Environment, Human Development and Economic Growth

Valeria Costantini and Salvatore Monni

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Valeria Costantini and Salvatore Monni, *Department of Economics, Roma Tre University*

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Summary

Over the last few years, environmental issues have entered into policy design, particularly development and growth policies. Natural resources are considered necessary production inputs and environmental quality is considered a welfare determinant. The integration of environmental issues into economic growth and development theories and empirics is currently widely analyzed in the literature. The effects of natural resources endowment on economic growth are mainly analyzed through the so-called Resource Curse Hypothesis (RCH) whereas the effects of economic growth on environmental quality are part of the Environmental Kuznets Curve (EKC). Furthermore, recent contributions on RCH and EKC have shown the important role of institutions and human development dimensions in building a sustainable development path. In this paper, we attempt to analyze the causal relationships between economic growth, human development and sustainability combining the RCH and EKC models and adopting a human development perspective.

Keywords: Natural Resources, Sustainability, Human Development, Trade

JEL Classification: O15, Q01, Q56

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Address for correspondence:

Valeria Costantini
Department of Economic
Roma Tre University
Roma
Italy
Phone: +39 06 57374215
E-mail: v.costantini@uniroma3.it

1. INTRODUCTION

Over the last decades, development thinking has been profoundly changed by two different, albeit complementary, issues that emerged in the international literature: the concepts of human development (HD) and sustainable development (SD).

The definition of a widely known concept of human well-being based on the capability approach formulated by Sen (1979, 1982, 1983, 1985) was the basis of the first Human Development Report published by UNDP in 1990.[1] The HD paradigm developed by UNDP focused its attention on how development could enlarge people's choices by expanding freedoms and capabilities.

Moreover, HD also means an expansion of the real freedom that individuals enjoy and attention must be shifted away from the means that allow liberties to expand such as economic growth, increased personal income, technological progress or social modernization towards the ends which are the liberties themselves (Sen, 1999).

Over the last years, a great deal of attention has also been given to the role of natural resources and the environment, fundamental aspects of human well-being and the quality of life. Attention has gradually shifted from a vision of environment as a limit to economic growth (Meadows *et al.*, 1972) to its active role in reducing poverty, achieving higher living standards and increasing human development levels. As claimed by the Brundtland Report, the definition of SD requires the same level of well-being achieved for the present generation to be maintained for future generations (WCED, 1987).

The first Human Development Reports have not explicitly considered the role of the natural environment in enhancing people's choices but in more recent editions, the environment and more broadly sustainable development have been progressively introduced (UNDP, 1996). In the year 2000, the definition of the Millennium Development Goals by the United Nations definitively recognized the full integration of human development and the environment as mutually reinforcing development goals.

[1] "The capability approach is a broad normative framework for the evaluation and assessment of individual well-being and social arrangements, the design of policies, and proposals for social change in society. […] It can be used to evaluate several aspects of people's well-being such as inequality, poverty, the well-being of an individual or the average well-being of members of a group. It can also be used as an alternative evaluative tool for social cost-benefit analysis or to design and evaluate policies ranging from welfare state design in affluent societies to development policies by governments and non-governmental organisations in developing countries." (Robeyens, 2005, p. 94).

From a theoretical perspective, an integrated Sustainable Human Development paradigm has been defined as development that promotes the capabilities of people in the present without compromising the capabilities of future generations (Sen, 2000).[2]

Two different approaches seem to be the most appealing for this integrated paradigm. The effects of natural resources endowment on development are mainly analysed through the so-called Resource Curse Hypothesis (RCH) whereas the effects of economic growth and development process on environmental quality are part of the Environmental Kuznets Curve (EKC).

There are many empirical contributions that analyze the role of natural resources endowments in the economic growth process and define the so-called Resource Curse Hypothesis (RCH). The scope of these analyses is to capture the positive or negative role of natural resources in enhancing or reducing economic growth rate. The empirical models of RCH adopt both the convergence theory developed by Barro and Sala-i-Martin (1995) and the huge amount of literature that analyzes the causal relationships between trade openness (and more broadly globalization) and economic growth. Furthermore, the specific role of human capital accumulation (related especially to education) and the quality of institutions has been introduced as a further explanation of the resource curse.

It is worth noting that the role of trade and economic globalization – defined as a process of enlarging opportunities in terms of new technologies, such as information, communication and competitiveness (Bhagwati, 2004), – is particularly important in all the explanations proposed as the basis of the RCH. The influence of the exploitation of natural resources on economic growth must be linked to the export flows of such primary resources and the role of innovation technology and foreign direct investment are equally recognized. Most of the RCH contributions explicitly relate to the trade-growth literature which analyzes links between trade liberalization and economic growth (Frankel and Romer, 1999; Winters, 2004), with specific effects on poverty and income distribution (Dollar and Kraay, 2004; Ravallion, 2001, 2003), or specific issues related to the role of institutions (North, 1990; Rodriguez and Rodrik, 2001; Rodrik, 1998, 2000; Sokoloff and Engerman, 2000) and the effects on developing countries (Acemoglu *et al.*, 2001; Greenaway *et al.*, 2002; Martin, 2001; Moseley, 2000). The RCH literature has

[2] For an empirical survey on measurement of Sustainable Human Development, see Costantini and Monni (2005).

made a further step forward by including natural resources endowment as a possible source of low growth rate together with trade restrictive policies, macroeconomic instability, low human capital accumulation rate, corruption and so on.
The opposite causal relationship - the effects of economic growth and development on the environmental quality – has been mainly analyzed through the so-called Environmental Kuznets Curve (EKC). Pioneering contributions stressed the importance of pure economic growth (in terms of income per capita) as a major source of environmental degradation (Grossman and Krueger, 1995; Shafik, 1994) whereas recent contributions have shown the important role played by further aspects related to globalization, health, education and other well-being dimensions (Hill and Magnani, 2002; Tisdell, 2001).
It seems clear that both the RCH and the EKC models are deeply influenced by human development dimensions and such a common element could be a useful link between the two causal relationships. Furthermore, the role of globalization is a necessary additional perspective that should be scrutinized and strictly connected to the quality of institutions and investments for human capital accumulation.
The rest of the paper is structured as follows. In Section 2 we specifically analyze the RCH while in Section 3 we underline the effects of institutions and measures of human well-being on the RCH. In Section 4 we describe the classic EKC contributions and we build a partially modified EKC that accounts for human development and sustainability. In Section 5 we test the possibility of building an integrated model linking the RCH with the modified EKC, which allows us to analyze the reciprocal causality links among economic growth, human development and sustainability with special attention given to the role of the globalization process and the quality of institutions. Section 6 concludes with some reflections on the policy actions proposed at international level.

2. THE RESOURCE CURSE HYPOTHESIS: THEORIES

The Resource Curse Hypothesis maintains that countries with high natural resources endowments have experienced lower economic growth rates than countries with scarce stocks of natural resources. The resource curse is paradoxical because production of natural resources has been the initial source of nearly all development, providing an almost immediate source of foreign exchange, attracting foreign capital and skills and increasing the availability of both raw materials for processing and a market for manufactured inputs. Nonetheless, over the last fifty years, countries rich in natural (commercial) resources (e.g., Russia, Nigeria and Venezuela) experienced economic growth that was somewhat lower than other countries with scarce resources (Auty, 2001).

Sachs and Warner (1995) provided a first formulation of an empirical RCH, claiming that the resource curse is a historically common pattern and the abundance of natural resources is one of the most evident causes of low economic performances. Countries that base their economies on natural resources tend to be examples of development failures. In contrast, countries such as Japan, Hong Kong, Korea and Ireland experienced high economic growth rates although they had relatively lower endowments of natural resources. A third category includes countries with a relatively higher dependence on primary resources and good growth performance as is the case for Norway and Botswana.

