Institutions and the Volatility Curse

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Abstract

This paper revisits the resource curse paradox and studies the impact of resource rents and their volatility on economic growth under varying institutional quality. Using five-year non-overlapping observations between 1970 and 2005 for 112 countries, we find that while resource rents enhance real output per capita, their volatility exerts a negative impact on economic growth. Therefore, we argue that volatility, rather than abundance per se, drives the resource curse. However, we also find that higher institutional quality can help offset some of the negative volatility effects of resource rents. Therefore, resource abundance can be a blessing provided that growth and welfare enhancing policies and institutions are adopted.

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1 Introduction

According to the resource curse paradox, resource rich countries perform poorly when compared to countries which are not endowed with oil, natural gas, minerals and other non-renewable resources. Therefore, resource abundance is believed to be an important determinant of economic failure. This paper explores whether the abundance of natural resources in itself is a curse or whether instead the negative growth effects observed in many resource-rich economies could be due to the price volatility in commodity markets. It will also investigate whether there is a role for institutions in offsetting some of the negative effects of volatility.

There are different explanations for why resource rich economies might be subject to this curse. Dutch disease (see Corden and Neary (1982), Neary and van Wijnbergen (1986), and Krugman (1987)) is one of the channels through which the resource curse makes itself felt: an increase in natural resource revenue leads to an appreciation of the real exchange rate, which negatively affects the profitability of the manufacturing sector. Economic growth is then adversely affected by the resulting re-allocation of resources from the high-tech and high-skill manufacturing sector to the low-tech and low-skill natural resource sector. Another explanation for the resource curse paradox focuses on the political economy considerations and argues that large windfalls from oil and other resources create incentives for the rent-seeking activities that involve corruption (Mauro (1995) and Leite and Weidmann (1999)), voracity (Lane and Tornell (1996) and Tornell and Lane (1999)), and possibly civil conflicts (Collier and Hoeffler (2004)). Some of these considerations have been recently formalized by Caselli and Cunningham (2009) where they attempt to characterize conditions under which an increase in the size of the resource rent leads to a decrease in real output, the so called "natural resource curse" hypothesis.[1]

Empirical support for the resource curse was originally provided by Sachs and Warner (1995) who showed the existence of a negative relationship between real GDP growth per capita and different measures of resource abundance, such as the ratio of resource exports to GDP, even when controlling for institutional quality. However, the empirical evidence on the resource curse paradox is rather mixed. Most papers in the literature tend to follow Sachs and Warner's cross-sectional specification introducing new explanatory variables for resource dependence/abundance, while others derive theoretical models that are loosely related to their empirical specification. Some of these papers confirm Sachs and Warner's results (see Rodriguez and Sachs (1999), Gylfason et al. (1999), and Bulte et al. (2005) among others). An important drawback of these studies with few exceptions, however, is their measure of resource abundance. Brunnschweiler and Bulte (2008) argue that the so-called resource curse does not exist when one uses the correct measure of resource abundance in regressions. They also show that while resource dependence, when instrumented in growth regressions, does not affect growth, resource abundance in fact positively affects economic growth.

There are also a number of other grounds on which the econometric evidence of the negative effects of resource abundance on growth may be questioned, see Cavalcanti et al. (2009) for an extensive discussion. For instance, the cross-sectional estimation method usually employed in the literature suffer from omitted variable and endogeneity problems among other

[1] See Sachs and Warner (1995) and Rosser (2006) for an extensive examination of these prominent accounts of the natural resource curse paradox.

things. Accounting for these shortcomings and using appropriate econometric techniques, the recent empirical literature seems to provide evidence against the conventional resource curse literature and argues for the positive effect of resource abundance on development and growth, see for instance Arezki and van der Ploeg (2007), Cavalcanti et al. (2009), and Esfahani et al. (2009). Moreover, while Cavalcanti et al. (2011b) and van der Ploeg and Poelhekke (2010) show a direct positive effect of resource abundance on growth, they provide evidence for the negative relationship between resource volatility and growth. Cavalcanti et al. (2011b) also demonstrate that volatility exerts a negative impact on economic growth operating mainly through lower accumulation of physical capital.

