Natural Resources: A Blessing or a Curse?

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NOTA DI LAVORO 8.2003

JANUARY 2003

NRM – Natural Resources Management

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Summary

We examine empirically the effect of natural resource abundance on economic growth. We find that natural resources have a negative impact on growth when considered in isolation, but a positive impact on growth when including in the analysis other variables such as corruption, investments, openness, terms of trade, and schooling, and treating these variables as independent. However, when we take account of the effect of natural resources on the other variables and furthermore consider the indirect effect on growth, that is, when we examine possible transmission channels, we find a strong negative effect of natural resources on growth. Finally, we calculate the relative importance of each transmission channel.

Keywords: Natural Resources, growth, transmission channels

JEL: C21, O13, Q33

The research has been funded by the Dutch National Science Foundation (NWO) under contract nr. 016.005.040.

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1. Introduction

It is a well documented fact, but still surprising finding of many studies, that there is a general tendency of natural-resource abundant economies to grow at a slower pace (Sachs and Warner 1995, 1997, 1999a, Gylfason 2000, 2001a, Rodriquez and Sachs 1999, Leite and Weidmann 1999). The last two centuries, countries rich in natural resources, e.g. Russia, Nigeria and Venezuela, experienced growth of comparatively low or mediocre magnitude. Sachs and Warner (1995) claim that this is a historically common pattern. Countries that base their economies on natural resources tend to be examples of development failures. In contrast, countries such as Japan, Hong-Kong, Korea, Singapore and Switzerland, that only had limited access to natural resources, experienced remarkably high economic growth rates. This paper studies, by use of growth regressions, the transmission channels through which natural resource abundance negatively affects growth, that is, the effect of natural resources on corruption, investments, trade, schooling, and then indirectly, on economic growth.

The negative impact of natural resources on growth is a paradox. There is no obvious reason why natural resources frustrate economic growth as experienced by many resource-rich countries. In contrast, natural resources are a potential source of income, and through savings this income could be converted into capital, adding to future output levels, e.g. if resource rents are used for the construction of roads, modernization of telecommunication systems, health and educational programs. Indeed, some countries, although a minority, managed to benefit from their natural wealth. The nineteenth century resource booms in Latin America certainly stimulated economic progress. For example, Ecuador experienced a significantly higher income per capita level after its boom (Sachs and Warner 1999a). Similarly, the industrial revolution that took off in Great Britain and Germany was only possible because of the vast deposits of ore and coal (Sachs and Warner 1995). Norway presents a recent example of a country that seems to manage its natural-resource abundance well, converting it into economic prosperity. Although Norway did not avoid recession for a few years, the way its present and future natural wealth is exploited is an example of carefully planned development. Almost 80 percent of the oil rents are collected through taxes and fees and invested into foreign securities, so that the economy is protected from abrupt and enormous income increases and a fair division of oil rents between generations is achieved (Gylfason, 2001a).

Given the (few) successful examples, it is the objective of this paper to investigate the causes for the under-performance of most countries rich in natural resources. In the literature, several transmission channels are mentioned. A sudden increased income level due to a natural resource

discovery may lead to sloth and less need for sound economic management and institutional quality (Sachs and Warner 1995, Gylfason 2000, 2001a). Also, it may create a false sense of security and weaken the perceived need for investments and growth promoting strategies. Natural resource abundant economies benefit less from technology spillovers, typical for the manufacturing industries, since export of these industries is harmed by an appreciation of the local currency, e.g. through inflationary pressure due to increased domestic demand (Sachs *et al.* 1995, 1999a, Gillis *et al.* 1996, Gylfason 2000, 2001). Finally, as the natural resource sector expands at the cost of other sectors, the returns to human capital decrease and investments in education decline (Gylfason 2001a).

Our analysis follows the methodology set out by Mo (2001), who investigates the transmission channels through which corruption affects growth. We will use cross-country regressions to show that, indeed, on average, natural resources are associated with the phenomena listed above that impede the economic process. Taking account of the relation between natural resources and other indexes used for growth regressions, we are able to better understand the "curse of natural resources". Specifically, we find that, when abstracting from the negative indirect effects, natural resources positively contribute to economic growth. Yet, taking account of the negative indirect impacts, these outweigh the positive direct contribution of natural resources on economic growth. We emphasize that this is an empirical finding and no economic law. When governments succeed in preventing the appearance of the phenomena through which natural resources harm growth, a country could benefit from its natural wealth.

