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Further investigation of natural resources and economic growth: Do natural resources depress economic growth?

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Abstract

One of the surprising findings in the economic development literature is that natural resource-rich countries tend to have slower economic growth than resource-poor countries, i.e., the natural resource curse and Dutch disease. In this paper, we revisit these issues by applying quantile regression and using the most updated data. The results demonstrate that resource-intensive countries in 1970 suffered from slower economic growth than resource-poor countries over the next 20 years, consistent with Sachs and Warner (1995, 1997, 2001). However, contrary to initial expectation, we find that natural resource abundance in 1990 had positive impacts on economic growth between 1990 and 2010. We further test the Dutch disease theory, and the result contradicts the hypothesis. Overall, our analysis suggests that in the period from 1970 to 1990, the hypotheses of a resource curse and Dutch disease hold. However, in the period from 1990 to 2010, these hypotheses no longer hold because manufacturing sectors have grown sufficiently even in resource-rich countries.

Key Words: Natural resources, economic growth, resource curse, Dutch disease

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Contents

1 Introduction

One of the surprising findings in the literature on economic development is that natural resource-rich countries tend to have slower economic growth than resource-poor countries. This is the opposite of our intuition that natural resource revenues should increase investment in and economic growth of a country. However, research in previous decades has empirically established that resource-rich countries had slower economic growth than resource-poor countries (see, e.g., Sachs and Warner (2001)). For example, resource-poor countries such as South Korea, Taiwan, Hong Kong and Singapore were among the fastest growing economies, while resource-rich countries such as Congo, Sierra Leone, Venezuela and Nigeria exhibited the poorest economic growth.

More specifically, some studies have demonstrated that there is a negative relationship between economic growth and natural resource abundance (Sachs and Warner, 1995, 1997, 2001). This negative relationship is called the "resource curse" and has become a well-established finding. However, the data used in many studies were occasionally considered unreliable, and many relevant variables were unavailable, particularly in underdeveloped countries (Brunnschweiler and Bulte, 2008). Therefore, several hypotheses have been introduced to explain the negative relationship between growth and natural resource abundance.

One of the early explanations for the resource curse is based on Dutch disease theory. The term Dutch disease derives from the Netherlands' experiencing of a declining manufacturing sector after the discovery of large natural gas reserves in the 1950s. The first Dutch disease model was developed by van Wijnbergen (1984) who shows how natural resource may reduce income via adverse effects on the learning-by-doing mechanism. The demand for non-traded goods increases after a natural resource boom occurs in a given country. Thus, the boom pulls resources out of traded sectors and decreases the corresponding production (Torvik, 2009).

Sachs and Warner (1995) is a pioneering paper that empirically illustrates Dutch disease, and the authors made a substantial contribution to the field with a series of papers on the resource curse.[1] They show that economies with a high share of primary product exports in 1970 experienced slower economic growth between 1970 and 1990 after controlling for the relevant variables. They conclude that a declining manufacturing sector is a primary explanation for the slower economic growth in resource-rich countries.

Another set of explanations for the resource curse focuses on the importance of institutional quality. Scholars in this tradition believe that the main difference between low and high growth countries is institutional quality. Ades and Tella (1999) present evidence of a positive relationship among natural resource abundance, corruption and rent-seeking using econometric analysis. Tornell and Lane (1999) identify weak institutions as being responsible for the slow growth experienced in Nigeria, Mexico and Venezuela after oil was discovered in these countries. Sala-i-Martin and Subramanian (2003) find that the corruption that emerged after the discovery of oil was responsible for the slow growth experienced by Nigeria. Finally Mehlum et al. (2006) also claim that good institutions are essential to solving the resource curse.

[1] A number of other models were developed using the Dutch disease framework. They include Krugman (1987); Matsuyama (1992); Gylfason (2001); Torvik (2001); Matsen and Torvik (2005).

Other theories have also been developed to explain the slower economic growth observed in resource-rich countries. Auty (1997); Woolcock et al. (2001); Isham et al. (2005); Boschini et al. (2007) state that the types of natural resources available in a country determine its rate of economic growth. For example, resources such as plantation crops and minerals tend to cause slower economic growth than others such as rice, wheat and livestock. In summary, nearly all the models introduced thus far suggest that a negative relationship exists between natural resource abundance and economic growth, irrespective of the theories employed. The variable employed in these studies to proxy for natural resource abundance was the share of primary product exports in GDP. Despite that a number of researchers have criticized this indicator, it is employed in many studies due to data limitations.

To the best of our knowledge, no previous studies have examined the effect that natural resource have had on economic growth in recent decades using the most updated data and quantile regression framework. Brunnschweiler (2008); Brunnschweiler and Bulte (2008) investigated the relationship between natural resource abundance and economic growth in the period from 1970 to 2000. However, their natural resource data were from the year 2000 present value. Analyzing a different time period has been identified as having the potential to bias the estimates, as commodity prices in the 1970s are substantially different from commodity prices in the year 2000.

Having reviewed the relevant literature, we can pose the following open questions:

1. How did natural resource intensity in 1970 affect economic growth between 1970 and 1990? To answer this question, we essentially follow the analytical framework employed by Sachs and Warner (1995, 1997, 2001) but use a different regression approach and updated datasets.

2. How did natural resource abundance in 1990 affect economic growth over the next 20 years from 1990 to 2010? If the natural resource curse persists in recent decades, is it a result of Dutch disease?