Several recent empirical works have also focused on the mitigating role of institutions. Using a cross-sectional approach, Mehlum et al. (2006) and Béland and Tiagi (2009) show that the impact of natural resources on growth and development depends primarily on institutions, while Boschini et al. (2007) illustrate that the type of natural resources possessed is also an important factor. These authors argue that when controlling for institutional quality, and including an interaction term between institutional quality and resource abundance, a threshold effect arises. Therefore there are levels of institutional quality above which resource abundance becomes growth enhancing.

In this paper we investigate the impact of natural resource rents and their volatility on growth using a panel of data on 112 countries and five-year non-overlapping observations between 1970 and 2005. The estimation results confirm that, in contrast to the predictions of the resource curse and dutch disease literature, a higher growth rate of resource rents significantly raises economic growth. In addition, our empirical findings also reveal a significant negative effect of rent volatility on output growth. Therefore, we argue that it is volatility, rather than abundance *per se*, that drives the resource curse paradox. Furthermore, using data on institutional quality, our results illustrate that better institutions can offset some of the negative effects of rent volatility. Therefore, our findings contrast with other studies on the role of institutions in resource abundant economies, which maintain that the abundance itself is a curse.

The rest of the paper is set out as follows: Section 2 describes the data used in our analysis. In Section 3 we transform our annual data to five-year non-overlapping averages and employ the system GMM methodology to estimate the effects of resource rent growth and volatility on cross country real output per capita growth. We then investigate the role of institutions. Finally, Section 4 offers some concluding remarks.

2 Data

To empirically test the relationship between economic growth and resource rent as well as rent volatility, we use annual data from 1970 to 2005 on real GDP per capita, a rent measure based on the prices, cost of production and quantities of 13 commodities, and other important determinants of growth such as investment share of GDP, human capital, trade openness, government burden, and lack of price stability.[2] Since we are also interested in

[2] In the growth literature government burden is defined as the ratio of government consumption to GDP while lack of price stability is defined as log(100 + inflation rate), see for instance Aghion et al. (2009).

testing whether or not better institutions can offset the negative growth effects of resource rents, we use a measure of institutional quality described in more detail below.

Our data set covers 112 countries, see Table 1, the number for which both rent and institutional quality data is available. Out of these countries 27 are on the African continent, 18 are located in Latin America and 12 can be found in the Middle East and North Africa (MENA) region. Our sample also includes 32 out of the 34 OECD countries and 8 out of the 12 of the Organization of the Petroleum Exporting Countries (OPEC). Thus our sample is very comprehensive.

To filter out business cycle fluctuations and to focus on the long-run growth effects of resource rent and volatility, we follow the literature in transforming the annual series into non-overlapping five-year averages. Given that the time span of our dataset is 1970-2005, we can construct an unbalanced panel with a maximum of seven five-yearly observations per country. A more detailed description of the data and their sources are provided in Table 2.

2.1 Resource Rent

Our country specific measure for real resource rent per capita is defined as:

$$R_{it} = \sum_{j=1}^{M} \frac{(P_{j,t} - C_{j,it}) \times Q_{j,it}}{L_{it} \times D_t} \tag{1}$$

where $P_{j,t}$ is the price of commodity j in year t in US dollars, $C_{j,it}$ is the average cost of production ($Q_{j,it}$) of commodity j in country i, L_{it} is the population in country i, and D_t is the US GDP deflator used to convert the nominal values of rent into real terms. M represents the 13 commodities that are included in our measure for resource rent. Three of which provide around 88 percent of total energy consumption in the world: oil, natural gas and coal, and ten of which are minerals: bauxite, copper, iron, lead, nickel, phosphate, tin, zinc, gold, and silver.

This measure of rent allows countries to be influenced by changes in commodity prices differently, depending not only on their production levels but also on the average cost of extraction. Equation (1) is used to construct two important variables. The first one is the growth rate of rents and the second is a measure of rent volatility, both are explained in more detail below.

