These factors potentially include the perceived ecological damage, the availability of anti-pollutant technology and the pressure exerted by supranational organizations. Analyzing the impact of these factors falls outside the realms of this study but will be addressed in subsequent analyses.

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