To resolve the questions, this study uses quantile regression. This method is effective in the case of a non-normally distributed dependent variable and robust to outliers. An additional advantage of quantile regression is that it reveals the effects of the independent variables on different spectra of the dependent variable. The central goal of this study is to revisit and improve the robustness of the conclusion obtained in Sachs and Warner's empirical analysis, i.e., the effects of resource abundance on economic growth using data from recent decades.

2 Overview of the resource curse

The relationship between natural resources and economic growth is depicted in figure 1. This figure presents a scatter plot of economic growth from 1970 to 1990 and the share of primary product exports in GNP in 1970 where each country is represented by one dot. As seen from figure 1, natural resource intensity and economic growth have a negative relationship and this negative effect is known as the "resource curse."

[Figure 1 about here.]

The resource curse hypothesis states that resource-rich countries tend to experience less economic growth than resource-poor countries. As mentioned previously, a number of studies have obtained evidence of this relationship, and many studies have analyzed individual countries. Unfortunately, however, there is no consensus on the appropriate theory to explain the relationship between economic growth and the resource curse. Various theories and explanations of the resource curse have been proposed in the literature. We summarize the potential explanations for the resource curse below.

First, exporting large volumes of natural resources often causes a country's currency to appreciate and hence causes non-resource sectors to lose competitiveness in the world market. This effect is called the "Dutch disease" (van Wijnbergen, 1984; Sachs and Warner, 2001). According to Dutch disease theory, the manufacturing sector is assumed to be the only growth-inducing sector, given its positive externalities such as learning-by-doing, which we may not find in the resource sector.

The Dutch currency appreciated substantially after the discovery of oil reserves, and all non-resource products suffered from a loss of competitiveness in the global market (Corden, 1984). In Sachs and Warner (1997)'s version of the Dutch disease model, they argue that the additional wealth created by the natural resource boom spurs increased demand for non-tradable goods within a country, resulting in increased prices for non-tradable goods. Because non-tradable goods are manufacturing inputs, an increase in non-tradable goods prices inevitably leads to a contraction of the manufacturing sector.

Second, countries that are highly dependent on natural resource industries suffer from commodity price fluctuations (Shaxson, 2005). Such countries face greater risk than other countries because natural resource prices are inherently volatile. Therefore, a heavy reliance on natural resource industries increases volatility risk in the economy as a whole. When resource prices change, countries usually alter their economic policies. If a country expects good economic conditions thanks to a commodity price increase, it implements extremely generous welfare policies. However, if prices collapse, this will have enormous consequences for national budgets (Shaxson, 2005).

Third, natural resource abundance stimulates rent-seeking behavior and associated corruption (Stijns, 2005; Brunnschweiler, 2008). In countries with poor institutional quality and significant corruption, natural resources may hinder growth as a result of rent-seeking behaviors or other non-productive activities. Compared to other industries, the natural resource industry creates high economic rents, most of which can be extracted by the government. These substantial revenues make governments complacent and unproductive, leading to further rent-seeking activities and corruption.

Fourth, natural resource abundance reduces the incentives to accumulate human capital (Gylfason, 2001). Education represents the most significant component of economic growth. It has numerous positive externalities that can increase the standard of living and benefits economic growth in a number of different ways. Compared to other industries, natural resource-based industries require low-skilled labor and do not demand high quality capital. Thus, in natural resource-abundant countries, many individuals tend to become dependent on natural resource-based industries and fail to improve their education. In an econometric analysis using cross sectional data from 1965 to 1998, Gylfason et al. (1999) show that natural resources crowd out investment in education.

3 Data and methodology

The data employed in this study comes from three sources. Real GDP per capita, the ratio of real gross investment to GDP and openness (the share of imports plus exports in total GDP) data come from the Penn World Tables, Mark 7.1. The share of manufacturing exports in total exports, the terms of trade, natural resource capital, the rule of law and non-natural resource (service and manufacturing) sector data come from World Bank datasets. Data on primary product exports and terms of trade (1970-1990) are obtained from Sachs and Warner's datasets. Using these data sources, the list of countries included in our analysis is summarized in table 1.

[Table 1 about here.]

A number of researchers have conducted empirical and theoretical studies on the contribution of natural resources to economic growth, and they typically focus on the "resource curse." However, most of these studies considered the share of primary product exports in overall GDP as a proxy to examine the relationship between growth and natural resource abundance. This is a problematic measure of resource abundance (Ding and Field, 2005). As stressed by Ding and Field (2005), if a country is overly specialized in primary industries, it would be considered a resource-rich country even if it is not. Similarly, it is likely that a resource-rich country will be considered a resource-poor country if it devotes less attention to the primary sector. Therefore, we decided not to use the share of primary product exports in GDP as a proxy for resource abundance.

In this paper, World Bank natural resource capital data are used as a proxy for natural resource abundance to analyze the resource curse in recent decades (1990-2010). In an attempt to develop a direct measure of natural resources, the World Bank released a series of natural resource wealth data for the years 1995, 2000 and 2005. The World Bank's natural resource capital stock data are derived from estimates of agricultural land, pasture land, forests, protected areas, minerals, oil and other subsoil assets (Ding and Field, 2005). In our regression analyses, we used the log of the per capita natural resource capital data to estimate the effect of natural resource abundance on economic growth over the period between 1990 and 2010.

When discussing economic growth, it is necessary to consider institutional quality. If we do not control for institutional quality in the regression, we could falsely conclude that natural resource abundance is the reason for slow economic growth when the problem is actually institutional quality. Accordingly, a proxy variable for institutional quality is included in the regression. There are six indices estimating institution quality contained in the World Bank's "world governance index." The index most relevant for the purposes of our estimation is the "rule of law."

