PRONTO

FP7-SSH-2013-2
GA: 613504
Start date of the project: 01/02/2014 - Project duration: 48 months

Deliverable N°	6.5
Deliverable name	The Effect of ERS on Resource Use / Poverty / Economic Development
Work Package	WP6 Analysing the impact of NTMs on sustainable growth and climate
Status-Version	Working paper (s)
Lead Participant	AUEB-RC
Date (this version):	28/02/2017 (subject to revision)
Date of paper:	February 2017
EC Distribution	Public

Abstract

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 61350

ERSs and Trade in Natural Resources: The Impact on Economic Growth and Poverty in LDCs*

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February 2017

Abstract

We study the impact on economic growth of LDCs of environmentally related standards (ERSs) adopted by such economies to bypass non-tariff-measures (NTMs) imposed as environmental regulatory requirements on their exports of natural resources to developed importing countries. In particular, we develop an empirical growth model that incorporates the impacts of resource abundance and of ERSs, the latter being measured by the number of ISO14001 certificates which a LDC holds, on per capita GDP growth. This specification allows to test for the existence of the "resource curse" and for the effects of ERSs on growth through their interaction with the resource abundance measure. Our results suggest that ERSs can be growth promoting and in certain cases a factor mitigating the "resource curse" in LDCs. Thus, compliance with ERSs combined with aid in institution formation or technology transfers can allow LDCs to enhance economic growth and alleviate poverty.

Keywords: Non-tariff measures; Environmentally related standards; Natural resource exports; Resource curse; Economic growth; Poverty.

JEL Classifications: F18, F43, O13, O44, Q56.

* The authors acknowledge financial support from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613504. All errors are our own.

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1. Introduction

A frequently invoked "bad" dimension of the trade-environment nexus argues that most developing countries fail to manage their natural resources efficiently and sustainably for successful development, primarily in resource dependent developing economies. Opening to international trade may exacerbate this problem, a phenomenon known as "*resource curse*". The resource curse, also known as the *paradox of plenty*, refers to the paradox that countries with an abundance of natural resources, and in particular non-renewable resources, e.g., minerals and fuels, tend to "fall back" in terms of economic growth and development relative to countries endowed with fewer natural resources.[1] This phenomenon is hypothesized to happen for a variety of reasons, and there are many academic and policy related debates as to when and why it occurs.

Most experts, however, believe the resource curse is neither universal nor inevitable, but it affects certain types of countries or regions under certain conditions.[2] For example, on the one hand, oil rich Nigeria, diamond rich Congo, and resource rich Angola, Libya, Sierra Leone fit this 'paradox of plenty'. Specifically, during the 1970s, Nigeria capitalizing in the success of their resource sector borrowed heavily to support public spending and investment plans. However, the 'oil slump', of the 1980s lead to huge fiscal budget deficits, which gradually could not be supported by the resource sector. Nigeria became heavily indebted, and with a weak agricultural sector it became almost entirely dependent on food imports (Otaha, 2012). Congo is the world's largest producer of cobalt (49% of the world production in 2009) and of industrial diamonds (30%), a large producer of gemstone diamonds (6%), and it has around 2/3 of the world's deposits of coltan and significant deposits of copper and tin. At the same time, however, according to World Bank's World Development Indicators, the country records the world's worst growth rate and the 8th lowest GDP per capita over last 40 years. In Angola, Libya,

[1] Many authors argue the resource curse is also held accountable for a long-range of non-economic ills in recourse-rich developing countries, e.g., armed regional conflicts, the undermining of democratic institutions and of the willingness for international cooperation, lack of public accountability and transparency, widespread corruption, and growing gender inequality, i.e., Mehlum et al. (2006). True or not, however, these issues are not a subject matter of the present studies. We confine the analysis to the economic arguments of the phenomenon.

[2] This argument stems from the view that, in general, economies with large natural resource sectors relative to the more dynamic sectors such as manufacturing and services sectors grow slower.

Sierra Leone, natural resources have been the keystone of violent armed conflicts which have led to the severest economic, political and humanitarian destructions worldwide (Paltseva and Roine, 2011). Contrary to the above examples, other developing countries recorded notable economic growth because of, not in spite of, their abundance of natural resources. The World Bank (2013) reports that in Botswana since the discovery of diamonds, the country "has been one of the fastest growing economies in the world and moved into the ranks of upper-middle income countries". Norway is another country where natural resource abundance worked into a blessing rather than a curse. Like the Netherlands, Norway discovered in the 1960s a huge oil and gas natural deposit. However, instead of channeling the export revenue generated from this natural deposit in the domestic economy, thus boosting incomes and demand for non-traded goods and services, it invested cautiously the largest part into an international fund of bonds and stocks, whose worth by 2012 rose to approximately $600bn. In doing so, Norway avoided dramatic fluctuations in the krone's exchange rate, and allowed non-resource traded good sectors to remain competitive, while at the same time creating a huge fund to fall back on should there be need to.[3]

International trade in resource based commodities and subsequent improvement in terms of trade, and the so-called "Dutch Disease", (DD) lead to further expansion/exploitation of natural resources against the other sectors by drawing economic resources away from them.[4] Corden and Neary (1982) give an insightful intuition of the phenomenon. They postulate that an economy is split into three sectors; a non-traded goods/services sector, a resource-based traded goods sector, and an agricultural or manufactured traded goods sector. If a country's resource-based traded goods sector expands, it generates two key effects in the economy. One called "*resource movement effect*", by which productive resources, such as capital and labor move from the other two sectors, primarily from the agricultural-manufacturing sector, in order to support the expanding resource sector. The other called "*spending effect*" leads to increased revenue from the expanding resource

[3] Other examples of resource rich countries which have grown considerably well over the last 40 years are Australia, Chile and Malaysia, while over the same period certain resource poor countries, e.g., Honk Kong, Singapore and S. Korea have been among the fastest growing economies.

[4] The term Dutch Disease is first coined by The Economist in 1977 to describe the decline of the manufacturing sector in the Netherlands after the discovery of the large Groningen natural gas field in 1959. Sachs and Warner (1997) argue that the DD is the key explanation for the resource curse. Other studies, however, e.g., Corden (1984), Cavalcanti et al. (2011) argue against the DD as the main cause of the resource curse.

sector, and causes increased demand for non-traded goods and services, thus further diverting capital and labor away from the agricultural-manufacturing traded goods sector.[5] These two effects may contribute to an exchange rate depreciation as prices of non-traded goods and services rise, while the internationally set prices of the agricultural-manufactured commodities remain relatively constant. That is, as resource rich economies gradually become more specialized in natural resource production and exports, economic growth may start slowing down due to this reversal in export (resource) prices. Thus, when a country has a sufficiently large non-resource tradable sector, the relative prices of resource based commodities can be rather stable, even when a commodity boom in the resource sector, say due to international trade. This results to a weakening and gradually non-competitive agricultural manufacturing traded goods sector, thus leaving the country heavily reliant on its resource sector. However, when the non-resource tradable sector is relatively small and an economy moves away from non-resource tradables, an increase in resource income due to international trade may lead to further specialization in the resource sector, greater volatility of relative prices of resource based commodities, lower level of capital and output in the non-tradable sector, thus ultimately causing a large and possibly more permanent decline in welfare. The above argument, however, may be read somewhat differently in interpreting the negative nexus between natural resource abundance and economic growth. For example, as Cavalcanti et al. (2011) postulate, because prices of natural resources are inherently volatile, due to low demand and supply price elasticities, when there is a shock to the supply of (demand for) a natural resource, prices adjust rapidly to meet the existing supply (demand), resulting to profound fluctuations in export revenues and in the rates of economic growth. If so, then, one may argue that the underlying factor for the resource curse is the volatility of prices, rather than the physical abundance of natural resources. On the other hand, Arezki and Gylfason (2011) conclude that regardless of the importance of resource price volatility in explaining the resource curse, volatility of natural resources pre-se, with oil and natural gas being by far the most volatile, cannot be undermined as a crucial factor for the resource curse.

[5] According to the authors, the "*revenue movement effect*" entails a direct de-industrialization impact in the agricultural-manufacturing traded goods sector, and the "*spending effect*" an indirect one.

1.1. Our Contribution

"Non-Tariff Measures", (NTMs), are trade barriers that restrict imports or exports of goods or services through mechanisms other than tariffs. Also, they can differ from import quotas, subsidies, customs delays and technical barriers. Noteworthy, NTMs have mainly affected the developing countries exports; more particularly the primary goods are the ones that are affected the most. This fact stems from the imposition of trade barriers and the establishment of environmental standards set mainly by international standard setting organizations or developed importing economies. Environmental standards are special NTMs and comprise a set of quality conditions that regulate the effect of human activity upon the environment.