The next section is devoted to the basic growth regressions. We verify the position that overall, natural resource abundance impedes economic development rather than that it acts as a stimulus. Yet we also find that, taking other indexes into account as independent variables such as corruption, investments, openness, terms of trade, and schooling, resource abundance has a positive impact on growth. Section 3 studies empirically the transmission channels and compares their relative weight in the overall negative impact of natural resources on economic growth. Section 4 concludes. .

2. Basic Cross-Country Regressions

To identify the dependence of growth on natural resource abundance, we estimate cross-country growth regressions in the tradition of previous empirical work by Barro (1989) and Sachs and Warner (1995, 1997). We base our equations on the conditional convergence hypothesis, which says that different growth rates between different countries are explained by various characteristics of these countries, whereas high-income countries have lower growth rates than

low-income countries, all other things equal. Thus, per capita economic growth from period t_0=1975 to t_T=1996, denoted by $G^i=(1/T)\ln(Y_T^i/Y_0^i)$, negatively depends on initial per capita income Y_0^i, it depends on natural resource abundance, R^i, the sign of dependence is subject for our analysis, and it also depends on a vector of other explanatory variables Z^i:

$$G^i = \alpha_0 + \alpha_1 \ln(Y_0^i) + \alpha_2 R^i + \alpha_3 Z^i + \varepsilon^i, \quad (1)$$

where *i* corresponds to each single country of the sample.

This paper studies the coefficient for resource abundance, α_2, and its relation to the (vector of) other variables *Z*. Before we turn to the data, let us briefly bring to mind the transitional and permanent income effects of a change in a country's resource income R^i, as described by growth equation (1). We will see that the permanent income effect of resource abundance is given by the ratio $(-\alpha_2/\alpha_1)$, assuming conditional convergence, i.e. $\alpha_1<0$. Consider a country, initially without natural resources, in which a new source of natural resources is discovered and exploited, leading to an instantaneous increase in income; say R^i is resource income as a share of total income. For the ratio $-\alpha_2/\alpha_1=1$, the decrease in $\alpha_1\ln(Y_0^i)$ equals the increase in $\alpha_2 R^i$, and economic growth is unaffected by the change in natural resource income. That is, the economy as a whole, apart from the natural resource sector, remains on its initial growth path and the natural resource sector provides a permanent income source additional to the income level that was reached without the natural resource. If, however, $-\alpha_2/\alpha_1>1$, then growth accelerates after the resource discovery, and thus, permanent income exceeds the instantaneous income effect by factor $-\alpha_2/\alpha_1$. If, on the other hand, $-\alpha_2/\alpha_1<1$, then growth is reduced; part of the natural resource income leaks away and the permanent income effect falls short of the temporary income effect. Finally, when $\alpha_2<0$ and $\alpha_1<0$, the resource leads to a short-lived increase in income, since growth is affected negatively by so much that in the long term, permanent income falls short of income without the natural resource. The latter case represents a situation known as the 'curse of natural resources'.

To assess the long-term income effects of a change in R^i or Z^i, let us assume that, initially, an economy is on a steady state or constant growth path, when R^i changes by ΔR^i and Z^i by ΔZ^i. Economic growth adjusts and the economy diverges from its initial path, but in the long term, economic growth returns to the same initial level. Then, the change in R^i or Z^i has a permanent effect on income, and equation (1) gives

$$0 = \alpha_1 \Delta\ln(Y^i) + \alpha_2 \Delta R^i + \alpha_3 \Delta Z^i. \quad (2)$$

In turn, we can solve for the long-term income effect ΔY^i resulting from a change in R^i and Z^i:

$$\Delta Y^i = (1-\exp((-\alpha_2/\alpha_1)\Delta R^i + (-\alpha_3/\alpha_1)\Delta Z^i)). \quad (3)$$

For small values of $(\alpha_2/\alpha_1)\Delta R^i$ and $(\alpha_3/\alpha_1)\Delta Z^i$, we can use the approximation

$$\Delta Y^i \approx -(\alpha_2/\alpha_1)\Delta R^i - (\alpha_3/\alpha_1)\Delta Z^i). \quad (4)$$

We will now estimate growth equation (1), using OLS, step-by-step increasing the set of variables Z^i. The appendix lists all variables and data sources. As a starting point, we only include initial income per capita at period 1975 ($Ln\,Y_{75}$), and natural resource abundance for which we take the share of mineral production in GDP in 1971 (*SNR*) as a proxy. The results are listed in column entry (1) of Table 1. For this equation, there is a highly significant and negative relationship between economic growth and natural resources. A one per cent point increase in income from mineral resources, relative to total income, decreases growth by 0.075% per year. An increase in income from mineral resources of one standard deviation (0.07), decreases the growth rate by about a half per cent per year. Natural resources indeed seem to be an impediment to economic growth.