The data are available from 1996 to 2010, and data for 1996 and 2000 are used in this study. The rule of law index indicates the quality of contract enforcement, police and courts, as well as the likelihood of crime and violence, and the values range from -2.5 to 2.5 (The World Bank Group, 2012). To analyze economic growth between 1970 and 1990, we used the rule of law index, which was also used by Knack and Keefer (1995). These data were constructed by the Center for Institutional Reform and the Informal Sector and measured in 1982. The data show the degree to which the citizens of a country are willing to accept the legitimacy of established institutions making and implementing laws and adjudicating disputes, and the values range from 0 to 6 (Sachs and Warner, 1997).

Another regressor we control for is trade openness. Sachs and Warner (1995, 1997) hypothesize that natural resource-rich countries are more likely to employ protectionist policies such as import-substitution and state-led development plan. To combat the effect of Dutch disease and the decline of non-resource sectors, resource-rich countries may adopt protectionist trade policies such as high tariffs and quotas. The trade openness variable measures the average share of trade in GDP over 10 or 20 years.

Countries that are heavily reliant on natural resource industries expose themselves to commodity price fluctuations. In such countries, commodity producers and exporters face greater risk than other sectors. Because all sectors are interrelated, the risk resulting from commodity price fluctuations also affects other sectors. Therefore, we controlled for average annual growth in the log of the terms of trade in the regression. The other variables included in the study are the initial income level and average real gross investment as a share of GDP. The initial level of income is included to capture capital accumulation (Barro, 1991), and investment is included because it is one of the most significant factors in determining economic growth.

As discussed previously, our goal is to analyze the impact of resource abundance on economic growth. The basic econometric specification for analyzing the effect of natural resource abundance in country i is

$$growth_i = \beta_0 + \beta_1 \cdot (\ln(initial\ GDPEA_i)) + \beta_2 \cdot (resource\ abundance_i) + \boldsymbol{\beta}_3 \mathbf{x}_i' + \epsilon_i \qquad (1)$$

where

- *Growth*$_i$ is the average annual growth in real GDP per economically active individual in a given period for country i.
- *Initial GDPEA*$_i$ is the real GDP per economically active individual in the initial year of a given period for country i.
- *Resource abundance*$_i$ measures natural resource abundance in country i.

- $\mathbf{x}_i$ is a vector of other explanatory variables including the average share of trade as a share of GDP, average real investment as a share of GDP, the rule of law and so on for country i.

- ϵ_i is the disturbance term.

To analyze the relationship between natural resource abundance and economic growth specified in equation (1), quantile regression is employed instead of OLS.

First, assumptions required by conditional-mean models are not realistic for social phenomena. For example, heavily-skewed distributions are more common than normal distributions (Koenker and Hallock, 2001). When the distribution is heavily influenced by outliers, a quantile regression method is able to effectively characterize the central location of a dependent variable. Second, when we analyze the effect of independent variables, the conditional-mean method cannot be extended to a location other than the central location. Quantile regression, which was first introduced by Koenker and Bassett, Jr. (1978), can model a variety of conditional quantiles of the dependent variable as a function of the independent variables. Thus, quantile regression provides a flexible means of characterizing a dependent variable's relationship with the independent variables.[2]

In the case of economic growth, it is likely that the distribution is non-normal, highly skewed and contains some outliers. Skewness-kurtosis normality tests were employed to confirm the non-normality of the dependent variable. We found that the variable representing economic growth is not normally distributed. In this study, the quantiles employed are the 25th, 50th and 75th quantiles. One of the features of quantile regression is that the estimated coefficients differ across the quantiles of the dependent variable's distribution. For example, the effect of an increase in share of investment in GDP may be larger in the 25th quantile of economic growth and lower in the 75th quantile. Similarly, the effect of an increase in natural resource capital may differ across economic growth quantiles. Therefore, this study

[2] In quantile regression, the least absolute distance estimation is used rather than the least-squared one (Koenker and Hallock, 2001).

also explores how natural resource abundance affects economic growth at the median, the 25th and 75th quantiles.

The quantile regression method requires the specific methodologies to obtain the standard errors and confidence intervals of estimated coefficients. There are two procedures to construct confidence intervals and hypothesis tests. One is an asymptotic method and the other is a bootstrapping method. Because the asymptotic method's assumptions do not hold, the bootstrapping procedure is the most frequently used in the literature. First introduced by Efron (1979), the bootstrapping method permits drawing samples of size n with replacement from the observed data. A total of 500 replications are employed in this study.

4 Results and discussion

The regression results presented in table 2 shows a negative relationship between economic growth and natural resource intensity (see table 3 for the definition of the variables used in this regression). The estimated coefficient of natural resource abundance remains negative and statistically significant in all three quantiles. Using the most updated data and controlling the same independent variables, we obtain results consistent with those of Sachs and Warner. Therefore, we can conclude that natural resource-intensive countries in 1970 suffered from slower economic growth than resource-poor countries over the next 20 years.

[Table 2 about here.]

[Table 3 about here.]

We next divide the sample from 1970 to 1990 into two subsamples of ten years (1970-1980 and 1980 to 1990) and run the same quantile regressions for each subsample as a robustness check. Tables 4 and 6 show the results of the regressions for 1970-1980 and 1980-1990, respectively. From the tables, we can see that there is a statistically significant negative relationship between natural resource intensity and economic growth in both regressions, consistent with the results of the regression for 1970-1990 shown in table 2.

[Table 4 about here.]

