Dutch Disease or Botswana's Blessing?

Natural Resources and Economic Growth – A Channel Approach[1]

Michael Jakob[2]

Potsdam Institute for Climate Impact Research (PIK)

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Abstract

This paper examines the effects of natural resource abundance on fundamental determinants of economic growth for a cross-section of 60 developing and least developed countries for the time period 1970-2000. We find resource abundance to have rather large positive growth effects by increasing investment rates and in some instances negative effects of similar magnitude by lowering the diversification of a country's export portfolio. We also find small negative effects of natural resources on growth by raising inequality, while the results on institutional quality are ambiguous. Overall, the results suggest small but positive growth effects for the average country, casting some doubt on parts of the earlier 'resource curse' literature. However, we observe considerable heterogeneity among regions, which suggests that natural resource abundance impacts on economic growth through various channels, which can turn resource abundance into a curse for some countries but a blessing for others.

Key words: Natural Resources, Economic Growth, Resource Curse

JEL classifications: Q32, Q33, O11, O43

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[2] Contact: jakob@pik-potsdam.de, Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14473 Potsdam, Germany

1. Introduction

For many countries natural resources abundance seems to be a serious constraint for development. Many resource-rich countries rank among the most spectacular growth disasters of the last decades[3], while the East-Asian growth-miracles are almost exclusively resource-poor countries. This counter-intuitive regularity is commonly known as the ‘natural resource curse’. Popular explanations for this phenomenon include:

- **Declining terms of trade** and **high volatility** explanations claim that a secular decline in the terms of trade coupled with high volatility form a kind of ‘staple-trap’ for commodity exporters
- The **Dutch Disease** literature attributes the natural resource curse to the crowding out of the manufacturing sector or other growth-generating economic activities by resource booms
- The **entrenched inequality** hypothesis claims that ownership of natural resources usually is concentrated and that the resulting inequality is detrimental to growth
- **Institutional failure explanations** argue that abundant natural resource endowments counteract the formation of high-quality institutions (and consequently hamper economic development)
- **Rent seeking models** lay down how natural resource rents can create perverse incentives for individual actors’ behaviour

However, several authors have pointed out that many of the world’s most highly developed countries, such as Australia, Canada, Scandinavia and the US, have successfully developed on the basis of, and not in spite of their resource base (De Ferranti et al., 2002; Wright 1990 and 2001). In addition, it has repeatedly been shown that earlier empirical results crucially depend on the measure of natural resource abundance and suffer from serious

[3] E.g. Nigeria, Venezuela, Zambia and the Republic of Congo

econometric problems (Lederman and Maloney, 2002 and 2003; Stijns, 2005; Brunnschweiler and Bulte, 2009).

This research article investigates how natural resources affect economic growth through a variety of channels for a cross-section of 60 developing and least-developed countries for the period 1970-2000. We estimate a single structural model which accounts for the impacts of natural resource abundance on investments, institutional quality, inequality, and export diversification and compare the results for different indicators of natural resource abundance. The econometric methodology adopted in this paper is a variation of Wacziarg's (2001) 'channel-approach', in which the fundamental growth determinants are regarded as endogenous, and the underlying variable under study (in our case the natural resource indicator) is used as an instrument for the endogenously determined channel variables.

The paper proceeds as follows: Section 2 reviews the existing literature; Section 3 explains the econometric model. The data are presented in Section 4, results in Section 5. Section 6 concludes.

2. Literature review

2.1. The declining terms of trade and volatility hypothesis

The idea that commodity dependent countries are disadvantaged was first made popular by Prebisch (1959) and Singer (1950), who argue that primary products face a secular decline in prices relative to manufactured goods in the world market.

Deaton (1999) shows that commodity prices exhibit a basically trend-less long-run behaviour with pronounced short term fluctuations and that the large majority of commodity exporters focus on a rather narrow range of primary products. This lack of diversification exposes them to price fluctuations that can generate large swings in national incomes.

A substantial body of literature examines links between volatility and growth. Easterly et al. (1993) note a large part of the observed variation in growth rates can be explained by external shocks, above all terms of trade shocks. Ramey and Ramey (1995) find lower growth rates for countries with higher macroeconomic volatility, Aizenman and Marion (1999) a negative impact of volatility on private investment, and Servén (1998) shows that uncertainty is negatively correlated with aggregate investment. Dehn (2000) highlights the fact that the actual realisation rather than just the prospect of shocks depresses growth, large negative shocks over-proportional impacts, and positive shocks do not systematically translate into higher growth rates. This is confirmed by Collier (2002), who argues that external shocks have strong asymmetric impacts and that for Africa a typical large export shock[4] can decrease GPD by as much as 20% in the long run.

2.2. The Dutch Disease hypothesis

Corden and Neary (1982) analyse a standard trade model with two traded and one non-traded good. A boom in the natural resource sector gives rise to a 'resource movement effect', drawing labour and capital into the natural resource sector and a 'spending effect', where the increased income from natural resources leads to extra spending on non-tradable goods and raises their price. Both effects cause factor prices to rise and the real exchange rate to appreciate, 'crowding-out' exports of manufactured goods. Van Wijnbergen (1984) argues that endogenous economic growth occurs primarily through spillovers in the exportable manufacturing sector[5]. Therefore, natural resource booms can have adverse effects on industrial structure and lead to lower growth rates in the long run. In the models of Krugman (1987) and Matsuyama (1992), increased specialisation in natural resources can delay learning-by-doing and permanently lock-in a country with a lower national income once a resource boom is over.

[4] Defined as the 2.5% tails of the distribution of price changes during a given four-year period

[5] This assumption is fundamental to the 'new growth theory', as e.g. in Romer (1986 and 1990) and Lucas (1988).

The seminal empirical paper on the Dutch disease is Sachs and Warner (1995), who regress growth rates of 89 developing countries between 1970-89 on resource abundance and a number of control variables. Their preferred measure of resource intensity is exports of primary products divided by GDP. Their results suggest that a unit standard deviation increase in the share of primary exports lowers annual per-capita growth by a little less than one percent. In closely related models, natural resources crowd-out other growth-generating activities, such as investment in physical and human capital. For instance, Gylfason and Zoega (2001) find that a higher share of output going to the owners of natural resources reduces the marginal productivity of capital, lowers the real interest rate and reduces saving, investment and therefore growth.