More often than not, importing countries impose environmentally related standards (ERSs) in order to block sales of products of foreign manufactures which do not comply with their environmental rules and regulations. In turn, exporters in developing countries often lack access to both necessary resources and information that would assist them to comply with product standardization as adopted by the developed importing countries. Under this specification, ERSs can be considered as a trade impediment for resource exporting countries, causing a significant decline in their potential export revenues. According to Bhagwati (2000) high-income countries impose such kind of standards on low-income ones, depriving them of their natural comparative advantage.

For these reasons, we view the nexus “resource abundance-international trade-economic growth” of pivotal importance in promoting economic prosperity and alleviating poverty in developing countries. By now, as it becomes evident in the following section, there is a deep and extended literature which examines the resource curse paradigm by considering various transmission channels. All and all, the results of this literature are quite diverse and ambiguous. While a sizable volume of empirical literature supports the negative relationship between natural resource abundance and economic growth, there is a non-negligible body of empirical studies attesting to a positive relationship between the two. Clearly, it is rather difficult and complex to identify precise factors behind the causal relationship between resource exportation and poor economic performance. Without much loss of generality one can argue that this relationship seems likely to be rooted in (non-) economic characteristics of the resource rich / poor countries, and on the different types of resources considered.

For this, we have a keen interest in further developing this line of research, but by raising a different and important policy relevant issue, which to the best of our knowledge, is not been considered yet by the current literature. This is the impact of the interaction between ERSs and exports of natural resources on the growth of GDP or of GDP per capita, thus on poverty, in resource dependent LDCs. Our motivation in pursuing this angel of research in this topic is that, on the one hand, ERSs set by developed importing countries on resource exporting countries LDCs can be considered as trade impeding measures which potentially can restrict their exports, and thus export revenue. This in turn, may be argued, could result to a dampening effect on (per capita) GDP particularly for LDCs heavily relying on resource tradable sectors. On the other hand, it can be argued that such ERSs, and LDCs compliance with them, can be beneficial in terms of reversing the "resource curse" paradigm, if they can be associated with positive effects on growth and poverty reduction. This beneficial effect could emerge by motivating the adoption of more efficient and cleaner emission and resource saving technologies which could increase the overall productivity of the LDC and provide better access to international markets. On these grounds, a new and relatively "thinner", literature is "just in the make", which gives a lot of room for new issues to be raised and contributions to be made along the lines described above.

2. Related Literature

A voluminous literature debates whether the natural resources are a curse or blessing for many countries, particularly LDCs which rely on tradable resources sectors for promoting economic growth. A seminal work in this long standing, primarily empirical literature and policy debate, is that by Sachs and Warner (1995), who studying global growth rates during 1971-89, note a negative and statistically significant correlation between resource abundance and economic growth. Furthermore, they note that several resource-poor countries often outperform resource-rich ones. For example, resource-poor East-Asian 'Newly Industrialized Countries' (NICs) have surged in economic performance ahead of resource-rich countries such as Mexico and Nigeria. Since then, a newer literature triggered by this "paradoxical" result embarked into examining the origins and validity of the nexus between resource abundance or scarcity and economic growth. Most studies confirming the resource curse have used the Sachs and Warner (1995) methodology, estimating resource abundance as the share of primary exports in GDP at the beginning of the observation period.

Other studies have explored alternative analytical and empirical channels to identify this paradigm. For example, a strand of the relevant literature links the resource curse to human capital. Gylfason (2001) argues that the negative growth effects of natural resources stem from lower education spending and less schooling in resource-rich countries. Bravo-Ortega and De Gregorio (2005) conclude that the negative resource effects can be offset by higher education levels. Stijns (2006) concludes that per capita rents from natural resources are positively correlated with human capital accumulation. Ross (2001), Jensen and Wantchekon (2004), Collier and Hoeffler (2005), and Hodler (2006) explain the negative associations between resource abundance and the stability and quality of the political system. The "Dutch Disease-resource curse" nexus is exploited, e.g., by Hausmann and Rigobon (2002), Stijns (2005), and Matsen and Torvik (2005). Baland and Francois (2000) and Torvik (2002) focus on the effects of natural resource abundance on rent-seeking behavior and income. The role and importance of institutions for the recourse curse paradigm are examined by La Porta et al. (1999), Acemoglu et al. (2001), Acemoglu and Johnson (2005). Brunnschweiler (2008) finds a positive direct empirical relationship between natural resource abundance and economic growth using new measures of resource endowment,[6] and by considering the role of institutional quality, rather than of institutions as such, as a determing factor of ec onomic growth and development. Brunnschweiler and Bulte (2008) re-examine the resource curse paradox by distinguish between, what they call, resource abundance (a stock measure of in situ resource wealth), resource rents (the flow of income derived from the resource stock at some point in time), and resource dependence (the degree to which countries do or do not have access to alternative sources of income other than resource extraction, again at some point in time). They conclude that treating resource dependence as endogenous, it appears statistically insignificant in growth regressions, and with no effect on institutional quality. Resource abundance, however, is significantly associated with both economic growth and institutional quality, but the association runs opposite to the resource curse paradigm. That is, it is the greater resource abundance which leads to better institutions and more rapid growth. Van der Ploeg (2011), and Venables (2016) survey long range of hypotheses, some supporting and others refuting, the empirical evidence whereby some countries benefit while others do not from natural resource abundance.

[6] Brunnschweiler (2008) proposes the use of *per capita minerals* and *total natural resource wealth* as alternative indices of measuring resource abundance.

The rest of the paper is organized as follows. Section 3 describes the Data and the various empirical specifications of this study. Section 4 presents the main empirical findings and discusses their robustness to the various extensions of the baseline models estimated. Section 5 offers some concluding remarks and policy implications.

3. Data and Empirical Specification

This section contains a brief description of the data we employ in our analysis as well as a discussion of the empirical models we use to obtain our results.

3.1 Empirical Models

To evaluate whether ERSs result in differences to the level of economic development across LDCs over time, we consider a standard growth regression model along the lines of Sachs and Werner (1995, 1999, 2001) Easterly and Levine (1997, 2003), and Rodrik et al. (2004). In particular, we consider a baseline model of the form:

$$y_{it} = \alpha_i + \lambda_t + \rho y_{it-1} + \gamma Resource_{it-1} + \boldsymbol{X}'_{it-1}\boldsymbol{\beta} + u_{it}; i = 1, \dots, N; t = 1, \dots, T \quad (1)$$

where α_i and λ_t denote a set of country- and time-fixed effects respectively, y denotes log output per capita, $Resource_{it-1}$ is a measure of resource abundance (in year $t-1$) and the vector $\boldsymbol{X}_{it-1}$ contains a set of standard controls (e.g. investment share, log terms of trade, trade openness and the percentage of population with secondary schooling). The literature of the so-called "resource curse" has demonstrated that $\gamma < 0$, so that resource abundance leads to lower level of economic development and hence higher poverty (see Werner and Sachs (1995, 1999, 2001)).

We extend the empirical framework in (1) by incorporating ERSs. Note here that ERSs cannot have any direct impact on the level of economic development. Essentially they can affect per-capita output only to the extent that they affect exports and/or rents from natural resources, hence by influencing the effect of $Resource_{it-1}$. The measure of ERSs we employ pertain to the number of standards adopted by producers/firms in the exporting country (see in the next subsection for a data description). In this manner, certificates of ERS compliance can be thought as an effort by developing economies to bypass any type of NTMs, imposed by developed importing countries, as environmental regulatory requirements related to their exports of natural resources. To assess this more formally we estimate a model of the form:

$$y_{it} = \alpha_i + \lambda_t + \rho y_{it-1} + \gamma Resource_{it-1} + \delta Resource_{it-1} \times ERS_{it-1} + \boldsymbol{X}'_{it-1}\boldsymbol{\beta} + u_{it}; \quad (2)$$

$$i = 1, \dots, N; t = 1, \dots, T$$

where ERS_{it-1} denotes the ERSs adopted by the exporting country during the previous year. In the above equation, finding that $\gamma < 0$ amounts to the presence of the resource curse phenomenon, while finding that $\gamma \geq 0$ provides prima facie evidence against the resource curse hypothesis. In addition, finding that $\delta < 0$ when $\gamma < 0$ implies that the presence of ERSs tends to magnify the effects of the resource cures, while finding that $\delta > 0$ when $\gamma < 0$ would imply that the presence of ERSs tends to mitigate the resource curse.

3.2 Data

The sample we analyze, covers the period from 1999 to 2014, which has been dictated by data availability. In particular, our measure of ERSs which is the number of ISO14001 certificates by country, are available over the period 1999-2014. These have been obtained from the International Organization for Standardization (ISO). Published international standards cover almost every industry i.e. technology, food safety, agriculture, healthcare and environment and can be applied to a variety of levels in the business, from organizational level, right down to the product and service level. In particular, the ISO14001 standards that we use, map out a framework that a company or organization can voluntarily follow to enhance its environmental performance. Each year, the organization reports the number of such certificates that have been issued by firms in each country.