[Table 5 about here.]

[Table 6 about here.]

[Table 7 about here.]

The second question is how natural resource abundance in 1990 affected economic growth over the next 20 years. Figure 2 presents a scatter plot of economic growth from 1990 and 2010 and natural resource abundance in 1995. As the figure shows, there is no clear relationship between natural resource capital stocks in 1995 and growth between 1990 and 2010. Table 8 presents the results of a regression designed to examine the relationship between natural resource capital stocks in 1995 and growth between 1990 and 2010 (For a description of variables used in this regression, see table 9).

In this quantile regression, we use natural resource capital data from the World Bank. As these data are available beginning in 1995, we used natural resource capital in 1995 in our regression. Although the resource capital data are measured as of 1995, these data can be considered a valid indicator of natural resource capital in 1990. First, we regress GDP growth between 1990 and 2010 on natural resource capital in 1995 and the log of GDP per economically active individual in 1990 and separately controlled for the relevant variables.

After controlling for all of the variables, we obtain a positive coefficient on natural resource capital in all three quantiles. This result demonstrates that the effect of natural resource abundance is quantitatively different in each quantile. The positive effect of natural resource capital declines from the 25th to the 75th quantile. Nonetheless, the estimated coefficient is only statistically significant at the 25th quantile. This implies that for countries with very low rates of economic growth (25th quantile) between 1990 and 2010, natural resource capital has a positive effect on growth. This finding is in contrast with Sachs and Warner's well-known "resource curse" phenomenon. Therefore, we can conclude that countries with abundant resources in 1990 have grown faster than those with fewer resources.

[Figure 2 about here.]

[Table 8 about here.]

[Table 9 about here.]

We again divide the sample from 1990 to 2010 into two subsamples of ten years (1970-1980 and 1980 to 1990) and run the same quantile regressions for each subsample as a robustness check. Tables 10 and 12 present the results of the regressions for 1990-2000 and 2000-2010, respectively. From the tables, we can confirm that positive and statistically significant relationship exists between natural resource capital and economic growth in both regressions, consistent with the results of the regression for 1990-2010 shown in table 8.

[Table 10 about here.]

[Table 11 about here.]

[Table 12 about here.]

[Table 13 about here.]

While exploring indirect effect of natural resource endowment, Sachs and Warner suggest that Dutch disease is the reason for slow economic growth. Their result indicates that growth in non-resource sectors is slower and manufacturing export volume is lesser in natural resource-intensive countries than in less-intensive countries. However, figure 3 shows no clear relationship between change in export share of manufacturing in total export from 1990 to 2010 and natural resource capital in 1995. Between 1970 and 1990, natural resource-intensive countries experienced slow growth in their non-resource sectors and manufacturing exports (Sachs and Warner, 2001). However, this appears not to be the case in the recent years (See figure 3).

[Figure 3 about here.]

In table 14, we examined Sachs and Warner's Dutch disease model using the share of services in GDP, share of manufacturing in GDP and natural resource capital stock data. The Dutch disease model implies that a natural resource boom increases the demand for and the price of non-tradable goods. Because the manufacturing sector uses non-tradable goods as a production input, this sector shrinks as a result of a natural resource boom. If this theory is correct, we would expect to find a positive association between natural resource capital and the ratio of service sector output to manufacturing sector output.

A regression of the ratio of service sector output to manufacturing sector output in 1990, 1995, 2000 and 2005 on natural resource capital in 1995 yields diametrically opposite results from those obtained by Sachs and Warner (see table 14). Using an OLS regression, Sachs and Warner (1995, 1997) demonstrated that there was significant and positive association between non-tradable goods and natural resource abundance. However, according to the results of our quantile regressions, the estimated coefficients of natural resource capital stocks are all negative and statistically significant in most quantiles. Thus, we can conclude that our result is not consistent with the Dutch disease model. More specifically, resource-rich countries tend to have a lower ratio of service output to manufacturing output over the last 20 years.

[Table 14 about here.]

Our results demonstrate that there is a negative relationship between natural resource intensity in 1970 and economic growth over the next 20 years. Conversely, natural resource abundance in 1995 had positive effects on economic growth in subsequent years and the Dutch disease hypothesis does not hold for the most recent two decades. After combining all of the results, we are able to conclude that resource intensity, not resource abundance, causes sluggish economic growth. The results cast doubt on the view that the resource curse exists in recent periods.

5 Conclusion

In this paper, we examined a "resource curse" phenomenon using quantile regression methods and the most updated data. We demonstrated that there is a negative relationship between the share of primary product exports in GDP and economic growth between 1970 and 1990. This negative relationship remains statistically significant even after controlling for a number of important variables in our quantile regression. These variables are initial GDP per economically active individual, trade openness, investment rates, changes in the terms of trade, and the efficiency of government institutions. Our findings are also consistent with famous Sachs and Warner's results at 25th, 50th and 75th quantiles.

We next used the World Bank's measure of natural resource capital stocks to investigate the effect of natural resource abundance in 1990 on growth between 1990 and 2010. Our results failed to uncover any evidence of a resource curse; contrary to expectations, we found that resource endowments have positive effects on economic growth but this result is only significant at the 25th quantile. In other words, countries with relatively low rates of economic growth (25th quantile) benefited from having abundant natural resources from 1990 to 2010. We further tested whether the expectations of Dutch disease theory with respect to natural resource abundance hold in the most recent two decades. The relationship between natural resource abundance and the ratio of service output to manufacturing output was the opposite of that predicted by the Dutch disease model suggested. The results cast doubt on the notion that the resource curse exists in recent periods.