Rent growth is calculated as the annual log differences in R_{it}, that is:

$$g_{R,it} = \ln R_{it} - \ln R_{it-1} \tag{2}$$

Resource rent or revenue has been used extensively in a number of recent studies in the resource curse literature as a measure of abundance, see for instance Brunnschweiler and Bulte (2008), Cavalcanti et al. (2011a), and Collier and Hoeffler (2009). Note that the rent measure in equation (1), and its growth rate in equation (2), portrait a country's ability to extract its stock of natural wealth and make use of the proceeds and so is indeed an appropriate measure of abundance.

In contrast to most studies in the growth literature which employ time-invariant measures of volatility, we construct a time-varying measure. We consider the five year non-overlapping

standard deviation of the annual growth rates of resource rents, $g_{R,it}$:

$$\sigma_{R,it,t+S} = \sqrt{\frac{1}{S}\sum_{s=0}^{S}\left(g_{R,it+s} - \frac{1}{S+1}\sum_{s=0}^{S} g_{R,it+s}\right)^2}, \tag{3}$$

where $S = 4$ as we are working with five-year averages. The volatility of $g_{R,it}$, indicates the extent to which resource rent growth deviates from a given mean at any point in time.

The left-hand graph in Figure 1 illustrate a simple bivariate relationship between GDP per capita growth and rent growth over the entire period 1970-2005, suggesting a positive correlation between these two variables. On the other hand, from the right-hand graph, we observe that higher rent volatility is associated with lower GDP growth. Overall, the results from Figure 1 represent preliminary evidence that while resource abundance does not reduce output per capita growth (contrary to the resource curse hypothesis), the volatility of rents stunts output growth. In Section 3 we will add a whole range of control variables and deal with possible endogeneity problems through the system GMM approach to examine whether the above results survive. We will also investigate whether the negative effects of rent volatility can be offset for countries with good institutional qualities.

2.2 Institutional Quality

Good economic institutions, as described in Acemoglu et al. (2005), should reflect a stronger rule of law, well-defined property rights and robust checks and balances. To capture these characteristics Sachs and Warner (1995) and Mehlum et al. (2006) use the institutional quality index, based on data from the Political Risk Services Group, in their cross-sectional analysis. This index is an unweighted average of five indices covering: (i) rule of law, (ii) bureaucratic quality, (iii) government corruption, (iv) risk of expropriation, and (v) government repudiation of contracts. However, this data is only available from 1984, and given that we would lose information for 3 out of the 7 non-overlapping five-year averages, we will not make use of this index. Another popular measure frequently used in the literature to represent institutional quality is the POLITY2 variable from the Polity IV: Regime Authority Characteristics and Transitions Datasets, see for instance Bhattacharyya and Hodler (2010) and Collier and Hoeffler (2009). This index measures how democratic a country is on a scale from 0 to 10, but does not take into account other institutional qualities such as the rule of law which is identified to be important for economic growth and development.

In this paper we use the Fraser chain-linked index (hereafter known as Fraser) as our measure of institutional quality, which is also the preferred measure in Béland and Tiagi (2009). This index contains panel data over the years 1970-2008 covering five appropriate areas: (1) size of government: expenditures, taxes, and enterprises, (2) legal structure and security of property rights, (3) access to sound money, (4) freedom to trade internationally, and (5) regulation of credit, labor, and business, for more detail see Gwartney et al. (2010). Using this index, which is rated on a scale of 0 (lowest) to 10 (highest), provides more precise estimates of the growth impact of economic institutions and their interaction with natural resources. We also specifically estimated our model using the chain-linked index covering the second area only (Fraser 2) since legal structure is purported to be a key determinant in

reducing rent-seeking motives. The Fraser index is not only a more comprehensive measure of institutions than those used in earlier studies, but given that we utilize panel data rather than cross-sectional averages, we do not lose information in the process of averaging the data, as is often done in the resource curse literature.

Table 3 reports average values of the Fraser and Fraser 2 indices for the whole sample as well as some selected regions. As expected, while the OECD countries have the highest level of institutions as measured by both indices, the 27 African countries have on average the lowest ranking in terms of the Fraser index while the same is true for the OPEC subset when it comes to the Fraser 2 index.

3 Empirical Results

In this section we first investigate whether abundance of natural resources by itself is a determinant of economic failure or whether the lack of growth in commodity abundant economies can be attributed to the volatility in rents. We then look at the role of institutions in dampening and potentially offsetting the negative effects of rents.