The idea behind an ISO14001 certificate is that a firm in possession of one will manage to by-pass certain types of NTMs in the form of environmental requirements at the destination country. These certificates indicate that a firm's products, activities, services and systems meet quality, safety and efficiency requirements complying with the most recent environmental laws and regulations. The original variable is measured in number of ISO14001 certificates by country, has been scaled to thousands of certificates by country.

We measure long-term development using GDP per capita in levels, following Hall and Jones (1999), Easterly and Levine (2003), Rodrik et al. (2004), and Alexeev and Conrad (2009). The use of GDP levels is more appropriate relative to *average* GDP growth rates

for a relatively limited period of time, e.g., Alexeev and Conrad, (2009).[7] In addition, from a welfare perspective which is affected by the consumption of goods and services, income levels are more relevant than growth rates (see Hall and Jones (1999) for a discussion). The data on real output (in chained PPP, 2011 US$) and population have been obtained mainly from Penn World Tables 9.0 (Feenstra et al. (2015)). As for some LDCs, PWT does not report data, for those countries we have used data from World Bank's World Development Indicators (WDI).

Following Sachs and Warner (1995, 1999, 2001), we proxy the resource abundance by the share of primary exports in GDP, also from the WDI.[8] These primary exports include fuels, ores and metals, agricultural raw materials, and food. This ratio indicates the relative importance of these production activities and therefore shows the importance of natural resources to the economy. One could argue that the GDP share of primary exports measures resource dependence rather than resource abundance, as it may also reflect policy measures that influence specific sectors.

As an alternative, we employ natural resource rents, also from the WDI (see for instance Boschini et al. (2007, 2013)). Resource rents are measured as revenues from natural resources (including coal, forestry, minerals, natural gas and oil) as a share of GDP. Rents are calculated as the difference between the price of a commodity and the cost of extraction/production. In this way, these variables measure the potential value of resource production in any country, and so they proxy for resource revenues that could be appropriated by local elites.

Our baseline controls include variables that are expected to influence the long-run level of output per capita. In particular, we employ openness which is measured by the sum of exports and imports over total GDP (from WDI); the investment share is measured as the ratio of gross capital formation to output is obtained from PWT 9.0 (and from WDI whenever values were missing); the (log of) terms of trade (from WDI); and the percentage of population with (some) secondary schooling (from WDI).

[7] Given the limited time span of data available (1999-2014) we have opted for this choice. Note here that year-on-year growth rates can easily be obtained from the empirical specifications we employ and this is on what we will be focusing our discussion. However, longer-term growth rates (say five-year or fifteen-year average growth rates) would have significantly reduced the number of observations in our analysis.

[8] The original variables are provided as percentage of merchandise exports. We have used the value of Merchandise exports (current US$) and the value of GDP at market prices (current US$) to obtain the ratio of primary exports to GDP.

The countries we analyze are least developed countries (LDCs) that are included in the Least Developed Countries Reports of 1996, 2000 and 2007 by the United Nations Conference on Trade and Development (UNCTAD). The list of these countries is reported in Table A.1 in the Appendix.

4. Empirical Findings

In this section, we describe our main empirical findings and their robustness to various extensions of the baseline models estimated.

4.1 Evidence on the Resource Curse: Is it There?

We start our discussion with the estimation of versions of equation (1) to assess the presence of the resource curse in the data. These findings provide a useful benchmark for our results below, when we also consider the presence of ERSs. To make our findings clear, we present two sets of results: one that employs resource exports and one that uses resource-based rents. When discussing resource exports, we provide results for total resource exports, but we also break resource exports into their main components: exports of ores and metals, exports of food, exports of fuel and exports of raw agricultural products. Similarly, when discussing resource rents, we provide results for overall resource rents, but also make use of their decomposition into rents from coal, forestry, minerals, natural gas and petroleum. Finally, to make comparisons more transparent across groups of countries we present our results for all LDCs combined, for African countries alone, for Sub-Saharan countries, for LDCs in Africa only, and for LDCs in Sub-Saharan Africa.

Results from estimating versions of equation (1) are reported in Tables A.2 (for natural resource exports) and A.3 (for resource-based rents) in the Appendix. Here we base our discussion mostly on the effect of the resource-related variables. As far as the other control variables are concerned, we find our proxy for human capital (percentage of people with some secondary education) to be invariably insignificant. When looking at resource-based rents (Table A.3) we find that openness, and investment share and terms of trade have positive signs and are in many cases statistically significant. On the other hand, when looking at resource exports, we note that the effect of openness is positive but insignificant in all cases; and the effects of terms of trade positive but significant only when we focus on agricultural raw materials. Finally, the effect of investment share is positive (and in some cases, significant) when we examine total natural resources exports

or fuel exports, but it is negative (and in some instances, significant) when we assess exports in ores and metals, food and agricultural raw materials.[9]

Turning next to the resource curse issue we note that the evidence supporting it are rather weak or even against it when we assess its relevance using resource exports. We find that resource exports exert either an insignificant effect on output per capita growth, or the effect is positive and significant. For instance, when looking at overall resource exports, food and fuel exports, the share of resource exports to GDP does not affect growth in output per person significantly – this is so regardless of the country group assessed. On the other hand, we find that an increase of resource exports to GDP lead to significant output per person growth increases across all country groups when looking at ores and metals exports. A positive and significant effect is also uncovered when looking at agricultural raw materials exports, especially when we examine this effect for African countries only or for Sub-Saharan African countries – the effect is positive but rather weak when looking at LDCs.

When we use resource rents as the appropriate measure of resource abundance, we get a slightly different picture. The effect of total resource rents and forestry rents are negative but invariably insignificant; in contrast the effect of mineral rents is positive but also insignificant. The picture that emerges when assessing coal, natural gas and petroleum resources is different: natural gas rents exert a negative effect on output per person growth, with the effect being significant when we consider all LDCs and all African countries together; the effect of petroleum rents is also negative and significant when we look at all African countries together or all Sub-Saharan African countries. Finally, coal rents exert an increasing effect on output per capita growth, but this effect is found significant only when considering the whole group of LDCs.

Overall, our results indicate that the only cases which seem to support the resource curse hypothesis are when we employ rents from natural gas and petroleum, whereas when coal rents or ores and metals exports and agricultural raw material exports are used, we find evidence against the resource curse hypothesis. With these at hand, we move on to

[9] A possible interpretation of this finding is that in countries which specialize in exporting these types of resources investment in physical capital destroys productive capacity: as investment in physical capital is related to manufacturing productive activities, an increase in manufacturing value added seriously undermines the value added of primary resource sectors. Albeit this is an interesting finding, we leave its thorough examination for future research.

evaluate the effect ERSs have on, via their impact on the 'resource' curse effects (i.e. through their interaction with the export shares or the rents' shares).

4.2 The Effects of Environmentally Related Standards: Magnifying or Mitigating the Effects of Resource Abundance on Growth?

Results from estimating versions of equation (2) are reported in Table 1 (when we employ export shares of primary resources) and Table 2 (when we employ GDP shares of natural resource rents). Starting with the results from primary export revenues, we note that the results for total resource exports (panel A of Table 1) and food exports (Panel C of Table 1) the results are identical to those discussed above: there is no effect of resource export on output per capita growth and this result remains unaffected by the presence of ERS. Similarly, we find that there is a positive effect of ores and metals exports to output per capita growth for African and Sub-Saharan African countries, but the effect remains unaffected by the presence of ERSs.

[Insert Table 1 about here.]

Instead, when we look at the estimates for fuel exports (panel D of Table 1) we note that there is a difference relative to our discussion above: for African countries, an increase in fuel exports results to lower growth rate in output per person and this effect is magnified by the presence of ERSs. To get an idea of the economic importance of this effect, consider an increase in fuel exports by 1% of GDP: in the absence of ERSs this would result in a drop in the growth rate of per capita output by 0.29%, whereas if there are about 406 ISO14001 certificates, the resulting drop in output per person growth rate would be 1%.

The results for agricultural raw material exports are similar to those discussed above for African and Sub-Saharan African countries (columns (2) and (3)). Instead, they differ markedly when we look at all LDCs and LDCs in Africa, where the interaction term is significant. To get a feeling of what the interaction term implies, consider an increase in export revenue for this type of product by 1% of GDP. In the absence of ERSs, this has no significant effect on per capita output growth. Instead, when ERSs are present (about 57 and 63 certificates per country respectively) this leads to an increase in the growth rate of per capita output by 1%.

Let us now turn to the case when resource abundance is proxied by rents to GDP ratio (Table 2). The results for total resource rents (panel A) are again different from those discussed in the previous subsection (without the presence of ERSs): for instance, we find that an increase in rents by one percentage point of GDP has no effect on the growth rate, while the presence of ERSs results in an increase of the growth rate of per capita output by 1% when the average country has about 48 to 50 certificates. Given these findings, it is more instructive to have a look at each component of resource rents separately.