Overall, our analysis suggests that natural resource-intense countries, which were highly dependent on natural resource for generating national income, experienced slow economic growth due to Dutch disease. This describes the economic situation of the periods from 1970 to 1990. However, natural resource abundance could have positive effects on economic growth if a country were able to develop a manufacturing sector strong enough to escape the effects of Dutch disease. Our analysis using the most recent and updated data, for the period from 1990 to 2010, appears to show that some natural resource-rich countries, such as Indonesia, have adopted this successful strategy in recent years.

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Figure 1: Growth and natural resource intensity

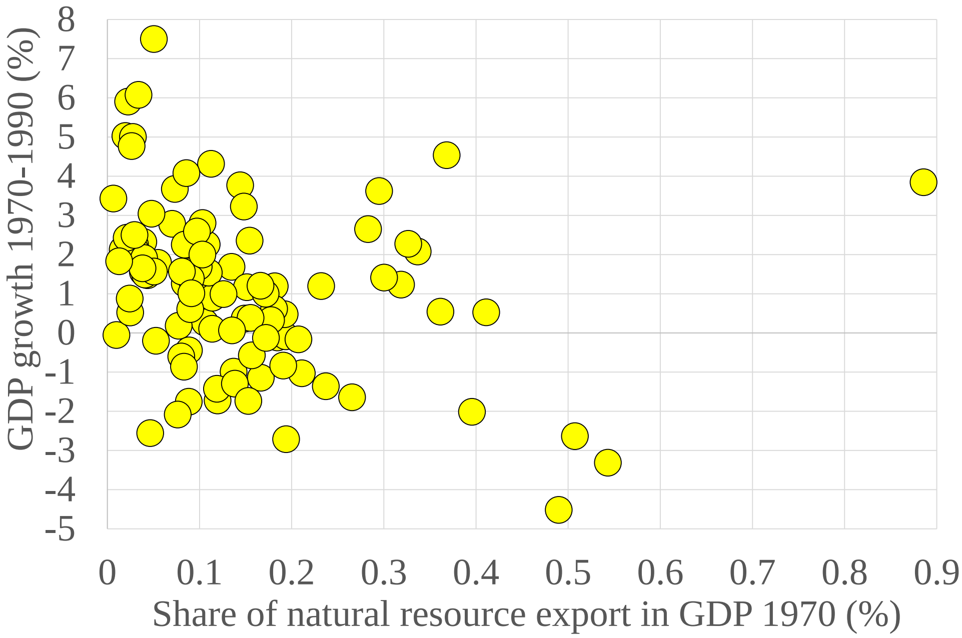


Figure 2: Growth and natural resource abundance

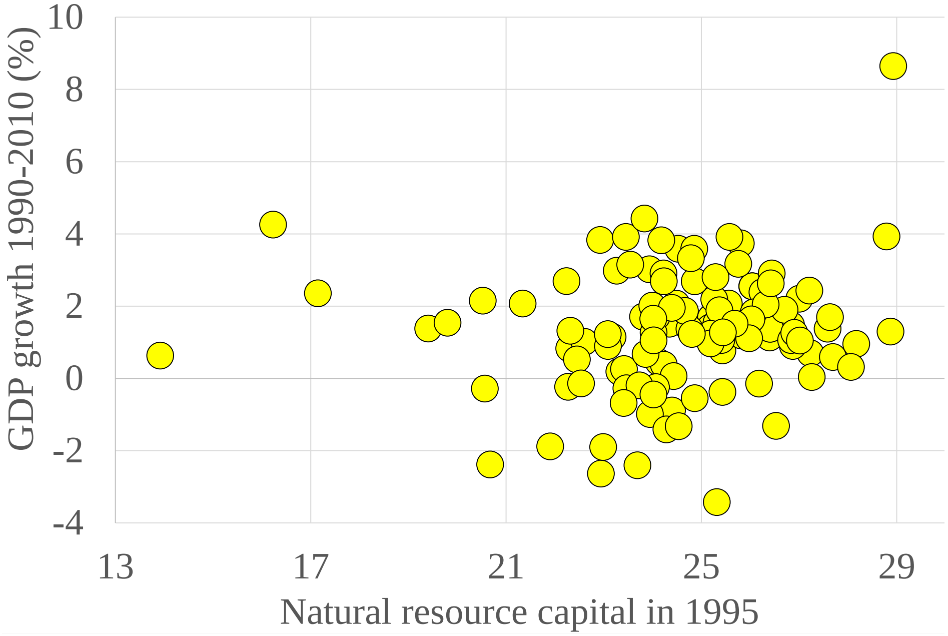
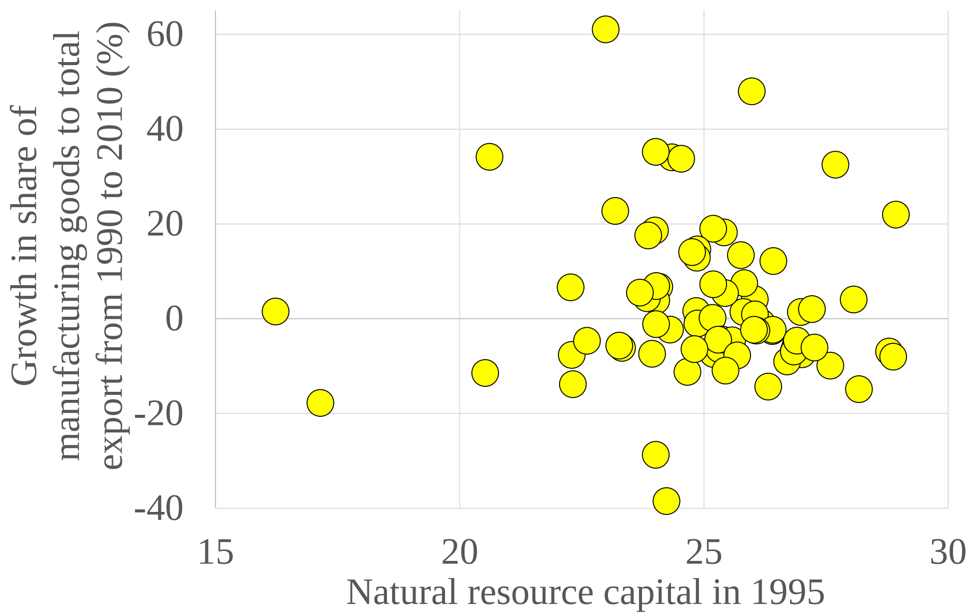