3.1 Volatility and Growth

To correct for the biases created by lagged endogenous variables and the simultaneity of growth determinants, we follow Arellano and Bover (1995) and Blundell and Bond (1998) in employing the system generalized-method-of-moments (GMM) estimator developed for dynamic panel data models. But as the two-step standard errors on estimated coefficients will be biased downward in small samples like ours, we make use of Windmeijer (2005) approach to correct for that bias. The following equation is then estimated:

$$\begin{aligned} \Delta y_{is} &= (\phi - 1)\, y_{is-1} + \gamma_1 g_{R,is} + \gamma_2 \sigma_{R,is} + \gamma_3 I_{is} \\ &\quad + \boldsymbol{\beta}' \mathbf{z}_{is} + \mu_i + \eta_s + \varepsilon_{is}, \end{aligned} \tag{4}$$

where $i = 1, 2, ..., N$, and $s = 1, 2, ..., S$, in which $S = \frac{T}{5}$, with T denoting the years between 1970 and 2005. Δy_{is} is the average growth rate of real GDP per capita between dates s and $s-1$; y_{is-1} is the logarithm of real GDP per capita at the beginning of each period; $g_{R,is}$ is the growth rate of real rent per capita; and $\sigma_{R,is}$ is its volatility. I_{is} is a measure of institutional quality and $\mathbf{z}_{is}$ is a set of other control variables now standard in the growth literature[3] including education and the investment share of GDP. η_s is the time-specific effect; μ_i is the country-specific effect; and ε_{is} is the error term.

Table 4 presents the estimation results of the impact of resource rent growth and volatility as well as institutional quality on GDP per capita growth. In the first regression, [1.1], we observe that an increase in g_R is both growth enhancing and highly significant. Including volatility of rents in regression [1.2], we find that while the coefficient of g_R remains positive and significant σ_R has a statistically significant negative effect on output growth. These results, $\gamma_1 > 0$ and $\gamma_2 < 0$, survive even when we control for institutional quality using the Fraser index, regression [1.3], as well as the Fraser 2 index, regression [1.4].

[3] See, for instance, Levine et al. (2000), Mehlum et al. (2006), and Aghion et al. (2009).

The positive growth effect of g_R is in line with the results obtained in a number of recent studies in the literature, such as Arezki and van der Ploeg (2007), Brunnschweiler and Bulte (2008), and Cavalcanti et al. (2009), and provides evidence against the traditional resource curse hypothesis, which argues that it is the level of resource abundance that affects economic growth negatively. Therefore, the overall evidence in Table 4 suggests that the source of the resource curse is the volatility of rents as opposed to resource abundance. Further evidence for the negative growth effect of the volatility channel is provided in van der Ploeg and Poelhekke (2010) and Cavalcanti et al. (2011b).

Regressions [1.3] and [1.4] aim to test the impact of institutional quality on real GDP per capita growth using the Fraser chain-linked index in [1.3] as well as a more specific measure of legal structure (Fraser 2) in [1.4]. As expected γ_3 is statistically significant and positive in both regressions, implying that better institutions enhance real GDP growth. In addition, there is evidence of income convergence across countries in our sample as the coefficient on the lagged dependent variable is both negative and significant in all regressions.

To test the validity of the instruments and therefore consistency of the GMM estimator, we consider two specification tests suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The first is a Hansen test of over-identifying restrictions, which tests the overall validity of the instruments and the second test examines the hypothesis that the error term ε_{is} is not serially correlated.[4] As can be seen from Table 4 the Hansen and second order serial correlation test statistics are all well above the conventional significance levels, therefore, the instruments used are valid.