[**Insert Table 2 about here**]

The results for coal rents (Panel B of Table 2) are also different to those discussed in the previous subsection. We find that an increase in coal rents revenue results in higher per capita growth rates for African and Sub-Saharan African countries, but the effect is mitigated using environmental certificates. Results for forestry rents (Panel C) also differ to those discussed above. Now we find that the direct effect of an increase in forestry rents is in line with the resource curse hypothesis – the effect being statistically significant when looking at all LDCs, all African and Sub-Saharan African countries. In all these cases, however the resource curse effect is mitigated by the presence of ERSs. For instance, an increase in forestry rents by one percentage point of GDP would lead to drop in the per capita growth rate by 0.31%-0.36% (for all LDCs and African countries) when no ERSs are present, while the presence of 42, 50 and 49 ISO14001 certificates respectively in the average country would result in 1% higher growth rate.

The results for mineral rents (Panel D of Table 2) are in line with those discussed to total resource rents. While there is no direct effect of any increase in rents on output growth, the effect is positive in the presence of ERSs. Looking at the results for natural gas rents, we find again evidence in favor of the natural resource curse, but the effect is strongly mitigated by the presence of environmental certificates. When assessing all LDCs together, we note that an increase in natural gas rents by one percentage point of GDP would result in a drop of 5.23% in per capita output growth in the absence of any ISO14001, while in the presence of just 24 such certificates, the same increase in rents would increase the growth rate to 1%. Similarly, when looking at LDCs in Africa, the same increase in rents would result in a massive drop in output growth by 8.82%, while

the presence of just 19 ISO14001 certificates turns that to a 1% higher growth rate of per capita output.

Finally, when we examine petroleum rents, we find strong evidence of the resource curse. In general, an increase in petroleum rents by 1% of GDP leads to a lower growth rate of output per person between 0.35% and 0.61%. The presence of ERSs strengthens the effect significantly when the group of countries assessed is all African countries. For instance, the same increase in rents would have results in a drop in the growth rate of per capita GDP by 0.56%, in the presence of 130 certificates, the resulting drop in growth is 1%.

Overall our results indicate that in certain cases, the adoption of ERSs by LDCs may result in higher growth rates of output per person, of at least as a mitigating factor of the negative effect of resources on output growth (the resource curse). In other cases, their presence functions as a factor enhancing growth which stems from increases in exports of primary resources or in rents obtained from the production of primary commodities.

4.3 Robustness Results and Extensions

In order to assess the robustness of our results we have re-estimated models for food and agricultural raw material and for forest rents, we have estimated models which also include interactions of exports/rents with tariffs – we feel that tariffs are only relevant for these types of goods/commodities.[10] Our results remain largely unaffected. The exact coefficient estimates change slightly but none of our previous findings is changed in any important manner.

Following Sachs and Werner (1995, 1999, 2001), and Rodrik et al. (2004) we also control for the quality of institutions. In particular, we include in our specifications a measure of the quality of Law and Order and a variable that measures the degree of Ethnic Tensions within a country.[11] In general we find that Law and Order exerts a positive (and in many cases, significant) effect on per capita output growth. On the other

[10] We constructed tariffs for primary products as weighted averages. For each exporting country, using bilateral trade flows at the 4-digit level, we estimated the trade shares in primary commodities for each exporting country. Then we used these weights and constructed a 'weighted average' tariff for each exporting country, based on the tariffs in primary products imposed by the country's trading partners. Results are not reported here for the sake of brevity, but are available from the authors upon request.

[11] The variables have been obtained from the International Risk Guide (ICRG) of PRS group. For a detailed description of the data and methodology in compiling these measures see https://www.prsgroup.com/about-us/our-two-methodologies/icrg. Again, detailed results are not reported here for the sake of brevity, but are available upon request.

hand, countries with higher degree of Ethnic Tensions are found to have lower growth rates (with the effect being significant in most cases). The key feature of this results however is that none of empirical findings above are reversed in any manner. Overall our results are robust also to controlling for institutions and tariffs.

5. Concluding Remarks and Policy Implications

A long standing literature postulates that LDCs which are primarily exporters of non-renewable resources, such as minerals and fuels could face the so called "resource curse", implying that resource abundance has a negative effect on their economic growth. The present paper revisits empirically the international trade – environment-economic growth nexus in the context of LDCs. In particular, we examine the impact on economic growth of LDCs of environmentally related standards (ERSs), adopted by such economies to bypass NTMs imposed as environmental regulatory requirements on their exports of natural resources to developed importing countries. By extending a traditional growth equation which includes resource abundance, with a term representing the interaction of ERS with resource abundance, we seek to determine the impact of ERS on economic growth.

Using data on various subsets of LDCs we run two basic groups of growth regression. In the first group we run a baseline model which does not include the interaction between resources and ERSs. Results from these estimations indicate whether a resource curse emerges or not. In the second group this interactions term is included. Results from these estimations indicate whether ERSs have a positive or negative effect on growth though resource abundance. A positive effect indicates that a resource curse, if exists in the first place, can be mitigated by ERSs.

Our results indicate that the resource curse hypothesis seems to be supported when we use as a measure of resource abundance the rents from natural gas and petroleum. When coal rents or ores and metals exports and agricultural raw material exports are used, we find evidence against the resource curse hypothesis.

When we include the resource abundance-ERS interaction into the growth equations our results indicate that in certain cases the adoption of ERSs by LDCs may enhance the growth of per capita GDP, especially when we use as a measure of resource abundance agricultural exports, forestry rents, mineral rents, and natural gas. However, we find that

the adoption of ERSs by LDCs may mitigate the growth of per capita GDP, especially when we use as a measure of resource abundance fuel exports, coal and petroleum rents.

Our results of a positive impact or at least a non-negative impact of ERS on the growth of LDCs suggest that the presence of these standards induce LDCs to adopt methods and technologies which would allow them to produce tradable goods adhering to these standards. This could imply the adoption of new technologies and the development of skills which increase the productivity of the whole economy. Furthermore, compliance with the ERSs could increase the share of the LDCs complying with the standards in the world market and thus increase exports.

A policy implication related to the developed countries imposing the ERSs, would be for these countries to combine the environmental standards with aid in institution formation or technology transfers to LDCs. This would allow the LDCs to comply with the imposed environmental standards and at the same time increase growth and alleviate poverty.

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Tables

Table 1. Results Using Resource Exports and ERSs

VARIABLES	(1) LDCs	(2) Africa	(3) Sub-Saharan Africa	(4) LDCs in Africa
Panel A: Total Resources Exports				
log GDP per capita (*t*-1)	0.84456***	0.82339***	0.81990***	0.83483***
	(0.03412)	(0.01985)	(0.01994)	(0.04752)
Resources Exports (% GDP) (*t*-1)	0.00099	-0.00048	-0.00012	0.00093
	(0.00100)	(0.00138)	(0.00144)	(0.00138)
Resources Exports (% GDP) (*t*-1) × ERS (*t*-1)	**0.04562**	**-0.00252**	**-0.00067**	**0.07270**
	(0.05544)	**(0.00308)**	**(0.00340)**	**(0.06946)**
Openness (*t*-1)	0.00058	0.00063	0.00051	0.00055
	(0.00080)	(0.00064)	(0.00064)	(0.00132)
Investment Share (*t*-1)	0.00009	0.00509	0.00685**	0.00448*
	(0.00140)	(0.00347)	(0.00253)	(0.00238)
log Terms of Trade (*t*-1)	0.01587	-0.00228	0.01112	0.04574
	(0.02626)	(0.02582)	(0.02730)	(0.03562)
Percentage of Population with Secondary Schooling	0.00013	-0.00059	-0.00126	-0.00093
	(0.00161)	(0.00152)	(0.00148)	(0.00176)
Constant	1.01866***	1.37361***	1.33312***	0.94504**
	(0.29543)	(0.24373)	(0.24606)	(0.42207)
Observations	338	499	452	274
Number of countries	33	43	39	25
Adjusted R-squared	0.86080	0.87068	0.86996	0.83383