Figure 3: Growth in share of manufacturing goods in total exports from 1990 to 2010 and natural resource abundance



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Afghanistan	Cape Verde	Ghana	Lebanon	Norway	St. Vincent and the Grenadines
Albania	Central African Republic	Greece	Lesotho	Oman	Sudan
Algeria	Chad	Grenada	Liberia	Pakistan	Suriname
Angola	Chile	Guatemala	Libya	Panama	Swaziland
Antigua and Barbuda	China	Guinea	Lithuania	Papua New Guinea	Sweden
Argentina	Colombia	Guinea-Bissau	Luxembourg	Paraguay	Switzerland
Armenia	Comoros	Guyana	Macao SAR, China	Peru	Syrian Arab Republic
Australia	Congo, Dem. Rep.	Haiti	Macedonia, FYR	Philippines	Taiwan
Austria	Costa Rica	Honduras	Madagascar	Poland	Tajikistan
Azerbaijan	Croatia	Hong Kong	Malawi	Portugal	Tanzania
Bahamas, The	Cuba	Hungary	Malaysia	Puerto Rico	Thailand
Bahrain	Cyprus	Iceland	Maldives	Qatar	Togo
Bangladesh	Czech Republic	India	Mali	Romania	Tonga
Barbados	Denmark	Indonesia	Malta	Russian Federation	Trinidad and Tobago
Belarus	Djibouti	Iran	Marshall Islands	Rwanda	Tunisia
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Burkina Faso	France	Kuwait	New Zealand	Spain	Vietnam
Burundi	Gabon	Kyrgyz Republic	Nicaragua	Sri Lanka	Yemen, Rep.
Cambodia	Gambia, The	Lao PDR	Niger	St. Kitts and Nevis	Zambia
Cameroon	Georgia	Latvia	Nigeria	St. Lucia	Zimbabwe
Canada	Germany				

Table 1: A list of countries included in the analysis.

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea70	0.044	0.027	0.105	0.19	0.074	0.069	0.017	-0.024	-0.28	−0.93**	−1.07**	−0.96**	−0.76**	−0.61	−0.71
sxp70	−8.05**	−8.74**	−0.69	−9.67**	−10.0**	−6.09	−8.51**	−8.85**	−5.55	−12.3**	−11.7**	−9.12**	−11.6**	−12.0**	−9.46**
lopen7089				0.30	0.44	1.01**	0.18	0.28	0.74	0.72**	0.84**	0.86**	0.49	0.66*	1.09**
linv7089							0.69	1.54*	1.47*	0.012	0.26	0.611	-0.12	0.023	0.35
rl82										0,69**	0.54**	0.50**	0.52**	0.411**	0.35
dtt7090													-0,15*	-0.07	0.007
R-squared	0.11	0.06	0.01	0.12	0.07	0.06	0.14	0.1	0.13	0.42	0.34	0.29	0.46	0.30	0.23
Sample size	105	105	105	105	105	105	105	105	105	78	78	78	60	60	60

Note: **Significant at the 5% level and *Significant at the 10% level. A description of the variables is provided in table 3.

Table 2: Quantile regressions for economic growth with natural resource intensity 1970-1990 when the dependent variable is $GEA7090$.

gea7090	Average annual growth in real GDP divided by the economically active population between the years 1970 and 1990.
lgdpea70	Natural log of real GDP divided by the economically active population in 1970. The source of the economically active population data is the World Bank dataset. This is a number of individuals aged 15 $\sim$ 64. Real GDP data are taken from Penn World Tables, Mark 7.1.
sxp70	Share of exports of "fuels" and "non-fuel primary products" in GNP in 1970. Source: Sachs and Warner's publically available dataset.
lopen7089	Natural log of average openness (sum of exports and imports) to GDP from 1970 to 1989. Source: Penn World Table, Mark 7.1.
linv7089	Natural log of average real investment to GDP per capita from 1970 to 1989. Source: Penn World Table, Mark 7.1.
rl82	Rule of law index was used by Knack and Keefer (1995). The data are measured as of 1982 and shows the degree to which the citizens of a country are willing to accept the established institutions crafting, implementing laws and adjudicating disputes (Sachs and Warner, 1997). Source: Sachs and Warner's dataset.
dtt7090	Average annual growth in the log of the external terms of trade between 1970 and 1990 (Sachs and Warner, 1997). Source: Sachs and Warner's dataset.