2.3. The entrenched inequality hypothesis

Economic historians Engerman and Sokoloff (1994, Sokoloff and Engerman, 2000) and Hoff (2003) suggest that inequalities in wealth, human capital and political power in conjunction with colonial institutions designed to reproduce them are responsible for the disappointing growth experience of many New World economies. In their view, a region's suitability for production of sugar, coffee or cocoa, its mineral reserves and its supply of native slave labour were of particular significance for generating these inequalities.

Leamer et al. (1999) conclude that natural-resource-rich economies are predisposed to follow a particular development path: instead of going through a stage of light manufacturing typical for labour abundant countries, manufacturing in resource-rich countries concentrates on moderate- to high-capital-intensity products. Therefore, industrialisation occurs later and inequality will be high until very late in the development process. Easterly (2001 and 2006) presents 3SLS estimate with natural resource abundance as an instrument for the income share of the middle class (respectively the GINI coefficient) and indeed confirms a positive correlation between natural resources and inequality as well as a negative correlation between inequality and growth.

2.4. The institutional failure hypothesis

Acemoglu et al. (2002) point out that colonial settlements occurred in thinly populated, relatively poor areas, whereas extractive institutions were put into place in resource abundant, densely populated areas. With the opportunity to industrialise, however, those societies that had strong institutions and an extensive participation of a broad cross-section of society found themselves in a more advantageous position, leading to a 'reversal of fortune' with countries that used to be the poorest by the time of their colonisation being the first to industrialise.

Ross (2001) suggests that oil can affect institutional quality by three mechanisms: (1) Natural resources generate large rents for the state so that there is less need for taxing the population such that it becomes less likely to engage in civil society. (2) The state disposes of sufficient resources to effectively combat internal opposition. (3) Resource extraction delays social and cultural changes (such as education and occupational specialisation) which are conducive to democratisation. His empirical results show that oil and mineral wealth are negatively correlated with a constructed index of democracy.

Isham et al. (2005) conjecture that commodities extracted from a narrow geographic or economic base ('point source' resources) are more susceptible to state capture than diffuse resources. They estimate two equations, including constructed indices for point source and diffuse resources as instruments for institutional quality. Their results show consistently negative impacts for exports of point source resources on institutional quality, while institutions positively affect growth. This suggests that *export structure* affects growth through institutions.

2.5. The rent seeking hypothesis

Tornell and Lane (1999) present a model that involves an efficient formal production sector to which powerful interest groups have access through taxation and an inefficient informal sector free from taxation. A windfall gain in the formal sector triggers strategic interactions between the interest groups and leads to a ‘voracity effect’, i.e. “a more than proportional increase in discretionary distribution”, with capital being transferred from the formal to the informal sector, resulting in slower growth[6].

Tanzi (1999) examines the relationship between natural resources and corruption. To the Sachs and Warner (1995) regression, he adds an index of corruption, which is instrumented by natural resources. The first stage regression reveals that prices of fuel and ores as well as political instability are positively correlated with more corruption. In the second stage, corruption is found to have a significant negative impact on growth.

2.6. Contesting the resource curse

Several recent publications cast doubt on the resource curse hypothesis. Davis (1995) compares 91 developing countries and concludes that mineral-rich economies significantly outperformed non-mineral ones in terms of GDP and human development between 1970 and 1991. De Ferranti et al. (2002) point out that many of the world’s most highly developed countries, such as Australia, Canada, Scandinavia and the US, “have successfully developed on the basis of, and not in spite of their resource base”. Wright (1990 and 2001) notes that US manufacturing exports at the turn of the 20th century displayed a high intensity in non-reproducible resources and that the latter increased when the country ascended to a position of world industrial pre-eminence. Stijns (2005) criticises Sachs and Warner (1995), pointing out that the SXP (natural resource exports/GDP) variable is not an appropriate measure of

[6] This conclusion is very different from the Dutch disease: While the Dutch disease literature assumes that the windfall gain takes place in the less efficient sector and leads to its expansion, in this model the boom occurs in the more efficient sector which in turn experiences a contraction.

resource abundance. He re-estimates their regression with data on land, oil, gas, coal as well as mineral reserves and finds no significant correlation with growth. If the SXP measure is included in addition, it still remains negative and significant, suggesting that SXP indeed proxies for some other effect than resource abundance.

Lederman and Maloney (2002) show that the Sachs and Warner (1995) results are sensitive to the time period used and suffer from bias due to omitted variables and endogeneity. Lederman and Maloney (2003) also suggest that the appropriate proxy of natural resource endowments derived from theory is natural resource exports per worker[7]. Their regression results show a significant *positive* effect of natural resource exports on growth, while there is a *strong negative impact* of export concentration. Finally, Brunnschweiler and Bulte (2009) employ natural resource endowments as an instrumental variable for institutions and natural resource dependence. Their results suggest that natural resource endowments are positively related to both resource dependence and institutional quality. While institutional quality is found to be conducive for growth, resource dependence enters with an insignificant coefficient, resulting in a positive overall growth effect for resource endowments.

3. Empirical Strategy

3.1. Testable hypotheses

From the literature reviewed in the previous section, we conjecture that natural resource abundance does not directly affect economic development but acts through a number of fundamental determinants of economic growth. In our empirical analysis, we focus on four particular channels of transmission: the investment rate, institutional quality, inequality and export concentration. In the following, we give a brief overview of the hypotheses we are able to test with our econometric specification. Table 1 gives an overview of relevant studies that

[7] According to this measure, Norway, New Zealand, Trinidad and Tobago, Finland and Australia turn out to be the most resource abundant countries.

show natural resource abundance to be related to a particular channel of transmission as well as this channel's relevance for economic growth.

Export concentration

Theories linking the natural resource curse to volatility stress that resource rich countries' export portfolios are usually less diversified, which increases their exposure to fluctuations in commodity prices. Therefore, we empirically test if natural resources are related to a less diversified export structure and if more concentrated exports, in turn, negatively affect growth.

Investments

According to the Dutch disease hypothesis, natural resource abundance can be expected to result in lower investments in manufacturing industries, which is detrimental to economic growth. On the other hand, it is argued that resource rich countries dispose of the means to achieve higher investment rates by productively investing resource rents.

Institutional quality

The institutional failure hypothesis points out that abundant natural resource endowments counteract the formation of high-quality institutions (which are fundamental to growth) through corruption and rent seeking.