One of the first explanations for the observed slow growth rate despite the resource endowments in some countries has been attributed to the substantial terms of trade volatility in primary commodity exports (Mikesell, 1997).[3] Empirical investigations have not been able to find a strong relationship between terms of trade volatility and per capita growth (Sachs and Warner, 1999; Sala-i-Martin *et al.*, 2003), and have turned to other transmission channels in order to explain such a curse. The main body of literature suggests five different explanations: the Dutch disease effect, the misallocation of revenues from resource exploitation, the rent seeking behavior, the quality of institutions and the role of human capital (Auty, 2001; Ross, 1999).

The Dutch disease hypothesis suggests that a resource boom will divert a country's resources away from activities that are more conducive to long-term growth.[4] A resource boom causes the appreciation of the exchange rate, producing a contraction in

[3] In this context, terms of trade volatility is defined as the standard deviation of the percentage growth rate of the terms of trade.

[4] The term 'Dutch disease' was used for the first time in relation to the discovery and importation of silver in the 16th century to the Netherlands, and the related negative economic impacts occurred in the country. Normally, the term refers to adverse effects on the traded sector when resources income pushes domestic demand up and adverse effects on economic growth following the reallocation of production factors (Matsen and Torvik, 2005).

manufacturing exports or displacement of capital and labor factors away from manufacturing towards the extractive industries and raising manufacturing costs as a result. Moreover, the appreciation of the exchange rate reduces prices for tradable products (manufactured goods and agricultural products) relative to prices of non-tradables (construction and services) so that labor and capital are withdrawn from the tradable sector (considered typically the most dynamic one, with positive effects in terms of economic growth) and flow into the non-tradable sector. Foreign Direct Investment (FDI) may be attracted by investment opportunities in the export boom sector which may cause further appreciation of the real exchange rate. The increased capital imports may lower the interest rate which induces domestic capital to go abroad in response to higher earnings.[5] Obviously FDI inflows would have such negative impacts only in the case of highly concentration in the resource-intensive sector. The movement of resources between sectors may reduce capital accumulation. If the non-tradable sector is relatively labor intensive while the tradable sector is more capital intensive, the movement in favor of the non-tradable sector will tend to raise wages and lower returns to capital, thereby reducing capital accumulation. Furthermore, technological progress is faster in the traded sector than in the non-tradable sector. The more recent explanations of the resource curse based on the Dutch disease effect include the role of Learning by Doing (LD) differently distributed among the sectors. The agreement rests upon the assumption that LD is only generated in the traded sector (implicitly assumed to be the manufacturing sector). Since a foreign exchange gift (linked to competitive exports in the international market) decreases the size of the traded sector through the reduction of capital accumulation and investment in such activities, productivity growth is reduced (i.e., the reduction of the tradable sector productivity is more than proportionate to the reduction of investments whereas the increasing productivity in the non-tradable sector is proportionate to the increasing factor endowment). When the real exchange rate appreciation is accompanied by increasing real exchange rate volatility, the traded sector is further depressed because investment is reduced (Torvik, 2001).

Theoretical and empirical models of Dutch disease have been developed by van

[5] The negative effects of a Dutch disease hypothesis from the supply side could exceed the positive effects on the demand side linked to a resource boom if the revenues from the resource exploitation are deeply concentrated and the resulting increase in income per capita is far less then the increase in revenues. The extractive activities are typically capital-intensive, and the resource boom would have a smooth effect in terms of increasing real wages.

Wijinbergen (1984), Torvik (2001) and Matsen and Torvik (2005) among others. It must be underlined that Dutch disease effects are mainly used for an explanation of negative economic performance due to a temporary resources boom (in terms of both increasing resource stocks or rising resource price). As in van Wijnbergen (1984), high but temporary resource revenues may be a mixed blessing. Many oil producing developing countries encountered serious problems in building up a diversified export base whereas West European oil and gas producers (Netherlands and United Kingdom) suffered a decline in their traded goods (manufacturing) sector induced by real wages pressures.

Directly linked to the Dutch disease effect, a second explanation is based on the role of savings. Among resource-rich countries, empirical evidence has shown that those countries with the highest (resource wealth adjusted) savings rate generally have managed to escape the resource curse (Atkinson and Hamilton, 2003; Boyce and Emery, 2005; Neumayer, 2004). Countries that manage their resource wealth more in accordance with the optimality criteria will fare better than those who do not. Looking at data on resource wealth-adjusted savings rate – built on the basis of the World Bank Genuine Savings measure (column GS in Table 1) - there is a propensity for countries that have escaped the resource curse (Malaysia, Thailand, as only developing countries examples) to have a higher resource wealth-adjusted savings rate than those that have not escaped (Congo, Nigeria, United Arab Emirates, among others).[6]

The adjusted saving rates with consumption of natural resources are the very first signal of a misallocation of revenues from exploitation of such resources. Negative values of GS characterize countries with a resource curse whereas positive values of GS are associated with virtuous countries. It should be noted that Oman (an oil dependent country) has a positive (but low) economic growth rate but a deeply negative adjusted saving. This means that income growth has been obtained through the dissipation of natural capital without appropriate investments to replace the exhaustible resources. From a sustainability point of view, such growth progress will not last forever because capital accumulation is less than the amount that must be produced in the future constant (or increasing) income flows.

Most of the time, the decision to invest revenue from resource exploitation or not is

[6] The average value reported in table 1 is partially decreased by Oman with an outlying value (-112.89) but compensated by the Japanese resource wealth adjusted savings (+137.6). Notes on Genuine Savings methodology are addressed in par. 4.

biased by distorted price signals. If the market price of the resource does not include all the factors affecting the real total production cost (as the sum of the marginal extraction cost plus the marginal use cost), the resource will seem more profitable (with a higher marginal profit) and it will be exploited at an unsustainable rate. The effective consumption path will be higher than the constant consumption path whereas the re-investment of resource revenues will be less than the amount required to replace the resource depletion. This overexploitation will negatively affect the long-term economic growth (Atkinson and Hamilton, 2003).[7]

[7] Alternative economic measures of resources depletion such as the El Serafy method proposed by Neumayer (2004), have been taken into account by Atkinson and Hamilton (2003) but for the chosen time period (and with low discount rates such as those used by the World Bank), the estimates would not be highly divergent.

Table 1 – Main statistics for countries: resource curse and resource blessing

Resource curse	EG 1970-2003	GS 1970-2003	DIFFUSE	POINT	TOT-RES	LIFE 1970	EDU 1970	IQ 2004	HDI 2003	HDI 1975-2003
Bolivia	0.21	-2.33	1.85	19.29	21.14	46.07	24.56	-0.43	0.69	0.36
Central African Rep.	-1.23	-2.79	10.29	0.03	10.31	42.36	4.18	-1.39	0.36	0.02
Congo, Dem. Rep.	-3.94	-6.57	3.93	17.20	21.13	45.16	9.39	-1.70	0.39	-0.05
Jamaica	-0.16	0.25	5.81	5.54	11.35	68.36	45.56	-0.05	0.74	0.16
Kuwait	-2.87	-47.05	0.57	68.45	69.02	66.11	63.45	0.30	0.84	0.34
Mauritania	0.34	-45.87	4.54	35.53	40.07	42.64	2.13	-0.21	0.48	0.21
Nicaragua	-1.73	3.70	20.11	0.66	20.78	53.89	17.22	-0.32	0.69	0.25
Nigeria	0.12	-18.80	4.16	20.84	24.99	42.86	5.24	-1.21	0.45	0.20
Peru	0.09	9.51	4.94	5.28	10.22	53.94	30.67	-0.35	0.76	0.33
Saudi Arabia	0.41	-85.46	0.07	67.62	67.70	52.31	12.05	-0.38	0.77	0.43
Senegal	0.16	-6.43	12.45	4.48	16.93	40.86	9.29	-0.18	0.46	0.21
United Arab Emirates	-3.23	-2.52	0.61	41.84	42.45	61.11	21.83	0.69	0.85	0.43
Venezuela	-1.42	-8.23	0.36	24.98	25.34	65.12	34.96	-0.97	0.77	0.19
Average	-1.02	-16.35	5.36	23.98	29.34	52.37	21.58	-0.48	0.63	0.24