Table 3: Description of variables used in the regression in table 2

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea70	0.37	0.24	0.05	0.42	0.24	0.05	0.105	−0.005	−0.16	−0.49	−0.59	−1.45**	−0.91	−0.53	−0.83
sxp70	−1.81	−4.20	1.90	−3.66	−6.08	−5.25	−9.12**	−4.05	−0.07	−12.7**	−9.62**	−7.50	−12.0**	−5.15	2.36
lopen7079				0.57	0.83*	0.77	0.88*	0.44	0.47	1.03**	0.66	0.47	1.41**	0.711	0.17
linv7079							2.28**	2.15**	2.04**	2.45**	1.20	1.91*	0.008	0.664	1.39
rl82										0.29	0.17	0.17	0.45	0.238	0.40
dtt7080													−0.07*	-0.06	−0.09*
R-squared	0.02	0.03	0.001	0.03	0.06	0.02	0.12	0.16	0.09	0.25	0.19	0.11	0.22	0.20	0.17
Sample size	105	105	105	105	105	105	105	105	105	78	78	78	61	61	61

Note: **Significant at the 5% level and *Significant at the 10% level. A description of the variables is provided in table 3.

Table 4: Quantile regressions for economic growth with natural resource intensity 1970-1980 when the dependent variable is $GEA7080$.

gea7080	Average annual growth in real GDP divided by the economically active population between the years 1970 and 1980.
lopen7079	Natural log of average openness (sum of exports and imports) to GDP from 1970 to 1979. Source: Penn World Table, Mark 7.1.
linv7079	Natural log of average real investment to GDP per capita from 1970 to 1979. Source: Penn World Table, Mark 7.1.
dtt7080	Average annual growth in the log of the external terms of trade between 1970 and 1980 (Sachs and Warner, 1997). Source: Sachs and Warner's dataset.

Table 5: Description of variables used in the regression in table 4

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea80	0.26	0.24	−0.20	0.20	0.23	−0.11	0.07	0.15	−0.26	−0.57	−0.98**	−1.14**	0.02	−0.4	−1.31*
sxp80	−5.48*	−4.42	−0.22	−5.64*	−4.38	−0.50	−5.21	−5.65*	−0.18	−11.6**	−7.75**	−9.06**	−8.03	−9.32**	−12.3**
lopen8089				0.38	−0.01	0.93*	0.48	0.09	−0.08	1.03*	0.42	0.58	1.17*	0.28	1.06
linv8089							0.39	0.42	1.23	−0.68	0.22	1.02	−1.26	−0.017	0.7
rl82										0,74**	0.73**	0.66**	0.61**	0.57**	0.778**
dtt8090													0.012	−0.012	0.14
R-squared	0.11	0.05	0.01	0.11	0.05	0.03	0.11	0.06	0.09	0.35	0.31	0.25	0.38	0.32	0.22
Sample size	109	109	109	109	109	109	109	109	109	76	76	76	60	60	60

Note: **Significant at the 5% level and *Significant at the 10% level. A description of the variables is provided in table 3.

Table 6: Quantile regressions for economic growth with natural resource intensity 1980-1990 when the dependent variable is $GEA8090$.

gea8090	Average annual growth in real GDP divided by the economically active population between the years 1980 and 1990.
lgdpea80	Natural log of real GDP divided by the economically active population in 1980. Source: Penn World Tables, Mark 7.1 and World Bank dataset.
sxp80	Share of exports of "fuels" and "non-fuel primary products" in GNP in 1980. Source: Sachs and Warner's dataset.
lopen8089	Natural log of average openness (sum of exports and imports) to GDP from 1980 to 1989. Source: Penn World Table, Mark 7.1.
linv8089	Natural log of average real investment to GDP per capita from 1980 to 1989. Source: Penn World Table, Mark 7.1.
dtt8090	Average annual growth in the log of the external terms of trade between 1980 and 1990 (Sachs and Warner, 1997). Source: Sachs and Warner's dataset.

Table 7: Description of variables used in the regression in table 6

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea90	0.48**	0.048	−0.23	0.43*	−0.009	−0.25	0.015	−0.068	−0.46**	−0.70**	−0.86**	−1.03**	−0.96**	−0.57	−0.33
lnat_cap95	−0.0002	0.0006	−0.01	0.029	0.094	0.17*	0.053	0.157	0.203	0.21**	0.14	0.14	0.36**	0.09	0.05
lopen9010				0.26	0.45	1.00**	−0.21	0.47	0.93**	0.22	0.33	0.57	0.29	-0.48	-0.27
linv9010							1.55**	1.42*	1.73*	1.23**	0.73	1.18	1.23	0.82	0.06
rl1996										1.05**	0.97**	0.81**	1.64**	1.51**	1.31**
dtt9010													0.16	0.13	0.03
R-squared	0,05	0.003	0.007	0.06	0.02	0.05	0.1	0.03	0.08	0.26	0.13	0.12	0.3	0.19	0.16
Sample size	119	119	119	119	119	119	119	119	119	119	119	119	71	71	71

Note: ∗∗Significant at the 5% level and ∗Significant at the 10% level. A description of the variables is provided in table 9.