3.2 Impact of Institutions on Volatility

To investigate whether institutional quality can help offset some of the negative growth effects of rent volatility, we follow Mehlum et al. (2006) and Boschini et al. (2007) and introduce an interaction term in our regressions. As before, we use the system GMM dynamic panel data approach to estimate the following equation:

$$\begin{aligned} \Delta y_{is} &= (\phi - 1)\, y_{is-1} + \gamma_1 g_{R,is} + \gamma_2 \sigma_{R,is} + \gamma_3 I_{is} + \gamma_4 \left[\sigma_{R,is} \times I_{is}\right] \\ &\quad + \boldsymbol{\beta}' \mathbf{z}_{is} + \mu_i + \eta_s + \varepsilon_{is}, \end{aligned} \tag{5}$$

where $\sigma_{R,is} \times I_{is}$ is the interaction term between resource rent volatility and institutional quality, and all other variables are as defined in equation (4). Regressions [1.1] to [1.4] illustrated that $\gamma_2 < 0$, and given our hypothesis that γ_4 is positive, the total impact of rent volatility, $\gamma_2 + \gamma_4 I_{is}$, is increasingly negative the lower a country's institutional quality. In addition, a threshold effect arises if γ_2 and γ_4 have opposite signs, that is:

$$\frac{\partial \Delta y_{is}}{\partial \sigma_{R,is}} = \gamma_2 + \gamma_4 I_{is} > 0 \quad \Longrightarrow I_{is} = \widehat{I} = -\frac{\gamma_2}{\gamma_4}. \tag{6}$$

Table 5 presents the result of the estimations carried out with the interaction term, which echo those obtained in Table 4. We observe that in contrast to the predictions of

[4] We test whether the differenced error term is second-order serially correlated as by construction, it is most likely first-order serially correlated even if the original error term is not.

the resource curse hypothesis, a higher growth rate of resource rents enhance real output per capita growth significantly while higher volatility leads to lower growth. These findings are consistent with the ones obtained in regressions [1.1] and [1.4] and with the evidence that is provided in the recent literature on the resource curse hypothesis, which argues that abundance of resources is not a curse and could even under certain conditions be a blessing.

As expected the coefficient of the interaction term, γ_4, is both positive and significant regardless of which institutional quality measure is used. Therefore the better institutions an economy has the less adversely it is affected by rent volatility. Using the estimates for γ_2 and γ_4 in Table 5 and given that the Fraser indices are on a scale from 0 to 10, we can calculate the minimum institutional quality, i.e. the threshold value, required to turn the marginal effect of volatility to zero using equation (6). The implied threshold for regressions [2.1] and [2.2] is 5.61 and 5.81 respectively, see Table 5.

Our results are in line with those in Mehlum et al. (2006) and Boschini et al. (2007), who argue that better institutions help offset the negative growth effects of natural resources. But as opposed to their cross-sectional studies the evidence in Tables 4 and 5 suggest that it is the volatility in rents, rather than abundance per se, which drives the resource curse.

Regression [2.3] and [2.4] test the robustness of our results, especially the interaction term, in presence of other control variables that are usually included in Barro-type regressions. As can be seen the sign, magnitude, and significance levels of resource rent growth and its volatility as well as the interaction term remain fairly similar to those in regressions [2.1] and [2.2], thus providing evidence for the robustness of our results. The implied threshold value is now 5.82 using the Fraser index and 5.99 using the Fraser 2 index, which is slightly larger than before.

Using the higher threshold value for the Fraser index (5.82) we see that except for the OECD countries all other countries fall below this value and so will not have the sufficient institutional quality needed to completely offset the adverse effects from rent volatility, see Table 3. On the other hand, no matter which threshold value we use for the Fraser 2 index (5.81 or 5.99) all countries outside the OECD subset have significantly lower value than this. In fact, the average Fraser 2 value for the whole sample at 5.44 is well below both threshold values. Therefore, on average the 112 countries in our sample do not have the sufficient institutional quality, as measured by legal structure and security of property rights, to offset the negative impact of resource rent volatility entirely.

Overall our results suggest that when institutional quality is high, volatility of resource rents is less output-reducing. This is likely because countries with better economic institutions can set up transparent, accountable, and forward-looking government bodies to invest their rents appropriately and control rent-seeking motives, which are likely to increase under greater uncertainty as agents become more interested in short term benefits. In addition, prudent governance embodied in good institutions will encourage the invest of current resource rents in productive capital such as education, and ensure credible checks and balances to eschew excessive borrowing and private abuse of rents.

As before, we have income convergence across countries. Moreover, the Hansen and the second order serial correlation test statistics in the four regressions in Table 5 confirm the validity of the instruments used and the lack of second order serial correlation in the error terms.