Panel B: Ores and Metals Exports				
log GDP per capita (*t*-1)	0.83355***	0.82038***	0.81731***	0.82352***
	(0.02842)	(0.02036)	(0.02009)	(0.04239)
Ores and Metals Exports (% GDP) (*t*-1)	0.00249	0.00357**	0.00348**	0.00267
	(0.00160)	(0.00169)	(0.00171)	(0.00172)
Ores and Metals Exports (% GDP) (*t*-1) × ERS (*t*-1)	**0.09506**	**-0.00416**	**-0.00359**	**0.11708**
	(0.09318)	**(0.00411)**	**(0.00421)**	**(0.12080)**
Openness (*t*-1)	0.00030	0.00043	0.00037	0.00060
	(0.00058)	(0.00054)	(0.00056)	(0.00098)
Investment Share (*t*-1)	-0.00143	-0.00196	-0.00183	-0.00269*
	(0.00116)	(0.00117)	(0.00124)	(0.00156)
log Terms of Trade (*t*-1)	0.01316	-0.00705	0.00661	0.04293
	(0.02553)	(0.02527)	(0.02636)	(0.03277)
Percentage of Population with Secondary Schooling	-0.00009	-0.00077	-0.00121	-0.00096
	(0.00157)	(0.00140)	(0.00139)	(0.00206)
Constant	1.14180***	1.41691***	1.36858***	1.04332***
	(0.25966)	(0.23076)	(0.23055)	(0.37302)
Observations	389	538	491	311
Number of countries	35	44	40	26
Adjusted R-squared	0.86173	0.86988	0.86902	0.83350

Panel C: Food Exports				
log GDP per capita (*t*-1)	0.84063***	0.82365***	0.82086***	0.84438***
	(0.02802)	(0.01958)	(0.01913)	(0.03550)
Food Exports (% GDP) (*t*-1)	-0.00036	-0.00102	-0.00116	-0.00201
	(0.00152)	(0.00111)	(0.00111)	(0.00161)
Food Exports (% GDP) (*t*-1) × ERS (*t*-1)	**-0.02030**	**0.00017**	**0.00088**	**0.03748**
	(0.20805)	**(0.02040)**	**(0.02088)**	**(0.20967)**
Openness (*t*-1)	0.00048	0.00066	0.00061	0.00098
	(0.00059)	(0.00049)	(0.00051)	(0.00082)
Investment Share (*t*-1)	-0.00103	-0.00240**	-0.00240**	-0.00327**
	(0.00119)	(0.00116)	(0.00116)	(0.00141)
log Terms of Trade (*t*-1)	0.02144	-0.00144	0.01305	0.04664
	(0.02630)	(0.02507)	(0.02591)	(0.03330)
Percentage of Population with Secondary Schooling	0.00030	-0.00074	-0.00120	-0.00017
	(0.00150)	(0.00150)	(0.00147)	(0.00133)
Constant	1.04087***	1.36468***	1.31233***	0.86136***
	(0.25499)	(0.23039)	(0.22828)	(0.30841)
Observations	397	543	496	316
Number of countries	35	44	40	26
Adjusted R-squared	0.85981	0.86885	0.86812	0.83289

Panel D: Fuel Exports				
log GDP per capita (*t*-1)	0.84980***	0.82073***	0.81723***	0.85219***
	(0.03173)	(0.01775)	(0.01917)	(0.04335)
Fuel Exports (% GDP) (*t*-1)	0.00009	-0.00290*	-0.00240	-0.00169
	(0.00159)	(0.00172)	(0.00192)	(0.00322)
Fuel Exports (% GDP) (*t*-1) × ERS (*t*-1)	**-0.06155**	**-0.01745****	**-0.00573**	**-0.08990**
	(0.11250)	**(0.00784)**	**(0.01346)**	**(0.15991)**
Openness (*t*-1)	0.00075	0.00078	0.00068	0.00093
	(0.00078)	(0.00062)	(0.00062)	(0.00121)
Investment Share (*t*-1)	-0.00012	0.00520	0.00690**	0.00493*
	(0.00149)	(0.00328)	(0.00295)	(0.00283)
log Terms of Trade (*t*-1)	0.01775	0.00566	0.01338	0.04672
	(0.02677)	(0.02472)	(0.02681)	(0.03489)
Percentage of Population with Secondary Schooling	0.00037	-0.00067	-0.00114	-0.00069
	(0.00152)	(0.00129)	(0.00145)	(0.00145)
Constant	0.97046***	1.35804***	1.33920***	0.80956*
	(0.28923)	(0.22671)	(0.24411)	(0.39574)
Observations	344	506	459	279
Number of countries	33	43	39	25
Adjusted R-squared	0.85997	0.87240	0.87083	0.83302

Panel E: Agriculture Exports				
log GDP per capita (*t*-1)	0.83739***	0.82624***	0.82285***	0.83845***
	(0.02797)	(0.01881)	(0.01902)	(0.03778)
Agricultural Exports (% GDP) (*t*-1)	0.00313	0.00529**	0.00530**	0.00195
	(0.00328)	(0.00202)	(0.00205)	(0.00280)
Agricultural Exports (% GDP) (*t*-1) × ERS (*t*-1)	**0.17735****	**0.20175**	**0.20192**	**0.16014***
	(0.08156)	**(0.18918)**	**(0.18823)**	**(0.07961)**
Openness (*t*-1)	0.00044	0.00055	0.00049	0.00085
	(0.00061)	(0.00053)	(0.00054)	(0.00089)
Investment Share (*t*-1)	-0.00092	-0.00218	-0.00220	-0.00313*
	(0.00125)	(0.00130)	(0.00135)	(0.00164)
log Terms of Trade (*t*-1)	0.02457	-0.00001	0.01516	0.05048
	(0.02647)	(0.02537)	(0.02594)	(0.03406)
Percentage of Population with Secondary Schooling	0.00052	-0.00106	-0.00154	-0.00010
	(0.00163)	(0.00168)	(0.00167)	(0.00163)
Constant	1.03718***	1.33439***	1.28172***	0.87474**
	(0.26255)	(0.21943)	(0.21981)	(0.33537)
Observations	388	533	486	308
Number of countries	35	44	40	26
Adjusted R-squared	0.85944	0.87050	0.86989	0.83153

Notes: The table reports the results from estimating variations of equation (2). The dependent variable is the log of real GDP per capita and ERSs are expressed in thousands of ISO14001 certificates per country in each year. Panel A reports results for all resource-related exports; Panel B reports results for ores and metals exports; Panel C shows results for food exports; Panel D reports results for fuel exports and Panel E for agricultural raw meterial exports. Column (1) reports all LDCs for which data are available. Column (2) reports results for all African countries (LDCs and feveloped). Column (3) reports results for all Sub-Saharan African Countries and Column (4) results for LDCs in Africa only. As the data available lead to a number of LDCs in Africa coinciding with the number of LDCs in Sub-Saharan Africa, the results for both cases are reported column (4). A Fixed Effects and Time Effects included in all columns. The sample runs from 1999 to 2014. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Results Using Resource Rents and ERSs

VARIABLES	(1) LDCs	(2) Africa	(3) Sub-Saharan Africa	(4) LDCs in Africa	(5) LDCs in Sub-Saharan Africa
Panel A: Total Resources Rents					
log GDP per capita (*t*-1)	0.8428***	0.8071***	0.8022***	0.8036***	0.8043***
	(0.0318)	(0.0233)	(0.0242)	(0.0315)	(0.0316)
Total natural resources rents (% of GDP) (*t*-1)	-0.0003	-0.0013	-0.0014	-0.0010	-0.0010
	(0.0010)	(0.0011)	(0.0012)	(0.0011)	(0.0011)
Total natural resources rents (% of GDP) (*t*-1) × ERS (*t*-1)	**0.2123*** **	**0.0026**	**0.0061**	**0.2256*** **	**0.2257*** **
	(0.0212)	**(0.0093)**	**(0.0117)**	**(0.0195)**	**(0.0192)**
Opennes (*t*-1)	0.0004*	0.0004**	0.0004**	0.0004*	0.0004*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0010	0.0013	0.0019**	0.0016	0.0015
	(0.0007)	(0.0010)	(0.0008)	(0.0010)	(0.0009)
log Terms of Trade (*t*-1)	0.0187	0.0130	0.0249	0.0586	0.0589
	(0.0259)	(0.0298)	(0.0312)	(0.0396)	(0.0402)
Percentage of Population with Secondary Schooling	-0.0005	-0.0010	-0.0015	-0.0014	-0.0013
	(0.0016)	(0.0016)	(0.0017)	(0.0016)	(0.0016)
Constant	1.0465***	1.4422***	1.4166***	1.1348***	1.1236***
	(0.2091)	(0.2009)	(0.2052)	(0.2194)	(0.2167)
Observations	565	672	612	411	403
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8732	0.8545	0.8546	0.8435	0.8439