Inequality

Following the Engerman-Sokoloff hypothesis, one can expect natural resource abundance to result in higher levels of inequality. Higher inequality, in turn, can lower growth either because certain actors won't be able to undertake investments that would be beneficial for society as a whole or because of resulting distortionary taxation and redistribution.

<Table 1 about here>

3.2. The empirical model

Our econometric model relies on the estimation of a system of simultaneous equations with instrumental variables. We build directly on Wacziarg's (2001) 'channels-approach', originally used to investigate impacts of trade policy on growth[8]. Wacziarg specifies a growth equation containing fundamental determinants of growth (investment, FDI, price distortions, government consumption, manufactured exports and macro policy) and estimates the indirect impact of trade policy through these variables. In this framework, the fundamental determinants of economic growth are regarded as endogenous and the underlying variable under study (in our case natural resource abundance) is used as an instrument. Figure 1 depicts this methodology adapted to fit the needs of our study.

<Figure 1 about here>

Our econometric specification consists of five structural equations: a cross-country growth equation (1) and four channel equations (2) – (5). The system of equations can be written as:

Growth equation:

$$G = \beta_{10} + \beta_{11} \ln Y_0 + \beta_{12} INV + \beta_{13} INST + \beta_{14} INEQU + \beta_{15} EXPCON + \varepsilon_1 \qquad (1)$$

(-) (+) (+) (-) (-)

Channel equations:

[8] see also Tavares and Wacziarg (2000) for the effects of democracy on growth

$$INV = \beta_{20} + \beta_{21} NATRES + \beta_{22} FRAC + \beta_{23} EUROLANG + \varepsilon_2 \quad (2)$$

(+/-) (-) (+)

$$INST = \beta_{30} + \beta_{31} NATRES + \beta_{32} \ln Y_0 + \beta_{33} FRAC + \beta_{34} EUROLANG + \varepsilon_3 \quad (3)$$

(-) (+) (-) (+)

$$INEQU = \beta_{40} + \beta_{41} NATRES + \beta_{42} \ln Y_0 + \beta_{43} \ln Y_0^2 + \beta_{44} FRAC + \beta_{45} EUROLANG + \varepsilon_4 \quad (4)$$

(+) (+) (-) (+) (-)

$$EXPCON = \beta_{50} + \beta_{51} NATRES + \beta_{52} \ln Y_0 + \varepsilon_5 \quad (5)$$

(+) (-)

In this system of equation $\varepsilon_1 ... \varepsilon_5$ are white noise error terms. G denominates the growth rate, Y_0 initial income, INV the investment rate, INST our measure of institutional quality, INEQU the inequality measure and EXPCON the index of export concentration. NATRES is the respective natural resource indicator that is used as an instrument. As each of our three individual natural resource measures can be assumed to be correlated with each of the four channel variables but not to be influenced by GDP, we conjecture that it constitutes a valid instrument[9]. FRAC stands for ethnic fractionalisation and EUROLANG for the percentage of the population speaking a European language, for which we control in the channel equations for the investment rate, institutional quality and inequality. We also include lagged income levels in the equations for institutions, inequality and export concentration and a squared

[9] We report the results of a Hansen-Sargan test of overidentifying restrictions (Baum et al., 1999) with each regression to check that the instrumental variables are jointly uncorrelated with the residuals of the regression

income term in the inequality equation to allow for a Kuznets curve (reversed U-shape) type of relation. Each coefficient's expected sign is indicated in brackets.

Furthermore, we include dummies for Sub-Saharan Africa, Latin America and the Caribbean and North Africa and the Middle East, as well as dummy variables for exporter type (exporter of non-fuel primary products, fuels, manufactured products or services) in the first stage regression to construct our instruments (but not in the system of equations estimated in the second stage).

This system of equations will be estimated simultaneously, using 3SLS, combining the advantages of instrumental variables and generalised least squares estimation. In the first stage, instruments for each endogenous variable are constructed by OLS. The second stage consists of estimating every equation of our system separately (by 2SLS) using the instruments from the first stage. Finally, the third stage employs the covariance matrix for the error terms that can be derived from the second stage together with the instruments from the first stage to jointly estimate the system of equations (Greene, 2008).

As 3SLS takes into account the correlation of error terms between equations, it is more efficient than 2SLS. However, if the dependent variables are measured with errors, 3SLS propagates the error between equations and increases the bias of the estimates. For this reason, we separately report 3SLS as well as 2SLS results.

As far as the channel equations (2) – (5) are concerned, we are interested in the effect of a marginal change of the natural resource indicator on the dependent variable. The impact of natural resources on growth through a particular channel is determined by the product of the coefficient in the channel equation and the coefficient in the growth equation (1). For instance, the effect of a one standard deviation increase of the natural resource variable on growth through the investment channel can be expressed as (let σ_{NATRES} denominate the standard deviation of the natural resource measure):

$$\Delta G = \beta_{12}\beta_{21}\sigma_{NATRES} \,,$$

and the aggregate effect through all channels as:

$$\Delta G = (\beta_{12}\beta_{21} + \beta_{13}\beta_{31} + \beta_{14}\beta_{41} + \beta_{51}\beta_{15})\sigma_{NATRES}$$

4. The Data

4.1. Data sources and description

Our sample includes cross-section data for 60 developing as well as least-developed countries from 1970-2000. This section describes in detail the data used for this study.

Growth rates, initial income and investment rates

The average growth rate for 1970-2000, our dependent variable, is defined as the annual increase of real GDP per capita. (The log of) initial income (i.e. in 1970) is real GDP per capita in PPP-adjusted year 2000 US$. The investment rate is measured in percent to GDP and enters the regression as an average over the time period 1970-2000. All data on growth rates, initial incomes and investment rates was taken from the Penn World Tables 6.2 (Heston et al., 2006).

Institutional quality

Indices of institutional quality are from Kaufman et al. (2006), who build aggregate measures the rule of law, voice and accountability, control of corruption, political stability, regulatory quality and government effectiveness. These measures were compiled from more than 300 individual sources based on expert evaluations and normalised to a distribution with a mean of zero and a standard deviation of one in each period. Virtually all scores range between -2.5 and 2.5, with higher scores indicating better outcomes. As these indicators are only available from 1996 onwards we employ the value for our final year (i.e. the year 2000) as a proxy for the average institutional quality over the whole period under study. Our preferred indicator, which we call 'inst', is an average over all six categories.