Next, in column entry (2), we include an average *Corruption* measure for the 1980-1985 period of time, provided by Transparency International, where higher values of the index correspond to higher levels of corruption and lower levels of institutional quality. The period 1980-1985 is the earliest for which the index is available. In general, we attempt to choose variables referring either to the beginning of the period 1975-1996 or to average values for the entire period to avoid endogeneity problems that may arise between variables. Mo (2001) argues, though, that for the corruption variable, endogeneity is less likely since institutions tend to evolve slowly. The second regression shows a negative sign for the coefficient α_0, so that it supports the conditional convergence hypothesis. Also, corruption negatively affects economic growth, as expected. An increase in the corruption level of one standard deviation decreases growth by 2.68 x 0.44 = 1.17 per cent. In the long term, this leads to a permanent income decrease of 74 per cent.[2] Corruption hampers the economic process considerably. The coefficient for natural resources remains almost unaffected, though its significance is substantially lowered. An increase in natural resource income of one per cent of total income decreases growth by 0.07% per year, and long-term total income by about 7.39/1.16=6.4 per cent (see equation (4)). The regression illustrates the argument that whereas in the short term natural resources increase wealth, in the long term the economy falls back more than it gained.

[2] 1–exp(–1.17/1.16)=0.74, see equation (3).

In the subsequent column entries, we include as independent variables the ratio of real gross domestic *Investments* to real GDP averaged over the period 1975-1996, an index of *Openness*, that is the percentage of years during the period 1970-1990 in which the country is considered an open economy according to the Sachs and Warner database, a *Terms of trade* index measuring the average annual growth over 1970-1990 in the ratio of the export price index divided by the import price index, and finally a *Schooling* index by King and Levine measuring (the log of) the average number of years of secondary schooling during 1970-1989, as a proxy of educational quality.

We highlight some observations regarding the sequence of regressions in Table 1. As we move to the right and we include more explanatory variables, the coefficient for natural resources gradually decreases and becomes less significant. What is more, in the last column entries (5) and (6), the coefficient of natural resources has become positive. This suggests that natural resources are not harmful to growth *per se*. In the sixth regression, the possible effect of natural resources on corruption, investments, trade policies, terms of trade, and schooling, and the indirect effect thereof on economic growth, that are the so-called transmission channels, is taken account of through the coefficients of these variables. The coefficient for natural resources only measures the direct effect of natural resource income on growth, and abstracting from the indirect effects of natural resource abundance, we find an almost one-to-one relation between natural resource income and long-term income, that is, $\alpha_2/\alpha_1 \approx -1$. An increase in income due to natural resources is permanent. It is the indirect effects that make natural resources harmful to economic growth. This finding calls for a further investigation of the transmission channels. But, before going into the subject in the next section, we want to draw attention to some other features of the sequence of regressions.

The coefficient for corruption also decreases over the sequence of column entries, though the coefficient remains negative. This finding is consistent with the results of Mo (2001), who shows that corruption affects growth mainly through several indirect channels. By including these channels in the regression, the corruption coefficient loosens significance. Yet corruption has no direct positive effect on income, as is the case for natural resources; its coefficient remains negative. Furthermore, the coefficients for investments, openness, terms of trade, and schooling do not vary much over the regression sequence and are intuitive and in line with the values found in the literature. An economy characterized by a high investment ratio, with a higher openness index, a lower initial income per capita, favorable terms of trade, and high educational standards, is expected to experience a relatively high growth rate. (Sachs and Warner 1995, 1997, 1999, Sala-I-Martin 1997, Mo 2001).