Panel B: Coal Rents					
log GDP per capita (*t*-1)	0.8568***	0.8238***	0.8197***	0.8246***	0.8252***
	(0.0291)	(0.0198)	(0.0206)	(0.0310)	(0.0313)
Coal rents (% of GDP) (*t*-1)	0.0820*	0.0426***	0.0425***	-0.3010	-0.2999
	(0.0427)	(0.0128)	(0.0130)	(0.2985)	(0.2984)
Coal rents (% of GDP) (*t*-1) × ERS (*t*-1)	**-3.1424**	**-0.0453*** **	**-0.0443*** **	**21.1563**	**21.0974**
	(2.5600)	**(0.0119)**	**(0.0122)**	**(19.1272)**	**(19.1184)**
Openness (*t*-1)	0.0004*	0.0003	0.0003	0.0004*	0.0004*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0008	0.0010	0.0016**	0.0013	0.0013
	(0.0006)	(0.0011)	(0.0008)	(0.0010)	(0.0010)
log Terms of Trade (*t*-1)	0.0240	0.0068	0.0185	0.0562	0.0568
	(0.0252)	(0.0270)	(0.0289)	(0.0380)	(0.0388)
Percentage of Population with Secondary Schooling	-0.0001	-0.0006	-0.0010	-0.0011	-0.0011
	(0.0017)	(0.0014)	(0.0014)	(0.0020)	(0.0019)
Constant	0.9092***	1.3270***	1.2944***	0.9859***	0.9753***
	(0.2049)	(0.1812)	(0.1829)	(0.2123)	(0.2106)
Observations	573	680	620	419	411
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8666	0.8544	0.8542	0.8324	0.8328

Panel C: Forest Rents					
log GDP per capita (*t*-1)	0.8444***	0.8038***	0.7999***	0.8099***	0.8106***
	(0.0305)	(0.0185)	(0.0190)	(0.0314)	(0.0315)
Forest rents (% of GDP) (*t*-1)	-0.0031*	-0.0036**	-0.0036*	-0.0033	-0.0032
	(0.0018)	(0.0017)	(0.0018)	(0.0019)	(0.0020)
Forest rents (% of GDP) (*t*-1) × ERS (*t*-1)	**0.3112****	**0.2748****	**0.2788****	**0.3309****	**0.3322****
	(0.1250)	**(0.1210)**	**(0.1197)**	**(0.1264)**	**(0.1256)**
Openness (*t*-1)	0.0004*	0.0003*	0.0003*	0.0004*	0.0004*
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0011	0.0015	0.0023***	0.0019*	0.0018
	(0.0008)	(0.0012)	(0.0008)	(0.0011)	(0.0011)
log Terms of Trade (*t*-1)	0.0208	0.0050	0.0172	0.0561	0.0567
	(0.0251)	(0.0256)	(0.0272)	(0.0355)	(0.0361)
Percentage of Population with Secondary Schooling	-0.0011	-0.0025	-0.0029*	-0.0025	-0.0024
	(0.0017)	(0.0016)	(0.0016)	(0.0019)	(0.0019)
Constant	1.0555***	1.5559***	1.5174***	1.1424***	1.1296***
	(0.2398)	(0.2084)	(0.2108)	(0.2758)	(0.2740)
Observations	580	687	627	425	417
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8739	0.8595	0.8597	0.8436	0.8440

Panel D: Mineral Rents					
log GDP per capita (*t*-1)	0.8445***	0.8119***	0.8083***	0.8022***	0.8027***
	(0.0283)	(0.0165)	(0.0173)	(0.0228)	(0.0230)
Mineral rents (% of GDP) (*t*-1)	0.0012	0.0024	0.0022	0.0010	0.0010
	(0.0014)	(0.0018)	(0.0018)	(0.0013)	(0.0013)
Mineral rents (% of GDP) (*t*-1) × ERS (*t*-1)	**0.4257*** **	**0.0102**	**0.0097**	**0.4729*** **	**0.4721*** **
	(0.0575)	**(0.0210)**	**(0.0206)**	**(0.0368)**	**(0.0371)**
Openness (t-1)	0.0003*	0.0002*	0.0002	0.0003*	0.0003*
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Investment Share (*t*-1)	0.0011	0.0013	0.0020***	0.0020**	0.0019**
	(0.0008)	(0.0010)	(0.0007)	(0.0008)	(0.0008)
log Terms of Trade (*t*-1)	0.0132	0.0024	0.0144	0.0543	0.0549
	(0.0262)	(0.0269)	(0.0289)	(0.0360)	(0.0366)
Percentage of Population with Secondary Schooling	-0.0017	-0.0021	-0.0024	-0.0032	-0.0031
	(0.0017)	(0.0016)	(0.0016)	(0.0019)	(0.0019)
Constant	1.0905***	1.4772***	1.4349***	1.2046***	1.1931***
	(0.2059)	(0.1694)	(0.1707)	(0.1875)	(0.1858)
Observations	592	699	639	437	429
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8760	0.8575	0.8573	0.8477	0.8480

Panel E: Natural Gas Rents					
log GDP per capita (*t*-1)	0.8746***	0.8161***	0.8079***	0.8693***	0.8693***
	(0.0373)	(0.0230)	(0.0297)	(0.0549)	(0.0549)
Natural Gas rents (% of GDP) (*t*-1)	-0.0523***	-0.0538***	-0.0517**	-0.0882***	-0.0882***
	(0.0171)	(0.0166)	(0.0248)	(0.0179)	(0.0179)
Narural Gas rents (% of GDP) (*t*-1) × ERS (*t*-1)	**2.6201*** **	**-0.0826**	**0.8451**	**5.2254*** **	**5.2254*** **
	(0.9199)	**(0.0534)**	**(2.1825)**	**(1.0837)**	**(1.0837)**
Openness (*t*-1)	0.0004*	0.0001	0.0000	0.0004	0.0004
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Investment Share (*t*-1)	0.0018	0.0028*	0.0037**	0.0018	0.0018
	(0.0018)	(0.0015)	(0.0017)	(0.0023)	(0.0023)
log Terms of Trade (*t*-1)	0.0129	-0.0187	-0.0122	0.0453	0.0453
	(0.0286)	(0.0293)	(0.0315)	(0.0506)	(0.0506)
Percentage of Population with Secondary Schooling	-0.0030	-0.0035	-0.0037	-0.0036	-0.0036
	(0.0029)	(0.0024)	(0.0027)	(0.0035)	(0.0035)
Constant	0.9119***	1.6775***	1.6940***	0.8073**	0.8073**
	(0.2359)	(0.2708)	(0.3251)	(0.2803)	(0.2803)
Observations	249	385	333	153	153
Number of countries	21	30	26	14	14
Adjusted R-squared	0.9243	0.9000	0.8996	0.9068	0.9068

	Panel F: Petroleum Rents				
log GDP per capita (*t*-1)	0.8583***	0.8074***	0.7986***	0.8258***	0.8258***
	(0.0364)	(0.0233)	(0.0329)	(0.0506)	(0.0506)
Petroleum rents (% of GDP) (*t*-1)	-0.0035*	-0.0056***	-0.0061***	-0.0057***	-0.0057***
	(0.0020)	(0.0012)	(0.0013)	(0.0018)	(0.0018)
Petroleum rents (% of GDP) (*t*-1) × ERS (*t*-1)	**0.3865**	**-0.0335***	**0.0242**	**0.4178**	**0.4178**
	(0.2760)	**(0.0185)**	**(0.0963)**	**(0.2971)**	**(0.2971)**
Openness (*t*-1)	0.0010***	0.0010***	0.0010***	0.0013***	0.0013***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Investment Share (*t*-1)	0.0010	0.0018*	0.0013	-0.0002	-0.0002
	(0.0018)	(0.0010)	(0.0014)	(0.0020)	(0.0020)
log Terms of Trade (*t*-1)	-0.0064	0.0010	0.0056	0.0564	0.0564
	(0.0314)	(0.0320)	(0.0353)	(0.0563)	(0.0563)
Percentage of Population with Secondary Schooling	-0.0014	-0.0024	-0.0022	-0.0012	-0.0012
	(0.0036)	(0.0021)	(0.0023)	(0.0033)	(0.0033)
Constant	1.0547***	1.5859***	1.6053***	0.9821***	0.9821***
	(0.2642)	(0.2153)	(0.2807)	(0.3126)	(0.3126)
Observations	264	400	348	168	168
Number of countries	21	30	26	14	14
Adjusted R-squared	0.9063	0.8918	0.8924	0.8878	0.8878

Notes: The table reports the results from estimating versions of equation (2). The dependent variable is the log of real GDP per capita and ERSs are expressed in thousands of ISO14001 certificates per country in each year. Panel A reports results for all total resource-related rents; Panel B reports results for coal rents; Panel C shows results for forest rents; Panel D reports results for minerals rents; Panel E reports results for natural gas rents and Panel F for petroleum rents. Column (1) reports all LDCs for which data are available. Column (2) reports results for all African countries (LDCs and developed). Column (3) reports results for all Sub-Saharan African Countries. Column (4) shows results results for LDCs in Africa only and Column (5) for LDCs in Sub-Saharan Africa only (the number of countries differ in this case). See also notes for Tables 1.