Resource blessing	EG 1970-2003	GS 1970-2003	DIFFUSE	POINT	TOT_RES	LIFE 1970	EDU 1970	GOV 2004	HDI 2003	HDI 1975-2003
Chile	2.52	-8.99	1.23	9.99	11.22	62.40	37.40	1.25	0.85	0.51
Hong Kong	4.30	81.02	1.52	0.64	2.16	69.96	35.81	1.31	0.92	0.65
Indonesia	3.82	9.70	8.06	11.95	20.01	47.92	16.09	-0.74	0.70	0.43
Ireland	4.01	40.20	14.72	1.68	16.40	71.09	73.76	1.48	0.95	0.71
Japan	2.40	137.60	0.41	0.16	0.58	71.95	86.59	1.13	0.94	0.60
Korea, Rep.	5.47	35.79	2.60	0.78	3.39	59.93	41.61	0.61	0.90	0.66
Malaysia	3.79	17.38	23.97	9.82	33.78	61.55	34.23	0.38	0.80	0.47
Norway	2.83	31.00	3.84	4.79	8.63	74.19	83.49	1.74	0.96	0.72
Oman	1.99	-112.89	0.11	49.77	49.88	47.37	0.00	0.49	0.78	0.57
Sri Lanka	2.89	19.00	13.16	0.65	13.81	64.65	47.00	-0.25	0.75	0.37
Syrian Arab Republic	2.15	-3.16	3.23	7.76	10.99	55.79	38.09	-0.91	0.72	0.39
Thailand	4.24	39.64	10.51	1.68	12.18	58.44	17.42	0.03	0.78	0.42
Tunisia	2.89	13.51	6.17	8.61	14.78	54.19	22.69	-0.01	0.75	0.49
Average	3.33	23.06	6.89	8.33	15.22	61.49	41.09	0.50	0.83	0.54

The exact definition of all variables is available in Table A1 in the Appendix. All data are from World Development Indicators, data base 2004, The World Bank.

The third explanation of the RCH is linked to the presence of rent seeking behavior, based on the assumption that resource rents are easily appropriable and this, in turn, leads to distortion in public policies and pressure from lobbies and oligopolistic companies to seek public favors (Torvik, 2002). Concentration of rents in the hands of a few private owners directs revenue away from human resources, infrastructures, traditional agriculture, small enterprise towards consumption and rent dissipation.

Rent seeking behavior negatively affects economic growth under three specific conditions (Baland and Francois, 2000).[8] First, entrepreneurial activity, by creating new and better goods and services, destroys rents accruing to those holding licenses restricting trade in already existing goods and services. Secondly, profits to entrepreneurs increase with aggregate income. Thirdly, rent-seekers possess entrepreneurial skills and can switch between these activities. Under these conditions, an increase in entrepreneurship reduces rent-seeking and encourages further entrepreneurship. On the contrary, a resource boom provides increasing revenues for rent-seekers, and entrepreneurship (and economic growth) will be reduced.

Similar mechanisms are explained in Torvik (2002) with a specific model explaining that in the event of a resource boom, rent-seeking activities become more profitable then before whereas modern production sector guarantees the same level of profits. In this case, rent-seeking activities become more attractive and entrepreneurs from modern sectors move to rent-seeking activities. Under the hypothesis that modern sector has increasing returns to scale whereas rent-seeking activities have constant returns to scale, a reduction in the modern activities produces a fall in production that is greater than the increase in the production of rent-seeking activities, thus reducing total output and therefore welfare. Furthermore, the timing of the natural resource boom is important as is the sectoral distribution of the increasing returns and whether the boom stimulates the right sectors. Following Sachs and Warner (1999), conditions such as the degree of trade openness and the structural dimension of the economic system (development stage, as

[8] There are different forms of rent seeking (Bhagwati, 1982): *premium seeking*, or activities whereby claimants compete for premium-fetching import licenses; *revenue seeking*, where economic agents try to obtain a slice of the tariff revenue resulting from the adoption of a protectionist tariff and *tariff seeking*, where lobbies seek protectionist trade tariffs. All these components lead to directly unproductive profit seeking behavior. Such agents "yield pecuniary returns but do not produce goods or services that enter a utility function directly or indirectly via increased production or availability to the economy of goods that enter a utility function" (Bhagwati, 1982, p. 989).

primary sector led economies vs. tertiary sector) seem to be specific conditions that affect the natural resource curse.

A fourth explanation looks deeply at the relationships between the quality of institutions and the capacity to manage resources exploitation with theoretical (Mehlum *et al.*, 2002; 2005) and empirical studies (Bulte *et al.*, 2005; Isham *et al.*, 2003; Leite and Weidmann, 1999; Sala-i-Martin and Subramanian, 2003). The linkages between the resource curse and the role of institutions may be divided into two strands: where the quality of institutions is damaged by resource abundance and constitutes the intermediate causal link between resources and economic performance and where resources interact with the quality of institutions so that resource abundance is a blessing when institutions are good and a curse when institutions are bad. The first linkage (destruction of institutions or an obstacle to the formation of solid institutions) can be found in many examples including Saudi Arabia, Sudan, Nigeria, Angola and Congo, to mention a few. On the other hand, natural resources endowment may not negatively affect institutional quality as in Chile, Malaysia and Norway. It is worth noticing that countries with a higher quality of institutions (except for Norway) are those with lesser resources endowments (e.g., Hong Kong and Ireland).

Finally, a fifth explanation classifies recent contributions that have stressed the importance of other characteristics, conjunctural and structural, linked to the absence of adequate investments in enhancing human resources (Gylfason, 2001). In particular, a contribution by Gylfason (2001) has emphasized that resource abundance may have the effect of "crowding out" the accumulation of human capital, reducing the incentives for investments in education or knowledge sectors (such explanation is partially linked to the LD effect). As claimed by Atkinson and Hamilton (2003), public investments in human capital accumulation makes a great contribution to economic growth in resource abundant countries whereas countries with higher government consumption have generally experienced a significant resource curse. This result is consistent with the fourth explanation of the RCH based on the quality of institutions. Countries that escaped from the curse present a higher initial level for dimensions such as life expectancy at birth and secondary gross enrolment ratio. If we look at the average value for all the variables in Table 1, it is clear that a relative abundance of natural resources, especially fuels and minerals (defined as point resources)[9] goes hand in hand with a lower level of initial level of human development dimensions and with a lower growth rate of human development index (HDI).

The last two explanations linked to the role of institutions and the investments in human capital are more recent than the classic RCH. In particular, the role of corruption, rule of law, government effectiveness and voice and accountability are analyzed by Isham *et al.* (2003), Leite and Weidmann (1999) and Sala-i-Martin and Subramanian (2003) after the considerable efforts of Kauffman *et al.* (2003) to provide widely accepted measures of institutional quality. The specific role of education in the development process and the effects of natural resources are empirically investigated in Bulte *at al.* (2005) and Gylfason (2001) with special attention to investments in secondary education, recognized as one of the most effective policy actions through which the resource curse can be avoided (as shown for Botswana in Sarraf and Jinwanji, 2001). As in Papyrakis and Gerlagh (2004), the schooling transmission channel is almost twice as important as the corruption channel whereas the indirect effects of resource abundance on growth through the institutional quality are higher than the direct effects on economic growth (Sala-i-Martin and Subramanian, 2003).

These two transmission channels offer specific links between economic growth, natural resources, human development and even globalization where institutional quality and schooling are specific dimensions of the wider concept of human development and capabilities approach.

In this context, globalization seems to operate in contrasting directions. Countries with a larger share of natural resources on total exports may be negatively affected by expanding export flows in primary products as the RCH occurs. On the contrary, the main literature on economic growth has found consistent results of positive effects of trade liberalization on the economic performance and development path (Dollar and Kraay, 2003, 2004; Frankel and Romer, 1999).