Inequality

A measure of inequality we employ the widely used GINI index, obtained from the WIDER (2004) dataset. To ensure comparability of surveys across countries, surveys are classified along the following dimensions: earnings versus total income, income versus expenditure, gross versus net income (after taxes and transfers), and household versus individual values. To account for average bias due to different sampling methodology, we regress the GINI coefficients on dummy variables capturing the dimensions above and adjust the GINI coefficients to remove average differences (see Easterly, 2006). For our regression, we use average values of each country's GINI coefficients for the period 1970-2000.

Export concentration

Our measure of export concentration is the Herfindahl index (defined as the sum of squared shares of all products relative to total exports) for all exports exceeding US$ 100'000 or 0.3% of GDP. This index takes on values between zero and one, one for a country exporting only one single product and zero for a country exporting an infinite number of products. It was taken from the UNCTAD Handbook of Statistics (2005), where it is available from 1980 on. We employ the average value for the time period 1980-2000 as a proxy for export concentration during the time period under study.

Natural resource abundance

We employ three different indicators of natural resources, without particularly favouring any one of them: The first is a measure of total natural resource reserves (called 'natw'), given by (the log of) the sum of subsoil reserves, forest and non-forest timber resources, as well as cropland and pasture valued in real year 2000 US$, compiled by the World Bank (2005). Our second measure is (the log of) commodity exports per capita (called 'leamer'), defined as SIC codes 0,1,2,3,4, and 68 except 22 and 28 (agricultural materials, agricultural raw materials, food, fuels as well as ores and metals) in real year 2000 US$. It was calculated from COMTRADE (2007) data. Our third measure is commodity exports divided by GDP (called 'sw'), as used by Sachs and Warner (1995) and numerous successive studies. This indicator was obtained from the UNCTAD Handbook of Statistics (2005).

These three measures capture different aspects of the relationship between natural resources and economic growth: The first measure can be seen as actual endowments, the second one as a country's specialisation in its comparative advantage, and the third one as an indicator of dependence on natural resource exports.

Control variables

We include regional dummy variables for the three regions that are commonly believed to be most affected by the resource curse: Sub-Saharan Africa (SSA), North Africa and the Middle-East (MENA) as well as Latin America and the Caribbean (LAC). Hence, all other countries constitute the control group. In particular, we allow the impacts of natural resources on fundamental determinants of growth to differ between regions by including slope dummies, i.e. interaction terms between the measure of natural resource abundance and regional dummy variables. Our regional dummy variables were compiled by the New York University (2004) based on World Bank classifications.

The indicator on ethnic fractionalisation denotes the probability that two randomly selected individuals from the total population belong to different ethnic groups. We expect ethnic fractionalisation to be relevant for the formation of coalitions, which play an important role in rent seeking and determining institutional quality. The values used for this study are for the year 2000 and taken from Alesina et al. (2003). We further include the percentage of the population speaking a European language as their first language (in the year 1999) as a control variable to account for a country's colonial history and its influence on the formation of institutions. This measure comes from the Hall and Jones (1999) dataset.

4.2. Summary Statistics

For the sample period 1970-2000, Sub-Saharan Africa displays the lowest initial income, the lowest rates of economic growth and investment and the lowest institutional quality. Inequality is particularly high in Latin America and the Caribbean and Sub-Saharan Africa.

With regards to resource endowments, total natural wealth varies significantly between as well as within regions; the lowest average values are found for Sub-Saharan Africa, while Latin America and the Caribbean as well as North Africa and the Middle East are relatively richly endowed with natural resources. Our different measures of natural resources are robustly (but far from perfectly) correlated with each other.

Resource endowments and resource exports are strongly correlated with initial incomes and investment rates, but their correlation with growth rates is fairly low. Our measure of resource dependence (commodity exports to GDP) shows a rather robust negative correlation with growth and a positive one with inequality and export concentration.

5. Results

This section presents the results of the estimations described in the previous sections. Sections 5.1. to 5.3. discuss the results (reported in the Appendix). Section 5.4. gives a summary of key findings.

5.1. Natural Resource Endowments and Growth

First, we run regressions using total natural wealth (in year 2000 US$ per capita) as a measure of natural resources. To allow for different impacts for regions, we include slope dummies (i.e. the indicator of total natural wealth interacted with regional dummies for Sub-Saharan Africa, Middle-East and North Africa as well as Latin America and the Caribbean, respectively) in our equation (regressions 1 and 2).

All variables except export concentration are statistically significant at the 5% or 1% levels and show the expected signs in the (third stage) growth equation. The adjusted 'pseudo'-R-square of roughly 60% seems satisfactory and is in line with most empirical growth studies. The Hansen-Sargan test of over-identifying restrictions does not reject the null hypothesis that our instruments are uncorrelated with the residuals of the regression, which strengthens our conviction in their validity.

For initial income, we find a negative sign, indicating convergence at a speed compatible with results obtained in previous empirical work. The investment rate bears a positive coefficient, implying that a 1% increase results in a 0.15% higher growth rate. The coefficient on institutions is positive and large, implying a differential in growth rates of roughly 2.7 percentage points between the countries with the highest and lowest values in our sample. The coefficient on inequality is negative and a one standard deviation increase in the GINI index is found to lower growth by roughly 0.5 percentage points. The coefficient on export concentration is negative and insignificant.

With regards to the channel regressions, we find that for the control group and the MENA countries, natural resource endowments have a significant positive effect on the investment rate. A one standard deviation increase in resource endowments raises the investment rate by 2.4% and consequently growth by 0.4%. However, this effect is significantly weaker (but still positive) for Sub-Saharan Africa and Latin America and the Caribbean, pointing to Dutch Disease effects.

For institutions, the coefficient for the impact of natural resource endowments is statistically insignificant for all regions except Latin America and the Caribbean, where it is small, negative and significant at the 10%-level. For this region, a one standard deviation increase in resource endowments lowers institutional quality by 0.04 points and thus the growth rate by 0.04%.

For the relationship between inequality and initial income, our data display a pronounced Kuznets curve (reversed U-shaped) type of pattern. Natural resource endowments significantly increase inequality in Sub-Saharan Africa and Latin America and the Caribbean, supporting the entrenched inequality hypothesis. However, this effect is fairly weak: a one standard deviation variation in natural resource endowments increases inequality by less than 1.5% and thus reduces the growth rate by less than 0.1%.

Finally, resource reserves are positively related to more concentrated exports. However, as already mentioned earlier, we find no evidence that export concentration reduces growth.