TABLE 1. *Growth regressions as in equation* (1)

Dependent variable: $G_{75\text{-}96}$	(1)	(2)	(3)	(4)	(5)	(6)
Constant	–2.62	10.03	11.66	12.87	12.33	12.03
LnY_{75}	0.52**	–1.16***	–1.61***	–1.77***	–1.76***	–1.61***
(0.89)	(2.48)	(–3.00)	(–4.93)	(–5.55)	(–5.98)	(–3.91)
SNR	–7.57***	–7.39**	–4.41	–3.11	0.93	1.59
(0.07)	(–4.09)	(–2.04)	(–1.47)	(–1.07)	(0.32)	(0.59)
Corruption		–0.44***	–0.30**	–0.26**	–0.19*	–0.09
(2.68)		(–3.06)	(–2.52)	(–2.25)	(–1.76)	(–0.86)
Investments			0.16***	0.13***	0.15***	0.16***
(8.06)			(4.82)	(4.15)	(5.07)	(5.56)
Openness				1.26**	1.64***	1.26**
(0.45)				(2.31)	(3.23)	(2.39)
Terms of Trade					–0.27**	–0.31***
(1.90)					(–2.52)	(–3.23)
Schooling						0.584
(0.61)						(1.229)
R^2 adjusted	0.18	0.25	0.51	0.55	0.62	0.66
N	103	47	47	47	46	39

Note: Standard deviations for independent variables in parentheses, based on the sample N=39 of *regression (6); t-statistics for coefficients in parentheses. Superscripts* *, **, *** *correspond to a 10, 5 and 1% level of significance.*

3. Transmission channels

In this section, we analyze the magnitude and relative importance of the transmission channels, that is, we estimate the effect of natural resources on corruption, investments, openness, terms of trade, and schooling, and the indirect effect thereof on economic growth. We estimate the dependence of the variables Z^i on resource income:

$$Z^i = \beta_0 + \beta_1 R^i + \mu^i, \tag{5}$$

where Z^i, β_0, β_2, and μ^i are vectors of which each element is associated with the corruption, investments, openness, terms of trade, and schooling indexes. Table 2 lists the results for the estimated equation (5). To avoid the problem of different sample sizes (because of available data) among different regressions that would influence our results, we confine the transmission analysis

to the final sample of 39 countries used in the last regression of Table 1. The coefficients are not highly significant but this is due to small sample size. Running the same regressions for the largest possible sample available for each transmission channel provides significant coefficients at the 1% level for the terms of trade and openness indexes and at the 5% level for the investment and schooling indexes. The corruption channel seems to be the weakest channel since it is only significant at the 16% level. The R^2 increases for each transmission channel and the value of the coefficients is robust against the sample size.

TABLE 2. *Indirect Transmission Channels, estimation of equation* (5)

	Corruption	Investments	Openness	Terms of Trade	Schooling
Constant	5.87	20.77	0.68	–0.74	–0.70
SNR	7.21	–28.83	–1.82*	7.75*	–2.16
(0.07)	(1.13)	(–1.52)	(–1.74)	(–1.75)	(–1.50)
R^2 adjusted	0.007	0.034	0.051	0.052	0.0032
N	39	39	39	39	39

*Note: t-statistics for coefficients in parentheses. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance.*

When natural resources explain part of the investment and other variables, this can help us to understand the direct plus indirect impact of natural resources on growth. Substitution of (5) in (1) gives

$$G^i = (\alpha_0+\alpha_3\beta_0) + \alpha_1 \ln(Y_0{}^i) + (\alpha_2+\alpha_3\beta_1)R^i + \alpha_3\mu^i + \varepsilon^i, \quad (6)$$

where $\alpha_2 R^i$ is the direct effect of natural resources on growth, $\alpha_3\beta_1 R^i$ is the indirect effect of natural resource abundance on growth, and μ^i are the residuals of (5). The estimated values for the coefficients α_1, $\alpha_2+\alpha_3\beta_1$, and α_3 are listed in Table 3.