Moreover, considering the financial flows that characterizes globalization, as FDI or technological diffusion and royalties (Stiglitz, 2000; Winters, 2004), the relative

[9] Recent studies adopted a distinction between natural resources classifying them as “diffuse” resources, agriculture and food production and as “point” resources, fossil fuels and mineral production, recognizing that this second type is the main responsible for the negative effects on economic growth (Bulte *et al.*, 2005; Isham *et al.*, 2003).

abundance of natural resources could be a source of bias in the correct allocation of financial and investment flows. Due to large initial investments necessary for the exploitation of oil and mineral reserves, there is often no market competition and the exploitation of resources is managed by a few oligopolistic firms that are often controlled by foreign multinationals. The capital flows from resource exploitation could be invested abroad and most of the revenues from national resource endowments lost. The facility of capital investment on international markets could partially increase the exit of such revenues.[10]

3. THE RESOURCE CURSE HYPOTHESIS AND THE ROLE OF INSTITUTIONS

The general formulation for the RCH is represented in equation [1] where we distinguish globalization (GLOB) as a specific aspect, other conditioning variables (COND) representing other macroeconomic aspects, human development dimensions (HD) and finally, natural resources endowments (NR) and the quality of institutions (INST):

$$EG_{t-T} = \beta_0 + \beta_1 \ln GDP_T + \beta_2 GLOB_{t-T} + \beta_3 COND_{t\text{-}T} + \beta_4 HD_T + \beta_5 NR_T + \beta_6 INST_t + e_i \quad [1]$$

Initial GDP per capita is included in all the empirical studies on this issue, on the basis of the idea of conditional convergence: an economy will enjoy a faster growth rate the further it is from its own steady state value of output. EG performance and the income per capita level reached at the end of the analyzed period are deeply influenced by some conditioning variables which influence the savings rate, capital and labor productivity (Barro and Sala-i-Martin, 1995). These conditioning variables include trade openness, FDI flows, public investments in human capital accumulation, natural resources endowments, quality of institutions and so on.

In our specification, globalization includes trade openness (defined following the

[10] A counter example has been given by the last policy options chosen by the president Hugo Chavez in Venezuela, where oil companies are now all dependent on national government and revenues from oil exports are invested in infrastructures and human capital. In the Venezuelan case, the absence of consolidated democratic institutions has been surely one of the main obstacles to a rapid and consistent economic growth during last decades.

measure of trade openness provided by Sachs and Warner, 1995b), FDI flows and low inflation rate as a proxy of macroeconomic stability on the international markets (Winters, 2004) whereas other conditioning variables include private investments. HD dimensions are represented as the initial level of life expectancy and secondary education as a proxy for the initial level of human capital. Natural resources (NR) are estimated separately as point and diffuse resources as described above. Moreover, the quality of institutions (INST) is considered a specific conditioning variable because the variation across societies of the institutions is a relevant condition to growth and development paths such as the security of property rights, prevalence of corruption, structures of the financial sector, or investments in infrastructures and social capital (Sokoloff and Engerman, 2000). In particular, the role of the institutions in enhancing the broader social capability has been highlighted as a major development engine (Abramovitz, 1986, 1993).

Other macroeconomic conditioning variables such as export price level or terms of trade are not included in the analysis due to the recurrent non-significant statistics in previous studies on the RCH (Neumayer, 2004; Sala-i-Martin and Subramanian, 2003). Furthermore, what we are really interested in is the role of structural features such as the level of well-being and sustainability rather than more conjunctural issues such as price level fluctuations.

Results in Table 2 are consistent with those found in the RCH literature where NR endowment negatively affects the EG performance and both diffuse and point resources coefficients are statistically significant in each model specification.

With regard to the effects linked to the globalization process, from this first specification it seems that trade openness has positive effects on EG whereas FDI does not significantly affect EG, due to low coefficients with non-robust statistic tests. On the contrary, the positive role of capital investments is consistent in all specifications.

The positive effects linked to INST and initial HD (especially life expectancy at birth) are consistently high, in line with other specific results on the effects of health conditions on economic growth (Bhargava *et al.*, 2000). In particular, the role of education as initial human capital endowments has the same role as the initial GDP level where countries with higher school enrolment ratios are those with lower growth rates.

Table 2 – Model specification for the resource curse hypothesis

Dependent variable: EG 1970-2003	(1)	(2)	(3)	(4)	(5)
Initial GDP	-0.864*	-0.780*	-1.124*	-1.124*	-1.102*
	(-6.75)	(-6.40)	(-6.53)	(-6.95)	(-7.17)
TRADE	1.240*	1.191*	1.366*	1.172*	1.115*
	(3.03)	(3.10)	(3.55)	(3.14)	(3.12)
FDI	0.037	0.101	0.033	0.066	0.047
	(0.37)	(0.87)	(0.29)	(0.63)	(0.46)
INVESTMENTS	3.784*	3.961*	3.201*	3.115*	3.001*
	(7.61)	(8.51)	(6.21)	(6.32)	(6.30)
IQ	1.160*	0.917*	0.959*	..	..
	(4.92)	(4.02)	(4.24)	..	..
RL	..	..	..	1.031*	..
	..	..	..	(5.27)	..
GE	..	..	..	..	1.133*
	..	..	..	..	(6.02)
DIFFUSE	..	-3.689*	-3.459*	-3.121**	-2.581**
	..	(-2.14)	(-2.07)	(-1.95)	(-1.67)
POINT	..	-3.174*	-2.423*	-2.502*	-2.625*
	..	(-3.86)	(-2.87)	(-3.14)	(-3.44)
Initial LIFE EXPECT.	..	..	5.532*	5.723*	5.276*
	..	..	(3.66)	(3.96)	(3.81)
Initial SEC. EDU.	..	..	-1.568	-1.937*	-1.984*
	..	..	(-1.65)	(-2.11)	(-2.26)
CONSTANT	13.157*	13.624*	12.203*	12.328*	12.035*
	(10.77)	(11.46)	(9.90)	(10.49)	(10.72)
Number of Observations	95	94	90	90	90
Adjusted R-squared	0.65	0.71	0.75	0.77	0.79

Statistics for t-Student in parenthesis. * p-values < 0.05, ** p-values < 0.1.

In order to quantify the real effect linked to the quality of institutions, most of the recent contributions consider this aspect endogenous. In this analysis, the general formulation of the institution-related equation (INST) has been structured in the same way as in previous contributions and takes into account the specific role of globalization, human development dimensions and natural resources:

$$INST_t = \beta_0 + \beta_1 \ln GDP_T + \beta_2 GLOB_{t-T} + \beta_3 COND_{t-T} + \beta_4 HD_T + \beta_5 HD_{t-T} + \beta_6 NR_T + e_i \quad [2]$$

where GLOB and NR variables are exactly the same as those tested for eq. [1] whereas other conditioning variables include not only the initial level of HD but also changes that have occurred during the analyzed period (t-T).
In order to increase the robustness of the estimates, most of the authors apply a two stage system of equation (2SLS) with a specific formulation for growth and links with natural resources consumption on one side and another equation with formal relationships between the quality of institutions and the relative abundance of resources (Bulte *et al.*, 2005; Isham *et al.*, 2003; Sala-i-Martin and Subramanian, 2003).[11]
It is worth noticing that globalization (trade openness and FDI) only positively affect the quality of institutions but the direct influence on EG has been reduced. High levels of investments remain positively correlated with EG and a low inflation rate contributes to the quality of institutions. This last result is particularly interesting and explains the role of macroeconomic stability in promoting good institutions (Table 3).
When a 2SLS model is applied, the effects of initial level of HD on EG partially change. The coefficient associated with life expectancy at birth increases in RCH equation whereas it is not significant for INST equation. If we consider the secondary school enrolment ratio, it is worth noticing that the negative direct effect on EG (reclaiming the same mechanism for initial GDP level) is partially compensated by the positive indirect effect linked to INST. This result indicates the important role of human capital endowments (and accumulation) in guaranteeing a high quality of the institutions. The relatively low coefficient associated with changes in HD dimensions (human capital accumulation) highlights the major role played by initial conditions.