Appendix: Data

Table A.1 Least Developed Countries (UNCTAD Reports)

Afghanistan	Gambia	Rwanda
Angola	Guinea	Samoa
Bangladesh	Guinea-Bissau	Sao Tome and Principe
Benin	Haiti	Senegal
Bhutan	Kiribati	Sierra Leone
Burkina Faso	Lao People's Dem. Rep.	Solomon Islands
Burundi	Lesotho	Somalia
Cambodia	Liberia	Sudan
Cape Verde	Madagascar	Timor-Leste
Central African Republic	Malawi	Togo
Chad	Maldives	Tuvalu
Comoros	Mali	Uganda
Dem. Rep. of the Congo	Mauritania	United Rep. of Tanzania
Djibouti	Mozambique	Vanuatu
Equatorial Guinea	Myanmar	Yemen
Eritrea	Nepal	Zambia
Ethiopia	Niger	

Appendix: Baseline Results without Environmental Standards

Table A.2: Baseline Results Using Resource Exports

VARIABLES	(1) LDCs	(2) Africa	(3) Sub-Saharan Africa	(4) LDCs in Africa
Panel A: All Natural Resources				
log GDP per capita (*t*-1)	0.8595***	0.8424***	0.8383***	0.8622***
	(0.0350)	(0.0211)	(0.0205)	(0.0435)
Resources Exports (% GDP) (*t*-1)	0.0011	-0.0004	1.43×10^{-6}	0.0008
	(0.0009)	(0.0013)	(0.0014)	(0.0013)
Openness (*t*-1)	0.0006	0.0005	0.0004	0.0006
	(0.0008)	(0.0006)	(0.0006)	(0.0011)
Investment Share (*t*-1)	0.0004	0.0050	0.0067***	0.0050*
	(0.0014)	(0.0033)	(0.0024)	(0.0029)
log Terms of Trade (*t*-1)	0.0187	0.0062	0.0206	0.0465
	(0.0257)	(0.0230)	(0.0253)	(0.0324)
Percentage of Population with Secondary Schooling	0.0011	-0.0006	-0.0011	0.0000
	(0.0015)	(0.0013)	(0.0012)	(0.0014)
Constant	0.8736**	1.1849***	1.1449***	0.7263*
	(0.3198)	(0.2429)	(0.2431)	(0.4068)
Observations	354	525	475	289
Number of countries	33	43	39	25
Adjusted R-squared	0.8682	0.8879	0.8877	0.8466

Panel B: Ores and Metals Exports				
log GDP per capita (*t*-1)	0.8488***	0.8399***	0.8364***	0.8492***
	(0.0284)	(0.0209)	(0.0200)	(0.0372)
Ores & Metals Exports (% GDP) (*t*-1)	0.0030**	0.0036**	0.0035**	0.0030*
	(0.0014)	(0.0016)	(0.0016)	(0.0015)
Openness (*t*-1)	0.0003	0.0004	0.0003	0.0006
	(0.0006)	(0.0005)	(0.0005)	(0.0009)
Investment Share (*t*-1)	-0.0012	-0.0020*	-0.0019	-0.0025
	(0.0012)	(0.0012)	(0.0013)	(0.0018)
log Terms of Trade (*t*-1)	0.0171	0.0021	0.0162	0.0432
	(0.0252)	(0.0229)	(0.0249)	(0.0295)
Percentage of Population with Secondary Schooling	0.0010	-0.0008	-0.0012	0.0003
	(0.0014)	(0.0012)	(0.0012)	(0.0014)
Constant	0.9876***	1.2197***	1.1771***	0.8343**
	(0.2665)	(0.2283)	(0.2273)	(0.3322)
Observations	408	567	517	329
Number of countries	35	44	40	26
Adjusted R-squared	0.8696	0.8875	0.8871	0.8478

Panel C: Food Exports				
log GDP per capita (*t*-1)	0.8518***	0.8430***	0.8395***	0.8602***
	(0.0290)	(0.0205)	(0.0195)	(0.0350)
Food Exports (% GDP) (*t*-1)	-0.0006	-0.0014	-0.0015	-0.0021
	(0.0015)	(0.0009)	(0.0009)	(0.0015)
Openness (*t*-1)	0.0005	0.0006	0.0006	0.0009
	(0.0006)	(0.0004)	(0.0004)	(0.0008)
Investment Share (*t*-1)	-0.0008	-0.0026**	-0.0026**	-0.0032*
	(0.0012)	(0.0012)	(0.0011)	(0.0015)
log Terms of Trade (*t*-1)	0.0251	0.0083	0.0233	0.0483
	(0.0250)	(0.0223)	(0.0237)	(0.0293)
Percentage of Population with Secondary Schooling	0.0010	-0.0004	-0.0008	0.0005
	(0.0015)	(0.0013)	(0.0012)	(0.0014)
Constant	0.9318***	1.1627***	1.1177***	0.7360**
	(0.2717)	(0.2271)	(0.2242)	(0.3117)
Observations	417	573	523	335
Number of countries	35	44	40	26
Adjusted R-squared	0.8677	0.8865	0.8862	0.8474

Panel D: Fuel Exports				
log GDP per capita (*t*-1)	0.8599***	0.8392***	0.8354***	0.8663***
	(0.0333)	(0.0191)	(0.0192)	(0.0433)
Fuel Exports (% GDP) (*t*-1)	0.0002	-0.0025	-0.0021	-0.0017
	(0.0015)	(0.0017)	(0.0020)	(0.0030)
Openness (*t*-1)	0.0007	0.0006	0.0006	0.0009
	(0.0008)	(0.0005)	(0.0005)	(0.0011)
Investment Share (*t*-1)	0.0001	0.0052	0.0067**	0.0050
	(0.0014)	(0.0032)	(0.0028)	(0.0030)
log Terms of Trade (*t*-1)	0.0203	0.0108	0.0231	0.0482
	(0.0256)	(0.0212)	(0.0242)	(0.0311)
Percentage of Population with Secondary Schooling	0.0011	-0.0006	-0.0009	-0.0001
	(0.0015)	(0.0013)	(0.0013)	(0.0014)
Constant	0.8693***	1.1867***	1.1526***	0.6955*
	(0.3123)	(0.2260)	(0.2333)	(0.4032)
Observations	360	532	482	294
Number of countries	33	43	39	25
Adjusted R-squared	0.8675	0.8889	0.8882	0.8463

Panel E: Agricultural Raw Materials Exports				
log GDP per capita (*t*-1)	0.8487***	0.8406***	0.8364***	0.8546***
	(0.0292)	(0.0191)	(0.0184)	(0.0375)
Agricultural Raw Materials Exports (% GDP) (*t*-1)	0.0045	0.0071***	0.0070***	0.0031
	(0.0029)	(0.0023)	(0.0023)	(0.0025)
Openness (*t*-1)	0.0004	0.0004	0.0003	0.0008
	(0.0006)	(0.0004)	(0.0005)	(0.0008)
Investment Share (*t*-1)	-0.0007	-0.0024*	-0.0024*	-0.0031*
	(0.0013)	(0.0013)	(0.0013)	(0.0018)
log Terms of Trade (*t*-1)	0.0280	0.0104	0.0264	0.0522*
	(0.0251)	(0.0225)	(0.0239)	(0.0303)
Perc. Of Population with Secondary Schooling	0.0014	-0.0001	-0.0006	0.0007
	(0.0017)	(0.0013)	(0.0013)	(0.0017)
Constant	0.9194***	1.1497***	1.1031***	0.7411**
	(0.2769)	(0.2171)	(0.2154)	(0.3329)
Observations	407	562	512	326
Number of countries	35	44	40	26
Adjusted R-squared	0.8677	0.8878	0.8875	0.8466

Notes: The table reports the results from estimating versions of equation (1) in text. The dependent variable is the log of real GDP per capita. Panel A reports results for all resource-related exports; Panel B reports results for ores and metals exports; Panel C shows results for food exports; Panel D reports results for fuel exports and Panel E for agricultural raw material exports. Column (1) reports all LDCs for which data are available. Column (2) reports results for all African countries (LDCs and developed). Column (3) reports results for all Sub-Saharan African Countries and Column (4) results for LDCs in Africa only. As the data available lead to a number of LDCs in Africa coinciding with the number of LDCs in Sub-Saharan Africa, the results for both cases are reported column (4). A Fixed Effects and Time Effects included in all columns. The sample runs from 1999 to 2014. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: Baseline Results Using Resource Rents