TABLE 3. *Growth regression, taking account of indirect effects as in equation* (6)

Dependent variable: $G_{75\text{-}96}$	(7)
Constant	16.53
Ln Y_{75}	–1.61***
(0.89)	(–3.90)
SNR	–9.60***
(0.07)	(–4.30)
μ_1 (*Corruption*)	–0.091
(2.63)	(–0.86)
μ_2 (*Investments*)	0.16***
(7.82)	(5.56)
μ_3 (*Openness*)	1.26**
(0.43)	(2.39)
μ_4 (*Terms of Trade*)	–0.31***
(1.82)	(–3.23)
μ_5 (*Schooling*)	0.58
(0.59)	(1.23)
R^2 adjusted	0.66
N	39

Note: Standard deviations for independent variables in parentheses; t-statistics for coefficients in parentheses. Superscripts *, **, *** *correspond to a 10, 5 and 1% level of significance.*

The coefficient of natural resources (–9.60) now includes both direct and indirect effects. A one per cent increase in natural resource income leads to a decrease in the growth rate of –0.096 per cent, and a decrease in long-term income of about 6 per cent (equation (4)). This finding is consistent with the simple regression (2) in Table 1.[3] An increase in the share of mineral production in GDP of one standard deviation would directly and indirectly (through corruption, investment, openness, the terms of trade and schooling) result in a reduction in annual per-capita growth of 0.67% (–9.60x0.07), and a long-term income decrease of 33% (equation (3)).

Furthermore, we estimate the relative importance of each transmission channel in explaining the overall negative impact of natural resources on economic growth. The direct effect is given by

[3] We notice that the second regression of Table 1 is based on a larger sample.

α_2 and the indirect effect by $\alpha_3\beta_1$ (6). Results are listed in Table 4. Then, we will discuss each separate transmission channel.

TABLE 4. *Relative Importance of Transmission Channels, as in equation* (6)

Transmission channels	α_3 (Table 1)	β_1 (Table 2)	Contribution to $\alpha_2+\alpha_3\beta_1$	Relative Contribution
SNR			1.59	–17%
Corruption	–0.09	–7.21	–0.66	7%
Investment	0.16	–28.83	–4.53	47%
Openness	1.26	–1.82	–2.30	24%
Terms of Trade	–0.31	7.75	–2.43	25%
Schooling	0.58	–2.16	–1.26	13%
Total			**–9.60**	**100%**

Our estimation of the effect of natural resources on corruption is depicted in the first column entry of Table 2. Natural resources indeed tend to increase the level of corruption, but the indirect effect on growth is relative limited compared to the other transmission channels. This finding is consistent with recent empirical work of Sachs and Warner (1995) and Gylfason (2000). Yet, though the contribution of corruption to the overall negative impact of natural resources seems minor, only 7%, nonetheless, corruption is a significant consequence of natural resource abundance since it alone cancels out about 40 per cent of the positive direct effect of natural resources on economic growth. In the literature, we find the following arguments that explain the effect of natural resources on institutional quality and, more specifically, corruption. Natural resources provide an easy way of receiving rents, and lead to rent-seeking competition rather than productive activities (Krueger 1974). Also, natural resource rents stimulate economic agents to bribe the administration in order to gain access (Sachs and Warner 1995, Gray and Kaufmann 1998, Ascher 1999, Leite and Weidmann 1999, Sachs and Rondriguez 1999, Gylfason 2001a, Torvik 2002). Additionally, natural resources are often associated with the emergence of politically powerful interest groups that attempt to influence politicians prone to corruption in order to adopt policies that are not in favor of the general public interest (Mauro, 1998).

As a second transmission channel we consider investments. This channel is the most important; it accounts for 47% of the negative impact of natural resources on growth. Natural resource wealth decreases the need for savings and investments, since natural resources provide a continuous stream of future wealth, which thus seems less dependent on the transfer of man-made capital to future periods. Yet, world prices for primary commodities tend to be more volatile than world prices for other goods. Therefore, an economy based on primary production will easily shift

from booms to recessions and this creates uncertainty for investors in natural resource economies (Sachs and Warner 1999b). Additionally, under a natural resource boom, increased rents in the primary sector cause a move in factors of production from the manufacturing sector towards the booming primary sector. Often, the manufacturing sector is characterized by increasing returns to scale and positive externalities. A decrease of the manufacturing sector further decreases the productivity and profitability of investments, accelerating the decrease in investments (Sachs and Warner 1995, 1999a, Gillis *et.al* 1996, Gylfason 2000, 2001a).