Table 8: Quantile regressions for economic growth with natural resource intensity 1990-2010 when the dependent variable is $GEA9010$.

gea9010	Average annual growth in real GDP divided by the economically active population between the years 1990 and 2010.
lgdpea90	Natural log of real GDP divided by the economically active population in 1990. Source: Penn World Tables, Mark 7.1 and World Bank dataset.
lnat_cap95	Natural log of total natural capital in 1995. Source: World Bank.
lopen9010	Natural log of average openness (sum of exports and imports) to GDP from 1990 to 2010. Source: Penn World Table, Mark 7.1.
linv9010	Natural log of average real investment to GDP per capita from 1990 to 2010. Source: Penn World Table, Mark 7.1.
rl1996	Rule of law index in 1996. It measures the quality of contract enforcement, the police and the courts, as well as the likelihood of crime and violence. Takes values between -2.5 and 2.5. Source: World Bank
dtt9010	Average annual growth in the log of terms of trade between 1990 and 2010. Source: World Bank.

Table 9: Description of variables used in the regression in table 8

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea90	0.73**	0.48**	0.48**	0.79**	0.32	0.40**	0.56*	0.12	0.25	−0.45	−0.55*	−0.28	0.39	0.07	0.08
lnat_cap95	0.03	−0.001	−0.18	0.144	0.007	0.03	0.16	0.11	0.02	0.13	0.11	−0.05	0.34*	0.22	0.11
lopen9099				0.41	0.64	0.80	0.25	0.50	0.60	0.49	0.25	0.08	0.24	−0.16	0.24
linv9099							0,42	1.24*	1.57**	0.85	1.06*	1.43	−0.39	0.35	−0.05
rl1996										1.42**	1.36**	0.84*	1.57**	2.29**	1.68**
dtt9000													−0.28	−0.177	−0.29
R-squared	0.12	0.06	0.05	0.12	0.07	0.06	0.13	0.11	0.11	0.25	0.19	0.14	0.26	0.24	0.24
Sample size	119	119	119	119	119	119	119	119	119	119	119	119	71	71	71

Note: **Significant at the 5% level and *Significant at the 10% level. A description of the variables is provided in table 11.

Table 10: Quantile regressions for economic growth with natural resource intensity 1980-1990 when the dependent variable is $GEA9000$.

gea9000	Average annual growth in real GDP divided by the economically active population between the years 1990 and 2000.
lopen9099	Natural log of average openness (sum of exports and imports) to GDP from 1990 to 1999. Source: Penn World Table, Mark 7.1.
linv9099	Natural log of average real investment to GDP per capita from 1990 to 1999. Source: Penn World Table, Mark 7.1.
dtt9000	Average annual growth in the log of the external terms of trade between 1990 and 2000. Source: World Bank.

Table 11: Description of variables used in the regression in table 10

Model	1			2			3			4			5		
Quantile	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th	25th	50th	75th
lgdpea00	−0.17	−0.54**	−0.84**	−0.25	−0.76**	−1.01**	−0.46**	−0.63**	−1.01**	−0.88**	−1.02**	−0.34	−1.08 ∗∗	−0.91 ∗∗	−0, 31
lnat_cap00	0.19*	0.12	0.02	0.31**	0.27**	0.26	0.33**	0.27**	0.28	0.29**	0.26**	0.28	0.33**	0.21*	0.28
lopen0010				0.99**	1.16**	0.91	0.77	0.78	0.94	0.77*	0.66	1.32**	0.82*	0.54	1.54**
linv0010							1.27*	1.40	0.27	1.03	1.07	0.89	0.95	1.06	0.82
rl2000										0.67**	0.51	−0.99**	0.87**	0.43	−0.93*
dtt0010													0,13	0,13	0,20
R-squared	0.03	0.07	0.09	0.05	0.09	0.11	0.09	0.11	0.12	0.13	0.12	0.15	0.13	0.12	0.16
Sample size	142	142	142	142	142	142	142	142	142	142	142	142	142	142	142

Note: **Significant at the 5% level and *Significant at the 10% level. A description of the variables is provided in table 13.

Table 12: Quantile regressions for economic growth with natural resource intensity 200-2010 when the dependent variable is $GEA0010$.

gea0010	Average annual growth in real GDP divided by the economically active population between the years 2000 and 2010.
lgdpea00	Natural log of real GDP divided by the economically active population in 2000. Source: Penn World Tables, Mark 7.1 and World Bank dataset.
lnat_cap00	Natural log of total natural capital in 2000. Source: World Bank.
lopen0010	Natural log of average openness (sum of exports and imports) to GDP from 2000 to 2010. Source: Penn World Table, Mark 7.1.
linv0010	Natural log of average real investment to GDP per capita from 2000 to 2010. Source: Penn World Table, Mark 7.1.
rl2000	Rule of law index in 2000. Source: World Bank.
dtt0010	Average annual growth in the log of terms of trade between 2000 and 2010. Source: World Bank.

Table 13: Description of variables used in the regression in table 12

(a) The ratio of service sector output to manufacturing sector output in 1990

Quantile	25th	50th	75th
lnat_cap95	-0,08**	-0,39**	-0,48**
R-squared	0.01	0.07	0.11
N	102	102	102

(b) The ratio of service sector output to manufacturing sector output in 1995

Quantile	25th	50th	75th
lnat_cap95	0,004	-0,27**	-0,50**
R-squared	0.0002	0.052	0.13
N	108	108	108

(c) The ratio of service sector output to manufacturing sector output in 2000

Quantile	25th	50th	75th
lnat_cap95	-0,07	-0,32*	-0,80**
R-squared	0.002	0.05	0.19
N	112	112	112

(d) The ratio of service sector output to manufacturing sector output in 2005

Quantile	25th	50th	75th
lnat_cap95	-0,23	-0,45*	-0,71**
R-squared	0.02	0.07	0.2
N	110	110	110

Table 14: Quantile regressions for the ratio of service sector output to manufacturing sector output with respect to natural resource capital in 1995.