4 Concluding Remarks

Using panel data on 112 countries between 1970 and 2005, this paper has examined the effects of resource rents and their volatility on GDP per capita growth under varying institutional arrangements. We used a system GMM dynamic panel estimator to deal with the simultaneity problem as well as the omitted variable bias, which is not dealt with by the current literature on the resource curse and institutional quality.

While the traditional resource curse hypothesis predicts a negative effect of resource abundance on growth, our results show the contrary: resource abundance, as proxied by real resource rent per capita growth, has a positive impact on output growth. However, we find strong evidence for the negative growth effects of resource rent volatility. Therefore, we argue that volatility, rather than abundance per se, drives the resource curse paradox. Moreover, we contributed to the existing literature by showing that countries with good institutional arrangements can offset some of the negative impacts of rent volatility. As such, resource abundance can be a blessing provided that growth and welfare enhancing policies and institutions are adopted.

Resource-rich countries can improve the management of volatility in resource income by setting up forward-looking institutions such as Sovereign Wealth Funds (if they have substantial revenues from their exports), or adopting short-term mechanisms such as stabilization funds with the aim of saving when commodity prices are high and spending accumulated revenues when prices are low. The government can also intervene in the economy by increasing public capital expenditure when private investment is low, using proceeds from the stabilization fund. Alternatively the government can use these funds to increase the complementarities of physical and human capital, such as improving the judicial system, property rights, and human capital. This would increase the returns on investment with positive effects on capital accumulation, TFP, and growth. Improving the functioning of financial markets is also a crucial step as this allows firms and households to insure against shocks, decreasing uncertainty and therefore mitigating the negative effects of volatility on investment and economic growth.

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Tables and Figures

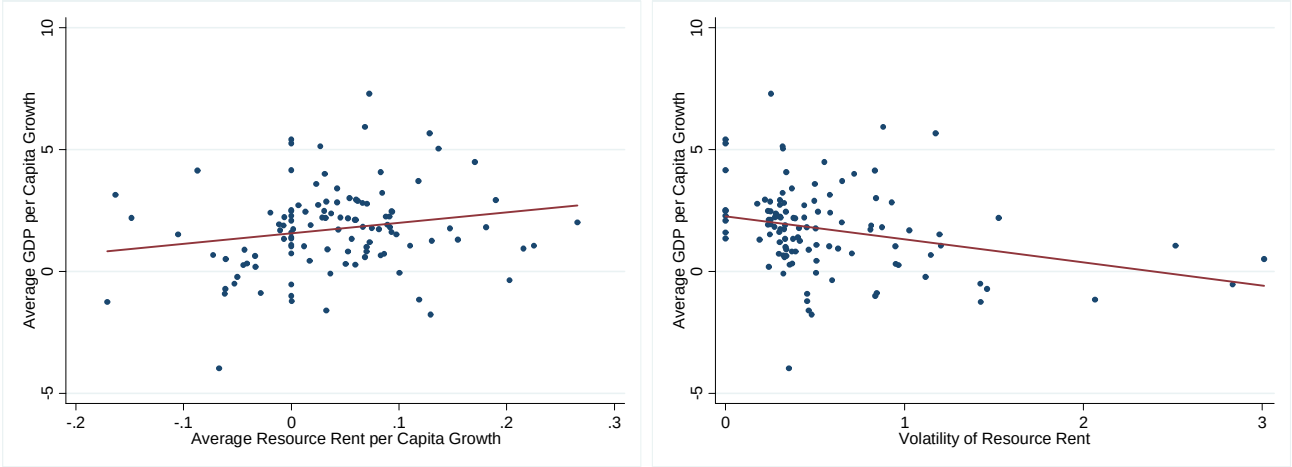
Table 1: List of the 112 Countries in the Sample