5.2. Natural Resource Exports and Growth

Second, we use primary commodity exports per capita as a measure of natural resource abundance. The rationale behind this is twofold: Firstly, endowments and exports are not perfectly correlated; a country with a rich natural resource base might either consume its resources domestically, fail to exploit its resource base, or move up the value chain and use the resources as inputs for manufactured products. Secondly, data on resource endowments inevitably come with a considerable amount of insecurity attached, and we expect trade data to be of a much higher quality. Therefore, our measure of natural resource exports can be expected to shed some further light on the underlying economic mechanisms.

With regards to convergence, the investment rate, and institutions, the estimations (regressions 3 and 4) deliver results similar to those obtained with total resource reserves as the natural resource variable. However, inequality appears with an insignificant coefficient, while the coefficient on export concentration is significantly negative and economically large, with a variation of one standard deviation resulting in a decrease of the growth rate of 0.5%. Furthermore, the coefficients on initial income and the investment rate are considerably larger as in the previous set of estimations. The Hansen-Sargan test does not reject our choice of instruments, but the statistics is at the fringe of significance at the 10%-level for the 3SLS regression.

The channel equation for the investment rate again points to a large, positive effect of resource exports for the control group, where a one standard deviation increase results in a 4.7% increase in the investment rate and a 0.7% increase in the growth rate. For Sub-Saharan Africa and Latin America and the Caribbean, this effect is roughly half, and for Northern Africa and the Middle East, it is diminished by about one third (the slope dummy is significant at the 10%-level).

The equation for institutions indicates a positive effect of resource exports on institutions for the control group and Sub-Saharan Africa. For Latin America and the Caribbean (and North Africa and the Middle East on the 10%-level), we find that this effect is still positive, but lower, pointing to some kind of institutional failure type of effects in these two regions.

Export concentration increases with resource exports for Sub-Saharan Africa, Latin America and the Caribbean and the MENA countries, but not for the reference group. A one standard deviation variation of commodity exports increases export concentration by around 7% for Sub-Saharan Africa, resulting in a reduction of 0.25% in the growth rate. This effect is able to account for a difference in growth rates of around 1% (ceteris paribus) between the countries with the highest and the lowest resource exports in this region (given the difference of roughly four standard deviations).

5.3. Commodity Dependence and Growth

Finally, we employ the Sachs-Warner indicator, defined as the share of natural resource exports in GDP, as our natural resource measures (regressions 5 and 6). We do so, firstly, because it is the most widely used indicator in the literature, and, secondly, because we believe it constitutes an appropriate measure of commodity dependence. In the growth equation estimated with 3SLS, all coefficients bear statistically significant signs (export concentration only on the 10%-level) and values close to those found earlier. Employing 2SLS, the coefficients on inequality and export concentration appear with insignificant signs. The Hansen-Sargan statistics indicates that our null hypothesis (of valid instruments) is only barely accepted at the 5%-level for the 3SLS regression. This is not surprising, as our instrument (resource exports divided by GDP) directly contains the level of income, which clearly makes it endogenous[10].

The channel equation for the investment rate suggests that positive effects exist for the reference group and the MENA region. However, these are nullified or even reversed for Sub-Saharan Africa and Latin America and the Caribbean, strengthening the assumptions that Dutch disease effects are present in these regions and that these are more pronounced when one regards commodity dependence instead of natural resource endowments or primary commodity exports.

For institutions, the resource dependence measure has a positive influence (significant on the 10%-level) for the control group as well as for Sub-Saharan Africa, but it turns negative for Northern Africa and the Middle East as well as Latin America and the Caribbean. For the former, a one standard deviation increase in the sw measure will increase institutional quality by roughly 0.3 points and the growth rate by around 0.4%, while for the latter growth will be lowered by around 0.2% and 0.1%, respectively.

[10] For this reason, among other, this indicator has been heavily criticised by some researchers, e.g. Stijns (2005) and Lederman and Maloney (2002 and 2003)

For inequality, the share of resource exports in GDP is related to lower levels for the reference group and MENA, but to higher levels in Sub-Saharan Africa and Latin America and the Caribbean. As in the previous regressions, the resulting effects on growth are economically fairly small and of little explanatory power to account for the large observed difference in growth rates between countries.

Finally, resource dependence significantly increases export concentration for all regions except the control group. The magnitude of this effect is fairly large; for instance, a variation of one standard deviation results in a drop in growth rates of around 0.4% for Sub-Saharan Africa as well as Northern Africa and the Middle East and around 0.25% for Latin America and the Caribbean.

5.4. Summing up the evidence

Our results lend support for the presence of growth effects of natural resource abundance through each channel of transmission under consideration.

Investment rates are positively correlated with all three indicators of natural resources, but this positive effect is considerably smaller or can even turn negative (depending on the indicator used) for Sub-Saharan Africa, Latina America and the Caribbean and North Africa and the Middle East, pointing to some kind of Dutch disease in these regions.

For institutions the results are ambiguous; we find small negative effects of resource endowments for Latin America and the Caribbean, while higher resource exports are related to higher institutional quality for all regions under consideration. The indicator of commodity dependence has positive effects on institutional quality for the control group and Sub-Saharan Africa, but negative ones for MENA and Latin America and the Caribbean.

In all regression where inequality was found to have a negative influence on growth, we could confirm the Engerman-Sokoloff hypothesis for Sub-Saharan Africa as well as Latin America and the Caribbean. The effects, however, are economically small.

We also find statistically significant negative result for the impact of export concentration on growth in two of our three sets of regressions. In this case, our results indicate that natural resource abundance can result in less diversified exports for Sub-Saharan Africa, Latin America and the Caribbean as well as Northern Africa and the Middle East. A one standard deviation increase in the natural resource measure decreases the growth rate between 0.1% and 0.4%, depending on the indicator used as well as the region under study.

Table 2 summarises these results and gives the effect on growth of a one standard deviation increase of the respective natural resource indicator through each channel. The investment channel accounts for the strongest positive contribution, while the export concentration channel represents the most pronounced negative influence. For institutional quality the results are mixed, depending on the particular indicator as well as the region. For inequality, the results indicate a mostly negative but fairly small impact.