The third transmission channel we consider is the impact of natural resources on the degree of openness in the economy and the terms of trade. Natural resource abundance reduces the openness of an economy and harms its terms of trade. Since natural resources weaken the manufacturing sector, policy makers may impose import quotas and tariffs that, in the short run, protect domestic producers (Auty 1994, Sachs and Warner 1995). In the long run, such measures harm the openness of the economy and its integration into the global economy. Also, natural resource booms increase domestic income and the demand for goods, triggering inflation and an overvaluation of the domestic currency. The relative price of all non-traded goods increase, the terms of trade deteriorate, and exports become expensive relative to world market prices and decline, a phenomenon known as the "Dutch Disease" (Sachs and Warner 1995, Torvik 2001, Gylfason 2000, 2001a, 2001b, Rodriguez and Sachs 1999).

Finally, we consider the schooling transmission channel. Natural resource booms decrease the manufacturing sector for which human capital is an important production factor. The need for high-quality education declines, and so does the returns to education (Gylfason 2001a). It is also claimed that natural resource abundance creates a false sense of confidence: "easy riches lead to sloth" (Sachs and Warner 1995). An expanding primary sector does not need a high-skilled labor force, and there is no feeling of urgency to increase spending on education. This restricts the future expansion of other sectors that require educational quality (Gylfason 2000, 2001a, 2001b, Sachs and Warner 1999b) and the technological diffusion in the economy (Nelson and Phelps 1966). We find schooling to be a moderately important transmission channel, e.g. more important and more significant than corruption. This contrasts empirical work by Sachs and Warner (1995, 1999a).

4. Conclusions

During the past decades, the paradox of a negative impact of natural resource abundance on economic growth has been widely observed. Many countries rich in oil reserves, gas, or tropical forests used for timber production experienced disappointing growth levels. In contrast, resource-

poor countries surged ahead. Though this is a common trend, it is no empirical law. In the eighteenth and nineteenth century, steel and coal reserves were the stimulant for an industrial revolution and growth. Similarly, in the twentieth century resource abundant countries such as Norway and Iceland experienced remarkable and sustained growth rates. Natural resources seem to stimulate growth but under certain conditions. It is essential to control the indirect possible adverse effects. A natural resource economy that suffers from corruption, low investments, protectionist measures, a deteriorating terms of trade, and low educational standards will probably not benefit from its natural wealth.

An empirical analysis has been performed to show that natural resources increase growth, when abstracting from possible negative indirect effects. The analysis also made clear that, when accounting for the transmission channels, the overall effect of natural resource abundance on economic growth is strongly negative. It was shown that the investment channel is the most important. An extension of the analysis should try to extent the sample used for the empirical analysis, and to identify additional transmission channels through which natural resources affect growth. Also, we would like to investigate more carefully mechanisms behind the transmission channels. Such a better understanding is essential for presenting policy measures that may halt the negative impact of natural resources on economic growth.

Acknowledgments

The research has been funded by the Dutch National Science Foundation (NWO) under contract nr. 016.005.040.

Appendix: List of variables used in the regressions

G	Average annual growth in real GDP per person between 1975-1996, $G=\ln(Y_{1996}/Y_{1975})$. GDP data from Penn World Tables 6.0 (http://pwt.econ.upenn.edu)
$\mathrm{Ln}\,Y_{75}$	The log of real GDP per capita in 1975 (1985, International Prices) (Data from The Penn World Tables of Summers and Heston)
SNR	The share of mineral production in GDP for the 1970-89 period (Sachs and Warner Dataset: http://www.cid.harvard.edu/ciddata/ciddata.html**)**
Corruption	The Corruption Perception Index as provided by Transparency International: the degree to which corruption is perceived to exist among public officials and politicians (http://www.transparency.org)
Investments	Real gross domestic investment (private and public) (1985 International Prices). Average value for the 1975-96 period. (Summers and Heston)
Openness	The fractions of years during the 1965-1990 period in which the country is rated as an open economy according to the criteria in Sachs and Warner. Data from Sachs and Warner dataset.
Terms of Trade	The average annual growth in the log of external terms of trade between 1970-1990 (where the terms of trade is conceived by the ratio of an export price index to an import price index. Data from Sachs and Warner Database.
Schooling	The log of average secondary schooling during 1970-1989 (King and Levine database, http://www.cid.harvard.edu/ciddata/ciddata.html)

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(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001

(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europaische Integrationsforschung (ZEI), Milan, July 5-6, 2001

(lviii) This paper was presented at the Workshop on "Game Practice and the Environment", jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

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