Albania	Dominican Republic	Korea	Romania
Algeria	Ecuador	Kuwait	Russia
Argentina	Egypt	Latvia	Rwanda
Australia	El Salvador	Lithuania	Senegal
Austria	Estonia	Madagascar	Sierra Leone
Bahrain, Kingdom of	Fiji	Malawi	Slovak Republic
Bangladesh	Finland	Malaysia	Slovenia
Belgium	France	Mali	South Africa
Benin	Gabon	Mauritius	Spain
Bolivia	Germany	Mexico	Sri Lanka
Botswana	Ghana	Morocco	Sweden
Brazil	Greece	Namibia	Switzerland
Bulgaria	Guatemala	Nepal	Syrian Arab Republic
Burundi	Guinea-Bissau	Netherlands	Tanzania
Cameroon	Guyana	New Zealand	Thailand
Canada	Haiti	Nicaragua	Togo
Central African Rep.	Honduras	Niger	Trinidad and Tobago
Chad	Hungary	Nigeria	Tunisia
Chile	India	Norway	Turkey
China, People's Rep. of	Indonesia	Oman	Uganda
Colombia	Iran, I.R. of	Pakistan	Ukraine
Congo, Dem. Rep	Ireland	Panama	United Arab Emirates
Costa Rica	Israel	Papua New Guinea	United Kingdom
Côte d'Ivoire	Italy	Paraguay	United States
Croatia	Jamaica	Peru	Uruguay
Cyprus	Japan	Philippines	Venezuela, Rep. Bol.
Czech Republic	Jordan	Poland	Zambia
Denmark	Kenya	Portugal	Zimbabwe

Table 2: Definitions and Sources of Variables Used in Regression Analysis

Variable	Definition and Construction	Source
Real GDP per Capita	Ratio of gross domestic product (GDP) (in 2005 US dollars) to population.	Authors' construction using data from Heston et al. (2009) and World Bank (2010) World Development Indicators (WDI).
GDP per Capita Growth	Log difference of real GDP per capita.	
Initial GDP per Capita	Initial value of the ratio of GDP (in 2005 US dollars) to population.	
Investment	Ratio of real gross domestic investment to real GDP.	
Real Resource Rent per Capita	Energy and mineral resource rent per capita deflated using the US GDP deflator.	Authors' calculation using data from the World Bank (2010) WDI.
Real Resource Rent per Capita Growth	Log difference of real resource rent per capita.	
Volatility of Real Resource Rent per Capita	Standard deviation of real resource rent per capita growth in a five-year interval.	
Fraser Index	A chain-linked index of: (1) size of the government; (2) legal structure and security of property rights; (3) access to sound money; (4) freedom to trade internationally; (5) regulation of credit, labor, and business.	Data from Gwartney et al. (2010) Economic Freedom of the World Dataset.
Fraser 2 Index	A chain-linked index covering legal structure and and security of property rights.	
Education	Ratio of total secondary enrollment to the population of the age group that officially corresponds to that level of education.	Authors' construction using data from World Bank (2010) WDI and UNESCO (2010) UIS.
Trade Openness	Ratio of Exports and Imports to GDP.	Authors' construction using data from the World Bank (2010) WDI.
Government Burden	Ratio of government consumption to GDP.	
CPI	Consumer price index (2005=100).	Author's calculations using data from the World Bank (2010) WDI.
Inflation rate	Annual percentage change in CPI.	
Lack of Price Stability	log(100+inflation rate).	

Figure 1: Resource Rent Growth and Volatility, 1970-2005



Notes: Average GDP per capita growth is the average growth rate of real per capita GDP between 1970 and 2005 and is in percent. Average resource rent per capita growth is the mean growth rate of real resource rent per capita, over 1970 to 2005. Volatility of resource rent is the standard deviation of the growth rate of the real resource rent per capita. For a list of the 112 countries included in the dataset see Table 1.

Table 3: Comparative Statistics, 1970-2005

Country Group	Number of Countries	Fraser Index	Fraser 2 Index	Real GDP per Capita Growth
All Countries	112	5.82	5.44	1.67
Organisation for Economic Co-operation and Development (OECD) Countries	32	6.72	7.74	2.36
Middle East and North African Countries	12	5.57	4.72	1.81
Organization of the Petroleum Exporting Countries (OPEC)	8	5.37	4.02	1.52
Latin American Countries	18	5.64	4.22	1.30
African Countries	27	5.11	4.34	0.56

Notes: All numbers are averages over the period 1970-2005 across countries in each sub-group. See Table 1 for a list of the different countries in each sub-group. For a description of the Fraser and Fraser 2 indices see Table 2.