For the average country in our sample, the influence of natural resources on economic growth is rather small: A one standard deviation increase in natural resource wealth (natw) or commodity exports per capita (leamer) raises the growth rate by roughly 0.25%; for the measure of commodity dependence (sw) the respective value is slightly below 0.1%. On average we find positive effects of natural resources, dismissing the notion of a general ‘resource curse’. However, there is considerable heterogeneity across regions with negative effects in some instances. In particular, in all three sets of regressions, we find Sub-Saharan Africa as well as Latin America and the Caribbean to either derive the lowest benefits or to suffer the most from the adverse effects of natural resource abundance. We believe that this finding can reconcile the evidence from the resource curse literature with more recent results that find either positive (e.g. Wright, 2001; Lederman and Maloney, 2002 and 2003; Brunnschweiler and Bulte, 2009) or insignificant (e.g. Stijns, 2005) effects of natural resource abundance on growth.

< Table 2 about here >

5.5. Robustness Checks

To check the robustness of our results, we examine the validity of the instruments and if the results are sensitive to outliers, include additional control variables, and employ various different measures of institutional quality. We run all robustness checks using natural resource endowments per capita (natw) as the indicator of natural resources[11].

Validity of the instruments

In addition to the over-identification tests, we re-run our regressions adding the instruments to the growth equation. In this set of regressions, practically all coefficients turn out to be insignificant, indicating (as can be expected) considerable co-linearity between the explanatory variables and the instruments from which they were constructed. The fact that the instruments do not enter with significant coefficients confirms the results of the over-identification tests, namely that the instruments are not correlated with the residuals of the regression.

Stability to outliers

Secondly, we examine if the results are driven by individual 'extreme' observations. For this reason, we exclude resource rich countries that have performed exceptionally well (Botswana, Chile, Malaysia, and Mauritius) or exceptionally poorly (Iran, Nigeria, and Venezuela) from the sample. Except institutional quality being on the fringe of significance at the 10% level in one regression, the results differ only slightly in terms of significance and absolute values from those obtained from the entire sample, and we conclude that the results apply for the whole sample and are not due to outliers.

[11] The regression results can be obtained from the author upon request.

Unobserved country specific effects

Thirdly, to allow for omitted country-specific effects, we control for lagged average growth rates for the period 1950-1970. The reasoning behind this is the following: If there are unobserved country-specific effects that are correlated with the growth rate, these effect should be robustly correlated with previous growth rates, too. Including lagged growth rates should hence pick up some of the correlation between the country-specific effects and the explanatory variables and reduce bias due to unobserved effects.

Due to gaps in the data, the sample is reduced to 56 observations. This control variable is (negatively) significant at the 10% level in the growth equation and increases the R-square of this regression by nearly 10%, indicating that we indeed have omitted important country-specific explanatory variables from the regression. However, the coefficients of the other independent variables in the growth as well as the channel equations change only little and remain statistically significant (almost all of them at the same levels found earlier).

Controlling for terms of trade

Fourthly, to ensure that observed growth patterns are not mainly influenced by adverse developments of commodity prices, we control for fluctuations in the terms of trade by including average yearly changes from 1970-2000 in the growth equation. Terms of trade were calculated as the ratio of export price to import price deflators, using data from the World Development Indicators (2006). In the respective regression, this control variable ('tot') is statistically insignificant. In this specification, institutional quality takes on an insignificant coefficient in the growth regression. However, all other coefficients change only slightly and remain significant so that we can conclude that the inclusion of changes in the terms of trade does not overturn our general results.

Measures of institutional quality

Finally, we re-run the regression using four different measures of institutional quality from Kaufman et al. (2006). For the 'Rule of Law' measure, we find results very similar to those in the base regression, while the coefficient on 'Voice and Accountability' (encompassing different aspects of democracy) is statistically insignificant. 'Control of Corruption' and 'Regulatory Quality' are found to be strongly correlated with growth and highly significant. In three of these four regressions, the coefficient on inequality in the growth equation becomes insignificant. As all other coefficients change very little compared to the regression using our generic (average) measure of institutional quality, our main results do not appear to be particularly sensitive to changes of the measure of institutional quality.

6. Conclusions

This paper examines the influence of natural resource abundance on economic growth through four particular channels of transmission: the investment rate, institutional quality, inequality and export concentration.

We find that natural resource abundance affects economic growth through each of these channels. Hence, results from numerous previous studies are validated in the framework of a single structural model. The results indicate a positive impact of natural resource abundance on investment rates and support the hypothesis of resource-driven development. However, this positive effect is significantly reduced for Sub-Saharan Africa and Latin America and the Caribbean, likely through Dutch Disease type effects. We also find resource wealth related to inequality in some regions. For institutional quality, the results are ambiguous, suggesting positive impacts for some regions and indicators of resource abundance but negative ones for others.

The strongest positive influence of resource abundance on growth runs through the investment rate channel; the largest negative effects are of similar magnitude and stem from increased export concentration, while the negative impacts of increased inequality are considerably smaller. The findings suggest that for the average country in our sample, natural resource abundance has a small but positive aggregate effect on growth, contradicting some earlier findings in the tradition of the ‘resource curse’ literature. However, there is remarkable heterogeneity between regions, which can turn resource abundance into a curse for some countries but a blessing for others.

This study can be understood as a first step towards bridging the gap between the resource curse literature and more recent studies that find either positive or insignificant effects. It confirms the presumption that there is no simple ‘one-size-fits-all’ approach for the relation between natural resources and economic development. Future research in this field should pay increased attention to the underlying mechanisms involved and be careful in the selection of countries as well as indicators of resource abundance in order to be able to disentangle this complex relationship.

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Appendix: Regression Results

natw, (1) and (2), leamer, (3) and (4), and sw, (5) and (6), as measures of natural resources (natres)