[11] Following Boschini et al. (2005), we tested whether there is endogeneity between income growth and institutions through the resource intensity channel, and the Hausman test confirms this hypothesis, with p-values associated to a joint-F test lower than 5%. Endogeneity could create biased estimations if the model errors are correlated with the dependent variable. One approach used to test for endogeneity is a procedure known as Hausman test. The basic idea is to test the null hypothesis that endogeneity between the instrument variables and the endogenous variables have no significant impact on the estimates. The null hypothesis is accepted if the two estimates of the same equation differ only randomly. First, we ran the two-stage least square (2SLS) regression, and, after an additional OLS regression, we calculated the Hausman test to analyze if the 2SLS and OLS results are significantly different. The Hausman test with a p-value of 0.05 indicates that the null hypothesis, that differences in coefficients are not systematic, can be rejected and hence the OLS regression is not a consistent and efficient estimator.

Table 3 –Resource curse hypothesis and quality of institutions

Variable	RCH(1)	INST(1)	RCH(2)	INST(2)	RCH(3)	INST(3)
Initial GDP	-0.856*	0.233*	-0.741*	0.230*	-1.230*	0.191*
	(-3.82)	(2.73)	(-3.50)	(2.61)	(-6.31)	(2.29)
TRADE	0.944		1.103**		0.817	0.410*
	(1.44)		(1.83)		(1.60)	(2.06)
FDI	0.077		0.153		0.013	0.116*
	(0.72)		(1.23)		(0.11)	(2.13)
INFLATION						-0.249*
						(-3.30)
INVESTMENTS	3.753*		3.895*		2.957*	0.130
	(6.50)		(7.24)		(5.56)	(0.49)
RL	1.167*		0.821*		1.500*	
	(1.99)		(1.48)		(3.09)	
Initial LIFE EXPECT.	..	0.002		-0.323	6.028*	-0.103
	..	(0.00)		(-0.39)	(3.96)	(0.12)
Initial SEC. EDU.	..	2.125*		2.276*	-2.537*	1.487*
	..	(3.86)		(4.15)	(-2.30)	(2.91)
Change LIFE EXPECT.		0.031		-0.012		-0.026
		(0.15)		(-0.06)		(-0.15)
Change SEC. EDU.		0.028*		0.035*		0.024*
		(2.70)		(3.24)		(2.45)
DIFFUSE	..		-3.554*	-0.470	-2.728	-0.974
	..		(-2.04)	(-0.53)	(-1.61)	(-1.16)
POINT	..		-3.347*	-0.876*	-2.213*	-0.742*
	..		(-3.58)	(-1.78)	(-2.55)	(-1.72)
CONSTANT	13.368*	-2.585*	13.538*	-2.361*	12.758*	-0.703
	(8.79)	(-5.71)	(9.56)	(-4.92)	(9.95)	(-1.10)
Number of Observations	91	91	90	90	90	90
Adjusted R-squared	0.67	0.75	0.72	0.76	0.75	0.83

Statistics for t-Student in parenthesis. * p-values < 0.05, ** p-values < 0.1.

Finally, with regard to NR it is clear that the direct effect found in the single equation model becomes non-robust for diffuse resources whereas for point resources it is still consistent both for EG and INST equations. In particular, the indirect effect channeled through the role of institutions is statistically consistent and higher than the direct one. If we calculate the direct effect of NR on the quality of institutions as the product of the coefficient associated with POINT in INST(3) (-0.742) with the standard deviation of

POINT (+16.59) and we multiply then such a result by the coefficient of INST (+1.500 in RCH(3)), we obtain the indirect effect of NR channeled by institutions (-18.47) which corresponds to a decrease in EG of 0.54% per year in addition to the average annual reduction of about 1% directly associated with the RCH mechanism.

Following the explanation based on institutional quality, the presence of point resources seems to have a greater effect on the growth path than the presence of diffuse resources (Isham *et al.*, 2003). The presence of large oil or mineral reserves is one of the major causes of corruption and misallocation of rents from resource exploitation. Therefore, natural resource abundance is negative for economic development especially if the country lacks proper institutions for dealing with conflicts and corruption (Boschini *et al.*, 2003). This result reaffirms the important role played by the corruption of institutions induced by resource abundance (Leite and Weidmann, 1999).

Following Bulte et al. (2005), Isham et al. (2003) and Sala-i-Martin and Subramanian (2003), Rule of Law (RL) and Government Effectiveness (GE) seem to be more consistent with other control variables for economic growth modeled with natural resources abundance and human development dimensions. At the same time, these two dimensions have absolute magnitudes of the effects of the natural resource variables that are higher than the other variables for institutions available.[12] In general, model specification using RL as an institutional quality proxy fits very well with our hypothesis whereas, when using the GE variable, the equation for institutions has inconsistent estimates for globalization variable and natural resources. Furthermore, eq. [2] calculated with GE gives heteroskedasticity and requires a GLS estimator.

In this context, we have not adopted all the control variables for institutions indicated in the main literature and we have ignored variables such as ethnic fractionalization, the fraction of people speaking English as a first language or the fraction of people speaking a European language, as in the other papers linking the RCH with institutions. This is for two reasons. First, these variables are not updated to 2002 and they are only available for 1998. Secondly, some of these control variables could help to explain the relationships between growth and consumption of natural resources but they are not of

[12] Our results are consistent with results in other papers where natural resource abundance is analyzed together with institutional quality. Such measures are based on indicators provided in Kaufmann et al. (1999, 2003) where six different characteristics describe the quality of institutions: Rule of Law (RL), Political Instability (PI), Government Effectiveness (GE), Control of Corruption (CC), Regulatory Framework (RF), and Property Rights and Rule-based Governance (PR).

fundamental importance and they are sometimes not statistically significant. Furthermore, as in Isham *et al.* (2003), the effects linked to variables such as a country's share of English and European language speakers are less than the effects of natural resources endowment on economic growth and institutions. In Bulte *et al.* (2005), these variables are not statistically significant whereas basic human development dimensions are much more influential.

The results in this section show that point resources affect national institutions. Secondly, institutions that are endogenously determined by the nature of natural resource dependence (high share of primary exports on total exports or on GDP) are significant (negative) determinants of growth.

4. THE ENVIRONMENTAL KUZNETS CURVE AND SUSTAINABILITY

The analysis based on the RCH described in the previous section represents a specific point of view that models economic growth without specific consideration for sustainability of development. In this sense, Neumayer (2004) has changed the dependent variable in the growth equation, substituting traditional income per capita with a measure of macroeconomic sustainability such as the Genuine Saving (GS) index provided by the World Bank (2004). Moreover, links between economic growth and sustainability under the RCH have been considered in Atkinson & Hamilton (2003) where the achievement of a sustainable development path seems to be highly correlated with the investments in human capital formation and consequently the human development level.

In this context, the aim of this paper is to provide a link between the RCH modified with the role of institutions on one side and the relationship between economic growth and sustainable development on the other . In order to compare these two models, we have adopted the so-called Environmental Kuznets Curve (EKC) formulation[13] where relationships between economic growth and pollution are synthesized. The classical reduced functional form representing the EKC is given by equation [3]:

[13] The exact term Environmental Kuznets Curve was introduced for the first time in Selden and Song (1994).

$$E_i = \beta_0 + \beta_1 X_i + \beta_2 X_i^2 + \beta_3 X_i^3 + \beta_4 COND_i + e_i \qquad [3]$$

where E_i represents the general level of environmental stress and X_i the income per capita. The inverted *U*-shaped curve deriving from such a formula requires β_1 to be positive, β_2 negative and β_3 positive.[14]

Two main arguments have been proposed to explain the EKC. On the demand side, there is the role of public opinion in requiring policy actions to reduce environmental degradation where environment is no more a luxury good, as it is in poor economies and on the supply side, the role of structural changes in the economic system where economic growth is followed by technological innovation and change in the productive structure (from basic industries to high-tech services) producing a reduction in polluting emissions (Barbier, 2003). The specific nature of the abatement technologies with increasing returns to scale could constitute a further explanation of the EKC where high fixed initial investment costs for pollution abating techniques reduce the capacity of poor countries to implement pollution control policies (Andreoni & Levinson, 2001).