VARIABLES	(1) LDCs	(2) Africa	(3) Sub-Saharan Africa	(4) LDCs in Africa	(5) LDCs in Sub-Saharan Africa
Panel A: Total Resources Rents					
log GDP per capita (*t*-1)	0.8690***	0.8328***	0.8284***	0.8488***	0.8494***
	(0.0298)	(0.0215)	(0.0225)	(0.0359)	(0.0360)
Total natural resources rents (% of GDP) (*t*-1)	0.0004	-0.0006	-0.0007	-0.0002	-0.0001
	(0.0011)	(0.0010)	(0.0010)	(0.0011)	(0.0011)
Openness (*t*-1)	0.0004**	0.0003***	0.0003***	0.0004**	0.0004**
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0008	0.0009	0.0015**	0.0007	0.0007
	(0.0006)	(0.0011)	(0.0007)	(0.0010)	(0.0010)
log Terms of Trade (*t*-1)	0.0317	0.0222	0.0341	0.0641	0.0644
	(0.0290)	(0.0285)	(0.0304)	(0.0400)	(0.0404)
Percentage of Population with Secondary Schooling	0.0003	-0.0009	-0.0013	-0.0004	-0.0003
	(0.0018)	(0.0013)	(0.0013)	(0.0019)	(0.0019)
Constant	0.7932***	1.2049***	1.1762***	0.7814***	0.7724***
	(0.1986)	(0.1753)	(0.1789)	(0.2305)	(0.2285)
Observations	592	714	651	436	428
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8817	0.8793	0.8797	0.8600	0.8604

Panel B: Coal Rents					
log GDP per capita (*t*-1)	0.8656***	0.8407***	0.8366***	0.8463***	0.8467***
	(0.0277)	(0.0190)	(0.0197)	(0.0320)	(0.0322)
Coal rents (% of GDP) (*t*-1)	0.0461**	0.0231	0.0235	0.0249	0.0251
	(0.0225)	(0.0183)	(0.0182)	(0.0161)	(0.0161)
Openness (*t*-1)	0.0003*	0.0003*	0.0003*	0.0004*	0.0004*
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0008	0.0007	0.0014*	0.0008	0.0008
	(0.0005)	(0.0011)	(0.0008)	(0.0010)	(0.0009)
log Terms of Trade (*t*-1)	0.0357	0.0168	0.0284	0.0643*	0.0650*
	(0.0258)	(0.0257)	(0.0276)	(0.0352)	(0.0357)
Percentage of Population with Secondary Schooling	0.0006	-0.0013	-0.0017	-0.0001	-0.0001
	(0.0018)	(0.0014)	(0.0015)	(0.0019)	(0.0019)
Constant	0.8020***	1.1761***	1.1486***	0.7998***	0.7912***
	(0.1942)	(0.1709)	(0.1735)	(0.2154)	(0.2137)
Observations	601	723	660	445	437
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8806	0.8788	0.8791	0.8578	0.8582

Panel C: Forest Rents					
log GDP per capita (*t*-1)	0.8624***	0.8295***	0.8256***	0.8419***	0.8425***
	(0.0299)	(0.0200)	(0.0205)	(0.0355)	(0.0356)
Forest rents (% of GDP) (*t*-1)	-0.0019	-0.0022	-0.0021	-0.0019	-0.0018
	(0.0021)	(0.0020)	(0.0021)	(0.0023)	(0.0023)
Openness (*t*-1)	0.0004**	0.0003*	0.0003*	0.0004**	0.0004**
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Investment Share (*t*-1)	0.0009	0.0010	0.0018**	0.0011	0.0010
	(0.0007)	(0.0012)	(0.0008)	(0.0011)	(0.0011)
log Terms of Trade (*t*-1)	0.0342	0.0177	0.0296	0.0637*	0.0643*
	(0.0257)	(0.0254)	(0.0273)	(0.0335)	(0.0339)
Percentage of Population with Secondary Schooling	-0.0002	-0.0014	-0.0018	-0.0012	-0.0012
	(0.0018)	(0.0013)	(0.0013)	(0.0018)	(0.0018)
Constant	0.8605***	1.2740***	1.2425***	0.8688***	0.8582***
	(0.2392)	(0.2051)	(0.2097)	(0.2840)	(0.2825)
Observations	608	730	667	451	443
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8833	0.8800	0.8804	0.8616	0.8620

Panel D: Mineral Rents					
log GDP per capita (*t*-1)	0.8640***	0.8328***	0.8291***	0.8403***	0.8406***
	(0.0265)	(0.0172)	(0.0180)	(0.0278)	(0.0280)
Mineral rents (% of GDP) (*t*-1)	0.0020	0.0023	0.0021	0.0017	0.0017
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Openness (*t*-1)	0.0003**	0.0002*	0.0002*	0.0003**	0.0003**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Investment Share (*t*-1)	0.0009	0.0010	0.0016**	0.0010	0.0010
	(0.0005)	(0.0010)	(0.0007)	(0.0009)	(0.0009)
log Terms of Trade (*t*-1)	0.0265	0.0146	0.0260	0.0594*	0.0600
	(0.0279)	(0.0258)	(0.0280)	(0.0350)	(0.0354)
Percentage of Population with Secondary Schooling	-0.0003	-0.0016	-0.0019	-0.0012	-0.0012
	(0.0018)	(0.0012)	(0.0012)	(0.0019)	(0.0019)
Constant	0.8760***	1.2562***	1.2230***	0.8886***	0.8800***
	(0.1854)	(0.1615)	(0.1641)	(0.1889)	(0.1870)
Observations	621	743	680	464	456
Number of countries	43	49	44	31	30
Adjusted R-squared	0.8849	0.8817	0.8819	0.8642	0.8645

Panel E: Natural Gas Rents					
log GDP per capita (*t*-1)	0.8900***	0.8404***	0.8332***	0.8733***	0.8733***
	(0.0398)	(0.0243)	(0.0260)	(0.0612)	(0.0612)
Natural Gas rents (% of GDP) (*t*-1)	-0.0400*	-0.0519**	-0.0390	-0.0490	-0.0490
	(0.0192)	(0.0208)	(0.0293)	(0.0363)	(0.0363)
Openness (*t*-1)	0.0004*	0.0001	0.0001	0.0005	0.0005
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Investment Share (*t*-1)	0.0014	0.0023	0.0029*	0.0012	0.0012
	(0.0019)	(0.0015)	(0.0015)	(0.0024)	(0.0024)
log Terms of Trade (*t*-1)	0.0149	-0.0033	0.0051	0.0598	0.0598
	(0.0310)	(0.0293)	(0.0330)	(0.0455)	(0.0455)
Percentage of Population with Secondary Schooling	-0.0010	-0.0034	-0.0035	-0.0026	-0.0026
	(0.0031)	(0.0024)	(0.0025)	(0.0036)	(0.0036)
Constant	0.7512***	1.3911***	1.3900***	0.6832*	0.6832*
	(0.2540)	(0.2665)	(0.2765)	(0.3476)	(0.3476)
Observations	260	409	354	162	162
Number of countries	21	30	26	14	14
Adjusted R-squared	0.9319	0.9189	0.9191	0.9238	0.9238

Panel F: Petroleum Rents					
log GDP per capita (*t*-1)	0.8730***	0.8324***	0.8257***	0.8499***	0.8499***
	(0.0356)	(0.0239)	(0.0264)	(0.0549)	(0.0549)
Petroleum rents (% of GDP) (*t*-1)	-0.0016	-0.0036***	-0.0038**	-0.0031	-0.0031
	(0.0015)	(0.0013)	(0.0015)	(0.0018)	(0.0018)
Openness (*t*-1)	0.0006**	0.0006**	0.0006**	0.0008**	0.0008**
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Investment Share (*t*-1)	0.0012	0.0015	0.0014	0.0001	0.0001
	(0.0016)	(0.0009)	(0.0012)	(0.0018)	(0.0018)
log Terms of Trade (*t*-1)	0.0205	0.0128	0.0273	0.0830	0.0830
	(0.0339)	(0.0315)	(0.0354)	(0.0576)	(0.0576)
Percentage of Population with Secondary Schooling	-0.0012	-0.0021	-0.0025	-0.0016	-0.0016
	(0.0034)	(0.0021)	(0.0023)	(0.0034)	(0.0034)
Constant	0.8356***	1.3198***	1.2943***	0.7130**	0.7130**
	(0.2444)	(0.2048)	(0.2155)	(0.3035)	(0.3035)
Observations	276	425	370	178	178
Number of countries	21	30	26	14	14
Adjusted R-squared	0.9151	0.9091	0.9101	0.9044	0.9044

Notes: The table reports the results from estimating versions of equation (1) in text. The dependent variable is the log of real GDP per capita. Panel A reports results for all total resource-related rents; Panel B reports results for coal rents; Panel C shows results for forest rents; Panel D reports results for minerals rents; Panel E reports results for natural gas rents and Panel F for petroleum rents. Column (1) reports all LDCs for which data are available. Column (2) reports results for all African countries (LDCs and developed). Column (3) reports results for all Sub-Saharan African Countries. Column (4) shows results results for LDCs in Africa only and Column (5) for LDCs in Sub-Saharan Africa only (the number of countries differ in this case). See also notes for Tables A.1