	(1) 3SLS natw	(2) 2SLS natw	(3) 3SLS leamer	(4) 2SLS leamer	(5) 3SLS sw	(6) 2SLS sw
‚R-squared'						
g	0.6155***	0.6278***	0.5689***	0.6060***	0.6270***	0.6346***
inv	0.3734***	0.3735***	0.5158***	0.5167***	0.2603***	0.2606***
inst	0.3754***	0.3773***	0.4330***	0.4362***	0.3805***	0.3821***
inequ	0.4638***	0.4702***	0.4755***	0.4761***	0.3765***	0.3789***
expcon	0.5375***	0.5375***	0.5324***	0.5328***	0.5260***	0.5272***
Growth Equation						
g						
lny70	-.890208*** (.3398724)	-1.02240*** (.3642134)	-1.70985*** (.3430696)	-1.54925*** (.3676182)	-1.22676*** (.3544948)	-1.28652*** (.3774425)
inv	.1433497*** (.0487856)	.148547*** (.051898)	.144429*** (.038549)	.1416728*** (.0413633)	.15585*** (.051276)	.1433629*** (.0546185)
inst	.8618473* (.4598632)	1.013541** (.4937981)	1.909565*** (.4776635)	1.709491*** (.5131449)	1.252687** (.4776154)	1.362572*** (.5103262)
inequ	-.0594268** (.0253216)	-.0493798** (.0271641)	-.0076822 (.0242257)	-.0182997 (.026212)	-.0440962** (.0254)	-.0394203 (.0271582)
expcon	-1.095567 (1.690406)	-.1.124314 (1.786985)	-3.459462** (1.440494)	-2.98415* (1. 547559)	-2.405406* (1.53242)	-2.256565 (1.621808)
_cons	8.601553*** (2.08409)	9.152559*** (2.214623)	12.93389*** (2.30366)	12.1419*** (2. 458525)	10.56805*** (2.20865)	10.92748*** (2.338149)
Channel Equations						
inv						
frac	-2.077266 (3.346212)	-1.825439 (3.571068)	-2.436922 (2.837217)	-2.066664 (3.07387)	-3.992767 (3.735984)	-3.844506 (4.022111)
eurolang	3.445327* (1.746299)	3.523443* (1.864564)	2.942762* (1.524914)	3.188438* (1.659336)	3.063442 (1.934789)	3.139071 (2.086009)
natres	2.661137*** (.9602962)	2.654557*** (1.02597)	3.499587*** (.5708454)	3.544477*** (.6103549)	.4168845** (.1764632)	.4247391** (.1887807)
ssa*natres	-.932087*** (.2667707)	-.929143*** (.284017)	-1.83052*** (.4074632)	-1.8645*** (.4356679)	-.529979*** (.1693755)	-.533926*** (.180292)
lac*natres	-.733231*** (.2400208)	-.739720*** (.2556304)	-1.61928*** (.3520748)	-1.68938*** (.3764007)	-.4147008** (.1686666)	-.4150599** (.1771393)
mena*natres	-.3667362 (.3617393)	-.3592478 (.3365052)	-.8272691* (.4546933)	-.9330438* (.4872776)	-.2069554 (.2226298)	-.226656 (.2377678)
_cons	-1.575324 (7.221887)	-1.653097 (7.695103)	4.906705* (2.527457)	4.687496* (2.710473)	15.40859*** (1.912523)	15.30226*** (2.050327)
inst						
lny70	.5306341*** (.1206645)	.5796022*** (.133088)	.2380751 (.1489273)	.2890403* (.1624702)	.4105555*** (.1015679)	.4504212*** (.1102646)
frac	-.7827527** (0.3283121)	-.7817994** (0.3568413)	-1.12649*** (.3081097)	-1.03944*** (.3424335)	-.935540*** (.3425072)	-.8996251** (.3684787)
eurolang	.0337362 (.1658039)	.0319591 (.1819351)	-.0538318 (.1579863)	-.0109589 (.1768613)	-.0423752 (.1731668)	-.0383029 (.186247)
natres	-.0134969	-.0205575	.2132462***	.2045267**	.0270166*	.0274014

	(1) 3SLS natw	(2) 2SLS natw	(3) 3SLS leamer	(4) 2SLS leamer	(5) 3SLS sw	(6) 2SLS sw
	(.0943051)	(.1019377)	(.0747177)	(.0813204)	(.0156745)	(.016856)
ssa*natres	.013784 (.0257017)	.0131403 .0276614	.0146 (.0424466)	.0102968 (.0460268)	-.0164021 (.0149739)	-.0164328 (.0161004)
lac*natres	-.0448944* (.0251298)	-.0480082* (.0267816)	-.0764078** (.0381317)	-.0907763** (.0415315)	-.0333867** (.0149503)	-.0348051** (.016079)
mena*natres	-.0437995 (.031006)	-.0467157 (.0335475)	-.0798552* (.0474513)	-.0978083* (.0517456)	-.044063*** (.0198592)	-.045698** (.0213513)
_cons	-3.22313*** (.9494691)	-3.47435*** (1.034695)	-2.18085*** (.8378335)	-3.2682*** (.9156826)	-2.63739*** (.7083169)	-2.91193*** (.7685802)
inequ						
lny70	45.16732** (20.3445)	52.39329** (24.73728)	48.13294** (20.94097)	48.35683* (25.21603)	48.74036** (24.1302)	46.8442* (27.72765)
lny70sq	-3.370367** (1.550422)	-3.81545** (1.885622)	-3.596331** (1.577761)	-3.579308* (1.900266)	-3.504966* (1.815492)	-3.304507 (2.115953)
frac	10.09557** (4.709412)	10.30412** (5.174244)	2.317233 (2.491679)	2.5023 (2.730414)	13.31812** (5.218904)	13.64262** (5.793276)
eurolang	2.363678 (2.439562)	2.433886 (2.677874)	8.683713* (4.716721)	9.163202* (5.176461)	3.74883 (2.717056)	3.590968 (3.019199)
natres	-1.041769 (1.355613)	-1.278404 (1.482554)	-.6397982 (1.128068)	-.7310028 (1.26733)	-.5175588** (.2474549)	-.5221991* (.2705599)
ssa*natres	1.496686*** (.3710551)	1.508554*** (.4038992)	2.859607*** (.6469741)	2.838907*** (.7045007)	.7406118*** (.2355999)	.7441235*** (.2572794)
lac*natres	1.555247*** (.3575884)	1.456906*** (.3941217)	2.420732*** (.5758109)	2.326392*** (.6302806)	.667843*** (.2321735)	.6595505*** (.2531196)
mena*natres	. 4153757 (.4436283)	.3319997 (.4852183)	.7084084 (.7190501)	.5928178 (.782764)	.1969156 (.308148)	.209805 (.3356465)
_cons	-111.9215* (65.99729)	-137.8406* (80.03156)	-126.357*** (68.18929)	-128.1508 (82.05511)	-131.8112 (78.48172)	-128.1183 (90.13003)
expcon						
lny70	-.095213*** (.0286756)	-.097889*** (.0302692)	-.152252*** (.0353783)	-.163578*** (.0407194)	-.078677*** (.0238993)	-.087744*** (.0254393)
natres	.0265243 (.0220313)	.0269205 (.0232327)	.014091 (.0184424)	.0169954 (.0203811)	-.004804 (.0036536)	-.0051328 (.0038776)
ssa*natres	.0388901*** (.0056146)	.0389417*** (.0059187)	.0600892*** (.0100375)	.0610875*** (.0115355)	.0149965*** (.003526)	.0150468*** (.0037358)
lac*natres	.0201061*** (.0059269)	.0202682*** (.006251)	.0389014*** (.0094666)	.0414608*** (.0104089)	.0109745*** (.0035869)	.0114758*** (.0038044)
mena*natres	.0293104*** (.007419)	.0294698*** (.0078246)	.0497545*** (.0120514)	.0518035*** (.0129688)	.0192101*** (.004701)	.0199826*** (.0049793)
_cons	.5994719** (.225625)	.6131035** (.2380252)	1.11554*** (.1883161)	1.190014*** (.2294944)	.7849249*** (.1577072)	.8448248*** (.1678449)
Test of over-identifying restrictions						
Hansen-Sargan Statistics	47.759	43.309	55.652	49.766	59.514	53.144
pval*	0.3226	0.5011	0.1119	0.2535	0.0593	0.1632