Many contributions have empirically tested the existence of an EKC using cross-country relationships (Grossman & Krueger, 1995; Shafik, 1994; Stern *et al.*, 1996) or time series analyses (Egli, 2002; Vincent, 1997). Further contributions have introduced other control variables in order to improve representation of the effects linked to trade openness, globalization and the manufacturing sector (Cole, 2004; Hettige *et al.*, 1998; Tisdell, 2001) or linked to well-being aspects such as income distribution, education and health (Gangadharan & Valenzuela, 2001; Hill & Magnani, 2002; Magnani, 2000). Finally, many contributions try to shed some light on possible failures in the theoretical interpretation of the EKC (Arrow *et al.*, 1995; Munasinghe, 1999; Stern & Common, 2001).

In this context, we attempt to substitute the income factor of the EKC with a more capability-oriented measure such as HD maintaining the other control variables such as the percentage of polluting industries in the whole economy or the effect of globalization on pollution. Furthermore, in order to represent a more general framework geared towards sustainable development, the pure pollution dependent variable is replaced by a macroeconomic sustainable indicator such as the negative value of GS.

[14] The cubic term derives from the empirical evidence found by Grossman and Krueger (1995), where the relationship between income and emissions becomes positive again for certain types of pollution (SO_X) for higher income level.

The GS index provided by the World Development Report is formally expressed in equation [4]:

$$GS = \dot{K} - (F_R - f_R)(R - g) - b(e - d) \qquad [4]$$

where $\dot{K}$ represents economic capital formation while other terms are adjustments for consumption and degradation of natural capital. In particular, the economic value of natural resources consumption (resources extracted *R* minus natural growth rate *g* for renewables) is given by the resource rental rate (F_R) net of the marginal cost of extraction (f_R), while pollution (emissions *e* minus natural dissipation rate *d*) is evaluated by the marginal cost of abatement *b*.
Separate economic values for some types of natural resources exploited at national level such as energy and mineral resources, forests and marginal economic damage linked to CO_2 emissions (i.e., the cost of climate change) are then available.[15]
GS is based on the assumption of perfect resource substitutability and it could therefore be interpreted as a limit value of sustainability, where

GS > 0	sustainability
GS = 0	minimum level of sustainability
GS < 0	non-sustainability

The inverted *U*-shaped relation between GDP per capita and pollutant emissions - depicted in the EKC - can be re-formulated by using a modified EKC (MEKC), replacing the GDP per capita with a modified Human Development Index (HDIM) that does not include the income factor and replacing the pollution emissions with the negative value of Genuine Saving per capita (-GS) as a measure of non-sustainability. This simple accounting rule allows the original EKC - where the dependent variable is a negative effect related to economic growth – to be compared with the MEKC. Furthermore, the absence of the GDP index in the HDIM eliminates multicollinearity between the GS and the HDI. The value added of such analysis is the presence of

[15] Energy and mineral resources considered in the WDR are oil, natural gas, coal, bauxite, copper, lead, iron, nickel, phosphates, tin, zinc, gold, silver. For methodological and empirical explanation of effective components of Genuine Saving index, see Hamilton and Clemens (1999).

depletion and degradation value of natural resources contained in the GS index compared with the simple pollutant emissions considered in a classical EKC model (Costantini, 2006). In addition, using a HD measure and not a simple EG level allows broader considerations to be made on the sustainability of the development path or if future generations could enjoy the same well-being level (and not only income). In line with classic EKC, the inclusion of other control variables such as trade flows and manufactures as the share of value added even allows us to analyze the effects of economic globalization on sustainable development.

The estimation output (Table 4) comes from a GLS specification in order to correct the heteroskedasticity of the error terms as underlined in a number of contributions (Cole, 2004; Egli, 2002; Gangadharan & Valenzuela, 2001; Hill & Magnani, 2002). Traditional EKC estimates are similar to the results available in the literature and are consistent for the three years considered (1990, 1995, 2000). The cubic term in EKC3 (2000) is significant but the R-squared is reduced (examples of EKC applied to CO_2 emissions use both quadratic and cubic model specifications). Accounting for other control variables, such as trade (as % of GDP) and manufacture value added (as % of GDP), or human development (expressed as a HDIM excluding the income term), improve the estimates. In particular, a higher value of trade and manufacture are associated with higher CO_2 emissions, isolating the composition effect and the scale effect claimed for a supply-side explanation of the EKC. This is consistent with Chichinilsky (1994) and Suri and Chapman (1998) where increasing openness to trade is associated with increasing pollution emissions especially for developing countries due to the delocalization of polluting industries known as the pollution heaven effect (Copeland and Taylor, 2004).

Estimates of a MEKC that account for human development and sustainability give results that are quite similar to traditional EKC, with lower values of R-squared but statistically significant parameters (excluding the hypothesis of a cubic term that gives estimates that are not always consistent).

In particular, considering the quality of institutions expressed as Rule of Law (RL), the R-squared is consistently higher, once again stressing the role of institutions as an engine for economic growth and sustainable development. It is worth noting that in the case of the MEKC, the three conditioning variables (trade, manufacture and institutions) positively contribute to reaching a higher level of GS (but manufacture is not statistically significant), as an opposite result of the traditional EKC.

Table 4 –Traditional and modified Environmental Kuznets Curve

Panel A: (CO_2)	EKC1(2000)	EKC2(2000)	EKC3(2000)	EKC(1995)	EKC(1990)
GDP	2.875*	2.551*	5.059*	2.263*	2.187*
	(21.40)	(19.33)	(5.45)	(17.38)	(11.04)
GDP^2	-0.133*	-0.120*	-0.472*	-0.108*	-0.090*
	(-15.57)	(-16.20)	(-4.00)	(-13.76)	(-8.29)
GDP^3			0.016*		
			(3.17)		
TRADE	0.278*	0.303*	0.287*	0.239*	0.156*
	(6.43)	(7.69)	(8.47)	(6.11)	(3.75)
MANUF.	0.193*	0.073*	0.060*	0.150*	0.036
	(6.44)	(2.75)	(2.14)	(3.83)	(0.44)
HDIM		1.202*	1.947*	2.898*	1.227*
		(5.65)	(8.34)	(14.25)	(3.18)
CONSTANT	-7.068*	-6.250*	-12.061*	-6.818*	-5.656*
	(-13.93)	(-2.88)	(-5.01)	(-15.20)	(-8.61)
Numb obs	141	138	138	124	98
R-squared	0.73	0.80	0.76	0.81	0.78

Panel B: (-GS)	MEKC1(2000)	MEKC2(2000)	MEKC3(2000)	MEKC(1995)	MEKC(1990)
HDIM	2.784*	2.110*	-1.251	2.843*	2.483*
	(7.58)	(7.35)	(-1.04)	(10.99)	(11.58)
HDIM^2	-2.412*	-1.678*	4.002*	-2.493*	-2.257*
	(-8.52)	(-7.38)	(2.04)	(-11.84)	(-13.37)
HDIM^3			-2.993**		
			(-2.91)		
TRADE	-0.080*	-0.042*	-0.063*	-0.044*	-0.015*
	(-5.05)	(-3.10)	(-5.31)	(-3.57)	(-1.40)
MANUF.	-0.020	-0.006	-0.027*	-0.023	-0.108
	(-1.47)	(-0.46)	(-2.01)	(-1.59)	(-6.44)
RL		-0.142*	-0.161*	-0.095*	
		(-13.20)	(-16.42)	(-10.33)	
CONSTANT	-8.214*	-8.382*	-7.672*	-8.344*	-8.483*
	(-68.18)	(-83.51)	(-30.86)	(-104.67)	(-109.12)
R-squared	0.37	0.52	0.51	0.42	0.40
Numb obs	133	132	132	121	101

Statistics for t-Student in parenthesis. * p-values < 0.05, ** p-values < 0.1.