Table 4: Resource Rent Growth and Volatility

	[1.1]	[1.2]	[1.3]	[1.4]
Initial Output per Capita, in logs	-1.085**	-1.769**	-2.069**	-2.819***
	(0.460)	(0.812)	(0.892)	(0.750)
Resource Rent Growth	1.621***	5.692***	4.901***	6.461***
	(0.555)	(1.241)	(1.050)	(1.728)
Resource Rent Volatility		-0.425*	-0.534**	-0.812**
		(0.225)	(0.257)	(0.388)
Fraser			0.960**	
			(0.397)	
Fraser 2				1.003***
				(0.290)
Control variables				
Investment	3.862***	2.580**	1.486	0.832
(investment share of GDP, in logs)	(0.656)	(1.107)	(0.903)	(0.998)
Education	-0.484	3.731	3.102	3.470
(secondary enrollment, in logs)	(1.591)	(2.355)	(2.362)	(2.828)
No. Countries/No. Observations	112/635	112/635	112/635	112/598
Specification tests (p-values)				
(a) Hansen Test	0.237	0.382	0.138	0.123
(b) Serial Correlation				
First-order	0.002	0.001	0.000	0.001
Second-order	0.338	0.456	0.726	0.400

Notes: The dependant variable is the growth rate of output per capita. Time and fixed effects are included in all the regressions. The estimation method is two-step system GMM with Windmeijer (2005) small sample robust correction. Units of observation is non-overlapping five-year averages over the period 1970-2005. Standard errors are presented below the corresponding coefficients in brackets. Symbols ***, **, and * denote significance at 1%, 5%, and at 10% respectively. Source: Authors' estimations.

Table 5: Resource Rent Volatility and Institutional Quality

	[2.1]	[2.2]	[2.3]	[2.4]
Initial Output per Capita, in logs	-1.394*	-1.822**	-1.941***	-1.704*
	(0.721)	(0.753)	(0.734)	(0.923)
Resource Rent Growth	1.944***	3.868***	4.376***	3.525***
	(0.695)	(1.335)	(1.386)	(1.266)
Resource Rent Volatility	-4.739**	-9.413***	-3.398*	-8.295**
	(2.334)	(3.513)	(1.721)	(4.005)
Fraser	2.364**		1.417*	
	(1.009)		(0.788)	
Fraser × Resource Rent Volatility	0.845**		0.584*	
	(0.414)		(0.320)	
Fraser 2		0.186		-0.159
		(0.346)		(0.278)
Fraser 2 × Resource Rent Volatility		1.621***		1.385**
		(0.604)		(0.687)
Control variables				
Investment	-2.094	0.512	0.084	0.452
(investment share of GDP, in logs)	(1.763)	(1.317)	(1.619)	(0.859)
Education	1.861	3.556	5.931***	4.110
(secondary enrollment, in logs)	(2.302)	(2.184)	(1.920)	(2.915)
Trade Openness			-2.826	7.380
(trade volume/GDP, in logs)			(3.860)	(4.725)
Government Burden			-3.694	1.169
(government consumption/GDP, in logs)			(3.180)	(3.672)
Lack of Price Stability			-0.089	-1.759
(log [100 + inflation rate])			(2.339)	(1.566)
No. Countries/No. Observations	112/598	112/598	107/538	107/538
Specification tests (p-values)				
(a) Hansen Test	0.398	0.438	0.114	0.366
(b) Serial Correlation				
First-order	0.001	0.000	0.002	0.001
Second-order	0.956	0.685	0.904	0.692
Threshold analysis	5.61	5.81	5.82	5.99

Notes: The dependant variable is the growth rate of output per capita. Time and fixed effects are included in all the regressions. The estimation method is two-step system GMM with Windmeijer (2005) small sample robust correction. Units of observation is non-overlapping five-year averages over the period 1970-2005. Standard errors are presented below the corresponding coefficients in brackets. Symbols ***, **, and * denote significance at 1%, 5%, and at 10% respectively. Source: Authors' estimations.