Standard errors in parentheses. Significance levels: *: 1%, **: 5%, *:10%**

*** Testing the null hypothesis that the excluded instruments are valid, i.e. uncorrelated with the error term and correctly excluded from the equation.**

Tables and Figures

Channel	Impact Channel -> Growth	Impact Natural Res. -> Channel
Investment Rate	Barro (1991); De Long and Summers (1991); Mankiw, Romer and Weil (1992)	Gylfason and Zoega (2001); Sachs and Warner (1995)
Institutions	Kaufmann et al. (1999); Acemoglu et al. (2000, 2002); Rodrik et al. (2003)	Easterly and Levine (2002); Ross (2001, 2003); Isham et al. (2005)
Inequality	Galor and Zeira (1993); Banerjee and Newman (1993); Alesina and Rodrik (1994); Deininger and Squire (1998)	Engerman and Sokoloff (1994); Sokoloff and Engerman (2000); Leamer et al. (1998); Hoff (2003), Easterly (2001, 2006)
Volatility and Export Concentration	Easterly et al. (1993); Ramey and Ramey (1995); Servén (1998); Aizenman and Marion (1999); Rodrik (1999); Dehn (2000)	Lederman and Maloney (2003); Manzano and Rigobon (2003); Jansen (2004)

Table 1: Linkages between natural resources and fundamental determinants of economic growth

Indicator: Resource Endowments per capita (NATW)	Control Group	SSA	LAC	MENA
INV	+0.37%	+0.18	+0.25%	+0.40%
INST	-	-	-0.04%	-
INEQU	-	-0.05%	-0.07%	-
EXPCON	-	-	-	-
TOTAL EFFECT	+0.37%	+0.13	+0.14%	+0.40%
Indicator: Resource Exports per capita (LEAMER)	**Control Group**	**SSA**	**LAC**	**MENA**
INV	+0.67%	+0.30%	+0.25%	+0.30%
INST	+0.46%	+0.43%	+0.18%	+0.21%
INEQU	-	-	-	-
EXPCON	-	-0.23%	-0.12%	-0.12%
TOTAL EFFECT	+1.13%	+0.50%	+0.31%	+0.39%
Indicator: Resource exports/GDP (SW)	**Control Group**	**SSA**	**LAC**	**MENA**
INV	+0.72%	-0.20%	+0.02%	+0.58%
INST	+0.36%	+0.39%	-0.08%	-0.19%
INEQU	+0.24%	-0.11%	-0.07%	+0.20%
EXPCON	-	-0.42%	-0.26%	-0.40%
TOTAL EFFECT	+1.32%	-0.34%	-0.39%	+0.19%

Table 2: Effects of a one standard deviation increase of the natural resource variable on growth

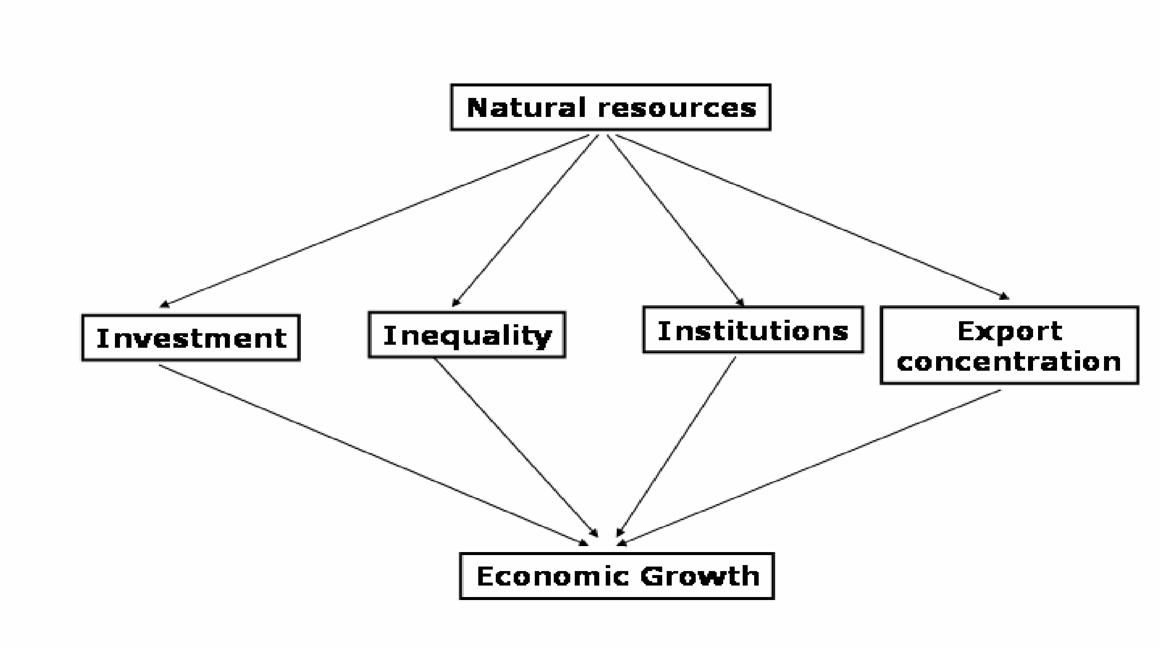

Figure 1: The adapted Wacziarg methodology to study different channels of interaction between natural resources and growth