5. INTEGRATED MODEL OF ENVIRONMENT, HUMAN DEVELOPMENT AND ECONOMIC GROWTH

Since income per capita *per se* is a poor indicator of welfare, rather than replacing alternative developing indicators in the RCH equation as suggested in Bulte *et al.* (2005), we attempt to introduce the well-being level in a MEKC function, estimating an integrated model in order to account for a RCH - including the role on institutions - and a MEKC, at current time *t* comparing to initial period *T* (omitting the *i* symbol for countries).
The full model specification is:

$$-GS_t = \beta_0 + \beta_1 HDIM_t + \beta_2 HDIM_t^2 + \beta_3 HDIM_t^3 + \beta_4 COND_t + e_i \qquad [5]$$

$$EG_{t-T} = \beta_0 + \beta_1 \ln GDP_T + \beta_2 GLOB_{t-T} + \beta_3 COND_{t\text{-}T} + \beta_4 HD_T + \beta_5 NR_T + \beta_6 INST_t + e_i \qquad [6]$$

$$INST_t = \beta_0 + \beta_1 \ln GDP_T + \beta_2 GLOB_{t-T} + \beta_3 COND_{t-T} + \beta_4 HD_T + \beta_5 HD_{t-T} + \beta_6 NR_T + e_i \qquad [7]$$

$$HDIM_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 COND_t + \beta_3 COND_T + e_i \qquad [8]$$

$$\ln GDP_t = \beta_0 + \beta_1 (EG_{t-T}) * (t-T) + \beta_2 \ln GDP_T + e_i \qquad [9]$$

where eq. [5] represents the MEKC, eq. [6] the RCH, and eq. [7] the role of endogenous institutions. Finally, eq. [8] and [9] are introduced in order to capture both chain A and chain B of the EG-HD relationships, as claimed in Boozer et al. (2003) and Ranis et al. (2000). The simple formulation of chain A, where only a few determinants of HD that are different from EG are included (initial level of GDP, initial level of life expectancy at birth, $COND_t$, and other conditioning variables describing the actual situation, $COND_T$), is due to represent the transmission channels in the RCH and the EKC in the simplest way.
As in Isham *et al.* (2003), we have adopted a 3-stage least squares (3SLS) method of estimation, since the model specification has both heteroskedasticity of error terms (for the MEKC) and endogeneity. The results are consistent with estimations by Sala-i-

Martin & Subramanian (2003) where major transmission channels of the resource curse to growth stagnation are linked to institutional quality and not directly to economic growth.

Results in Table 5 represent estimates that both use only equations [5], [6], and [7] – models (1) and (2) – and use the complete model (including equations [8] and [9]) – model (3) - in order to account for the effects underlined by chain A. Results are quite similar, and the inclusion of the two additional equations does not affect the robustness of the estimates both for RCH and MEKC.[16] The specific value added of such a complete model is that it allows calculation of the value of HDIM corresponding to the maximum non-sustainable GS level, and can therefore be compared with the GDP value corresponding to the maximum CO_2 emission level (given by the classic EKC).[17]

If we compare results of EKC with the turning point value of the MEKC, it is worth noticing that the HD threshold level of the inverted *U*-shaped curve is around 0.60 where it is clearly a medium development level (that is perfectly consistent with the average HDI value reported in Table 1 for countries in which the resource curse occurred). Using chain A (eq. [8]), it is possible to calculate the HD level corresponding to the GDP per capita that maximizes the CO_2 emissions in the EKC (results not reported in the paper). The turning point of the traditional EKC is around 30.000 US$ per capita – and this is consistent with most of the available contributions - corresponding to around 0.95 HD using equation [8]. These first results confirm the main criticisms of the EKC, related especially to the possibility of a different EG path - a turning point well below the predicted ones from classic EKC for developing countries as claimed by Munasinghe (1999) - which could invert the negative environmental effects caused by the development process well before what has occurred in the past for

[16] The robustness of the estimates reported in Table 5 has been tested by the insertion of regional dummies and by reproducing the same system without Sub-Saharan African countries. In order to exclude influence from outliers in the sample, we have applied Sachs and Warner (1995) criterion based on DFITS, where DFITS is defined as the square root of $[h_i/(1-h_i)]$, with h_i representing an observation's leverage, multiplied by its studentized residual. An outlier is an observation with a DFITS that is greater in absolute terms than twice the square root of (k/n), where k is the number of independent variables (including the constant) and n the number of observations. Applying this criterion, the same model has been tested excluding Botswana, Gabon, Malaysia and Zambia. The results remain coherent and consistent.

[17] Estimates from two separate equations systems (not reported in the paper), the first one with the RCH specification linked to institutional quality, and the second one with the simultaneous EKC, MEKC and the HD (chain A) equation give quite similar results as the complete 3SLS, both for the statistical and economic significance of regressors.

developed countries.
More generally, results provided by this model specification are not so distant from results obtained from independent estimates of the RCH and EKC. The role of globalization is positive in the sense that circulation of capital, people and technologies has a positive impact on the sustainable management of natural resources. Such a positive role is mainly linked to the positive role of institutions while trade openness and FDI flows seem to have limited effects on EG (with non-robust estimates). On the contrary, the role of HD dimensions is quite clear and unanimous where a higher initial level of HD corresponds to positive effects on institutional quality and indirectly on EG. With regard to sustainability, increasing HD is first associated with increasing exploitation of natural resources until a threshold level where such relation becomes positive and an increase in HD positively affects sustainability.
An increase in EG and in HD is associated with growing resource consumption in the first stages of development where the industrialization process requires great efforts from primary industries in the first development stage and the development of heavy (polluting) industries in the second stage. If the EG and HD process is followed by sufficient human capital accumulation with better institutions and qualified human resources, the industrialization process will move towards a further development stage characterized by the major role of services while reducing pollution and using less natural resources. A virtuous circle of this kind could be reinforced by public investments for health and education and more widely for social capability. The role of skilled labor force in conjunction with a higher income level are all necessary conditions for the adoption of an environmentally- friendly consumption path and production techniques.
Finally, we maintain that natural resource endowment could be a source of low economic growth rates if the institutions in a country do not have the ability to manage the resources in the right way. Therefore, investment policies geared towards human capital formation (education and high skilled labor forces) are to be considered the most effective actions for reaching a higher development level. At the same time, during the first stages of the development process, a large consumption of natural resources without appropriate investment policies to replace depleted resources - as explained by the Hartwick rule, or the investment of the Hotelling rent coming from the exploitation of natural resources - could produce a development path that is not sustainable in the long run.

Table 5 – Model for RCH, INST, and MEKC (estimates for period 1970-2003)

Variables	RCH(1)	INST(1)	MEKC(1)	RCH(2)	INST(2)	MEKC(2)	RCH(3)	INST(3)	MEKC(3)	HDI(3)
Initial GDP	-0.459*	0.260*		-1.054*	0.152**		-1.115*	0.154*		0.004*
	(-2.11)	(2.91)		(-5.84)	(1.74)		(-6.34)	(1.78)		(0.14)
OPENNESS	0.969			1.008*	0.421*		0.726	0.432*		
	(1.42)			(1.93)	(2.03)		(1.46)	(2.10)		
FDI	0.191			0.101	0.118*		0.050	0.116*		
	(1.40)			(0.80)	(2.02)		(0.41)	(2.00)		
INFLATION					-0.259*			-0.254*		
					(-3.50)			(-3.47)		
INVESTMENTS	4.163*			3.104*	-0.154		2.991*	-0.153		0.082*
	(7.33)			(5.85)	(-0.51)		(5.81)	(-0.51)		(1.43)
RL (2003)	0.306			0.995*			1.404*		-0.140*	
	(0.48)			(2.00)			(2.98)		(-13.15)	
Initial LIFE EXPECT.		-0.721		5.527*	0.282		5.543*	0.267		0.841*
		(-0.87)		(3.66)	0.325		(3.80)	0.311		(6.45)
Initial SEC. EDU.		2.442*		-1.812	1.481*		-2.288*	1.487*		0.065
		(4.06)		(-1.58)	(2.57)		(-2.08)	(2.91)		(0.85)
Change LIFE EXPECT		-0.051			-0.035			-0.026		
		(-0.26)			(-0.20)			(-0.15)		
Change SEC. EDU		0.149*			0.085*			0.024*		
		(1.98)			(1.13)			(2.45)		
DIFFUSE	-4.364*	-0.240		-3.689*	-0.947		-3.371*	-0.974		
	(-2.29)	(-0.26)		(-2.21)	(-1.11)		(-2.12)	(-1.16)		
POINT	-4.232*	-0.744*		-2.566*	-0.650**		-2.220*	-0.742*		
	(-3.28)	(-1.30)		(-2.32)	(-1.23)		(-2.11)	(-1.72)		
GDP (2003)										-0.002
										(-0.08)
HDIM (2003)			5.879*			5.652*			6.270*	
			(4.62)			(4.59)			(5.21)	
HDIM^2 (2003)			-4.691*			-4.541*			-4.977*	
			(-5.05)			(-5.03)			(-5.63)	
TRADE (2003)			-0.076*			-0.087*			-0.091*	
			(-1.94)			(-2.22)			(-2.41)	
MANUF. (2003)			0.001			0.005			0.009	
			(0.02)			(0.10)			(0.17)	
CONSTANT	12.242*	-2.611*	-10.039*	12.141*	-1.121*	-9.956*	12.418*	-1.153*	-10.153*	0.379*
	(7.67)	(-5.00)	(-22.30)	(8.82)	(-1.39)	(-23.03)	(9.24)	(-1.44)	(-24.05)	(2.91)
Numb. Obs	70	70	70	70	70	70	70	70	70	70
Adj Rsq	0.67	0.70	0.40	0.75	0.79	0.40	0.74	0.79	0.52	0.86

Statistics for t-Student in parenthesis. * p-values < 0.05, ** p-values < 0.1.

6. CONCLUSIONS

Different causal linkages have been analyzed in economic growth, human development, and environment and have provided some general results with regard to the sustainability of a development process.

The first result is that – in line with the results of the EKC studies - achieving an adequate sustainability level with a positive capital accumulation process is a very difficult task during the first stage of development. The satisfaction of basic human needs is a necessary condition for such an objective and environmental protection is considered a secondary (or luxury) good. Nevertheless, applying a MEKC it seems that it is possible to reduce (and invert) an unsustainable growth path at a medium level of development, while the reversing of environmental degradation using a traditional EKC seems to occur in correspondence with high income levels.

The second result is that human capital accumulation represents an valuable means to reaching and maintaining higher consumption path in the future. The positive role of health and education achievements is much bigger than the negative effects linked to natural resources endowments. The resource curse would not occur if appropriate investments in human capital accumulation have been placed, producing consistent positive effects in terms of the quality of institutions. Better institutions represent one of the most effective conditional variables for higher economic growth, together with private capital investments. This last element is perfectly in line with conditional convergence of Barro and Sala-i-Martin (1995), where higher savings rates are one of the variables which increase the economic growth rate and the steady-state income level.

A third result concerns the specific role of globalization process. From our analysis there is no specific sign that the globalization process could bring negative effects to developing countries. On the contrary, according to Stiglitz (2002) trade openness and FDI inflows positively affect the quality of institutions, and globalisation *ceteris paribus* could be a source of governance improvements for the economies exposed to increasing trade and capital inflows. At the same time, countries need to know how to invest the advantages they derive from such a process for the improvement of human development, without wasting available (albeit scarce) resources. Developing countries positively affected by the globalization process are those that succeed in modernizing their institutions in a democratic manner, investing in infrastructures, ensuring macroeconomic stability, and above all investing the relative benefits to enlarge people's choices. At the same time, the sustainability of such a process depends on how benefits from exploiting existing resources are invested and how depleted resources are replaced.

Comparing results from RCH and MEKC, we may affirm that in order to convert the resource curse into a blessing, it is necessary to increase investments in human capital accumulation and consequently in the quality of institutions. At the very first stages of the development path, the economic resources necessary to increase significantly human capital accumulation could be not available. If this does occur, the negative impacts are twofold. An economy based on resources exploitation without appropriate institutions would run into Dutch disease or rent-seeking effects, with reduced EG and therefore low HD levels (following chain A). The excessive resource exploitation at the beginning of the development path, associated with low investments in human capital, would bring the country towards an unsustainable path, with negative GS values and low HD levels.

In conclusion, developing countries should promote environmental protection as soon as possible but industrialized countries could help this process through coordinated know-how and technological transfer thus avoiding the great degradation and depletion of natural resources of the past decades.

Achieving a higher standard of living and maintaining natural capital could be complementary goals rather than competing ones by mutually reinforcing an upward spiral of development and economic growth.

Our results confirm that human development should be the first objective of international development policies whereas an increase in human well-being is necessary to provide a sustainability path. Active participation of industrialized countries, following the general framework of the Millennium Development Goals, is one of the necessary conditions for development. Globalization process could be a source of great advantage even for developing countries, under the necessary condition that they have adequate instruments to manage this process in a positive direction, enhancing human capabilities with higher levels of health and education. A higher technological level would transform such resource-intensive economies into knowledge-intensive ones reducing depletion and degradation of natural resources and reinforcing the virtuous cycle of economic growth and human development.

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APPENDIX A

Table A1: Data sources and definitions

EG	Economic Growth, annual growth rate of GDP per capita (constant 1995 $), 1970-2003
Initial GDP	Natural logarithm of GDP per capita (constant 1995 $), 1970
OPENNESS	Fraction of years in which the country is rated as an open economy (Sachs & Warner, 1995b)
FDI	Natural logarithm of Foreign direct investment, net inflows (% of GDP) average 1970-2003
INFLATION	Natural logarithm of Inflation (GDP deflator), average 1970-2003
INVESTMENTS	Natural logarithm of Gross private capital flows (% of GDP) average 1970-2003
GE	Government Effectiveness (Kauffman et al., 2003)
RL	Rule of Law (Kauffman et al., 2003)
IQ	Quality of Institutions, average value of Six Indicators provided by (Kauffman et al., 2003)
Initial LIFE EXPECT.	Life expectancy at birth (UNDP-HDR normalization criterion), 1970
Initial SEC. EDU.	Gross secondary enrollment ratio, (UNDP-HDR normalization criterion), 1970
Change LIFE EXPECT.	Change in life expectancy at birth, 1970-2002
Change SEC. EDU.	Change in gross secondary enrollment ratio, 1970-2002
DIFFUSE	Diffuse resources (Agriculture + Food) as % of GDP, average 1970-1975
POINT	Point resources (Oil + Minerals) as % of GDP, average 1970-1975
TOT-RES	Total Natural Resources as % of GDP, average 1970-1975
GDP	Natural logarithm of GDP per capita (constant 1995 $)
HDI	Human Development Index, standard UNDP methodology
HDIM	HDI without GDP Index
TRADE	Natural logarithm of Trade (imports + exports) as % of GDP
MANUF.	Natural logarithm of Industry, value added (% of GDP)
GS	Natural logarithm of Genuine Saving per capita (constant 1995 $)
CO_2	Natural logarithm of CO_2 emissions (ton. per capita)

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